BLUE RIDGE DISCOVERY CENTER

NATURAL HISTORY NARRATIVE OF THE MOUNT ROGERS REGION

"A living guide to a living place"

"To inspire curiosity, discovery and stewardship through the wonders of the Blue Ridge"

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Introduction

In far southwestern Virginia, in a region often referred to as the "rooftop of Virginia," the Blue Ridge Mountains sprawl across the landscape, soaring above the rest of the state. Mount Rogers–the Old Dominion's high point, peaking out at 5,729 feet in elevation–sits at the throne, and is surrounded by breathtaking highlands, mountaintop balds, spray cliffs, temperate hardwood and spruce-fir forests, bogs, mountain streams, and unique rock formations. This rich diversity of habitat types supports an incredible level of biodiversity unrivaled anywhere else in the temperate world, and the Mount Rogers National Recreation Area (MRNRA) encapsulates nearly 200,000 acres of this landscape. Since its designation in 1966, the MRNRA has attracted naturalists and outdoor recreationists, alike, and served as a playground for visitors to marvel at the ecological bounty of the Mount Rogers region.

A BRIEF HISTORY OF MOUNT ROGERS NATIONAL RECREATION AREA

An inset of the 1.8 million-acre George Washington-Jefferson National Forest, the MRNRA was one of the first National Recreation Areas established in the country, with a multi-use focus aimed at providing extensive opportunities for year-round recreation, in contrast to the core United States Forest Service (USFS) mission of managing the nation's timber and grassland resources. Its creation was largely the result of the vision of Congressman W. Patrick Jennings–a southwest Virginia native who ran a car and farm implement business in Marion, Virginia for most of his life. In part, the aim of the MRNRA was to provide a venue for outdoor tourism and recreation halfway between the popular Great Smoky Mountains and Shenandoah National Parks, and within a day's drive of a third of the population of the country.

The Act of Congress that designated the MRNRA in 1966 outlined 154,000 acres of land in Carroll, Grayson, Smyth, Washington, and Wythe Counties–most of which was already a part of the Jefferson National Forest. However 39,000 acres still needed to be attained by the government from local landowners. Jennings' bill, which he introduced in the early 1960s, called for a "Mount Rogers Wonderland," which, upon passing, the USFS later defined as a luxury version of "rural Americana" set in the Mount Rogers highlands, complete with ski slopes and a lodge, campgrounds, swimming areas, hiking and horseback riding trails, several impoundments, and a major scenic highway.

The booming nature of the 1960s gave the USFS perhaps a justifiable sense of confidence that such a massive undertaking was possible, and that the Recreation Area would attract enough visitors to the rural, mountainous corner of Virginia to log a lofty five million visitor days per year by the year 2000. Given such a grandiose forecast, the plans for the MRNRA initially drew very little resistance from local citizens, who likely gleaned hope for a certain economic boom in its wake. However, with the arrival of the 1970s, economic downturn and the reality of beginning land acquisitions began to inspire opposition.

While some of the 39,000 acres of land needed to complete the MRNRA were attained through easements and land transfers from willing sellers, a large percentage was slated to come through more forceful forms of acquisition. In the early 1970s, local landowners who were unwilling to sell, and whose properties fell within the outlined boundaries of the MRNRA, began being served Declarations of Taking–a severe form of condemnation that evicts landowners immediately, while providing them with the assessed property value and relocation expenses.

Naturally, this practice did not sit well with local communities, and citizen interest groups began forming as opposition to the USFS's propositions mounted. One such group, Citizens of Southwest Virginia, managed to collect 24,000 signatures in opposition to the Draft Environmental Impact Statement released by the USFS in 1978, which kept in its plans all of the facilities and infrastructure originally envisioned, despite significant economic downturn and uninspiring tourism growth numbers that paled in comparison to the projected rates. With help from larger interest groups, like the Sierra Club and the National Wildlife Federation, Citizens of Southwest Virginia largely shaped the structure of the MRNRA as it exists today, removing the proposed ski slope and scenic highway from the final statement, effectively preserving the rural, mountain landscape and pristine environment of Virginia's high country for the enjoyment of local people and moderate-impact outdoor tourism.

THE MRNRA TODAY

As it stands today, the MRNRA manages about 192,000 acres of land spanning over 50 miles from the town of Damascus in the west to the ancient New River Valley to the east near the towns of Fries and Ivanhoe. Elevations range from about 2,000 feet in these low-lying river valleys to the state high point of 5, 729 feet atop Mount Rogers.

Included within the boundaries of the MRNRA are four Congressionally designated wilderness areas–Raccoon Branch, Little Wilson Creek, Little Dry Run, and Lewis Fork, the latter of which envelopes the crest of Mount Rogers–as well as the Virginia Creeper Trail; the 50-mile-long Mount Rogers Scenic Byway; and the highest road in the state of Virginia, which provides vehicular access to the peak of Whitetop Mountain. 5,000 acres of otherworldly Crest Zone, featuring elevations over 4,000 feet; breathtaking mountain top balds and spruce-fir forests; and a renowned herd of wild ponies await the visitor at its heart.

Amenities and opportunities exist for camping, wildlife watching, fishing, hunting, hiking, bicycling, horseback riding, cross-country skiing, and swimming. Eleven campgrounds, catering to primitive and horse campers, as well as those with recreational vehicles, are maintained and open from mid-spring through fall. Visitors can also picnic and go swimming at the beach at Beartree Recreation Area on Beartree Lake. The Recreation Area is also home to 60 miles of the Appalachian Trail, which accounts for just a small part of the 500 miles of trails within the MRNRA.

On the southern border of the MRNRA, near the North Carolina-Virginia border, lies the 4,502-acre Grayson Highlands State Park. Though not managed by the USFS, Grayson Highlands State Park includes even more amenities to those visiting the region, including the most formal trail access to the Crest Zone and the peak of Mount Rogers, itself.

The vast diversity of habitat types present in this dynamic region of contrast and wonder is directly responsible for the dizzying array of species, communities, and ecological processes found within its boundaries. And the infrastructure available serves as a conduit for naturalists and other outdoor enthusiasts to revel in all it has to offer. The remaining pages of this guide will serve as an in-depth orientation to just a few of the marvels that our mountain region has to offer those willing to observe.

SKY ISLANDS

In ecology, islands are not always surrounded by water. An ecological island is a habitat that is cut off from surrounding habitats so that populations on the island can only interact with one another. In the southern Appalachians, mountains reach elevations high enough to experience unique climates. The species that have adapted to life on top of these mountains have several unique characteristics that help them thrive where others can not. However, these adaptations can also exclude them from living elsewhere. The small pockets of habitat for mountain top communities are called "sky islands."

In the lower atmosphere, air temperature tends to decrease as elevation increases. The adiabatic lapse rate describes the rate of temperature change over elevation change using several factors including humidity and the relative air pressure, so the rate can vary greatly between locations and weather patterns. For typical conditions in the Blue Ridge mountains, the adiabatic lapse rate describes a roughly 3ºF decrease for every 1,000ft gain in elevation. Temperature also changes with latitude. Land further from the equator is generally colder. In the northern hemisphere temperate zone, covering the latitudes from about 23.5ºN to 66.5ºN, the temperature tends to decrease by 1ºC for every 150 kilometers north. We can convert these units to find that the average temperature decreases by about 1ºF per 50 miles north. All of this is to say we can calculate that the change in temperature experienced by rising one mile in altitude is comparable to moving 800 miles north. Therefore, species found at the tops of high mountains can be many hundreds of miles away from another habitat that is suitable for them.

As populations find their way to the habitats supported by high mountains, they experience large changes in climate over relatively short distances. This factor has profound effects on the species who call the area home. Species that derive adaptations allowing them to survive at higher elevations benefit from the increase in habitat. However, as they adapt and specialize to these habitats, these species also become secluded from other populations, which can result in speciation. This leads to enormous biodiversity in mountaintop biomes. With diverse climates, species that may normally be separated by hundreds of miles can interact, opening new niches and habitat types.

An unfortunate side effect of the relatively small area and isolation that makes sky island communities possible is their sensitivity. If there is a sudden change in the environment, most of the organisms that live here are not able to simply migrate somewhere else, and later reintroduction is very unlikely. An environmental disturbance such as a rising average global temperature is especially dangerous for these habitats that depend on the difference of a few degrees. For every degree fahrenheit warmer, species must migrate to an elevation at least 300 ft higher to compensate. Sky islands rapidly shrink with small increases in global temperature. Once the habitat has reached the highest peaks, there is nowhere left for the species that depend on it to go.

Spruce/Fir Forests

Forty-nine of the highest fifty peaks East of the Mississippi are in the southern Appalachians. The ecosystems these peaks support are entirely unique, such as the spruce/fir forests found on Mount Rogers. There are only seven major naturally occurring spruce/fir stands remaining in the U.S. Southeast. These biomes are also known as "relics of the last ice age," the Pleistocene, when global temperatures averaged more than 10ºF colder than today. In biology, a relict is a taxon or feature that was once widespread but has

since greatly reduced. Boreal forests dominated most of North America. As global temperatures began to rise at the end of the Younger Dryas, broadleaf plants like deciduous trees were able to outcompete more cold-tolerant evergreens. This forced the boreal trees to retreat to higher elevations that maintain colder temperatures. Today, the descendants of these trees remain only on a few secluded mountaintops, a last reminder of a much different world 20,000 years past.

Spruce/fir forests are fittingly named for the two trees that define it. The red spruce, *Picea rubens*, and Frasier fir, *Abies fraseri*, are similar looking evergreens, both reaching past heights of 50 ft in suitable conditions. However, in the high wind conditions of the mountaintops, these heights aren't always seen. Both trees were prized softwood lumber in the early 20th century, resulting in great interest, and unfortunately destruction, in many of these forests. Frasier fir is widely recognized as a popular choice of christmas tree, so much that Frasier agriculture and distribution is still a major industry of the southern Appalachians. A reliable way to differentiate the trees is by handling the needles. Red spruce has four-sided, half-inch long needles that erupt from all sides of twigs. The needles are stiff and come to a fine point (think "spiky spruce"). Frasier fir can be identified by numerous resin-filled blisters on the bark of juvenile trees and flat needles that grow from spirals along their twigs. The needles are flexible, soft, and blunt on the end (think "friendly fir"). The trees were also nicknamed he-balsam and she-balsam respectively by loggers. Frasier fir likely earned the moniker "she-balsam" for the white resin blisters on the branch tips that looked as though they were filled with milk.

Despite, or perhaps because of, Frasier fir's marketability, the tree is listed as an endangered plant in the wild. Many of its natural habitats have been converted to tree farms where it is mostly grown in monoculture. The species is a close relative of the balsam fir, *Abies balsamea*, a widespread tree of Eastern Canada and far North U.S. Some botanists go so far as to list the Frasier as a subspecies or even variety of balsam fir, as they are understood to be fairly recently differentiated. Regardless of its standing as a verified species, the Frasier fir has a very restricted natural habitat of only a few standing spruce/fir forests. The remaining habitat has been destroyed for farming, by fire, or lost to encroaching deciduous trees spurred on by the warm temperatures since the end of the last ice age. Since the mid 1900s, the Frasier fir population left wild has been further decimated by balsam woolly adelgid infestations - an invasive European insect that parasitizes firs. The Frasier fir has no natural defenses against the sap sucker, and mortality rates for infested trees is estimated between 90 and 99%. Spruce/fir forests also happen to grow in the regions that receive the worst acid rain and acid fog, reducing the available nutrients in the soil and damaging new buds on young trees.

Since the spruce/fir forests of the Southern Appalachians are such a distinct habitat, there are many species that are only found within this biome. The Carolina flying squirrel (*Glaucomys sabrinus coloratus*) is an endangered subspecies of northern flying squirrel that is exclusively found in the boreal habitats on the mountaintops of the Tennessee/North Carolina border and southwestern Virginia. The rodents eat mostly lichen and fungi, including the truffle produced by a mycorrhizal fungi that spruce and fir trees depend on to uptake nutrients. By consuming the fruiting body of this fungus, the flying squirrel helps disperse its spores.

Another endangered species found only in spruce/fir forests is the fittingly named spruce-fir moss spider (*Microhexura montivaga*). As the smallest mygalomorph spider native to the Eastern U.S, it is related to tarantulas, trapdoor spiders, and funnel webs. The spider takes up to three years to mature, and only achieves a size of 1/8th inch. There is only one other species in the same genus, and it is a common small spider on the West coast. Not much is known about these reclusive spiders as they tend to hide in thick

mosses where in order to find them, ecologists would have to destroy their habitat. We expect the spruce-fir moss spider actively hunts small arthropods, likely springtails and mites, as the only webs they have been observed constructing are small tubes which serve more as shelter than traps. Within the microhabitat of spruce/fir moss beds, the moss spider is recognized as the apex predator, and its extinction could result in the overpopulation of moss-consuming insects.

Not only do we have in the Mount Rogers area the northernmost Fraser firs, but also the farthest north of Appalachian balds. Brooks (1965) suggests the open pastures at Elk Garden are the most northerly of these phenomena, that are best developed farther southwest especially around Roan Mountain and in the Smokies. By his criteria, these pastures probably are not really natural balds, because they lack an important indicator species three-toothed cinquefoil ((Sibbaldia tridentata (Aiton) Paule & Sojak)). This species does occur on the open bald on the southwest slopes of Whitetop, which may be a Pleistocene relic maintained by some as yet incompletely understood combination of aspect southwest exposure subject to drying by sun and wind, grazing by large, now missing ungulates, and fire, either naturally occurring or human induced.

FIRE ECOLOGY

From a fire ecology perspective, the MRNRA were once expansive spruce/fir and northern hardwood forests which probably experienced fire on long return intervals (100-200 years?) in the form of stand replacing fires. Native Americans undoubtedly used fire to manage the bald on Whitetop. After intense logging in the late 1800s and early 1900s, parts of the MRNRA (Scales and Grayson Highlands State Park, for instance) experienced very severe wildfires which consumed the large quantities of slash that had been left behind after logging. Those fires were probably intentionally set by humans in an effort to create/expand summer grazing opportunities in the high country. The Scales today is not really a natural community, but rather the by-product of very intensive human impacts in the first half of the 20th century. It presents a conflict of management objectives i.e., long horn cattle grazing vs spruce/fir restoration. It is worth noting that Iron Mountain (which is lower in elevation than Mount Rogers, Whitetop, and the Scales) is quite different - different geology, soil, vegetation, and disturbance history. There are remnant and decadent table mountain pine stands adjacent to Skulls Gap and elsewhere on Iron Mountain that speak to a much more frequent historic fire regime than the high country experienced. Proximity to the Holston Valley and Native Americans' use of fire would also have played a strong role in the south and west-facing aspects of Iron Mountain.

GEOLOGY

In addition to containing the highest point in Virginia (Mount Rogers, elevation 5,729 feet), the Mount Rogers National Recreation Area (MRNRA) is a window on the history of ancient volcanic eruptions and glacial movement.

The Mount Rogers area is widely regarded by geologists as containing some of the most fascinating and unusual rocks in Virginia. The oldest rocks exposed within the Blue Ridge are over a billion years old (Mesoproterozoic Era). These rocks are often referred to as basement rock— rocks on which younger rocks may be deposited, intruded or deformed by later mountain building events. Mesoproterozoic basement rocks in the Mount Rogers area are 1.3–1.0 billion year old granites, gneiss and other less abundant rock types. The rocks represent the period prior to and during the breakup of the supercontinent of Rodinia and the opening of the Iapetus Ocean. Few basement rocks are exposed within the MRNRA. Most basement

rocks are located to the southeast of the boundary of the MRNRA and underlie lower topography, as the informal name would imply. Basement rocks are exposed from Grayson, VA to Rugby, VA and wrapping the higher topography around Pine Mountain and continuing from Grant, VA to Elk Creek, VA There are many good exposures of basement rocks in the road cuts along VA Hwy 58 from Rugby to Volney, VA. The large roadcut across from the Rugby Volunteer Fire Department, contains 1.3 billion year old gneisses, some of the oldest rocks in the Blue Ridge. Within the MRNRA boundaries, basement rocks underlie the headwaters of Helton Creek in the valley below Elk Garden Ridge, the saddle between Buzzard Rock and Beech Mountain on the western shoulder of Whitetop Mountain, and several small fault-bound blocks northeast of Mount Rogers.

Mount Rogers and Whitetop are areas with prominent volcanic rock, chiefly rhyolite, which is very unusual for the southern Appalachians. The Mount Rogers Formation consists of bimodal volcanic rocks (rhyolite and basalt) and clastic sedimentary rocks. Rhyolite is a felsic volcanic rock that erupted at the surface of the earth, whereas basalt is a mafic volcanic rock that contains more iron and magnesium rich minerals. The lower part of the formation contains more sedimentary rocks and basalt, whereas the upper part of the formation is dominantly rhyolite. The Mount Rogers Formation was deposited in rift basins, much like the valleys and volcanoes associated with the Rio Grande rift in New Mexico. Now, the high topography of the Mount Rogers area is underlain by resistant rhyolites and distinct rhyolites are named for the areas in which they crop out: Buzzard Rock, Whitetop, and Wilburn Ridge. Recent studies obtained new U-Pb zircon ages of 760–749 million years old from Mount Rogers Formation rhyolites. These are eruption ages for the different rhyolites. The rhyolites are distinctly grayish purple to maroon with small crystals, that formed in the magma chamber before eruption, of quartz and feldspar. The rhyolites are concentrated in thick masses (1000 to 2500 ft thick) and are not the volcanic edifices from which the rhyolites were erupted. Intercalated with the rhyolites are clastic sedimentary rocks, including arkoses, siltstones, and conglomerates with numerous pebbles, cobble and boulders of rhyolite, granite and other rocks. Rhyolite clasts in the conglomerates attest to the erosion of rhyolites and greater volcanic field within the basin. Basalt in the lower part of the Mount Rogers Formation is dark gray to black to dark greenish gray and commonly contains gas bubbles in the lava that are now filled with minerals, quartz, epidote, and calcite. These occur at Elk Garden Ridge and along VA Hwy 58 with good outcrops that contain cobbles of basement granite at the site of the old Mount Rogers School. The granite cobbles attest that the basalt flowed onto the Neoproterozoic basement surface.

Additionally, there is evidence of glaciation. The Neoproterozoic earth is recognized as a period of major change in the earth's atmosphere and hydrosphere, shifting toward compositions more comparable with modern conditions. Globally there are many descriptions of glacial deposits at low paleo-latitudes (being deposited at tropical to equatorial latitudes) and at sea level (not an alpine glaciation). The snowball earth hypothesis suggests that at several times during the Neoproterozoic Era (Cryogenian Period), the earth was so cold that ice covered the entire earth (snowball). The Konnarock Formation is considered to be related to a snowball earth glaciation. The current ~751 million year age of the Konnarock Formation suggests it might be evidence of a global glaciation during the Tonian and older than other recognized snowball earth glaciations during the Cryogenian. The Konnarock Formation overlies the Mount Rogers Formation and is a glaciogenic sedimentary sequence of maroon laminated to bedded mudstones, rhythmites, arkose (sandstone) and diamictite.. The formation crops out for 60 km in the Blue Ridge from near Laurel Bloomery, TN, northeast to near Comers Rock, VA. As the name suggests, exposures in the vicinity of Konnarock, VA, show many of the diagnostic glaciogenic features of the formation. These can be seen in many roadcuts along VA Hwy 58, Whitetop Road (VA 600), Fairwood Valley Road (VA 603), and along the

Virginia Creek Trail at Creek Junction. Of special note is the occurrence of dropstones in several sections of rhythmite. Dropstones, as the name implies, are clasts that penetrate through layers of sediment as if they were dropped in the sediment. The dropstones require the clasts to be iced-rafted and uniquely imply a glaciogenic origin for the formation. Good examples of dropstones in rhythmite occur on the Virginia Creeper trail ~ 0.5 miles south of the trestle over Laurel Creek at Creek Junction. Flow banded rhyolite within the Konnarock Formation was dated and constrains the age of the formation and the associated glacial event to ~751 million years. Although the geologic history is not entirely unique to the Mount Rogers area — a similar geologic history is recognized for most of the Blue Ridge—there are many aspects that make this an exceptional place to study the geology of the Blue Ridge.

Seasons

WINTER

December, January, February

Weather Stats

Average Temp	35.2℉
Max Temp (avg.)	42.3℉
Min Temp (avg.)	26.6℉
Average Humidity	82%
Average Precipitation	4.36”
Average Snowfall	5”

Winter Weather

The weather observed during meteorological winter, which spans the months of December, January, and February, in the western portion of Virginia is dictated by the tracks of mid-latitude cyclone (low pressure) and anticyclone (high pressure) systems as they move from west to east, driven by the prevailing wind patterns. The large number of nighttime hours during the winter season makes for the possibility of unique weather phenomena. Mount Rogers and its satellite peaks–and the Appalachian Mountains of western Virginia as a whole–are classified as the “southern” portion of the mountain range, and, as such, rarely experience snow cover during the entire winter season. However, even without snow cover or snowstorms, phenomena such as hoar frost, needle ice, and rime ice can form, provided there is abundant moisture and appropriate thermal conditions.

Hoar frost and needle ice are common when western Virginia is influenced by the calm wind and clear sky conditions typical of anticyclones. With abundant water vapor in the air, hoar frost forms when water vapor changes directly to the ice phase on a sub-freezing surface. Its appearance is feathery or hairy and can produce beautiful pieces of natural art when the sub-freezing surface is a window. In contrast, needle ice forms when soil is above-freezing and the air temperature drops to sub-freezing temperatures. The liquid water within the soil is forced toward the surface (through capillary action) and freezes once it reaches the sub-freezing air. The porous soil causes the growing ice to form in the shape of columns or needles that move upward as they grow in length.

In contrast to hoar frost and needle ice, rime ice requires the presence of supercooled liquid water (water that exists in liquid form at sub-freezing temperatures) to be carried by updrafts in the atmosphere until it contacts sub-freezing objects or surfaces. These conditions are more typical of passing cyclones and can result in what looks to be a blanket of white at higher elevations of the mountains. The blanket is the result of the freezing of billions of what used to be supercooled liquid water droplets after colliding with tree branches located within a layer of sub-freezing air. If the number of supercooled droplets carried through a region by a passing cyclone is of sufficient number, the thickness of the rime ice can be substantial and subsequent melting after the appearance of the sun can result in large chunks of rime ice falling from tree limbs.

High-impact winter weather of the region depends on the path traveled by each mid-latitude cyclone system. Every cyclone passing through the region exerts its influence by the type of precipitation and strength of wind produced. When the storm center tracks just north of western Virginia, the local region experiences substantial rainfall that can be enhanced by the presence of an atmospheric river. An atmospheric river is a narrow zone of fast-moving air at low elevations that transports vast amounts of water vapor into western Virginia from the tropics or sub-tropics. Heavy rainfall from a winter storm can cause flooding and, if it follows a season of above-normal rainfall, can also trigger landslides in the mountains. If strong winds accompany a storm producing heavy rainfall, significant windthrow of trees can result and be the cause of widespread power outages.

Mid-latitude cyclone systems passing south of the region can drop significant amounts of snow, sleet, or freezing rain on the region, depending on the distance of its path southward from western Virginia. The path of a winter cyclone moving eastward across the states bordering the Gulf of Mexico generally brings significant snow accumulation to the region, particularly if it turns north along the Atlantic coast and moves toward the northeastern United States, a storm commonly referred to as a "Nor'easter."

Southerly storm tracks located closer to western Virginia often start with accumulating snow and can change to sleet and freezing rain as the storm center arrives just south of the region. The accumulation of snow, sleet, and freezing rain depends on the strength and depth of the relatively warm air layer moving northward just above the surface, and on the strength and depth of the cold air moving southward along the Appalachian Mountains. The layer of cold air moving southward along the mountains is often referred to as "cold air damming" and is quite common in the region during the winter season.

After the mid-latitude cyclone system and its cold front have moved past the region, winds blowing from the northwest bring cold air from Canada and, with enough residual moisture, can form clouds and snow along the northwest-facing slopes of the Appalachian Mountains as a growing anticyclone forms to the west and drops southward out of Canada. Snow events of this type are called "northwest flow snow" and can provide substantial accumulations if the anticyclone and cyclone systems stall in their respective locations for 24 hours or more. On occasion, the northwest flow snow events can drop significant snowfall downstream of the primary Appalachian Mountain ridgeline through cloud banding, and heavier snowfall accumulations are also known to occur if moisture is brought into western Virginia from the Great Lakes region. Although the accumulated snow will likely not stay around for the remainder of the winter season, spells of cold and warm air intrusions in the region result in instances of melting and refreezing so that the ground at high elevations is consistently icy for the entirety of the winter season, particularly for north-facing mountain slopes.

Winter Birds

Migrants and Residents

As fall wanes into winter in the Mount Rogers region, the environment changes. Days grow shorter; and the air, colder. A great number of plant species seal themselves off and become dormant. Food availability–type and abundance–changes. These changes in local environmental conditions affect the seasonal distribution of birds throughout the world. Each species' habitat and food requirements determines where they reside during the winter, often spurring large-scale migrations. Birds in the Mount Rogers region are less abundant and diverse in the winter than during other seasons. Many birds leave the

area each fall to avoid adverse conditions, while others increase in abundance as they migrate south from northern climates. However, there are 55 bird species that call the region home year-round.

The ruffed grouse (*Bonasa umbellus*), for example, is a permanent resident of the region. Grouse are most common in recently disturbed woodlands, where they can find the plants that produce the buds, leaves, seeds, and fruits that make up the majority of their diet. Grouse can survive in cold, snowy habitats due to several morphological and behavioral adaptations. One such adaptation is fleshy appendages grown on the fringes of each toe which function like snowshoes and are shed in the spring. Behavioral adaptations include their preference for dense conifer stands and the use of snow roosts for cover during and after winter storms.

Another permanent resident is the red-tailed hawk (*Buteo jamaicensisz*). Many redtails at this latitude remain near their breeding territories throughout the year as long as food is available. Their diet consists primarily of mammalian prey like rodents and rabbits, but they will also prey on birds and snakes. With the exception of snakes, these prey species are available here throughout the year.

Other permanent residents like the mourning dove (*Zenaida macroura*), downy woodpecker (*Picoides pubescens*), common raven (*Corvus corax*), Carolina chickadee (*Poecile carolinensis*), Carolina wren (*Thryothorus ludovicianus*), northern mockingbird (*Mimus polyglottos*), tufted titmouse (*Baeolophus bicolor*), field sparrow (*Spizella pusilla*), song sparrow (*Melospiza melodia*), dark-eyed junco (*Junco hyemalis*), and northern cardinal (*Cardinalis cardinalis*) have their own ways to survive harsh winter conditions. The abundance of each species during winter can vary dramatically, depending on the availability of food and the arrival of northern migrants.

Some bird species become more abundant and widespread each year during winter as birds from populations hundreds of miles to the north migrate into this area. The yellow-bellied sapsucker (*Sphyrapicus varius*) is a great example, found in the Mount Rogers area during summer months inhabiting northern hardwood stands above 3,000 feet. Whether or not these breeding birds remain during winter is not known, but sapsuckers occur throughout lower and mid-elevation habitats from October through mid-April. Most of these birds return north each spring.

Plant communities at higher elevations support small breeding populations of several other northern bird species that similarly increase in abundance in winter at lower elevations. The black-capped chickadee (*Poecile atricapillus*), golden-crowned kinglet (*Regulus satrapa*), red-breasted nuthatch (*Sitta canadensis*), brown creeper (*Certhia americana*), hermit thrush (*Catharus guttatus*), dark-eyed junco (*Junco hyemalis*), and yellow-rumped warbler (*Setophaga coronata*) are other examples.

Moreover, some northern birds absent from our region during the summer migrate to and winter in the Mount Rogers area. A good example is the white-throated sparrow (*Zonotrichia albicollis*), which breeds in the northern United States and Canada in the spring. This species can find the small seeds and fruits that comprise its winter diet in the Mount Rogers region, and other southeastern climes. Similarly occurring species include the fox sparrow (*Passerella iliaca*), Wilson's snipe (*Gallinago delicata*), white-crowned sparrow (*Zonotrichia leucophrys*), and swamp sparrow (*Melospiza georgiana*).

Some years, reductions in food availability or severe weather in northern states and provinces cause large numbers of northern-wintering bird species to flock south seeking greater resources–an event referred to

as an irruption. A great example of an irruptive winter occurrence can be observed in the purple finch (*Haemorhous purpureus*). Incursions of purple finches into the Mount Rogers region occur every other year, most likely due to variation in conifer cone crops in the northern portion of their winter range. Other irruptive species include the evening grosbeak (*Coccothraustes vespertinus*), pine siskin (*Spinus pinus*), and red-breasted nuthatch (*Sitta canadensis*).

Timberdoodles in Flight

Another unique winter migrant that adds spectacle to a Mount Rogers winter is the American woodcock (*Scolopax minor*).

The woodcock, also referred to as a "timberdoodle," is a forest-dwelling shorebird that migrates south into Virginia and other southeastern states from Canada when pushed out by harsh winter weather. Their small, round body; stout head; long bill; and mottled, brown-black plumage makes them perfectly adapted for blending into the forest floor and hunting subterranean foods like earthworms, grubs, and insect larvae. They require moist forest habitats for foraging, which is a primary driver of wintertime migration, as their northern habitats often freeze during periods of cold winter weather.

Specific habits associated with the fall woodcock migration have fascinated scientists, wildlife viewers, and upland hunters for generations. In contrast with other shorebirds, woodcock do not migrate in flocks, but as individuals that are independently motivated to seek more conducive seasonal habitats, and will feign community when they pile up in areas of good habitat when spurred by regional weather events in their northern range. Woodcock are leisurely migrators, taking many breaks in stop-over habitat during their migration. As such, studies have shown that they lose very little of their peak fall weight during migration, as compared to other shorebirds that make non-stop flights to wintering grounds. This habit leads to a very dynamic population of birds in specific covers as the migration proceeds, and because of their secretive nature, outside of courtship displays, their presence is difficult to determine.

Male woodcock use open fields, forest openings, and abandoned farmlands adjacent to foraging habitat for courtship flights, which usually begin in the Mount Rogers area in late February, or when the ground is thawed and snow-free. Male woodcock will gather in the half-hour before sunrise and after sunset daily to begin their aerial displays. These sky dances are preceded by calling from the ground, called "peenting." A "peent" is an unmistakable, single, short, buzzy note that is sounded repetitively while the male is on the ground, rotating every few seconds, causing a directional change in the intensity of the call.

When peenting concludes, the male woodcock begins a silent, sloping ascent into the sky above open habitat. As the bird gains height, his speed increases as he begins looping and zig-zagging through the dimly lit sky. A high-pitched twittering accompanies the rapid, erratic flight, which is produced entirely by air passing through three narrow outer primary feathers. At the apex of his sky dance, a male woodcock can reach heights of 200 - 300 feet, where wing twittering becomes intermittent with short, rapid bursts, overlapping with loud vocal chirping as the bird zig-zags downward, banking, and diving precipitously towards the ground in a silent descent.

The American woodcock's sky dance is a captivating opportunity to observe a unique and reclusive winter visitor, and an iconic salute to winter and harbinger of spring in the Mount Rogers region.

Though the natural world may seem harsh and barren during the coldest months of the year, a number of bird species find opportunity in the landscape of a Mount Rogers winter. As winter wanes into spring, available food and weather conditions change yet again, and with them, the abundance and assemblage of bird species.

Animal Winter Survival

Winter in the Southern Appalachian Mountains poses a major threat to the overall health and well-being of resident animals. The lack of available food, coupled with dangerously cold temperatures, requires non-migratory animals to have developed sufficient survival strategies to make it through the long winter months. As the days grow shorter and colder, many animals enter into a period of relative dormancy, in which their growth suspends, energy is conserved, and simply maintaining is the main priority. Daily torpor, hibernation, and prolonged sleep are the most common forms of dormancy, but even these are utilized in varying degrees.

Daily torpor is largely described as an inadvertent, unconscious response to resource shortages, cold temperatures, and other potentially life-threatening conditions, in which physiological activity slows, and motor activity largely ceases with partial or total insensibility. Animals cannot enter into or exit daily torpor at will, but usually this dormant state lasts only a short period of time until conditions become more suitable.

Typically, daily torpor is demonstrated by small birds and mammals, one example being the black-capped chickadee (*Poecile atricapillus*). These tiny birds engage in a daily battle against time and temperature, trying to consume enough calories to support their nightly bouts of shivering. When nighttime temperatures plummet, chickadees enter a state of torpor that resembles a controlled form of hypothermia by slowly decreasing the time between bouts of avian shivering, which is accomplished by the continual flexing of chest muscles. Through this process, the chickadee's body temperature can drop up to 20 degrees fahrenheit from their average daytime body temperature of about 107 degrees fahrenheit, allowing them to weather cold winter nights while conserving up to a quarter of their hourly metabolic expenditure. When dawn begins to break, the birds warm themselves back up by shivering more frequently, and then embark upon their daily quest to store up calories to weather the night to come. These calories are often supplied by their well-hidden food staches, which they spend the summer and fall building up to contain hundreds of seeds. In order to remember where these vital supplies are hidden, the brains of black-capped chickadees grow every fall replacing old neurons with new ones, allowing for new memory space.

Hibernation is commonly understood as a long period of rest, qualified by a large drop in body temperature, heart rate, and respiration. Animals that hibernate rely on their fat reserves to sustain them through long stints of inactivity. Species such as groundhogs (*Marmota monax*) and woodland jumping mice (*Napaeozapus insignis*) experience true hibernation for nearly the entire winter, curling into tight balls in their subterranean burrows, awaiting spring.

During periods of particularly harsh winter weather, some animals experience a prolonged sleep similar to true hibernation, but lacking in such a steep body temperature decline. Such animals still undergo a sharp decrease in heart and respiratory rates, but their temperatures remain close to normal, allowing them to arouse when disturbed. American black bears (*Ursus americanus*), racoons (*Procyon lotor*), and Virginia

opossums (*Didelphis virginiana*) are a few examples of species that rely on this form of dormancy to survive the winter.

These definitions of different dormancy strategies are by no means fixed. The fluidity of qualifications for true hibernation versus prolonged sleep versus daily torpor will likely continue to be a topic of much debate for years to come, but the specific winter survival strategies for the aforementioned species are commonly accepted.

An alternative wintertime survival strategy to dormancy is to remain active, but with some physical changes triggered by shorter photoperiod and decreasing temperature. Many species, such as white-tailed deer (*Odocoileus virginianus*), grow thicker coats to allow them to retain more body heat. Though their overall activity does decrease during the winter as their metabolism slows to conserve precious energy, they can still be seen awake on even the coldest days. Coyotes (*Canis latrans*), on the other hand, are known to become more active during the winter, spurred by the necessity of finding their next meal. Foxes, both gray (*Urocyon cinereoargenteus*) and red (*Vulpes vulpes*), share the coyote's pursuit of life-sustaining wintertime prey in the form of small mammals and birds.

Another adaptation for wintertime survival in mammals is observed in species such as the snowshoe hare (*Lepus americanus virginianus*) and the bobcat (*Lynx rufus rufus*). Not only do these species have thicker wintertime coats, but they also display a stark change in coloration- from tawny browns to more muted whites and grays. Snowshoe hares, though extremely rare in Virginia and only found in the boggy habitats of the highest elevations in the state, utilize their color shift from brown to bright white with dark tipped ears as a means of camouflage and evading predators. In contrast, bobcats have adapted to a lighter wintertime coat for potential benefits as both predator and prey. As coyotes and foxes become ravenous in the wintertime, bobcats are more likely to be on the menu, but bobcats are also hunters themselves, utilizing their lighter coloration to sneak up on their own targets.

Most of Virginia's small mammals do not truly hibernate. However, to get through winter safely, they all have similar needs–a cozy burrow, and plenty of food. Some, like mice, are primarily herbivores, while others are tiny carnivores (shrews) or insectivores (moles). Though not usually asleep for the winter, they certainly become less active during colder months, and some may experience a state of torpor. Most have very fast metabolisms, so they need to consistently wake and eat in order to keep their bodies functioning. Mice, squirrels, and voles will create stashes of food to get them through colder months when foraging is more energetically taxing and food resources are harder to come by. Other small mammals, like shrews, remain more active. Shrews have the fastest metabolism of Virginia's small mammals, needing to feed every couple of hours on spiders, centipedes, earthworms, or insects. Often, shrews will shrink in size as colder months approach, as will most of their major internal organs, including liver and brain. Scientists are not yet sure how these little creatures manage this physiological feat, but that shrinking means less energy must be consumed, and that makes all the difference when resources are slim.

Across the animal kingdom, there are an impressive number of highly specialized adaptations for surviving the frigid temperatures and low resource availability that comes with winter. While common threads and processes exist, the scale at which different species exhibit torpor, hibernation, and prolonged sleep varies greatly, and a great deal of other energy-conserving adaptations are often present alongside them.

Winter Plant Adaptations

If you take a hike on a seasonable January day on Whitetop Mountain, snow and ice aloft spruce boughs, one obvious fact should be apparent–it gets cold in the winter. Thankfully, as humans living in a technologically developed society, we can hop back in our heated cars, shake the frost off, and retreat to our heated homes and sip hot chocolate in t-shirts in our living rooms. Other living things–particularly plants, which lack the ability to locomote–are not so lucky. As such, perennial plants that have to brave winter and produce new growth in the spring–especially those that make their living in the frigid, wind-swept high elevations of the Mount Rogers region–must possess adaptations that allow them to survive the harshest months.

Death From Inside

The first, and perhaps primary, hurdle that plants have to overcome to survive the winter is the fact that they are absolutely full of water. When you consider the soft, fragile structure of the cells where this water is housed, in contrast with the sharp, jagged form that frozen water takes on, this presents a real threat to plants that have to endure a span of days–sometimes weeks or months–of sub-freezing temperatures. When freezing occurs inside of cells, cell membranes can be damaged, causing tissue death.

One method that perennial tree species–evergreen species that inhabit our high-elevations, in particular–use to survive the cold is the process of cold hardening. As fall turns to winter, trees acclimate through cellular changes. Lipid concentrations increase, protein chains are broken apart, and water is moved out of the cell to fill extracellular space. This extracellular water freezes first, releasing enough heat to insulate cellular water from external freezing temperatures, and moving more water outside of the cell.

Through this process of acclimation, trees undergo chemical changes allowing them to tolerate the full range of habitat and climatic conditions during each season within their native range, including any outlying frosts or periods of extreme weather following temporary unseasonable bouts. In fact, at the peak of winter cold hardening, well-adapted species are often able to tolerate extreme temperatures well below the lowest temperatures that occur naturally. The temperature at which a tree will begin to experience cell and tissue death is referred to as the "killing temperature." This temperature, as it relates to a species' ability to adapt beyond it, is sometimes a determining factor in that species' northern range.

Fighting Dehydration

Cell death via dehydration is a real threat in the winter, as liquid water can sometimes be a rare commodity. Thus, mitigating water loss is a primary concern.

With the first hard freeze of the year, broad-leafed trees lose their ability to shuttle water (even when it is available in liquid form), and since leaves are a major source of water loss, most deciduous trees lose their leaves in the fall. Triggered by a reduction in photoperiod and gradually cooling days, microscopic, thin-walled parenchyma cells form an abscission layer between the end of the leaf's petiole and the branch. These cells eventually sever ties between the leaf and the tree, allowing the tree to conserve energy and prevent excessive moisture loss throughout the winter.

Interestingly, some trees called marcescent trees, such as oaks and beeches, retain their dead leaves throughout the winter. These trees' abscission layers do not finish forming until the spring. Once they do and the new buds begin to form, the previous year's foliage will finally be shed. Scientists aren't positive why some trees retain their leaves, but it has been theorized that it protects their branches from browsing animals and ultimately protects the forming buds.

In contrast, conifers are better suited for moving water throughout their bodies, and will retain their needles, or scale-like leaves, year-round, photosynthesizing throughout the winter when conditions permit. Needles also have much less surface area than broad leaves and are much better at retaining moisture. Their stomatas remain closed in the winter, preventing the loss of moisture to the dry, winter air. Conifer needles also are resin-reinforced, and are capable of withstanding internal pressures up to 900 PSI, allowing it to better handle extracellular ice expansion.

Death From Exposure

Another common threat to trees in winter is the elements–namely wind and snow.

Conifers make up the bulk of the tree species in the high elevations of the Mount Rogers area, where snow falls very commonly in the winter. Thanks to their compact needles, evergreens have much higher leaf densities than hardwoods, and thus collect more snow as it falls. Conifers, like the red spruce (*Picea rubens*) that grow on Whitetop Mountain, exhibit determinate growth, meaning all of its branches emanate from a main stem. The cone-shaped tree that results is better suited to shedding and bearing the weight of snow than the indeterminate growth patterns of most lower-growing hardwoods.

Furthermore, conifer branches tend to grow at near-right angles to their trunks, allowing for snow to be shed with less bending than in branches growing at a more acute angle to the trunk, resulting in less breakage. Conifer wood is also composed of longer wood fibers than deciduous wood is, granting them a greater overall flexibility.

Wind can also be a highly abrasive element, particularly in open, mountainous areas, as are common in the Mount Rogers high country. Exposure to wind can increase water loss by abrading outer bark tissues. Individual conifers with denser foliage can mitigate this factor, breaking the wind with needle-dense boughs, but may also be more prone to breakage than its sparser neighbor. However, dense foliage in individuals on the perimeter of a conifer stand does protect internal individuals from wind.

Winter Blooms

Though most plants hunker down for the winter, some have filled an extreme niche. American witch hazel (*Hamamelis virginiana*) and skunk cabbage (*Symplocarpus foetidus*) are two species that, through specialized cold-season adaptations, are able to bloom during the peak of winter. .

American witch hazel is a deciduous shrub that produces spidery, yellow blooms from late fall into winter. The flowers bloom on a warm winter day, and the petals curl and uncurl as the temperature falls and rises.These blooms attract an array of pollinators, including bees, fruit flies, and other late-season stragglers. Their flowers can persist for up to eight weeks–a great feat when compared to the typical flower life of about two weeks–allowing the blooms to be seen from late October through March. Witch hazel's

genus name, Hamamelis, comes from the Greek words "hama," meaning "at the same time," and "melon," meaning "fruit," which refers to its ability to both fruit and flower at the same time, a rare occurrence amongst plants. Witch hazel can grow up to 20 feet tall and prefers part shade and moist, acidic soils, although it can tolerate a wide range of conditions, allowing for an expansive range within the Mount Rogers area.

Skunk cabbage is an early-blooming herbaceous plant that begins emerging in late February and early March. It has a leathery, rigid bloom that can penetrate snow and ice by generating its own heat through a process known as thermogenesis. Even if the air temperature is freezing, the plants can reach upwards of 70 degrees Fahrenheit. The first part of the plant to emerge is a red, hood-like modified leaf called a spathe. Inside the spathe is a collection of petal-less flowers called a spadix. When the flowers are ready, the spathe will open to allow pollinators in. The warmth generated by the flower also helps carry the unpleasant, feces-like smell that gives it its name, which attracts scavenging pollinators like flies. These plants can be found growing in the soft, soggy soils of wetlands and along streams.

While we sit indoors sipping our hot beverages in refuge from the natural winter transpiring outside, dreaming of the striking drama of spring in the Southern Appalachians, our native plants are executing a wide range of adaptations specialized to dealing with some of the most extreme weather that our region experiences. Observing such silent dramas just requires an eye for subtlety and a willingness to brave the cold.

Bark, Branches, and Buds

When attempting to identify tree species–or any species, for that matter–it is the most obvious and unique characteristics that we look for first, as they can usually reveal a tree's identity given just a basic level of knowledge. For example, most residents of the Southern Appalachians can probably identify an eastern redbud (*Cercis canadensis*) or flowering dogwood (*Cornus florida*) when their pink and white blooms paint the ridges with pastels in the spring, or a sugar maple (*Acer saccharum*) when its bright reds and oranges are on display in the fall, but when these classic telltales disappear, a deeper knowledge of the tree's characteristics is required. In general, leaf shape, structure, and arrangement provide the greatest opportunity to identify deciduous tree species during most of the year. However, leaves senesce in the fall, and are not present for identification in the winter, leaving bark and bud characteristics and branching patterns as the best clues to tree identity during the cold months.

Bark is the outermost layer of a tree. Its primary functions are to protect the tree from outside threats like weather, disease, and pests, and to prevent water loss. Bark consists of two main components–the inner bark, called phloem, and the outer bark, called cork cambium and cork. The phloem is responsible for shuttling sugars throughout the tree and is very short-lived. When the outer layers of phloem die, they begin to merge with the outer bark layer, transforming into the transitional layer known as the cork cambium. Cork cells are filled with air, which helps them insulate the tree.

As trees age, they exert more and more outward pressure on the outermost bark. Eventually this pressure causes the outer bark to split all the way down to the phloem. The outer bark is then replaced and split again, usually following the same general pattern, giving each tree their characteristic bark pattern. These bark patterns can present some identification challenges, however, as trees of the same species can appear very different at different ages, and different species can look similar at times. Moreover, since these

bark characteristics are largely a product of age and tree growth, most young trees and saplings do not exhibit the classic bark characteristics of mature trees of the same species, but are often smooth-barked, and in this case are not best-identified via bark characteristics.

Some descriptions of common bark characteristics as seen in some common Blue Ridge tree species:

Smooth: Most trees begin life with smooth, unbroken bark, but species like American beech (*Fagus grandifolia*) keep mostly smooth bark throughout their life. Still, the smooth, gray bark of the American beech can sometimes break or become bumpy due to beech bark disease, caused by interactions between a non-native insect and a few different species of fungi.

Ridges: As certain tree species age, the stretching of their bark causes the formation of deep ridging or furrowing, the characteristics of which can provide identification clues. As a northern red oak (*Quercus rubra*) grows, its bark splits into flat, vertical stripes of smooth bark separated by uninterrupted ridges sometimes referred to as "ski slopes" because of the silvery ridges' resemblance to a far-off hill covered in ski slopes. In contrast, white oak (*Quercus alba*) bark exhibits vertical ridges that are broken horizontally. The white ash (*Fraxinus americana*) is also ridged, displaying a diamond-shaped bark pattern of flat-topped, very broken ridges and highly intersecting furrows.

Peeling Strips: In some tree species, the outward pressure of a growing, maturing cambium layer can cause the bark to split and peel off. This is classically exhibited in many birch species, including the locally common yellow birch (*Betula alleghaniensis*). The bark of the common riparian species, American sycamore (*Platanus occidentalis*), also peels off in woody shingles as it ages.

Lenticels: Lenticels are pores in the tree that allow gasses to move from the atmosphere to the inner tissue. They are present in all trees, but are only visible on some species. Birch species are known for lenticels that appear as dots in short horizontal lines or distinct, unbroken horizontal lines. Yellow birches and frasier firs (*Abies fraseri*) both show very distinct, unbroken horizontal lenticels, often very densely patterned on their trunks.

Scales and Plates: Some species, like black cherry (*Prunus serotina*), have bark that flakes off and has a scaly appearance. Various pine and spruce species, including the red spruce (*Picea rubens*), heavily represented in the Mount Rogers region, also have scaly bark

Smell: In some cases, a tree's bark or stems give off a distinctive smell that can assist in identification. For example, the bark of the black cherry contains a chemical that deters browsing animals by emitting a bitter, almond scent when the outer bark is scraped. The original source of wintergreen oil, sweet birch and yellow birch twigs, when broken and crushed, produce a strong wintergreen scent.

Color: Some tree species have bark with a distinctive color that can aid in identification. For example, yellow birch, sometimes called golden birch, is so named because of the rich golden color of its bark. An eastern hemlock (*Tsuga canadensis*) begins its life with gray-brown bark, but matures into a sometimes deep cinnamon brown, and an American sycamore exhibits strikingly white trunks under peeling gray and brown bark. Countless species have indistinctive gray bark, making bark color only an occasionally useful tool for identification.

Pests: Because of a number of specialized tree pests that prey on our region's timber, as a clue, or qualifying tool, pest activity can sometimes be used in identification.

For example, most of the white ash trees in the eastern United States have been impacted by the emerald ash borer (*Agrilus planipennis*), an invasive insect from Asia that feeds on ash species. Adult beetles lay their eggs inside the bark, and after the larva hatch, they burrow into the phloem of the tree to eat. Trees that have been impacted can often be observed having "D" shaped exit holes in the bark from the adult beetles leaving their chambers in May/early June. Their excavations and heavy feeding ultimately kills the tree. It can take up to three years for an infestation to become obvious, but early signs include thinning of the branches in the upper crown, bark cracking, and woodpecker damage. After death, the outer bark can fall off and reveal the EAB tunnels through the phloem.

Another example is the beech scale (*Cryptococcus fagisuga*), an insect infests the American beech tree, piercing its bark and feeds on sap. Having an open wound allows Nectria fungi to move into the tree, and once a fungal infection takes hold, cankers and splits can form in the bark of the tree. These wounds slowly kill off the living part of the tree and can eventually girdle it.

Having knowledge of common pests and their relationships to specific tree species can help aid in the identification of impacted individuals, as bark characteristics can change in dead and dying trees.

A tree's bud characteristics can also be used to identify them in the absence of leaves or more obvious cues. Buds are any point of growth on the tree that can develop into a flower, leaf, or shoot. Buds scales are protective coverings for the buds in non-growing seasons. Two prominent types include terminal and lateral buds. Terminal buds are at the end of a branch where the new twig growth will occur in the spring. Lateral buds occur along the twig. A false terminal bud occurs when the growing tip of a branch dies and the lateral bud closest to the tip functions like a terminal bud, although the new growth will appear "crooked" when developed.

Some common bud descriptions of trees found in the Blue Ridge:

American beech (*Fagus grandifolia*): Buds are 3/4 inch long, light brown, and slender, and covered with overlapping scales. Buds stick out from their twigs, looking more like a thorn than a bud.

Yellow birch (*Betula alleghaniensis*): Buds are egg-shaped, sharply pointed, reddish brown with hairy scale margins.

Northern red oak (*Quercus rubra*): As is typical for an oak, there are multiple terminal buds. Buds are relatively large, cone-shaped, and covered with red/brown, mostly hairless scales, making it resemble a pinecone. Terminal bud scales may have some fine hairs.

Black cherry (*Prunus serotina*): Buds are very small, only 1/5 inch, and covered in several glossy, reddish/brown to greenish scales.

Red maple (*Acer rubrum*): Buds usually blunt, green/reddish with several loose scales usually present.

White ash (*Fraxinus americana*): Terminal bud is large, brown and slightly cone-shaped, like a Hershey's Kiss, and protected by leathery scales. The first lateral buds are touching the terminal bud, and are small, round, and brown.

White oak (*Quercus alba*): As is typical for an oak, it has multiple terminal buds. They are red/brown, small, rounded, and hairless.

A tree's branching pattern refers to how the branches, leaves, and leaf scars are arranged relative to each other. It can be difficult to find the pattern on some trees that have broken branches, so looking at the newest growth is helpful.

Trees generally display one of three different branching patterns–alternate, opposite, or whorled. Alternate branches are staggered and form a zig-zag pattern down the branch with leaves protruding from both sides of the branch. Opposite branches originate from either side of the same point on a branch. In the United States, there are only a few tree genuses that have opposite branching. The popular mnemonic used for remembering these few genuses is "**MADC**ap**H**orse," which stands for **M**aple, **A**sh, **D**ogwood, **C**aprifoliacea (honeysuckles and viburnums), and **H**orse chestnut. Finally, whorled branching is similar to opposite branching, but is used to describe a pattern where leaves originate all round a stem at the same spot on the branch, forming a "ring" around the branch. Trees that exhibit whorled branching include pines, spruces, and firs.

After senescence, the most obvious clues to a tree's identity are no longer in play. But leaf characteristics are not the only features unique to tree species. Looking to the bark, bud, and branching characteristics of dormant trees can provide identification points even during the winter, while providing understanding and insight into the life histories of our native trees.

Vernal Pools

As winter loosens its grip on the land and the last frost of the season thaws, snowmelt and warm rains quickly saturate the soil. Where the ground levels out in shallow valleys in the Blue Ridge, this moisture can elevate the water table to the surface. Small earthen depressions hold pools while the soil moisture remains high. These ephemeral aquatic habitats, called vernal pools, will not last forever. In late summer when the southern sun warms the pools, they will evaporate and water will be drawn back into the soil to recharge the groundwater. However, in their prime, these pools are an oasis for a great diversity of species with very specialized life histories.

Unfortunately, since vernal pools are so small, they are very sensitive to environmental conditions. Water temperatures can fluctuate wildly if the pool receives direct sun during the day. Sufficient shade from the tree canopy can help keep it more stable. Small pools are also very sensitive to contamination from runoff. Rainwater can pick up ground pollution and concentrate it in vernal pools. While the water is able to evaporate and permeate into the soil, pollutants are left behind, further increasing their concentration. For these reasons, a pristine vernal pool depends on an expansive riparian zone, and their health can be a great indicator of the health of the surrounding woodlands. Furthermore, most of the species who depend on vernal pools are semi-aquatic, living in the waters of the pools while they are present, but on land for the remainder of the year. The amphibians who live in these habitats depend on both a pristine vernal pool for the larvae to develop and a suitable woodland habitat during terrestrial stages.

Vernal Pool Obligates

Vernal pools are extremely important habitats for many native amphibians. Since the water is only temporarily present, fish and other aquatic predators can not survive year to year in the same pool. These ephemeral ecosystems provide a habitat safe from predation and with less competition to species that only need aquatic habitats for part of their lifecycle.

Obligate species need access to vernal pools in order to complete their life cycle. Amphibians like the spotted salamander (*Ambystoma maculatum*) and the wood frog (*Lithobates sylvaticus*) will only lay their eggs in vernal pools. Many invertebrates are also only found in vernal pools, such as the spring fairy shrimp (*Eubranchipus vernalis*). These animals are also called indicator species, as their survival depends on pristine vernal pools, which in turn indicate a healthy surrounding woodland environment.

Spotted salamanders get their name from the two rows of bright yellow spots on either side of their slate gray backs. During the first rain after the last thaw of winter, adults emerge from hibernation to congregate in the forming vernal pools where each female will lay around 200 eggs. These salamanders need the head start, as their eggs develop slowly compared to some other salamanders. Some larvae take up to seven weeks to emerge. Spotted salamander eggs are an almost fluorescent white halo surrounding an embryo that is bright green, thanks to a symbiotic algae that lives in between the developing salamander's cells, providing the embryo with extra sugars as it develops. Once the larvae emerge, they develop in two to four months and metamorphose into terrestrial juveniles in summer. Once on land, they will continue to mature for at least another three years before they are ready to mate. Adults can live upwards of 20 years and mate at the end of each winter.

Equipped with highly effective adaptations to cope with sub-freezing temperatures, the wood frog (*Lithobates sylvaticus*), literally translating to "the hunting stone of the woods," has an expansive range, from the mountains of northern Georgia, up the East coast, and throughout Canada and Alaska. These frogs allow themselves to freeze completely in winter through a process called cryogenic hibernation. They prepare for hibernation by excreting excess water and protecting their organs with glucose and proteins that resist ice formation. Once the temperature drops below freezing, the frog's lungs and heart cease operating as ice forms just below the skin and in muscles. At the end of winter when the ice inside the frog thaws, the heart jumpstarts. A wood frog can transition from completely frozen to normal behavior in the matter of a few hours.

As soon as they revive, male wood frogs seek out vernal pools and begin calling to females. Their call is often described as quacking, and they can be confused for the chatter of ducklings. Over a thousand tadpoles are laid in a single clutch, emerging from their eggs quickly and developing into adults by mid-summer, shortly before vernal pools begin to disappear. Adults are carnivorous and consume nearly anything they can fit in their mouth. They are efficient pest control, keeping vernal pools clear of mosquito larvae and other pests who would also enjoy the habitat. Eggs, larvae, and adult wood frogs are all important food sources for several predators as well including herons, minks, and salamanders.

Perhaps the most invisible inhabitant of vernal pools, the springtime fairy shrimp (*Eubranchipus vernalis*), can only be perceived by a well-trained eye for a small portion of the year. Not only are they small crustaceans, achieving sizes just shy of an inch, the fairy shrimp's exoskeleton is translucent, and their

filter-feeding diet lends their innards the same color as the water they live in. Springtime fairy shrimp are so named for the season in which they achieve adulthood and are most visible. Eggs emerge in late fall in especially deep vernal pools that freeze over in winter. Larval shrimp are microscopic and remain active, though barely, through the winter under a sheet of ice. Once the pool thaws and fills with rain water, the larvae grow rapidly and achieve their adult size. They feed primarily on algae but also consume microscopic animals like copepods, daphnia, freshwater hydras, and other freshwater zooplankton they are able to filter out. As adults, fairy shrimp are a crucial protein source for emerging amphibian larvae in the spring. The fairy shrimp that survive lay eggs just before dying off when their vernal pool dries in summer. A long diapause follows until water returns to the pool in fall. Since fairy shrimp are entirely aquatic, they are found in deep annual vernal pools that are only dry during summer months. Fairy shrimp eggs can disperse on the wind or be carried by animals to other vernal pools, but the larval and adult individuals will only know the pool they are born in.

Vernal Pool Visitors

Facultative species will preferentially use vernal pools when they are available, but can utilize other freshwater aquatic habitats when necessary. The majority of native amphibians fall into this group. The eastern newt (*Notophthalmus viridescens*), American bullfrog (*Lithobates catesbeianus*), spring peeper (*Pseudacris crucifer*), and American toad (*Anaxyrus americanus*) are just some of our native amphibians who are commonly found in vernal pools. A mind-blowing diversity of invertebrates also call these habitats home. Many insects have semi-aquatic life cycles, wherein, like the amphibians, the immature nymphs or larvae are aquatic before they metamorphose and take flight as adults. Microscopic crustaceans, including copepods and amphipods, and other invertebrates such as daphnia and freshwater hydra, make up a complex, invisible ecosystem.

The ubiquitous eastern newt is a common but exciting sight throughout Eastern North America. More specifically, the Blue Ridge is home to the subspecies *Notophthalmus viridescens viridescens*, the red-spotted newt. This newt can be found in almost any warm, still body of clean water since there are very few predators who pose a threat to them. The bright colors they are named for are aposematic, warning of the powerful toxins and bitter compounds present in the newt's flesh.

Newts are a kind of salamander that have three distinct life stages. Most salamanders have an aquatic larval stage and mature into terrestrial adults. Newts have a similar aquatic larva that metamorphose into terrestrial efts before they return to the water to fully mature into adults. Red-spotted newt larvae hatch in early spring and develop quickly during the summer months. During this stage, they are dark green with lighter speckling and large feathery external gills extending from just behind the head. In early fall, the larvae lose their gills after developing lungs. Their skin thickens and becomes dryer to the touch, and their color changes to bright red with two rows of black rings with yellow centers along their sides. Now called an eft, the newt leaves the water and is a terrestrial juvenile and will mature for another two to three years. During the winter, the eft hibernates under logs and leaf litter. Finally, the eft matures, and returns to the water to metamorphose once more into an adult. Their tail broadens into a paddle, reproductive organs develop, and their color reverts to a dark green, but they maintain the black and yellow spots. These adults mate in the late fall and burrow into the sediment at the bottom of the pool to hibernate during the winter. Mating continues in the spring when they emerge. Adult salamanders are able to revert between the terrestrial eft and aquatic adult stages based on their environment and the availability of habitat. If the newt has found a permanent aquatic habitat, like a pond or wetland, it will usually stay in its adult form for the remainder of

its 12 to 15 years of life. If the newt has found a vernal pool, it will revert back to the eft form when the water level drops in the summer until it locates another suitable habitat.

The appropriately named spring peepers (*Pseudacris crucifer*) sing a very familiar chorus from vernal pools and other wetland habitats across the eastern half of the continent. These small frogs are among the first to emerge in early March in the Mount Rogers region. Males congregate near bodies of water in leks of several hundred individuals. While their "peeps" are usually a welcome harbinger of warmer weather, when large populations call en masse, their shrill chirping can be painful to sensitive ears. Females lay up to 1,000 eggs immediately after breeding. The tiny tadpoles develop within a few months and leave the water before vernal pools disappear in summer. Being so small, their only defense from predators is their sheer numbers. While spring peepers will lay eggs in any shallow, still water, they strongly prefer vernal pools or shallow wetlands. The young fare much better in habitats with less competition and risk of predation. Adults vary in color from white, tan, or gray to green, brown, and sometimes even red or yellow, but they can be recognized by their small stature and a dark "X" pattern on their back, spanning from their shoulder to opposite hip, hence the species epithet crucifer meaning "cross".

A careful eye will also notice many of the smaller, less flashy, but no less captivating citizens of vernal pools. Many orders of insects such as dragonflies (Odonata) and caddisflies (Trichoptera), as well as some true bugs (Hemiptera), beetles (Coleoptera), and true flies (Diptera), start as aquatic nymphs or larvae that need standing water to develop. Caddisflies in the family Limnephilidae, which literally translates to "pond loving," have the most success in vernal pools. They are able to enter states of diapause at two stages of their life cycle–as eggs and as pupa. Caddisfly eggs are able to withstand dry conditions, only hatching when water returns to the pool. The next year, the larvae pupate while the water level is high and wait to emerge as winged adults until the pool has gone dry. The larvae are carnivorous and mostly feed on the nutritious gel surrounding amphibian eggs. However, once these eggs hatch, the frog and salamander larvae turn the tables. Skimmer dragonfly (Family *Libellulidae*) and especially spreadwing damselfly (*Lestes* sp.) nymphs are fearsome predators in vernal pools. In both odonatans, adults lay their eggs in fall, often on or near semi-aquatic plants. The eggs diapause through winter and nymphs merge once the water level rises. In the spreadwing damselfly, there is evidence that the eggs are photosensitive, and nymphs only emerge when the day is longer and the egg is submerged.

Microscopic Members

Especially enthusiastic naturalists may enjoy taking a sample of water from ephemeral pools to observe under a microscope. There is an entire ecosystem that escapes the naked eye filled by an immense diversity of freshwater zooplankton. These animals are extremely hardy–able to cope with the fluctuating environment of ephemeral pools.

Copepods are a diverse group of miniscule, planktonic crustaceans that can be found in nearly every wet environment– from flowing streams to stagnant ponds, and even wet soil and the moisture that covers mosses. Their diets are just as diverse as their numbers, and in turn are an important food source for slightly larger animals like fairy shrimp and limnephilid caddisflies. In good conditions, females lay eggs that develop very quickly, resulting in short generations that can quickly repopulate. In stressed conditions, when vernal pools recede, females lay "resting eggs" that can remain inactive for decades until water returns.

Daphnia, the genus of water fleas, are another hardy planktonic crustacean. Even smaller than copepods, they are very efficient at filtering algae from water. In fact, their populations help prevent harmful freshwater algal blooms, and are able to respond very quickly to changing environments. Females are capable of parthenogenesis (birthing young without fertilization), and these young can achieve reproductive maturity in less than 10 days. A female *Daphnia* actually has a pair of brood pouches where she holds eggs and juveniles for the first few days of their lives. Fertilized eggs may hatch immediately in suitable conditions, or can enter a diapause that can last years until conditions are suitable. Fertilized eggs remain in the brood pouch when the mother sheds her exoskeleton, which offers them extra protection.

Another interesting denizen of Blue Ridge vernal pools are freshwater members of the genus *Hydra*. This genus of Cnidarians is in the class of jellyfish called Hydrozoa. However, unlike the majority of Hydrozoans, *Hydras* do not mature into medusae–the free floating adult stage of Hydrozoan life cycles that are recognizable are jellyfish. Instead, they are mostly sessile polyps that attach to stones and vegetation, using their stinging tentacles to capture freshwater zooplankton like copepods, larval fairy shrimp, and *Daphnia*. Freshwater *Hydras* mostly reproduce asexually through budding–when a protrusion from the base grows into a miniature copy of the parent polyp that breaks off and floats to a new location. Fortunately, these cnidarians are far too small to cause harm to humans, and usually go unnoticed. Unfortunately, they can become a pest in fish hatcheries, where unchecked populations can kill fish fry. While *Hydras* are believed to live indefinitely in optimal conditions, they are sensitive to fluctuations in the environment. How they are able to persist in vernal pools is still a topic of research. Some marine Hydrozoans produce eggs with a thick case called a theca that is resistant to extreme environmental conditions related to pH, temperature, and salinity. It is theorized that freshwater *Hydras* are able to produce thecated eggs that persist during the dry season and emerge when the water returns.

Though fleeting and often small, vernal pools play host to a diverse array of species, and act as a stage for a long list of dramatic life history events that are made possible by these ephemeral habitats. When the wet nights of late winter creep into the comfortable realm, and spring feels like it is just a moment away, grab a flashlight and go witness the marvels for yourself, before the summer sun closes the curtain.

Maple Syrup

Wild edibles abound in the Mount Rogers region. From the many edible mushrooms, fruits, and flowers that sprout from our mountains, to the edible leaves of ramps (*Allium tricoccum*), the warm months provide a bounty of wild foods. However, for those with the knowledge and skill, even the depths of winter offer sweet, seasonal treats. Often associated with more northern climes, the skill and tradition of harvesting maple sap for its sugar and the creation of maple syrup is alive and well in the southwest Virginia highlands, thanks in large part to the cold, freezing winter nights that persist in the high elevations.

A Native Tradition

The tradition of maple sugaring dates back to the indigenous peoples of northeast America. It is unknown when they started harvesting sap from maple trees, but it was certainly long before European colonists arrived. Numerous legends exist, explaining how indigenous Americans discovered the nutritional value of maple sap, and they vary between tribes. One prominent theory is that they would eat "sap-sicles" that formed at the end of broken twigs in the winter. As water evaporates from the frozen drip, the sugar becomes more concentrated and creates a delicious, slightly sweet taste, which inspired their first method

of processing maple sap. When winter began to transition to spring, the tribes would move to sugar maple groves to maximize production. They would slash "V"s into the trees with their tomahawks and place a birchbark drip bucket underneath to collect the sap. Then the sap was transferred to a shallow birchbark container and left out in the freezing temperatures overnight. The next morning, the layer of ice that formed was removed. This was repeated until as much water as possible was removed.

Storing a liquid sap was a hassle, so the Indigenous Americans changed techniques. Instead of freezing, they started boiling. The sap collection method remained the same, but the sap was poured into a partially hollowed log. The thick walls of the log were important for structural support. To heat the sap, large stones were placed in a fire until they were extremely hot. Then they were dropped into the log with the sap. As one rock cooled, it was put back in the fire and replaced with another hot rock. Just like maple sugaring today, the process took days. They had to stir until the maple syrup began to crystallize, but in the end, there was maple sugar instead of concentrated maple sap.

Indigenous Americans stored their sugar in three forms. Grain sugar was similar in texture to the brown sugar we have today. Cake sugar was poured into wooden molds to make solid blocks that could be broken up. Wax sugar was extra-thick maple syrup poured on the snow to rapidly cool. Often called "sugar on snow."

The Indigenous Americans taught their maple sugaring techniques to European colonists throughout the northeast. As early as 1790, they realized that slashing the trees to collect sap wasn't healthy and did significant damage to the trees. So, they transitioned to the current method of drilling a half-inch hole in the tree's trunk and inserting a tap, called a spile. Initially these spiles were made of softwood twigs that had been hollowed out. With the introduction of metals like iron, the spiles transitioned to reusable metal and sap was cooked in kettles. Colonists would cook multiple kettles at the same time, transferring the sap as it thickened.

The Process

Sap can be collected from any maple tree to make maple syrup. Here in Virginia, the best species options are sugar maple (*Acer saccharum*) or red maple (*Acer rubrum*). Their leaves make these species easy to tell apart, however, they are absent in the winter. Both species also exhibit opposite branching patterns, so other identification methods must be used. Young red maples have smooth, light gray bark. Older trees have bark with large, scaly plates. Their twigs are red and shiny with scattered lenticels, and their buds are bluntly pointed with a few large scales, usually green or reddish. The bark of a sugar maple is variable, but is generally brown. As it ages, it becomes darker, develops furrows, and eventually ridges. The twigs are, like the bark, brown. They also have some scattered lenticels present. The terminal buds are brown, sharp and pointed, with tight scales. Predictably, sugar maples are the better choice for maple sugaring. They have the highest percentage of sugar in their sap, averaging 2.5%, though it can range from 1-4%.

The basis of the maple syruping process is seasonal change. Nights below freezing (32℉), and days slightly above freezing, are critical. The reason temperature is so important is because it changes the pressure in the tree. As the temperature fluctuates, it creates a freeze/thaw cycle. Freezing sap generates a negative pressure, while thawing generates the positive pressure that pushes sap flow. When the pressure inside the tree is greater than the atmospheric pressure, it pushes the sap out of the spile. This is why in the winter, sap will flow out of broken branches.

Most farmers harvest sap in the spring, but some will harvest in fall. The winter to spring transition is much more consistent and predictable than the fall to winter transition. Fall sap tends to have a lower sugar concentration. As the tree survives through the dry winter season, it loses some of its water, which increases sugar concentration, and harvesting in the fall can affect spring yields. Here in Virginia, the sugaring season takes place from February to March. Perfect conditions usually last four to six weeks. A good indication that it's time to stop is when the nights stay above freezing, the tree begins to bud, or your sap turns a yellow-brown color. The discoloration could be due to spoiled sap filled with bacteria, or a sign that the roots are beginning to absorb nutrients and minerals. Both will give the sap (and any syrup or sugar) a bitter taste.

Selecting a tree to harvest sap from is an important step in the syruping process. There are many guidelines available on the dos and do nots. The following are examples on the more conservative side.

To start, any tree with severe damage should not be tapped to prevent further stress, especially if there are broken branches, which will cause a decrease in pressure inside the tree. No tree under 12 inches in diameter (34 inches circumference) should be tapped. For reference, that's about 40 years of growth. Trees 12-18 inches in diameter (34-57 inches circumference) can have one tap, while trees over 18 inches diameter (57 inches circumference) can have two. Do not exceed two taps, no matter how large the tree. When tapping, each spile should be at least one foot apart, positioned between waist and chest height. Old tap holes should not be reused, and should be given time to heal. The sites of old taps will be surrounded by scar tissue, which will affect the flow rate.

In modern times, most people use an electric drill to create tap holes. The drill bit used for drilling tap holes should be the exact same size as the diameter of your spile. Drill at a slight upward angle to prevent sap from pooling, and go in no further than an inch and a half. Using a soft mallet, hammer in the spile to the tap hole. If the weather is right and the tap was inserted correctly, sap will immediately begin to drip.

Today, there are a few different collection methods. Some people still hang metal or plastic buckets from their spiles. Some people use tubing to lead to a sealed container. Major sugaring operations will have tubing that runs from all of their trees downhill into a large tank. Throughout the four- to six-week season, each hole will produce around 10 gallons of sap. Sap needs to be checked constantly to make sure that it does not spoil, and should be stored in the cold when not being used.

Lugging full five-gallon jugs around is harder than it seems. Historically, some people would use horse-drawn sleds, but for that to work, your trees need to be easily accessible!

Once you have a sufficient volume of sap, it is time to start cooking! It is possible to make maple syrup in a pot over a stove, but most commercial sugar shacks have an evaporator pan, which is essentially a large, rectangular pan with a flat bottom. It is separated into three sections, running longways. In the back corner of the first section, there is a valve that connects to a sap storage tank. Sap slowly drips into the full pan. As the sap cooks and water evaporates, its density increases. The new sap entering the back corner pushes the denser sap to the front of the pan and over into the second corridor. As it continues to cook, the thicker sap is pushed to the back of the second corridor, where it moves into the third corridor. At the front of the third corridor, there is an exit valve. When the syrup reaches the valve, it needs to be monitored. It's almost ready. When it is done, a bottle is placed under the release valve and opened to pour out the completed

syrup. If you mix the syrup, it will turn into maple sugar/butter. If you immediately pour it on a cold surface, it will make glass-like maple taffy.

The cooking process is laborious. The fire needs to be hot enough to maintain boiling, which means constant vigilance. People often work in shifts to maintain the heat overnight. It takes 40 gallons of sap to make one gallon of maple syrup. Starting at about 98% water 2% sugar, the finished product is about 33% water 67% sugar.

Syrup in the MRNRA

Here in the Mount Rogers region, there are a few local maple syrup farmers who have been tapping for generations. Virginia is located right on the southern boundary for viable maple syrup production. Thankfully, we have the Appalachian mountains and the high elevation forests that mean lower winter temperatures, which help us meet the criteria necessary for sap harvesting.

Of particular concern is the impact that climate change will have on sap production. Rare, biodiverse high-elevation communities are already under stress. Sap season will likely shift and shorten, moving earlier in the year. Non-timber forest products are an alternative way to make income utilizing native plants, and at its core is conservation. Sugar maples take 40 years to reach sap production age, and can not produce in unhealthy conditions. To maintain syrup production, a healthy ecosystem has to be maintained.

After the season has wrapped up, some vendors sell their products at local farmers markets. In March, Whitetop hosts the Maple Syrup Festival to showcase the syrup from the surrounding highlands. Maple tapping is very prominent in Elk Garden, and taps are visible just off the Appalachian Trail in Jefferson National Forest.

Thanks to the high elevations that span our corner of Virginia, and the cold winters that cling there, maple syrup production is a tradition alive and well in the Mountain Empire, providing a unique opportunity for locals to live off of the land–even at the height of winter–and adding even more depth to our mountain culture.

Rhododendron Dieback and Thermometer

The forest opens up in winter. As deciduous trees have long since dropped their leaves, and greenery has died back, much of the forest is in shades of gray during these colder months. With the screen gone, it does not take an expert eye to spot the thick, waxy green leaves of Rhododendron growing in dense thickets on steep slopes and along streambanks.

The genus Rhododendron is broad, including over 1000 species of large, woody shrub worldwide. In the Mount Rogers National Recreation Area, the most common species are great rhododendron (*Rhododendron maximum*), Catawba rhododendron (*Rhododendron catawbiense*), and the flame azalea (*Rhododendron calendulaceum*). The flame azalea, however, is deciduous and falls within a different subsection of the genus from the evergreen maximum and catawbiense.

Both great rhododendron and Catawba rhododendron are native to the Southern Appalachians, characterizing the landscape with their evergreen leaves, dense stands, and bright flowers. These plants

play a significant role in the larger ecosystem, providing food, cover, and erosion control. In the fall and winter, rhododendrons are browsed by white-tailed deer. Game birds such as ruffed grouse (*Bonasa umbellus*) and wild turkey (*Meleagris gallopavo*) eat the buds and leaves. Beavers browse rhododendron twigs. Small mammals, including species of deer mouse (*Peromyscus*) and the Allegheny woodrat (*Neotoma magister*), eat the leaves, while rabbits consume much of the plant, eating the bark, young wood, leaves, and buds. Shelter provided by rhododendron groves is especially important in winter, serving as escape cover for white-tailed deer (*Odocoileus virginianus*), eastern cottontail (*Sylvilagus floridanus*), black bear (*Ursus americanus*), snowshoe hare (*Lepus americanus*), ruffed grouse, wild turkey, and many songbirds. The thickets also commonly function as den sites, daybeds, and escape cover for black bears.

Rhododendron thickets occur because these plants reproduce primarily through layering, root sprouting, or stump sprouting, and only occasionally reproduce from seed. This creates a dense network of roots which works to stabilize soil on slopes and stream banks. Areas where rhododendrons prefer to grow are also areas particularly susceptible to erosion, which their networks help to mitigate.

Seasonal Dieback

Although Catawba and great rhododendron are evergreen, they still experience seasonal development and dormancy. An annual cohort of leaves will begin to grow each May and continue until leaf mortality begins in August. Some leaves will die off and drop in August and September, but it's not uncommon for dead leaves to cling on until November. Most leaf death is a result of aging due to sun exposure, as ultraviolet radiation damages the cell walls of the leaves. However, some leaf mortality is contributed to fungal infections. Mortality attributed to infection is known as dieback, and begins in the tips of leaves or roots before spreading into the body of the plant.

Many fungal pathogens can cause dieback in Rhododendrons, but the most common ones are *Botryosphaeria dothidea*, *Phytophthora cactorum*, and *Phytophthora cinnamomi*. *P. cinnamomi* begins in the roots, earning it the name “root rot,” while *B. dothidea* and *P. cactorum* both begin in the leaves and are typically just referred to as dieback. Dieback and root rot are native species of fungal infection and play a warranted role in the ecosystem. They contribute to genetic variation of rhododendrons and do not appear to endanger the overall survival of the shrubs.

P. cinnamomi begins in the finest roots before spreading towards larger roots and eventually up into the root crown, leaving a wake of browning and death as it moves through the plant. As the infection moves up the stem, the cambium dies first, followed by the phloem and then the xylem. As root and stem tissues are destroyed, the leaves will roll downward toward the midrib and gradually wilt before the entire plant dies. Younger plants have less established root networks and thus are more severely affected by this infection. One- to two-year-old plants can fully die off in as little as two weeks. Older plants, clustered in large networks on the landscape, may display no signs of *P. cinnamomi* infection until other stress factors further weaken the plant, and may show symptoms for as long as a year before dying.

Infection that specifically affects new growth rhododendron leaves is most commonly attributed to *P. cinnamomi*’s relative, *Phytophthora cactorum*. Infection begins when soil containing zoospores of the fungus lands on wet rhododendron leaves. The spores grow on the leaves, forming dark lesions that begin to appear on the leaves in two to three days. As infection spreads through each leaf, individual leaves wilt and turn inward taking on a brown-black color along the mid-rib and margin. Then, the infection travels

through the stems into mature leaves and branches, which causes the wood to appear a darker shade of brown compared to the usual light, almost white, shade. Infected leaves may open to release more spores, accelerating infection and repeating the cycle.

Overall, the most common cause of dieback in rhododendrons is caused by *Botryosphaeria dothidea* and is referred to as *Botryosphaeria* dieback, rhodo dieback or twig blight. In contrast to *Phytophthora* infections, *Botryosphaeria* dieback is more fatal to older plants. Great rhododendron plants are most affected by twig blight, but the disease occurs frequently across rhododendron species. Characteristic symptoms of B. dothidea infection are reddish-brown discoloration on the underside of the infected branches, sudden leaf wilting, and unusual gray-green leaf coloration. Leaves will also droop and curl downward parallel to the leaf midrib, similar to symptoms of P. cactorum infection. The infection can occur in multiple individual branches on the same plant at the same time, and results in eventual foliage death. Older infected plants may attempt to fight the infection by forming cankers that enlarge and can girdle the tree, causing more harm.

In each of these fungal infections, having a less established root system and stresses from heat or drought can increase both the occurrence and the severity of the disease.

A Natural Thermometer

As temperatures plummet in the peak of winter, great rhododendron leaves must rapidly adjust to temperature changes to protect the brittle, frozen leaves from sustained cellular damage by concentrated sunlight. While their chemical defenses are easily enough to protect the plant from the onset of ice and snow, sunlight poses a much different challenge to which the plants must quickly respond. A leaf can curl and re-open within a matter of minutes to adjust to the spontaneity of winter weather in the Blue Ridge Mountains. Using the graph and illustration developed by ecologist Erik Tallak Nilsen to analyze the curl of the leaf, a relatively accurate temperature estimate can be achieved. However, a rough estimate can be achieved simply by examining the position of the leaf.

Below zero to 29℉
The rhododendron leaves are tightly curled, extremely dark green, and appear to be withering. Each long leaf-tube resembles a short, green drinking straw. Often, these curled leaves hardly appear to be leaves at all from a distance.

Just below freezing (30℉) to freezing (32℉)
Leaves with normal color, slightly folded, and drooping. The leaves may be slightly beginning to curl, but the most obvious indicating sign of the onset of freezing temperatures is the arch of the petiole on the leaf.

Above freezing (32℉)
Leaves fully extended, spreading away from the branch or a terminal bud. No curling, although R. catawbiense almost always appears folded, so R. maximum is the ideal species to use for temperature readings.

A dominant presence on the winter landscape of our high-elevation forests, the dense character and lush appearance of rhododendron thickets betray the vital ecological roles the species fulfill –stabilizing slopes

and feeding and providing shelter to native fauna. The silent processes that occur–the pathogenic management of stands and the protective chemical adaptations that aid in the survival of winter temperatures and sun exposure–can be observed, too, but only by the well-trained eye.

Astronomy

Atop the tallest mountains in Virginia, there is a great view of the night sky. On the East coast it can be difficult to find areas that aren't tainted by light pollution. The mountains help keep the sky clear. For thousands of years, humans have been looking at the night sky - for navigation, as a calendar, to share stories; and today, the stars look just the same. The average person can see approximately 4,500 stars in the sky from where they are standing. If you could see both northern and southern hemispheres of the Earth at the same time you'd be able to see about 9,000, but there are millions in our galaxy alone. Mixed in with all those stars are 88 constellations. Constellations are groups of stars in the sky that make certain patterns, like mythological creatures, animals, people, and objects. Unofficial constellations are called asterisms. As an example, Ursa Major (Big Bear) is a Greek constellation, but it contains the asterism the Big Dipper.

To know astronomy, it helps to understand how our solar system works. From large scale to small scale, we are a part of the Milky Way galaxy, a collection of stars, dust and gas. The Milky Way galaxy is called a spiral because it looks like a pinwheel in space. Most of it is flat like a frisbee, except for a large bump in the center. The gravitational pull from that center is what holds the galaxy together, and keeps it flat. The spiral is made of two major arms, Perseus and Scutum-Centaurus, which break into minor arms and smaller offshoots. Our solar system is in the Orion spur, an offshoot of the Sagittarius minor arm, which comes from the Perseus major arm.

Our solar system formed when a cloud of interstellar gas and dust collapsed and formed a swirling solar nebula. The nebula continuously pulled more and more material in until pressure built up, hydrogen atoms combined to form helium, a massive amount of energy was released, and our sun was born. It contained 99% of the available matter in our solar system. Having that much mass meant that it had a large gravitational pull. Leftover matter got trapped traveling around it. Some of that matter was colliding over and over again, growing in size. At a certain point, it got its own gravity. Having gravity smoothed out its shape, and we got the planets.

All of the planets move from west to east around the sun in a set path. Because of the sun's gravitational forces, all of the planets orbit around the sun in the same plane, which makes our solar system flat like a frisbee. They also rotate as they spin, from west to east (counterclockwise). Because our solar system is flat, orbiting the sun, and Earth rotates, from the surface the sun appears to move from east to west across the sky. This is called the line of the ecliptic.

When the planets formed, it's thought that their equators lined up perfectly with the plane of our solar system, with their poles pointing up and down. So why is Earth's axis tilted at 23.5 degrees? Scientists suspect that a large object collided with Earth and tilted its axis. This tilt is what gives us opposite seasons in the northern and southern hemispheres. If the northern hemisphere is angled away from the sun, the light is dispersed across the surface and we experience winter. The reverse is true for summer.

Although the layout of the stars remains the same, the exact location of constellations in the sky will change throughout the year; not because the stars are moving, but because the Earth is moving. Earth's

orbit around the sun affects which constellations are visible because our perspective of the sky changes. During winter in the northern hemisphere, the summer constellations appear during the day, making them invisible. People used this annual movement to predict when the seasons would change. The constellations will also shift depending on the time you observe the night sky, since Earth is also rotating as it orbits. Stars, planets, sun, and moon all appear to rise in the east and set in the west. It can be disorienting to see how quickly the sky shifts.

Orienting Yourself to the Night Sky

The best way to orient yourself to the night sky is using the cardinal directions. Being in the middle of the northern hemisphere means that we can always see the north pole and the celestial bodies that surround it, called circumpolar stars. As long as you are above the equator, they will never fall below the horizon. The North Star falls almost exactly where magnetic north is, with a little bit of wobble throughout the year. This makes it a reliable navigational tool year round at any time of night. Despite the stories, the North Star is not the brightest star in the sky. The easiest way to find it is to use some basic circumpolar constellations. First, locate the Big Dipper asterism. Look at the outer edge of the bowl, furthest from the handle. Make a straight line that goes from the bottom of the bowl to the rim, and then continue that line. You'll quickly encounter the North Star. To verify, it should be the first star in the handle of the little dipper.

Method number two relies on the line of the ecliptic. All stars appear to move from east to west because of the Earth's rotation in the opposite direction. Because the solar system is flat, planets, the sun, and moon also move across the sky in a line from east to west. That alone isn't enough to figure out the cardinal directions, but all of the zodiac constellations fall on the line of the ecliptic. So if you can follow the line to either end, you will find east and west. The following constellations are all observed around 7:30PM - 11PM. From December to February, the constellation the furthest east will be Gemini, then Cancer, then Leo, and finally Virgo. These constellations are entering the sky. During that same time frame, the furthest constellation west shifts from Capricornus, to Aquarius, to Pisces, to Aries. These constellations are leaving the sky. Remember that sometimes you may not be able to see the stars at the horizon because of light pollution or obstructions.

Constellations

Cosmic patterns in the night sky are known as constellations and have captivated the human imagination for millenia. As the sun sets and darkness falls, these constellations transform into a timeless canvas of myth and wonder.

Constellations are not merely random groupings of stars; rather, they are imaginative figures and shapes created by connecting the dots of bright stars in the night sky. These stellar configurations often tell stories inspired by ancient cultures of gods, heroes and mythical creatures.

A storyteller of the cosmos, your eyes trace the lines connecting stars to form Orion, the mighty hunter. His distinctive belt, marked by three brilliant stars, draws the eye. Legends whisper that Orion was a giant of unparalleled strength, forever etched in the sky as a testament to his valiant deeds.

Adjacent to Orion, the Pleiades, a delicate cluster of stars, tells a different tale. Seven sisters, immortalized in Greek mythology, are said to be the daughters of Atlas. Their brilliance sparkles with an ethereal beauty, a celestial dance frozen in time.

Across the celestial sphere, Ursa Major, the Great Bear, strides through the night. Its distinctive shape, resembling a giant ladle or dipper, has guided sailors and wanderers for centuries. In Native American lore, this constellation is often seen as a great bear, forever chasing the circumpolar North Star.

The constellations transcend time and culture, linking generations through shared stories written in the stars. They serve as a cosmic roadmap, connecting humanity to the vastness of the universe. With each constellation, a new chapter unfolds in the grand narrative of the night sky, inviting us to look up, dream, and wonder.

SPRING

March, April, May

Weather Stats

Average Temp	49.3℉
Max Temp (avg.)	62.3℉
Min Temp (avg.)	42.0℉
Average Humidity	79%
Average Precipitation	5.80”
Average Snowfall	1.2”

Spring Bird Migration

Breeding Migrations

As winter fades and the natural world begins to awaken, environmental conditions change in the Mount Rogers region, once again. Temperatures rise, and food availability generally increases. With the arrival of spring, bird species across the world begin to feel a drive to fulfill a very important and particular natural history event–breeding. Each individual bird species has a set of unique requirements for breeding and rearing young, and those requirements, combined with where in the world they can satisfy those requirements, affects the spring migration patterns of breeding birds.

The Mount Rogers area provides suitable habitats for rearing young to many species of birds. These birds begin returning to the area in February and March each year, and their progress can be followed by birders using NexRad (next generation radar) and eBird data. The use of NexRad (next generation radar) data, along with community science data reported to eBird, has given scientists a method of monitoring bird migration as it happens. Many birders local to the Mount Rogers region follow the progress of spring migration by visiting the BirdCast website for Grayson County.

In terms of their migratory behaviors, the more than 200 bird species observed in the Mount Rogers area can be described as non-migratory, short-distance migrants, medium-distance migrants, or long-distance migrants.

The dark-eyed junco (*Junco hyemalis*) is a good example of a short-distance migrant. These birds find suitable habitats for nesting above about 3,000 feet in the Mount Rogers area. Come winter, only a few remain in the high mountain habitats used during the warmer months, while most move to lower elevation mountain valleys nearby, or further to even lower elevations. Other examples of short-distance migrants are the American robin (*Turdus migratorius*), eastern meadowlark (*Sturnella magna*), and red-winged blackbird (*Agelaius phoeniceus*). These birds are some of the first to increase in abundance each spring.

During the warmer months, the Mount Rogers region is also home to several species of medium-distance migrants. The brown thrasher (*Toxostoma rufum*) is a great example. This familiar songbird is common in the area from April through September, and a few may be observed slightly before or after that period. While they are not to be found in the area from November through February, they have not ventured far. A few can be found during winter in the upper Piedmont and Ridge and Valley regions, becoming more common towards the coast and to the south where the insects, fruits, and nuts they feed on are more readily available. Other short-distance migrants include the American woodcock (*Scolopax minor*), house wren

(*Troglodytes aedon*), gray catbird (*Dumetella carolinensis*), savannah sparrow (*Passerculus sandwichensis*), vesper sparrow (*Pooecetes gramineus*), chipping sparrow (*Spizella passerina*), pine warbler (*Setophaga pinus*), and common yellowthroat (*Geothlypis trichas*). These birds also return early each spring.

Many bird species that visit the Mount Rogers area in the spring are long-distance migrants. Within this classification of birds are two other distinct groups–those species that return to nest in the Mount Rogers region, and those that pass through on their way to nesting grounds further north. A good example of the latter group is the Cape May warbler (*Setophaga tigrina*). This species breeds in northern Canada and spends the winter in the Caribbean islands and coastal areas of northern Central America and southern Mexico. It can be regularly seen in the Mount Rogers area during spring migration. Other species of passage migrants here include the spotted sandpiper (*Actitis macularius*), Philadelphia vireo (*Vireo philadelphicus*), Lincoln's sparrow (*Melospiza lincolnii*), northern waterthrush (*Parkesia noveboracensis*), and bay-breasted warbler (*Setophaga castanea*).

Many of our bird species that are familiar sights during the summer leave the area completely at the onset of winter. For example, the wood thrush (*Hylocichla mustelina*) spends each winter in southern Mexico and Central America where fruits and insects are more available. A small number of this species appear around Mount Rogers in April, with the majority arriving in May. The wood thrush announces its arrival by delivering its melodious song at dawn and dusk soon after its return. Other species of long-distance migrants include the yellow-billed cuckoo (*Coccyzus americanus*), eastern whip-poor-will (*Antrostomus vociferus*), chimney swift (*Chaetura pelagica*), ruby-throated hummingbird (*Archilochus colubris*), broad-winged hawk (*Buteo platypterus*), Acadian flycatcher (*Empidonax virescens*), red-eyed vireo (*Vireo olivaceus*), veery (*Catharus fuscescens*), Baltimore oriole (*Icterus galbula*), magnolia warbler (*Setophaga magnolia*), indigo bunting (*Passerina cyanea*), and scarlet tanager (*Passerina cyanea*). Other species in the bird families represented in this list have similar migratory behavior.

Parulidae en Masse

Of particular interest to birders are the warblers. Of about 50 species of New World warblers (family *Parulidae*) found in the United States, 34 species regularly summer or pass through the Mount Rogers region. Many nest here. Only one, the yellow-rumped warbler (*Setophaga coronata*), could be regarded as a short-distance migrant. The remainder leave each winter, traveling hundreds or thousands of miles to wintering quarters. Their return each spring is a celebrated event, and birders travel to Mount Rogers to see these beautiful songbirds when they arrive. Many New World warbler species are habitat specialists and take advantage of the diverse array of plant communities found in our high elevations. They are able to find habitats here that provide foods with sufficient nutrition to fuel successful reproduction.

Mountain habitats above 3,500 feet in elevation provide northern hardwood and red spruce forest habitats attracting the black-and-white warbler (*Mniotilta varia*), ovenbird (*Seiurus aurocapilla*), common yellowthroat (*Geothlypis trichas*), hooded warbler (*Setophaga citrina*), American redstart (*Setophaga ruticilla*), northern parula (*Setophaga americana*), magnolia warbler (*Setophaga magnolia*), Blackburnian warbler (*Setophaga fusca*), chestnut-sided warbler (*Setophaga pensylvanica*), black-throated blue warbler (*Setophaga caerulescens*), yellow-rumped warbler (*Setophaga coronata*), black-throated green warbler (*Setophaga virens*), and Canada warbler (*Cardellina canadensis*).

Lower elevation habitats between 2,500 and 3,500-feet elevation provide a mixture of agricultural and forested lands that attract the worm-eating warbler (*Helmitheros vermivorum*), ovenbird, Louisiana waterthrush (*Parkesia motacilla*), black-and-white warbler, Swainson's warbler (*Limnothlypis swainsonii*), common yellowthroat, hooded warbler, American redstart, northern parula, yellow warbler (*Setophaga petechia*), chestnut-sided warbler, pine warbler (*Setophaga pinus*), yellow-throated warbler (*Setophaga dominica*), prairie warbler (*Setophaga discolor*), and black-throated green warbler.

Each of these species have very particular habitat types that they prefer for nesting. For example, the hooded warbler often chooses rhododendron thickets for nesting, as do Canada warblers, black-throated blue warblers, and Swainson's warblers. The northern parula, Blackburnian warbler, yellow-throated warbler, and black-throated green warbler usually choose tall trees for nesting.

The unique natural histories of each individual bird species dictates how they relate to their environment as the seasons progress. Geographic variations in habitat, environmental conditions, and food availability inspire migrations both large and small as birds seek to satisfy these biological needs. As the spring breeding season approaches, studying and understanding the breeding requirements and habits of each species will provide insight into their movements into, or through, our mountain home.

Spring Ephemerals

Signs of Spring

In the high-mountain, woodland landscape of the high country, spring is slow to arrive. After a long winter, the air grows warmer, and sunlight covers the mountains in longer and longer intervals, and plant life begins to stir, recognizing the approach of a new growing season. But before the trees begin to leaf out and bring a dense shade to the understory of the forested ridges, a whole group of plants with a specialized life history begin their season.

Spring ephemerals are a group of low-growing plants that grow in deciduous habitats. They often start blooming in early March, soon after snow melts, and before the deciduous trees begin to leaf out, allowing them unfiltered access to sunlight, water, and nutrients. They have high rates of photosynthesis and rapidly produce carbohydrates that are stored in an underground storage organ like a corm or bulb. It only takes about two months for most spring ephemerals to flower, store enough energy for the year, and produce its fruit before senescing and entering dormancy. When temperatures drop again in the fall, the storage organ uses some of its stored energy to extend the root system and prepare new shoots.

Spring ephemerals are often the first food sources available to native pollinators and wildlife after a long, cold winter, and their blooms are some of the first signs of spring on an otherwise muted landscape. Listed below are some of our most prominent, native spring ephemerals.

Native Ephemerals

The whitish-pink flowers of the spring beauty (*Claytonia caroliniana* and *Claytonia virginica*) grow in loose clusters on the forest floor. They have five petals that are striped with light to dark pink stripes, as well as pink anthers. This pink coloration reflects UV light and attracts native pollinators. Spring beauties are very generous with their nectar. During cloudy weather, or at night, the petals close and the flower turns downward to conserve energy. While they have leaves, they mass produce carbohydrates and store them in

an underground corm that is one-half to two inches long until the following spring when they will use the energy stored to get a jump on their deciduous neighbors. The corms of the spring beauty are often consumed by wildlife, and are popular targets of human foragers who cook and eat them like small potatoes. Spring beauties spread by both seed dispersal and root sprouting. Virginia spring beauty (*Claytonia virginica*) has longer and narrower leaves, and Carolina spring beauty (*Claytonia caroliniana*) has shorter, wider leaves. In the Mount Rogers region, the Carolina spring beauty is more widespread.

The wood anemone (*Anemone quinquefolia*) is an ephemeral member of the buttercup family, Ranunculaceae. Its species name, quinquefolia, is a reference to its compound, five-lobed leaves. Each flower has five white, petal-like sepals. Sepals are the outer parts of the flower, which protect the flower bud and offer support to the flower when it has bloomed. The flowers are in the center of the head. During cloudy weather, or at night, the petals close and the flower turns downward to conserve energy. Its seeds are fluffy and dispersed by wind. The name "anemone" refers to the Greek gods of the winds, the Anemos, and means "windflower."

Bearcorn (*Conopholis americana*), commonly called American cancer-root, is a very common spring ephemeral in the Mount Rogers region, and an obligate parasite of oak roots, meaning it can only grow where oak roots are present. As their hosts produce sugars via photosynthesis, the bearcorn siphons out the oak sap and stores the sugar in an underground tuber. For most of the year it exists only as a tuber, but after four years, it will send up flowering stalks in the spring. The flower stalks are two to eight inches in length and one-half inch to an inch thick, usually arranged in clumps. Bearcorn doesn't possess chlorophyll and do not photosynthesize. Thus, they lack any green pigmentation and their flowering stalks are of a yellow-brown coloration. As the flower stalk dies, it will turn dark brown.

Bearcorn spreads by both seed and root sprout. After a few years of flowering, it will die off. It prefers shady, forested habitats. Its genus is named because its scale-like flowers look a bit like a pinecone. In Ancient Greek, "conos" means "cone" and "pholos" means "scale." Despite its nickname, American cancer-root, there is no scientific evidence that it prevents or causes cancer, but may be a reference to the parasitic nature of the plant.

Dutchman's breeches (*Dicentra cucullaria*) is a fairly easy-to-identify spring ephemeral that grows throughout the Mount Rogers region. Their flowers are white (sometimes pinkish) with white or yellow "wings." Its petals are fused into two long, upward-pointing spurs that resemble upside down pants, which grants them their name. These characteristic spurs are used to store nectar. Bumblebees have the perfect length tongue to reach the nectar, brushing up against the reproductive parts of the plant at the bottom of the flower. Other insects try, and after failure may bite through the tip of the spur to access the nectar instead. The flowers are all connected to a leafless stalk that droops with their combined weight. Its finely-compound leaves look like little fern fronds and only grow at the base of the flower stalk. It has underground bulb-ets about the size of a grain of rice.

Often confused with dutchman's breeches, squirrel corn (*Dicentra canadensis*) has flowers that are white with a sometimes green or pink tint. The petals are fused into a heart shape about three quarters of an inch long and a half-inch wide. Nectar is stored in the top of the heart, which is much more accessible to most pollinators than in Dutchmen's breeches. After opening at the bottom, a pair of "wings" sticks out to the side, and a pair of ruffles stick out from the seam between the wings. The flowers are all connected to a leafless stalk that droops with their combined weight. Its finely-compound leaves resemble fern fronds and

only grow at the base of the flower stalk. Squirrel corn gets its common name from the yellow, underground corms that it grows that are roughly shaped like corn kernels.

Dutchman's breeches and squirrel corn prefer the same habitats and are often found growing together. The best way to differentiate them is by the flower. Some people say that Squirrel corn's compound leaves are more dainty and lacey.

Both plants also have a mutually beneficial relationship with ants. Ants love the oily, nutrient-dense elaiosome that the plant attaches to its seeds and will carry them back to their nests, eating the outside and leaving the seeds to stratify through the winter. This dispersal method benefits both species, instead of relying on the ants to over-collect food and leave some seeds uneaten.

Squirrel corn and dutchman's breeches are both toxic when consumed, and can cause mild irritation of the skin. They both contain the same alkaloid mixture, similar to opium, that can have similar effects. Another nickname for dutchman's breeches is "Little Blue Staggers," because if cattle eat it, it can cause staggering, incoordination, and even death if consumed in mass quantities.

A splash of color can be found in the early-spring understory in the trout lily (*Erythronium americanum*). The trout lily is a colony-forming spring ephemeral that showcases a single yellow, bell-shaped flower, often with fine red speckling near the center, that hangs from a leafless flower stalk. They have three petals and three sepals. Trout lilies do not flower for the first four to seven years of life, and in a colony, only around .5% will flower. Flowering plants have two basal leaves, while non-flowering plants have only one. The large leaves are green with purple-brown mottling, resembling the dorsal speckling of a brook trout (*Salvelinus fontinalis*) in pattern, which gives them their name. Trout lilies store starches produced by photosynthesis in underground corms.

Only 10% of pollinated trout lilies will successfully produce seeds. Therefore, they spread primarily by root sprouting, and form massive colonies on the forest floor, often near streams. Existing individuals will produce a dropper–a stem that grows off of the parent corm and grows up to the surface and then down into the dirt, where it grows a new corm. The dropper then dies off, leaving two separate individuals. Some colonies of trout lilies have been dated at up to 300 years old.

Jack-in-the-pulpit (*Arisaema triphyllum*) is a spring ephemeral very unique in appearance that can be found in the Mount Rogers region. It is composed of structures called a spathe and spadix. The spadix is a maroon stalk with a cluster of small, embedded flowers, similar in structure to a cattail (*Typha* sp.). The spadix is surrounded by a large bract, or modified leaf, called a spathe. The spathe is light green with maroon stripes, and surrounds the spadix like a cone-shaped cup, with a flap over the top called the spathe hood. The lip around the edge of the spathe cone functions as a landing platform for insects. The basal leaves of Jack-in-the-pulpit are split into three leaflets. Each plant usually only grows two leaves. After pollination, the spadix supports large, red berries, each with up to five seeds that ripen in the fall.

The leaves and fruits of Jack-in-the-pulpit contain a compound called calcium oxalate that can cause skin irritation. They spread by both seed dispersal and root sprouting from an underground corm. Jack-in-the-pulpit plants exhibit dichogamy, or sequential hermaphroditism. They do not flower until they are 1-3 years old, and produce only male flowers initially. As they age, they will produce more and more female flowers, until they produce no male flowers.

Fringed phacelia (*Phacelia fimbriata*) is a weak-stemmed ephemeral species often found growing in large colonies on the ground when in bloom. An individual plant can sport five to 15 flowers, each with five distinct, deeply-fringed petals. Their petals are usually white in color, but can sometimes show a slight blue or purple tint. Fringed phacelia is a lover of the high elevation deciduous habitats common in the Mount Rogers region, as they require cool temperatures for seed germination in the fall.

Other native phacelia include Miami mist (*Phacelia purshii*) and fernleaf phacelia (*Phacelia bipinnatifida*). Miami mist is often confused for fringed phacelia because its petals are also fringed, though its fringe is not as deep as the fringed phacelia, and its petals usually have a light purple tint on their outer edges. The fernleaf phacelia has purple petals and no fringe. Fernleaf and fringed phacelia are more common at higher elevations, while Miami mist is less common in the mountains.

A very common springtime sighting, and yet another native spring ephemeral, is the mayapple (*Podophyllum peltatum*). These plants are known for growing in colonies and for their large, deeply lobed leaves that resemble a closed umbrella when they emerge from the ground. When the stem matures to full height, the leaf unfurls. Each leaf has five to nine deep lobes. Each mayapple stem can have one or two leaves measuring up to a foot in diameter. If a stem has one leaf, it does not flower, but if it has two leaves, it will. The flower bud will hang where the two leaves meet. When it opens, it is two to three inches wide, with six to nine white petals and yellow reproductive organs. The flowers can be difficult to spot under the canopy of the large leaves, and they only live for a very short time, but pollinators are lured in by their light scent. After a mayapple has been pollinated, it produces a single berry, which is very popular among wildlife and foragers. All parts of the plant contain a toxin called podophyllotoxin, including the seeds, but when the fruit ripens from green to yellow, it is safe to eat. Mayapples primarily spread by root sprouting from underground tubers, forming massive colonies. They are thought to be indicators of ideal morel mushroom (*Morchella*) habitat. They both prefer moist, shaded areas with plenty of humus (decaying leaves). It's said that the mayapples bloom after the morels emerge. Mayapple rust (*Allodus podophylli*), a bright orange fungal parasite, can sometimes be found on the leaves of mayapple plants.

Red trillium (*Trillium erectum*) is perhaps our most easily recognized spring ephemeral. In typical trillium fashion, everything comes in threes. The plants have three distinct bracts, or modified leaves, right behind a flower with three petals. Petals in this species can range in color. Here in the Blue Ridge Mountains of Virginia, we see dark red or yellow petals with yellow reproductive organs. Only one color morph of the red trillium–white petals–has been recognized as an official variation (*Trillium erectum* var. *album*), and is found in the mountains of the Carolinas. Below the flowers are a set of three leaves in a whorl. Sometimes the flower will hang below the leaves, hidden from view. The nickname stinking Benjamin is a reference to their foul smell, which attracts pollinators like flies, as their scent mimics that of a carcass.

Indigenous people used tea brewed from the roots of red trillium to treat menstrual disorders, induce childbirth, and help with labor. Some call it "bethroot," when the true translation is "birthroot." The Cherokee used a paste made from the whole plant to treat tumors, inflammation, and ulcers.

Members of the mustard family (*Brassicaceae*) are rarely cited for their beauty. Cut-leaved toothwort (*Cardamine concatenata*) is an exception. This ephemeral species sprouts a single stem from a small, segmented rhizome, and grows eight to 15 inches in height, terminating in a cluster of small, white flowers about three quarters of an inch in diameter. The flowers can sometimes have a pink tint, particularly when

budding. Coarsely toothed leaves circle the stem in whorls of three. This species largely spreads by sending out tuberous rhizomes that sprout stems and flower, but also produces seeds stored in long, erect pods that split open, ejecting the seeds when ripe.

Cut-leaved toothwort, as well as other Cardamine species, are important host plants of the rare and endemic West Virginia white (*Pieris virginiensis*). While the butterflies are still abundant in some areas, including the valleys of the Mount Rogers region, West Virginia whites are rapidly declining, partially as a result of the introduction of the invasive-exotic herb known as garlic mustard (*Alliaria petiolata*). Garlic mustard is related to toothwort, so searching mothers often mistake it for toothwort species and lay their eggs on the larger, healthier plant that looks like their traditional host. However, compounds in garlic mustard are toxic to many insects, including West Virginia white caterpillars, which use their host plants to feed heavily upon hatching.

The Mount Rogers high country truly is a living, dynamic landscape, and in no other way is this perhaps more noticeable than in the progression of wildflower assemblages throughout the seasons. Spring ephemerals provide some of the first signs of an approaching spring in our forests, and a fleeting opportunity to glimpse some highly specialized organisms as they make hay while the sun shines.

Mammalian Mating

March is an interesting time on Mount Rogers and its surrounding peaks. With plenty of snow still on the ground at the highest elevations in Virginia, many animal species are still hunkered down in their winter dens waiting for warm weather and emergence of food sources. However, as the month progresses and spring matures, many of the region's mammals begin moving about, seeking to fulfill perhaps their most important duty–mating.

Spotted Skunks

Unlike many other mammalian species, eastern spotted skunks (*Spilogale putorius*) do not hibernate, and are active all winter long. By late February and early March, male spotted skunks are expanding their territories in search of mating opportunities. Spotted skunks are not monogamous creatures, and by mid- to late-March, males will have established a home range that encompasses multiple female home ranges, and will defend their home ranges (and their females) against competing males.

While most of the year this species lives a solitary life, during the mating season (mid-March to early-April), male and female spotted skunks will spend up to a few nights together in the same den, after which one or both may search out a different mate. Researchers have used radio telemetry to track the movements of spotted skunks on Mount Rogers and the surrounding Blue Ridge and Appalachian Mountains, and have found mate switching to be common for both male and female spotted skunks. This type of mating behavior is thought to improve the chance of producing high-quality and genetically diverse offspring. It is common for spotted skunks to use underground burrows that have been excavated by other species or rock crevices as den sites throughout the year. However, during the mating season, spotted skunks will often occupy hollowed out cavities in hardwood trees high above the ground. It is still unclear why spotted skunks in this area tend to use tree cavities more often during mating season than during any other time of year, but researchers hypothesize that the elevated den sites may provide protection from predators and assist with chemical signaling to help these rare and solitary animals find mates.

Courtship between spotted skunks has been rarely observed, as this species is nocturnal and secretive. When observed in captivity, courtship and mating between spotted skunks has been described as rough or aggressive. The pair will often spar or wrestle initially, and if the female is receptive, the male will hold the female in place during mating by biting the back of her neck. This is likely repeated over the course of a few nights before the pair separates. By mid- to late April, mating has mostly ceased, and male and female skunks go back to their solitary lifestyle.

By mid- to late May, pregnant spotted skunks will start searching for maternity dens. Females will often find an underground burrow hidden in dense vegetation where they will give birth to a litter of kits, usually during the last week of May after about a two-month gestation period. Litter sizes vary from one to six, with an average of two to four kits. Maternity dens differ from dens that male or non-breeding female spotted skunks typically use. Male skunks and females without kits will use a variety of dens including tree cavities, underground burrows, and rock crevices, switching dens often (every one to three days), whereas a maternity den will be occupied by a mother spotted skunk and her kits for one to several weeks unless disturbed by a predator.

While the newborn kits are nursing and growing, the mother will keep them in the underground burrow, only moving them if the burrow is investigated by another animal such as a coyote (*Canis latrans*), bobcat (*Lynx rufus*), striped skunk (*Mephitis mephitis*), or Virginia opossum (*Didelphis virginiana*). Smaller, non-predatory animals do not seem to upset a mother spotted skunk, as researchers have often seen Allegheny woodrats (*Neotoma magister*), mice, and squirrels around spotted skunk dens. However, mother skunks do not seem to leave the safety of their offspring to chance, as most maternity dens have more than one entrance or exit, which provides her and her brood with a quick escape route when needed.

Newborn spotted skunks are born blind, deaf, and hairless. The warm, moist microclimate inside the underground burrow provides an ideal climate for the helpless offspring. However, as they grow and begin to emerge from the den by mid-July, the mother skunk will move her offspring to a new den often located in an emergent rock outcrop or rock pile. These rock crevice dens provide ample escape cover from predators for rowdy, playful spotted skunk kits who spend most of their time exploring and playing with each other while waiting for their mother to bring tasty food back to the den. By this time of the season, the mother spotted skunk is weaning her kits and provisioning food such as salamanders, frogs, and large insects to teach her kits how to catch and handle their new food sources. Once the kits are large enough to travel with their mother, the family will start to change den sites often. The kits will stay with their mother, growing and learning to hunt until late fall when they will eventually disperse to establish their own home range. By November, the mother skunk is usually back to a solitary lifestyle, and spends the next few months resting, eating, and gaining back the weight she lost while raising her brood all spring and summer long.

High Country Squirrels

Spotted skunks are not the only tree-dwelling mammalian critters with reproduction on their minds come March. Carolina northern flying squirrels (Glaucomys sabrinus coloratus) are a federally endangered species endemic to high-elevation red spruce and Frasier fir forests. Little is known about the reproductive ecology of these small, gliding rodents, however researchers are continually learning more and more about this species in a collaborative, range-wide effort to recover the remaining populations in the southeast.

During annual winter surveys, researchers will often find groups of 2 or more flying squirrels nesting communally in tree cavities and artificial nest boxes. These are likely family groups including mothers and offspring, but sometimes groups of adult males are found together. Communal nesting during the cold months of winter at these high elevation sites helps these tiny rodents stay warm.

Mating typically occurs during the winter months starting in December, and continues into early spring. Females who successfully mated in winter will give birth to about two to four offspring in March after about a 37-day gestation period, though it is not uncommon to see litters born through June, or even as late as September. It is suspected that these later litters are a result of a second breeding attempt following a failed first litter. However, recent observations have shown that some female northern flying squirrels will attempt a second litter while still nursing the first litter. Multiple successful litters in a year could help increase population size of this critically imperiled species. Northern flying squirrel offspring will wean around two months old, though young will often stay with their mother for several months or even into the next mating season.

Another high-elevation squirrel that feels right at home in the Mount Rogers area is the red squirrel, or mountain boomer, as they are colloquially known.

These small tree squirrels, distinguished by their red fur, nervous disposition, and near constant chattering, will nest in tree cavities and artificial roosts in the same general areas as northern flying squirrels, though never together in the same nest with northern flying squirrels. Red squirrels typically mate from mid-January to late-September, with peak mating activity occurring from spring to late-summer. Red squirrels can produce more than one litter per year. Gestation lasts around 35 days, and the first litter is typically born in late spring. If there is a second litter, a second mating occurs in June or July and the litter is born in September or October. Litter size can vary greatly (one to eight) with an average of four to five. Young red squirrels are typically weaned around seven to eight weeks old and leave their mother after about three months. Offspring will reach sexual maturity around one year old. Litters born earlier in the year tend to have higher rates of survival, likely because they will reach a larger size before the colder months of fall and winter hit the mountain.

Mountain Marsupials

The Mount Rogers region is also home to North America's only marsupial, the Virginia opossum (*Didelphis virginiana*). This unique species can make its home in just about any natural or human-made habitat, making use of a variety of den types. In the high-elevation spruce-fir forests of the Mount Rogers area, Virginia opossums will nest in hollow trees, stumps, and logs and will frequently use the nests and burrows of other mammals such as squirrels, skunks, and foxes.

As a marsupial, the reproductive ecology of Virginia opossums is vastly different than any other mammal found in the region. Females of this species are polyestrous, meaning they can come into heat and reproduce multiple times throughout the year with a typical cycle lasting 22 to 38 days. Mating generally occurs from January through late fall, with two distinct peaks in mating activity. The first peak occurs from January through February, followed by a second from May through June. Gestation for this species is short, at just 12 days.

Like other marsupials, the offspring are born very underdeveloped. Most of the offspring's development occurs after birth in the marsupium (natal pouch) located on the mother's belly. A female Virginia opossum can give birth to an astounding number of offspring ranging from four to 35. However, even though a female Virginia opossum has 13 teats, not all of them are functional, which limits the number of possible surviving offspring to a maximum of 12. Newborn Virginia opossums will crawl from the birth canal to their mother's pouch and physically attach to one of her teats. The baby opossum will stay attached to that teat until it fully develops and can leave the pouch.

Once out of the pouch, the offspring will often ride on the mother's back and she will carry them from den to den until they are large enough to keep up with her on foot. Virginia opossums typically reach sexual maturity around six to eight months old, and will leave their mother to lead a solitary lifestyle. Once her brood has left, a female Virginia opossum will very quickly be ready to mate again and raise a whole new litter of offspring.

The mating ecology of mammals can be difficult to observe, especially for the secretive and cryptic species that call Mount Rogers their home. The cold, snowy winter months of March and April provide a challenge for small, warm-blooded animals to successfully mate and raise their offspring. What little we know of how each species goes about reproducing tells us a great deal about the diversity of life histories in this special high-elevation spruce-fir forest and how different species have adapted to succeed in this unique environment.

Emerging Insects

On the first warm days of spring, there is hardly a more subtle or important moment to banish the gray, unyielding bleakness of winter than the resurrection of insects. Most spring insects fall victim to the evolutionary curse of extremely short lifespans, emerging as a new, annual generation with the first wildflowers. As lush, floral life burgeons into a new spring in the Blue Ridge Mountains, insects begin to fulfill intricate and mysterious relationships.

Pollinators are some of the first insects to emerge, alongside wildflowers. Spring beauties (*Claytonia* spp.) are some of the first wildflowers to appear in the spring from tiny, potato-like roots. Often flowering while snow is still lingering on the ground, they are a common spring ephemeral that bloom and vanish in a matter of weeks. The spring beauty mining bee (*Andrena erigenae*) is a solitary bee, emerging from a mud nest underground in the forest to visit the white flowers once temperatures rise above freezing. Carrying swollen pockets of pink pollen, the small metallic bees quickly build another nest in a subterranean tunnel, lay eggs, and die away before spring ends. In the span of a few weeks, a mining bee is able to complete a legacy that requires an entire colony of domesticated honeybees and months of hive-mind labor to accomplish. The surge of energy spring induces creates these almost impossible feats, especially against adversaries.

There are many struggles a defenseless solitary bee endures to simply survive, but mining bees are hunted by certain specialist predators. Nomad cuckoo bees (*Nomada* spp.) are parasitic, solitary bees that require mining bee hosts. These wasp-like, almost hairless bees will search for mining bee nests on the forest floor, laying their own eggs to hijack the nest by unleashing their own carnivorous larvae. Since mining bees are solitary, a mother will not defend her nest even if she notices an intruder. By the time a mining bee larva has

eaten all of the nectar and pollen stored by a devoted, long-dead mother, the cuckoo bee larvae hatches, and the engorged, helpless mining bee is slowly devoured by the voracious cuckoo bee.

Different mining bees are keystone species in the greater phenomenon of spring pollination, especially for spring ephemeral wildflowers and insect-pollinated woody plants. Many harmless insects, including hover flies (*Syrphidae*), bristle flies (*Tachinidae*), bee flies (*Bombyliidae*), and many others mimic the small, stinging bees. Even though mining bees are not aggressive, if captured, they are capable of stinging repeatedly in contrast to familiar honeybees.

Many insects are vital as prey in the spring. Flies, moths, beetles, and a wide assortment of herbivorous insects become prey for migrating and emerging birds, amphibians, reptiles, and mammals. Most easily observed invertebrates have developed interesting strategies for self defense. The eastern tent caterpillar (*Malacosoma americana*) forms nests of silk in the canopy of wild cherry trees, and caterpillars emerge covered in irritating hairs. Cuckoos are their only regular predators, capable of vomiting up their stomach lining after consuming so many of the caterpillars that the hairs render their digestive system dysfunctional. Likewise, Short-winged blister beetles (*Meloe angusticollis*) and their relatives have a blue, metallic exoskeleton that reflects brightly on the dry leaves of the forest floor. As large and obvious beetles, they play dead when a potential predator investigates them. If the predator does not leave, the blister beetles break their own legs to bleed orange droplets of hemolymph, the insect equivalent of our blood. This hemolymph contains irritating compounds that discourage most insectivores on the forest floor, allowing the beetles to escape.

Other spring insects are less conspicuous. Ants play an extremely valuable role in springtime ecology. After the first spring ephemeral wildflowers bloom, ants begin to roam across the forest floor and into the canopy. The black thread-waisted ant (*Aphaenogaster picea*) is one of the most abundant insects in the high-elevation forests of the Blue Ridge, especially above 3,000 feet in mixed hardwood forests. They prefer the same habitat as many spring wildflowers. Dozens of local species, including trilliums, bloodroot, and violets, require ants for seed dispersal. As seeds mature, a fleshy coating called an elaisome forms around each seed. Filled with sugars, ants carry the entire seed to their nest. Feeding on the elaisome, the ants discard the viable seed into their trash heap within the nest. In this fertile environment, the seed is able to germinate and thrive.

Aside from seed dispersal, ants have many other ecological niches. They are opportunists. Some of the largest ants in the world are the American carpenter ants (*Camponotus*), and several of the smaller, cold-tolerant species occur in the Blue Ridge. Similarly, field and mound ants (*Formica*) become active, and are much faster predators on hot, dry ground. Underground, bright golden-yellow ants known as citronella ants (*Lasius aphidicola*) tend colonies of honeydew-producing root aphids or scale insects. When disturbed, they radiate a mist of formic acid that has a powerful, pleasant smell of lemons. Another group of extremely small ants, the acorn ants (*Temnothorax* sp.), fit an entire colony in an acorn hull to overwinter. When spring arrives, they become arboreal and clean debris from leaves in the canopy. Our broad and diverse arrays of ant species serve the surrounding ecosystem as a combination of pollinators, seed dispersal agents, predators, scavengers, and decomposers.

Together, insects begin many of the regenerative processes that give rise to a productive growing season. Without them, spring as we know it would never arrive!

Butterflies

As spring breathes new life into the Appalachian Mountains, a vibrant array of butterflies emerges, painting the landscape with fluttering beauty. Their emergence coincides with the blooming of flowers, creating a symbiotic relationship as butterflies pollinate plants while seeking nectar. Butterflies play a vital role in ecosystems by serving as pollinators. As they flit from flower to flower in search of nectar, they inadvertently transfer pollen, facilitating the reproduction of plants. This pollination process is essential for the production of fruits and seeds, contributing to the overall health of ecosystems.

The presence of butterflies in spring is indicative of a healthy and diverse ecosystem. These delicate creatures are sensitive to environmental changes, and their abundance reflects the well-being of local flora and fauna. Conserving butterfly habitats becomes crucial for maintaining biodiversity.

Among the myriad species that grace this region, three stand out as emblematic representatives: the Appalachian swallowtails, West Virginia whites, and Appalachian azures.

The Appalachian Swallowtail *(Pterourus appalachiensis),* with its graceful wings and distinctive markings, is a sight to behold. This species, endemic to the Appalachian region, showcases wings adorned with bold yellow and black patterns, reminiscent of the classic swallowtail design. These butterflies are often found fluttering near woodland edges and meadows, sipping nectar from a variety of spring-blooming flowers.

The Appalachian tiger swallowtail is believed to breed in the forest canopy in higher elevations, not in the understory, and can be seen during its peak flight and egg-laying period in May and June. The primary host plant remains unknown, though observations indicate that Black Cherry (*Prunus serotina*) is occasionally used along forest edge habitat. This species, recently described, is difficult to differentiate from its close relative, the Eastern tiger swallowtail, (*P. glaucus*) requiring photographic evidence to be verified by an expert.

West Virginia whites (Pieris virginiensis) are distinguished by their pristine white wings and subtle greenish undersides, West Virginia whites add a touch of elegance to the springtime Appalachian landscape. These butterflies favor cooler habitats, including mountainous areas and shaded woodlands. Their lifecycle is intricately linked with native plants like toothworts and mustards, upon which their caterpillars feed.

Previously numerous all along the Blue Ridge, the primary hosts are species of Toothwort(*Cardamine).* With the spread of Garlic Mustard (*Allaria petiolata*), the butterfly has completely disappeared wherever garlic mustard is established. The female butterflies prefer to lay eggs on garlic mustard but it is toxic to the larvae. Garlic mustard tends to take over the forest floor and native plants seem to disappear in stands of garlic mustard, which outcompetes native plants. While easy to pull out, the plant produces abundant seeds that remain in the forest floor's seed bank for many years, possibly decades. Teams of volunteers would need to be employed seasonally to keep this plant under control. Future conservation efforts to preserve the butterfly would likely, at this point, depend on reintroduction of the butterfly from active colonies elsewhere in combination with active removal of garlic mustard. Observing the West Virginia white in flight offers a serene glimpse into the delicate balance of nature that characterizes this unique ecosystem.

Appalachian Azures (*Celastrina neglecta*) are a petite and enchanting species, embodying the ethereal beauty of spring. With wings adorned in shades of pale blue and subtle hints of lavender, these butterflies evoke a sense of wonder as they flit among early spring blossoms. Their preferred habitats include shady, moist hillsides within mountain cove forests. The butterflies produce only one generation per year and usually fly after spring azures but before summer azures where their larvae feed on its host, black cohosh (*Actaea racemosa*). Although this species is not threatened with extinction, its habitat may also be threatened by the spread of the garlic mustard (*Alliaria petiolata*). Additionally, black cohosh is being harvested from the wild for use as a dietary supplement. Wild harvesting of medicinal plants can lead to low numbers of those plants. In many areas, rampant uncontrolled deer browsing eliminates the flower heads that the butterfly depends on. Once the flower heads are eaten, the butterfly colony disappears. While many people are not fond of the idea of deer hunting, such is necessary to save many of our native plant species that the deer are destroying in many areas.

The springtime butterflies of the Appalachian region enrich the landscape with their beauty and ecological importance. Their presence underscores the region's biodiversity and serves as a captivating reminder of the intricate web of life that thrives amidst the mountains, meadows, and woodlands of Mount Rogers.

SUMMER

June, July, August

Weather Stats

Average Temp	66.8℉
Max Temp (avg.)	80.7℉
Min Temp (avg.)	59.0℉
Average Humidity	78%
Average Precipitation	4.12”
Average Snowfall	0.1”

Millipedes and Land Snails

Hundreds of millipede species are found in the Blue Ridge Mountains and nowhere else in the world. Our cryptic and mysterious array of species rivals the tropical rainforest in diversity, eccentricity, and beauty. The millipedes at high elevations are also much more tolerant than tropical relatives; some individuals exist for years by crawling into channels of subterranean burrows to escape the winter cold.

Cherry Bugs and Iron Worms

One of the best ways to enjoy native millipedes is by understanding the difference between a centipede and a millipede. The most common scientific way to distinguish the two groups is by counting the number of legs on each segment. Centipedes have one pair of legs per segment, while millipedes have two. This is difficult to practice without a very close look at one of the animals, a view that might be dangerous in some cases. Despite widespread myths, the total number of legs will never allow you to distinguish the two very different groups. Although “milli-” means “one thousand,” and “centi-” means “one hundred,” many millipedes have very few legs compared to centipedes. None of our indigenous species have one thousand legs. While millipedes usually mature with only a few dozen legs, some indigenous centipedes boast several hundred.

Aside from their legs, their other differences are much more obvious and are better, safer tools for identification. Millipedes are harmless decomposers, equipped with a hardened exoskeleton that functions as a covering of interlocked plates of armor. They are slow-moving and often filled with powerful toxins, incapable of causing harm unless the whole millipede is consumed. Centipedes are fast, soft-bodied, and predatory, equipped with a pair of venomous fangs known as forcipules used to capture insects, worms, and even small vertebrates.

Cherry millipedes (*Xystodesmidae*), often called “cherry bugs” colloquially, forage across the Appalachian forest year-round. Almost as soon as spring wildflowers are in full bloom, the millipedes emerge from their winter haunts below to scour the forest floor in search of decomposing leaves and mates. Most species are black with extremely variable combinations of bright yellow, red, orange, or even blue and white bands. These colors are aposematic, meaning they warn potential predators that the millipedes contain powerful toxins.

Cherry millipedes are named for scented reserves of hydrogen cyanide under their plated exoskeletons. When disturbed, a cherry millipede is capable of spraying a fine, harmless mist thanks to specialized organs known as ozopores. The mist has a pleasant scent, much like cherries or almonds, but has a very different

taste. Exposure to these toxins on any soft tissues, such as the tongue or lips, causes a burning sensation similar to that of a habanero pepper. The traces of cyanide may be medically harmful if the entire millipede is ingested, but these millipedes are harmless even when handled with contact to bare skin.

Millipedes work to complete the annual cycle of falling leaves to nourish the woodland soil. As continual detritivores, they lower the depth of leaf litter just enough to aid the survival of wildflowers and other herbaceous plants in the forest while leaving enough to prevent erosion and keep delicate soil microfauna alive. Black-and-gold cherry millipedes (*Apheloria virginiensis*) are some of the most common and widespread cherry millipedes in the Blue Ridge Mountains. Like most cherry millipedes, they are biofluorescent, and are easily spotted en masse on cool, rainy nights with the beam of a UV flashlight.

The first researcher to realize the incredible diversity and importance of millipedes in the Southern Appalachian Mountains was Richard Hoffman, a local entomologist originally from Southwest Virginia who is known for his time as a professor at Radford University. Starting at age 16, he began publishing papers about natural history, particularly reptiles and amphibians. By the mid-20th century, he was considered the world authority on millipede classification, and of Virginia natural history as a whole. Although he was offered positions at much more prestigious universities and museums, he chose to stay in the place he loved. For decades, Hoffman regularly guided workshops at the Mt. Rogers Naturalist Rally when it was originally held at the then-dilapidated Konnarock Girl's Training School. When he passed in 2012, a close colleague and fellow myriapodologist (studier of myriapods, including millipedes and centipedes) Rowland Shelley compared his death to an extinction, in respect to the vast expanse of knowledge that was lost when he died. Hoffman never lived to see the restoration of the old school as it transformed into the Blue Ridge Discovery Center that was established exactly a decade after his death, where his research and conservation efforts would have thrived. Still, his legacy lives on in the names and relationships between the many-legged creatures that roam the mountains.

Picking up where Hoffman left off, a group of Virginia Tech researchers began to study these millipedes in the early 21st century. The Marek Lab set out to classify millipedes through genetics and dissection. Three researchers, Paul Marek, Derek Hennen, and Jackson Means dove into the study of millipedes around the time of Hoffman's death, keeping the legacy alive. Armed with handheld rakes, the scientists successfully completed collecting trips deep in the rhododendron thickets, or "laurel hells," of the Appalachians to high-elevation peaks. In the following dissections and genetics work, the team found something extraordinary. Almost every valley, every watershed, and every isolated mountain was home to a unique millipede species.

Sometimes, several coexisting species existed in these regional microhabitats and nowhere else in the world. Through this revelation, they discovered that the millipedes use Mullerian mimicry to protect themselves from predators. Instead of individual patterns unique to one species, the species mimic each other. Birds migrating across the country, or mammals foraging on the opposite side of a ridge, only have to learn to avoid one species of cherry millipede, once. The similarity between the coloration and scent of the millipedes keeps them thriving in solidarity across the Appalachians, and the rest of the Southeastern United States, with time-tested predator evasion capabilities.

The extreme endemism of millipedes is obvious in most species found in the Blue Ridge Mountains. The common millipedes of northern Smyth County, Virginia on Big Walker Mountain are *Appalachioria* species. On the southern edge of the county in the high-elevation Blue Ridge, they are replaced by *Apheloria*. To the

west, *Brachoria* species appear. One such is the Mendota mimic millipede (*Brachoria mendota*), named for the unincorporated community of Mendota at the foot of Clinch Mountain with a total population of 135 residents. The entire documented distribution of the species lies within one hundred miles of the town, following a narrow range of foothills southwest. So many new, cryptic species were discovered by the Marek Lab that naming them proved to be an interesting challenge. Many millipedes have been named for towns, habitats, and even popular musicians such as Taylor Swift (*Nannaria swiftae*). Still today, there is an abundance of undocumented biodiversity amongst these cryptic, visually-similar (or even identical) millipede species.

Despite their sheer number and diversity in the highlands, cherry millipedes are far from the only millipedes found in the Blue Ridge. American giant millipedes (*Narceus americanus*) are often spotted roaming in broad daylight. They are regionally known as "iron worms," since their metallic, cylindrical exoskeletons provide valuable armor against predators. They are harmless, long-lived millipedes that often carry communities of mites and other small invertebrates with them between the red bands on their exoskeletons. Some are phoretic, or just hitching a ride. Others are parasites, drinking the millipede's copper-based blood or chewing on their calcareous exoskeletons. Others still are beneficial, and necessary, to clean crevices of the millipede's rigid body. Other mites are predatory, eating their millipede-riding relatives regardless of occupation. The mite *Narceolaelaps americanus* is dependent on the *Narceus americanus* millipedes on which they ride, and are found on no other millipede species.

Giant millipedes grow up to five inches in overall length, and are easily noticed roaming the forest floor or while crawling along the mossy trunks of trees. When disturbed, some individuals violently thrash around or tightly coil up. Others ooze honey-colored benzoquinones that are quickly absorbed into the exposed skin of predators, causing mild chemical burns that transform into a dark maroon stain across the affected area. The burns are seldom felt by predators, but the stain can be very obvious. Virginia opossums (*Didelphis virginianus*) are some of the only vertebrate wildlife known to feed on giant millipedes regularly.

Other millipedes are much less conspicuous. Feather millipedes (*Brachycybe lecontii*) are flat, pink millipedes with a prehistoric body plan. They roam under the peeling bark of decaying logs. Living in colonies, they are known to practice a form of agriculture. Adult feather millipedes begin to move and grow patches of white, fungal mycelium in ideal crevices of the rotting wood. Several species are usually cultivated, all of which help decompose wood and feed the millipedes with nutrients indigestible to a typical animal digestive system. Over 176 species of fungi are cultivated by these millipedes, and several are undescribed. As the fungi grows, feather millipedes begin to reproduce and the males typically guard and care for the young, which huddle around the fungal rosettes.

While they boast nowhere near the diversity of millipedes in the region, some notable centipedes do occur in the Blue Ridge Mountains. The largest and most formidable of these is the eastern fire centipede (*Scolopocryptops sexspinosus*), a scarlet-orange centipede reaching adult sizes over three inches in length. Hunting large insects and other invertebrates, they do not hesitate to take prey as large as woodland salamanders (*Plethodon* sp.) with a bite that is lethal to small animals. The bite can also be excruciatingly painful to humans, although it is not typically medically significant. Their smaller, darker relative, the bluebelly centipede (*S. nigridius*) has a bright-red head and greenish-blue body.

Other unique centipedes include the forceps centipedes (*Theatops* spp.), which are similar in size to the fire centipedes. Instead of a single pair of fangs, their rear legs are modified into hooked fang-like structures for

capturing and stabilizing prey. Soil centipedes (*Geophilomorpha*) are another group of common, thread-like centipedes that feed on soil microfauna and earthworms, aerating the soil by creating thin, wandering tunnels. A few species of soil centipedes (*Strigamia*) are snail specialists with a tapered body to wrangle prey that would otherwise be retreating into an unreachable shell. Some individuals have over 300 legs, many more than other millipedes and centipedes in the region. All of these centipedes are extremely solitary and cannibalistic. Even mating takes place using specialized spermatophores rather than physical interactions between the parents. However, adult females are devoted mothers, protecting the eggs and young (protonymphs) until they are old enough to rapidly disperse before being eaten by siblings or a hungry mother.

Millipedes and centipedes have an enormous presence across the Blue Ridge landscape. As fascinating as they are, few people take the time to observe them. Hikers frequently step over them without a second glance, and many of their carcasses are found mashed by the tires of mountain bikes on trails. Many more do not even notice millipedes as they casually stroll the forest floor. A grand flourish of biodiversity, millipedes are some of the most colorful, interesting, and easy-to-observe wildlife in the highlands. Stopping to appreciate them can bring you into a parallel world of miniature wildlife with bizarre stories and new discoveries.

Land Snails

Over 250 species of land snails exist in the state of Virginia, most of which are found in the Blue Ridge Mountains. Some species of terrestrial snail can be found in almost every mountain habitat from semiaquatic, swamp-dwelling species in the river valleys to xeric, rock-dwelling species on grassy balds. Unlike aquatic snails, land snails have lungs, extendable eyestalks, and drastically different behaviors than those found under the surface of streams and ponds. Temperate rainforests across Appalachia provide a place for bizarre snail survival strategies to diversify and thrive, particularly in the harsher environments of the Blue Ridge escarpment.

A great example of uniqueness in high-elevation snails is the flamed tigersnail (*Anguispira alternata*). This common, red-banded species is found at almost all elevations of eastern North America, but only in humid old-growth cove forests with the ideal species composition can you find colonies of these mollusks. Sometimes hundreds of the snails are nestled into the moss and bark crevices on a single, ancient buckeye or sugar maple trunk. Tigersnails (*Anguispira* spp.) are the only obligate arboreal snails in the mountain range. Even though other species will climb trees occasionally, tigersnails require trees.

They're opportunistic scavengers, feeding on a wide range of strange foods provided by the giant trees they consider home. Slime flux is a sugary, sap-rich discharge from trees infected with a handful of internal fungi introduced by feeding insects, violent storms, or other external damage. Butterflies, bees, moths and other insects swarm these slimy, often fermented rivulets that course down tree bark. Tigersnails also find the slime flux delicious, and dozens gather around the "bleeding" scars of affected trees. A love for sticky, sugary fluids drives tigersnails to forge a special relationship with the yellow-bellied sapsucker, a migratory woodpecker common in the same habitats.

Sapsuckers drill rings of holes around the trunks of large trees. The wounded trees ooze sap, which, like the slime flux, attracts eager insects. Once the sap flow is steady and insects surround the tree, woodpeckers return to eat the baited prey. Tigersnails join this feeding frenzy, but have a secret defense against the

woodpeckers. Tigersnails generate a biofluorescent, glue-like slime when disturbed. Under an ultraviolet flashlight, the snail's defensive mucus glows bright green. Sapsuckers can see many more wavelengths of ultraviolet light than humans, and quickly recognize that the snails are not appetizing targets. Leaving the snails alone to feed, woodpeckers rapidly find their wells inundated with the colorful, spiral-shelled visitors. In certain habitats, their similar relative the mountain tigersnail (*Anguispira jessica*) and a few other relatives can be found, but the former is much more common.

The glassy grapeskin (*Vitrinizonites latissimus*) is another strange, mysterious snail of the highlands. Living in acidic environments with little available calcium for consumption, they have flexible, translucent shells much too small for their swollen, purple-blue bodies. They are the only known terrestrial snails with a nautiloid shell, a shell type found only in some oceanic relatives of squid considered living fossils deep beneath the sea. Grapeskin snails acquire calcium through their prey, particularly much larger, more herbivorous snails that retain calcium from plant material, bones, and fungi. Not only are the snails carnivorous, but they will actively hunt together to devour larger species on the forest floor. Like slow-motion, miniature wolves, they prowl the nocturnal forest during warm, wet weather. On rainy nights, they often gather on roads where the tiny carcasses of roadkill snails dapple the highway.

The Blue Ridge Mountains are also home to snails with hair. The highland slitmouth (*Stenotrema altispira*) has an extremely thick, rounded shell. The entire surface is covered with velvet hair, functioning as a velcro-like adhesive while they are climbing boulders or under bark. Slitmouth snails are also known for their jagged, narrow aperture or opening of the shell, narrow enough to keep voracious Snail-eating beetles (*Scaphinotus andrewsii*) away.

The most commonly encountered snails in the cove forests of the Blue Ridge Mountains, the grand globe (*Mesodon normalis*) and eastern whitelip (*Neohelix albolabris*) snails, are much larger. These snails are giant in comparison to other native species and feed on plants, fungi, and decaying organic matter, with shells almost as large as golf balls (around 30-40mm in diameter, typically). Their slime trails, and even feeding evidence (in the form of jagged radula scars and toothy bite marks in large mushrooms) are easily noticed. Some of the snails have annual cycles, maturing in a single growing season. Others live for several years, developing a weathered shell with scars from an inhospitable environment and unsuccessful predators over their years of journeys across the forest floor.

In the spruce-fir forest, there is an endemic relative known as the balsam globe (*Mesodon andrewsae*) with a maroon, translucent shell. The species is named for Mary Andrews who studied the snails of Southern Appalachia during the mid-1800s. The study of Appalachian snails was pioneered by several women who traveled on horseback for collecting expeditions, however their work was largely published through male scientists such as Henry Pilsbry since they were barred from submitting any of their own work to these scientific journals. Thankfully, their legacy at least lives on in the binomial names of many Southern Appalachian snails, tracing back to their history of scientific pursuits.

Land snails embody the ancient and steadfast, and still vulnerable, beauty of the Blue Ridge Mountains. They have dark secrets, but are invaluable to our highland ecosystems. Watching snails glide over rocks and logs in slow-motion is a special moment in the onslaught of outside, human struggles. Land snails know how to enjoy their time in the woods.

Nocturnal Insects

As the sun slips away into a warm summer dusk in the Blue Ridge, and the buzzings of ectothermic insects that thrive in the summer sun tuck into bed, another clan of insects emerges, and some of nature's most classic performances get underway. An adjusted eye will begin to notice gently floating, flashing lights of a warm yellow, green, or even blue, often accompanied by a chorus of melodic chirping. The visual performers are members of the family Lampyridae–colloquially referred to as lightning bugs, fireflies, and glow worms–while members of the order Orthoptera keep the tune. These wonder-inspiring actors are largely nocturnal insects, using summertime darkness to fulfill their reproductive purpose.

Light Shows

Despite their common names, members of the family *Lampyridae* are not flies, worms, or even bugs, in the true sense of the word, but members of the larger order Coleoptera–the beetles.

These insects' classic glow is produced through the process of bioluminescence, where sugars called luciferins are oxidized by an enzyme called luciferase (both named for Lucifer whose name means "light bearer") resulting in the release of light energy. This process is extremely efficient at producing light. Nearly 100% of the energy produced by the luciferase pathway is released as visible light. In comparison, incandescent bulbs are roughly 10% efficient, where the majority of electrical energy is converted to heat rather than light. While the luciferase enzyme is common across species of this family, the luciferin sugar varies between many, resulting in different hues and intensities of luminescence. Both luciferin and luciferase are produced and stored in the lightning bug's lantern, an organ at the end of the insect's abdomen. The digestion of luciferin, and thus light production, is controlled by the presence of oxygen carried by hydrogen peroxide and nitric oxide. Controlling the release of oxygen gives the beetle the ability to turn its lantern on and off.

It is believed that light production in *Lampyridae* originally evolved as a form of aposematic signaling, warning potential predators of the larva's mild toxicity and extreme unpalatability. The adults of some species continue producing a variation of the luciferin sugar called lucibufagin that is extremely distasteful to predators, specifically birds and spiders.

Now, the insects use their bioluminescence for mating displays. In most species, the males fly slowly and low to the ground while emitting their mating display–a series of flashes unique to the species. Females waiting on the forest floor may flash back with a response when they select a mate, usually the brightest male. However, not all Lampyridae species select mates this way. Some use pheromones instead of, or in addition to, visual displays.

While there are just over a hundred genuses described globally in the *Lampyridae* family, there are three genuses that are especially prevalent in the Blue Ridge Mountains. Species in the genus *Photinus* are very common and widespread in eastern North America, and most glow with mostly yellow light. The common eastern firefly (*Photinus pyralis*) is a ubiquitous sight throughout the region from woodlands to developed urban areas. Another noteworthy species is the less common synchronous firefly (*Photinus carolinus*). While they are not the only lightning bugs to synchronize their flashing, they are very conspicuous throughout the Appalachian mountains, primarily in eastern Tennessee, western North Carolina, and southwestern Virginia.

A closely related genus, *Phausis*, contains the blue ghost firefly (*Phausis reticulata*). These lightning bugs emit a very dim, continuous light rather than flashing, maintaining light for over a minute at a time. From afar, their luminescence appears pale blue, but it is actually in the green spectrum when observed up close. This illusion is likely due to the Purkinje effect, which causes us to see blue tints in low light conditions.

A final genus that can be commonly found throughout the Blue Ridge Mountains is *Photuris*. Species in this genus tend to be large for lightning bugs, and males often glow with a darker green light. Despite being a very common genus, this group was only recently divided into species complexes, and still many species remain noted but undescribed in the literature.

The largest and most common species complex of Photuris is called *Photuris versicolor*, named for the variety of flashes members of this species are capable of. A single male is often capable of two or more different mating displays in addition to warning flashes, trains, and other patterns. Many *Photuris* females are predaceous to other lightning bug species, especially *Photinus* males, earning them the moniker "femme fatale fireflies." The females will imitate the flashing of other females, triggering the sexual response behavior in the male. Once he approaches, the female *Photuris* attacks and eats her *Photinus* prey. Not only does she gain important nutrients she needs for her eggs this way, *Photuris* adults have lost the lucibufagin production pathway, so the female obtains these defensive compounds by ingesting them from *Photinus* males. Along with being larger and more predatory, adult *Photuris* are often more prone to "fight" than "flight." The males are known to show bright and rapid warning flashes when caught. In contrast, males of *Photinus* and *Phausis* often go dark when disturbed.

On nights when fireflies are active, if you keep your eyes trained on the ground, you may notice other bioluminescent denizens of the forest floor. As was aforementioned, female lightning bugs often wait on the ground, watching for a potential mate and calling him over with flashes of her own. In Phausis, and a few Photinus species, the female does not develop wings and remains larviform, never undergoing complete metamorphosis. These females look very similar to the larvae of the species, but they do develop complex eyes allowing them superb directional night vision and sensitivity to the males' specific hue. The larvae of firefly species are very difficult to differentiate, and since they bioluminesce for aposematism rather than sexual display, the hue and pattern of their light is not a reliable method of identification. These forms are often called "glow worms," colloquially, due to their long and wingless bodies. However, this is a misnomer.

True glow worms belong to the uncommonly encountered beetle family *Phengodidae*. A very unique genus of glow worm that can be found in these mountains is *Phrixothrix*–the railroad worm. The larvae and larviform females of this genus are capable of producing two colors of luminescence–a pair of red "headlights" on the front of the head, and rows of yellow-green stripes between each segment, as well as yellow spots on the side of each segment. The beetle is named for its resemblance to a train, headlights shining red and windows glowing yellow. Remarkably, the beetle only produces one kind of luciferin which is circulated throughout the insect's body. This likely means each light producing organ produces its own luciferase enzyme, resulting in the different colors.

Another very interesting feature of their bioluminescence is that larval and mature females appear identical. This indicates that their light does not play a role in mate attraction. Instead, it is hypothesized that females emit pheromones that males perceive with their large feathery antennae. Males are mostly nocturnal and

have very large eyes and wings, they seek out females by perceiving both their lights and pheromones. The females and larvae are ground-dwelling predators, feeding mostly on millipedes, especially iron worms. After hunting their prey, the railroad worm will often crawl inside the exoskeleton and wear it as armor, taking its time to eat the rest of the arthropod.

Nocturnal Songsters

Another group of insects belonging to the order Orthoptera is especially active at night. The charismatic members of this group include crickets, katydids, and grasshoppers. If you have stood quietly outside on a warm summer night, you have heard their chorus. Many people carry the misconception that the droning sounds at night are cicadas, but these insects of the order *Hemiptera* are typically very diurnal, only singing in daylight. The cicadas' drone is reminiscent of the buzzing of electrical transformers or sawmills. The trills, chirps, and buzzes heard at night are most likely Orthoptera.

These insects produce a distinct sound via stridulation, an action similar to running your fingernail along the teeth of a comb, producing a twanging or buzzing sound. Crickets and katydids have a tough edge on one wing–the scraper–and a series of wrinkles–the file–on the other. They strum the scraper along the file causing the wing to vibrate, producing the various sounds these insects make. For grasshoppers, a row of tines on the hind femur strum a modified taught vein on the wing. The toughness and size of the wing membrane, and distance between ridges on the file, all contribute to the pitch and timbre of the many members of Orthoptera's song.

Perhaps the most familiar of these singing insects are the crickets, who make up the family Gryllidae. The large subfamily Gryllinae describes the common field crickets. These small black insects make short, repetitive chirps, and it is likely these calls that come to mind when you think of crickets. With tough, leathery wings, the songs of these crickets are musical and mid-pitched, with short, toned chirps. Much like the fireflies, these insects sing to attract mates.

Only the males produce the loud chirps, while females listen with specialized structures called tympanum. These are thin membranes that are very sensitive to sound, often "tuned" to a specific frequency, so that females are able to pick out the calls of their conspecific males amidst the chorus of other species. In crickets, the primary tympana are on the front of the tibia, at the "elbow" of the insect's first pair of legs. By holding her legs to the sides, the female can better triangulate the direction of the male's call. Larger males typically chirp at slightly lower pitches and produce more volume when chirping, and there is some evidence that this makes them more attractive to females. The rate at which these crickets call is very dependent on temperature. If you are able to pick out the chirping of a particular field cricket amidst a chorus, set a timer for 15 seconds and count the number of chirps that transpire. By adding 40 to this count, you may approximate the temperature of the night in degrees Fahrenheit.

A more cryptic family of cricket, *Gryllotalpidae*, shares the grassland habitat of their field cricket relatives. However, as their name suggests, the mole cricket lives primarily underground in expansive tunnels, feeding on plant roots. These crickets have many specialized adaptations for this unique habitat, trading strong jumping hind legs for robust digging forelegs. In many species, the males have no need to fly, so their wings have reduced and specialized, improving their role as mate-attracting instruments. In our most common native species, *Neocurtilla hexadactyla*, or the Northern mole cricket, all individuals are flightless. The males produce low pitched, rhythmic chirps that resonate throughout the substrate from closed burrows. Mature

females wander on the surface until they detect these vibrations in the soil and begin to burrow towards the male. After mating, the crickets fight briefly, and the losing party (usually the male) leaves the burrow.
Another less conspicuous subfamily, *Oecanthenae*, is commonly called the tree crickets. As their name suggests, they have a much more arboreal lifestyle than their *Gryllinae* cousins. As such, they have several adaptations suiting them to life in the tree canopy, such as smaller bodies, lighter and longer wings, and a pale green color. Since the tree cricket's habitat requires more skilled flight, the insect unfortunately had to trade some of its wings' ability to produce very controlled sound. Tree crickets' songs are often quieter, very high pitched and vary among species from a constant drone to very short chirps that resemble tinkling bells. When many call at once, their chirping blends together into a constant high drone that may sound like a distant alarm. Like field crickets, tree crickets' calls vary with temperature. However, for tree crickets, the pitch of their call rises with increasing temperatures. This means that females cannot "tune in" to the pitch of the males, so females' tympanum are more sensitive to a wider range of sound frequencies than most Orthopterans.

One very noteworthy species of tree cricket is *Neoxabea bipunctata*, the two-spotted tree cricket. The males of this species are so small that their wings are too tiny to resonate loud enough to be heard from any significant distance. Males will eat a small hole in the center of a leaf and perch with his head and first pair of legs poking through it. The leaf acts as a megaphone, amplifying and directing his call so that females can hear him from farther away.

Katydids, despite also being called "long-horned grasshoppers" and "bush crickets," are actually neither, though they are more closely related to crickets than grasshoppers. They belong to the family *Tettigoniidae*, and are named for the raspy, quick *ka-ty-did* they call day and night. Unlike crickets, female katydids also sing along with the males, usually as a response when she has selected a suitable mate. If you listen carefully, you can often hear a back and forth *ka-ty-did, ka-ty-didn't* between distant mates, after which the two will approach one another for a few seconds before the male initiates another call and response. Most are masters of camouflage. For example, the common true katydid (*Pterophylla camellifolia*) has wings that make the insect look remarkably like a leaf when viewed from the side.

A final superfamily of Orthoptera are *Acridoidae*, the various families of grasshoppers. While grasshoppers are most active in the day, their calls can be heard into the evening, from sundown to just after dusk. Their calls are more of a constant, low-pitched droning than the musical chirping of crickets. Like the crickets, grasshopper species have specific calls that they can use to identify members of the same species. Females locate males using tuned tympana on the first segment of their abdomen, just behind the pair of long jumping legs. Once the male has a female's attention she may approach and respond with a much quieter call of her own. Once the potential mates have approached one another, the male emits pheromones and displays his bright colors to finish courting the female. Males usually perish shortly after the mating season, while females may last until the first frost.

Even as the sun sets on the longest days of the year, some silent–and not-so-silent–dramas are just beginning. Often, given a warm, dark night, the brilliant light shows and singing choirs of *Lampyridaen* and *Orthoptera* mating rituals can be enjoyed in concert, while soaking in a comfortable Southern Appalachian summer night.

Cryptic Species

The real secret to learning new species of plants and animals is study and repetition, but one thing that works especially well is to focus on the 10 most common species within each group you are trying to learn. Another is to examine the species that closely resemble each other and figure out how to tell them apart. The monarch-resembling group of butterflies can be difficult at first (monarch, queen. soldier, viceroy) but there are some clues that will help. For example, let's look at the viceroy butterfly (Limenitis archippus), a mimic that is also distasteful to birds due to its diet of willows, but less so than the monarch whose caterpillar feeds on milkweeds. It is reddish-orange with black veins, a little darker and smaller than a monarch; it flies more erratically and is often seen around wetlands with willows. A unique and distinctive feature is a dark line that crosses the main veins in the hindwings.

An even more difficult group of similarly appearing butterflies are swallowtails and others that are black, blue and yellow and mimic the toxic pipevine swallowtails. Isn't it amazing how these groups of mimics have evolved, and how hard they make it to learn to identify butterflies? This is believed to be the result of convergence in coloration among butterflies that are poisonous to eat and tasty or partially tasty mimics that find it advantageous to gain protection from a resemblance to a deadly lookalike..

But what about moths? With the wings closed the moths can be cryptic in the right background and would presumably escape detection by most predators. Take the Io moth (Automeris io Fabricius). If it is detected and is poked, it opens its wings and reveals a marvelous set of false eye spots. Many moths have eye spots on their hind-wings that mimic an owl's face or just provide something scary for a predator to think about. Once again we can be amazed by the evolutionary process that can lead to the development of such a remarkable pattern.

Beetles, which are not usually considered among the most colorful of the insects, have some striking exceptions to this rule, one of which is the six-spotted tiger beetle (Cicindela sexguttata). This little gem is an iridescent green of the most amazing hue which is accentuated by its habitat in sunny gaps in the forest. These little monsters are truly tigers at their scale and run amok among the tiny insect denizens of the forest floor. The adaptive advantages of their color patterns are unclear. Obviously it makes the beetle more visible to predators with color vision (birds), but the speed and alertness of this tiny tiger may negate this factor. Indeed it might even confuse a predator since the green wing covers are lifted during flight. The color is not a sexual attractor since both sexes are green. So we are left with another of nature's many mysteries.

Another impressively colored beetle is the dogbane beetle (Chrysochus auratus) which has an amazingly iridescent coat of many colors. Such rainbow-like patterns are normally produced by a series of tiny grooves that diffract light, not by pigments. This beetle feeds on dogbane which is a close relative of milkweed and has a similarly milky and toxic sap. So it is likely that this beetle is advertising a toxicity derived from its food. Such an advertisement is common among a group of insects that feed on milkweed, including the red milkweed or four-eyed beetle (Tetraopes tetrophthalmus). It’s interesting how birds recognize that red-orange advertises toxicity in insects, but that red fruits are ripe and yummy.

Our most feared wasps, the yellow jackets are not to be trifled with. They are fierce and have a strong sting and an attitude to go with it. Then there is the syrphid fly (Sphaerophoria philanthus), a close mimic of the yellow jacket wasp. It is in fact a fly, not a stinging insect. To tell the difference, look at the wings and you

will see that there is only one pair of wings (wasps have two which fold back). The eyes in flies are larger and placed differently and the antennae are shorter. If you can see the mouth, flies have sucking or piercing mouth-parts whereas wasps have chewing mouth-parts. With some practice you will be able to make this distinction, so do not just dismiss the swarm of bugs flying around you, have a look at them carefully and pick out the pretenders from the real bad guys.

So the predators, mainly birds, are clearly scrutinizing their prey in great detail trying to figure out which ones are good to eat and which are poisonous. The prey are doing their best to confuse the birds. While you are out and about in nature, watch for those cryptic species and contemplate the purposes, not to mention the beauty, of the many different colors and patterns that they possess.

Hellbender Ecology

The Mount Rogers region of southwest Virginia is home to a number of cryptic, rare, and highly charismatic species. However, perhaps none of them are as iconic as the eastern hellbender (*Cryptobranchus alleganiensis alleganiensis*) that calls the pristine coldwater streams of our mountains home. Unfortunately, the hellbender's favor may be due just as much to the species' sensitive nature and declining abundance as it is to its inherent charisma. As a true indicator species, the eastern hellbender is a beautiful, awe-inspiring creature–a symbol of a wild mountain region–in the presence of cold, clean water, and a tragic symbol of loss in the presence of pollution and land degradation.

Giant Salamanders

The Eastern hellbender, also called "water dog" and "snot otter," colloquially, is the largest known amphibian in North America, and the second largest salamander described in the world, second only to the Chinese giant salamander (*Andrias davidianus*). They can achieve lengths of nearly three feet, but an average adult hellbender is about 18 inches in length and weighs around three pounds. These salamanders can only survive in the most pristine and cold streams high in the Appalachian mountains. Despite being so large, hellbenders are a very cryptic species thanks to their preference for hiding and dark brown mottling that provides excellent camouflage in the mountain streams they call home.

Like most salamanders, hellbender larvae have large feathery gills stemming from just behind the head, and lack appendages other than a strong paddle-shaped tail. Individuals mature over two years, losing their gills for a pair of small gill openings on the sides of their head (hence the epithet *Cryptobranchus*, meaning "hidden gill") and gaining short but strong legs. Mature hellbenders may be as small as six inches, but they continue to grow indefinitely. Since mature hellbenders have so few differences from the larvae, they are considered to undergo partial metamorphosis. Adults retain the gill openings after maturing, and do not develop functional lungs. The small lungs adults do develop are likely used more similarly to how a fish uses a swim bladder–to regulate buoyancy. Adult hellbenders have very loose, deeply wrinkled skin to increase surface area for cutaneous respiration–absorbing dissolved oxygen from the water through diffusion over their skin. Unfortunately, this style of breathing makes them very susceptible to pollution in the water, making them a valuable indicator species for the watersheds they inhabit.

Mature hellbenders are notoriously picky eaters, almost exclusively eating crayfish. However, when their prey of choice is not available, they will resort to eating fish, insects, and other salamanders–including their

own young. They have extremely strong jaws and large mouths that they can open very quickly to suck in their prey. Hellbenders hunt mostly at night, rooting under rocks and in silt for crayfish. During the day, they retreat to burrows beneath large stones. Since young are so much smaller than adults, they are not able to hunt for crayfish. Instead, the young eat small aquatic insects, like caddisflies and mayflies.

On the front of a hellbender's snout is a shallow canal containing extremely sensitive olfactory cells called the Jacobson's organ. Hellbenders use their keen sense of smell to detect both prey and predators. Like many fish, hellbenders also have a lateral line that is very sensitive to changes in water currents and light. When a hellbender smells a predator, they will seek shelter. Unfortunately, they are only able to recognize the scents of native species, so introduced predatory fish are able to approach hellbenders without triggering their defenses. When a hellbender feels threatened, such as when it senses a sudden change in water current, they exude a thick defensive mucus to deter predators and give them time to escape.

Despite being fast swimmers, larval hellbenders are very susceptible to predation. They are a food source to several species of large game fish including largemouth bass and banded sculpin. Unfortunately, introduced brown trout and rainbow trout are also prevalent predators of hellbender larvae since they are unable to detect these non-native fish with their Jacobson's organ. Interestingly, brook trout are not known to be significant predators of hellbenders, likely since they are able to smell these predators and better hide or defend themselves.

Hellbenders mate in the fall, from late September to mid October. A male will select a nesting location and excavate a hollow beneath a large rock. During this time, males are very competitive with one another, defending their territory near their nest from other males. He will remain near the nest with his head visible until a female finds him. Males release a pheromone to attract females, and once one approaches, he cues her by wagging his head. If she approaches, the male guides the female to the burrow and blocks her from leaving until she deposits her eggs. Finally, the male externally fertilizes the eggs by releasing seminal fluid over the clutch and using his tail to make a current that carries it over the entire clutch. The male will fiercely guard these eggs until they hatch, and keeps them well oxygenated by pushing currents through the burrow with his tail and occasionally rolling the eggs. Meanwhile, the female is chased off, often to find more males' burrows and produce another clutch. While the males care for the eggs while they develop, they are not the best fathers. Hellbenders are known to consume a few eggs from their own clutch. Larval hellbenders are independent immediately upon hatching, and flee the nest quickly to avoid being preyed on by the father.

An Imperiled Species

Thanks to what some might call a frightening or grotesque appearance (though many others whole-heartedly disagree), hellbenders have historically gotten a bad rap thanks to several misconceptions. Their large, strong jaws, and their presence in streams that also support brook trout has led to a myth that hellbenders are predators of the game fish and will decimate their populations in the streams they share. Unfortunately, some anglers endorsed killing hellbenders they would come across, believing this would help the brook trout populations. However, this is not the case. Hellbenders eat almost exclusively crayfish, except the young who prefer small aquatic insects. Perhaps there is some competition between young hellbenders and brook trout for these insects, though in streams healthy enough to support these animals, there is usually an abundance of prey. There are also several "urban legends" about hellbenders having a

venomous bite, or that their defensive mucus is a powerful toxin that pollutes the waters they live in. These legends are not based in reality, and are falling out of favor.

Today, hellbender populations are threatened primarily by habitat loss, and though some populations–including some in Southern Appalachia–are still considered healthy, the International Union for Conservation of Nature (IUCN) lists the eastern hellbender as "near threatened." As an indicator species, they are very sensitive to water pollution and water temperature changes. Healthy riparian zones around their native streams can mitigate both of these issues, capturing runoff before it pollutes the stream, and shading the water to keep water temperature low. Not only is chemical pollution an issue to these salamanders, sedimentation is an extremely prevalent issue. Hellbenders rely on interstitial spaces–the crevices and gaps between stones at the bottom of rivers–for habitat. When excessive silt and fine sediment enter the stream, these spaces fill and become unavailable to both hellbenders and the crayfish they depend on.

Yet another challenge hellbenders face is habitat fragmentation by dams. Hellbenders are not able to leave the water to climb over or around dams, so these barriers isolate populations. Small populations have low breeding success and the barriers prevent young generations from dispersing to new habitats, promoting healthy genetic diversity.

To many, the eastern hellbender is a wild and awe-inspiring symbol of our lush mountain home–an iconic species rarely seen, hidden beneath the rocks, under the moving waters that bring life to our region. Continued restoration and conservation of riparian habitats, along with education dispelling the baseless disdain towards the species, is critical in preserving it, and has ecological benefits that transcend a single species.

Summer Berries of the Blue Ridge

The Southern Appalachian region, of which the Mount Rogers National Recreation Area is a prominent part, is climatically considered to be a temperate rainforest. The region typically receives more than 60 inches of precipitation in a year, most of which falls in the spring and summer months. As a result, summertime in the Appalachian high country is bursting with dense plant life. As summer matures, the bloom-covered shrubs that blanket the high-elevations phase into an abundance of wild berries. For many, memories of summer days feature the sweet taste of these berries baked into pies, boiled into jams, or picked fresh from the bush. However, humans are not the only species enjoying the region's berry bounty. A variety of wildlife feasts on the fruit each summer, as well. In particular, species of the genera *Rubus*–including raspberries, blackberries, dewberries, and the invasive wineberry–and *Vaccinium*–the blueberries–provide a reliable source of food, as well as essential habitat, for a wide range of summertime birds and mammals.

Rubus–Natives and Non-natives

The genus *Rubus* is known as the raspberry genus and falls into the rose family, Rosacea. This genus contains many species, all of which produce fruits in the form of aggregate drupes, and most of which are edible to humans. *Rubus* species occur commonly across the world, and can hybridize with ease to create fully fertile offspring. Many species are grown for commercial crops, and farmers have spent years domesticating and breeding ideal fruit-producing cultivars. Still, many species grow wild across the landscape, providing food for wildlife and hikers alike, and shelter within their brambles.

Rubus species tend to prefer full sun, acidic soil, and good drainage. Plants in this genus have alternate compound leaves in bipinnate, pinnate, or palmate arrangement. Their leaves are serrated or double serrated, rough in texture, and have hairs or small prickles, and many have stems with prickles or bristles. Pink or white flowers with four to five petals bloom in a cup shape during spring and summer.

The black raspberry (*Rubus occidentalis*) is a common *Rubus* member native to most of eastern North America, and is fairly widespread in the Mount Rogers region. The shrubs can grow quite tall–two to three meters in height–and often form dense colonies in forests, meadows, along roadsides, and in recently disturbed habitats. Their large, arching canes grow upright before growing back into the ground from their tips. The canes are blue-green when young, maturing into a purplish-red with large, curved thorns resembling a cat's claw, and are pruinose, meaning they are coated with a waxy substance that gives them a frosted appearance. Their leaves have white, hairy undersides, and are arranged palmately, though some natural genetic variations display pinnate arrangements. Flowering branchlets have three leaflets, while other branches may have three or five. Black raspberry flowers have five distinct sepals that are almost twice as long as their five petals, and bloom in spring and summer. The fruits of the plant emerge green, and turn red as they ripen, eventually becoming so dark red or purple that they appear black by the time they are fully ripe in the mid-summer, when they fall easily from their central carpal.

The most widely distributed highbush blackberry species across eastern and central North America is the Allegheny blackberry (*Rubus allegheniensis*), and the species is well-represented in Southern Appalachia. These sun-loving shrubs grow to about 1.5 to 2.5 meters in height when fully grown, often forming dense thickets with other shrubs. Similar to the black raspberry, Allegheny blackberries grow large, arching canes with stout thorns that root back into the soil from their tips. However, these canes are darker in color than those of the black raspberry, and are not pruinose. First year canes are green in color, and turn red. Second year canes are reddish and mature into a deep red-brown. They feature alternate, compound leaves of three to five egg-shaped leaflets with coarsely serrated edges, two to four inches in length. Like the black raspberry, Allegheny blackberries bloom white flowers with five petals. However, their flowers are large compared to other *Rubus* species, spanning about an inch in diameter, and in contrast to black raspberries, sepals much shorter than their petals. These flowers bloom in spring and early summer. The fruits are available in mid-summer, ripening from a young green to a deep purple or black. These fruits, in comparison to the raspberry that falls easily and cleanly from its central carpal, stays attached to its central carpal when picked or fallen from the plant.

Another common *Rubus* species native to the southwest Virginia highlands, and most of central and eastern North America, is the common dewberry (*Rubus flagellaris*). These low-growing plants rarely grow taller than 1.5 meters in height, but can grow 2.5 to 4.5 meters long along the ground as a woody vine. The young stems of the dewberry are bright green with hair-like prickles, while older stems are brown with small, straight, rigid prickles. Like other *Rubus* species, they feature alternate, compound leaves made up of three to five (usually three) ovate, serrated, and palmately arranged leaflets. These leaflets appear more rounded and less finely serrated than those of the black raspberry and allegheny blackberry. Dewberry blooms resemble those of the Allegheny blackberry in size–roughly one to one and a quarter inches in diameter–with sepals smaller than their five petals, and open and close with the presence and absence of sunlight. The fruits resemble blackberries, and remain clustered around their central carpal when picked. The dewberry shrub is specially adapted for life in textured soils like sand, loam, and clay. In comparison to

the other *Rubus* species of the region, dewberry does not tolerate drought well, but is more tolerant to shade.

Native to China, Japan, and Korea, the invasive wineberry (*Rubus pheonicolasius*) was originally brought to the United States as breeding stock for raspberry cultivars. Wineberries now grow wild and rapidly in forests, fields, stream banks, roadsides, edges, and disturbed habitats across most of the Mid-Atlantic and Mid-South, particularly in Appalachia. They are notably more tolerant to shade and can handle less acidic soil than native *Rubus* species, outcompeting those that occupy similar niches.

The wineberry grows to an adult height of one to three meters, and can be easily identified by their bright red, hairy stems riddled with small, bright red prickles. The compound leaves of flowering stems feature a large, terminal leaflet with two smaller leaflets arranged opposite beneath, while non-flowering stems feature three or five leaflets in similar arrangements. These leaflets are ovate and serrated with light green to white undersides with wooly hairs. The buds of the wineberry fruit and flowers are covered with glandular hairs that produce a sticky liquid, which resemble the hairs on some carnivorous plants that are used to trap and digest insects. However, the wineberry gets all of its needed nutrients from the soil, and these hairs are purely a defense mechanism for their fruits. Wineberry blooms are small, white, star-shaped flowers with pointed petals, and bloom in spring and early summer. The fruit, like other *Rubus* species, is an aggregate cluster around a central carpal, and ripens in June or July to a bright, vibrant red.

High Country Blueberries

The *Vaccinium* genus is a member of the *Ericaceae* (heath) family and includes blueberries, cranberries, and huckleberries, among others. A few members of this genus call southwest Virginia home. While all berries in this genus are technically safe for humans to consume, not all are appealingly palatable. This genus is characterized by woody shrubs with cane-like growth. Vaccinium leaves are arranged alternately, and vary in shape from elliptic to ovate and in size between one to three inches in length and width. Leaves have entire margins (meaning the leaf is smooth-edged, not serrated or otherwise patterned), and are greenish-blue in color with lighter, glabrous undersides. *Vaccinium* species flower in urn-shaped blooms arranged in racemes, and can vary in color from pink to white, depending on the species.

A very prominent Vaccinium species in the Mount Rogers high country is the highbush blueberry (*Vaccinium corymbosum*). Also known as a blue huckleberry, swamp blueberry, and high blueberry, the highbush blueberry grows in a variety of habitats, including swamps, bogs, acidic forests, and shrub balds at middle to higher elevations. In fact, this berry-bearing species represents a significant portion of the woody biomass on some of our mountain balds.

A large, upright-growing deciduous shrub, the highbush blueberry can stand up to four meters in height when fully grown. However, it is a slow-growing species compared to our native *Rubus* species. Its glossy, dark green leaves are simple, alternate, and oval, with entire, smooth edges, and tend to be one to three inches in length and no more than an inch wide. They are renowned for their beautiful color displays in the fall, ranging from gold to orange to deep purple or red. *V. corymbosum* flowers are delicate white or pale pink, urn-shaped blooms of about a third of an inch in length that grow in drooping clusters in the spring.

The fruits that follow the delicate flowers are of great ecological, cultural, and economic importance. The small, spherical berries sprout green in the summer, and ripen to a dark blue, purple, or black by late-August

in the high country. They're a significant food source for black bears (*Ursus americanus*), many small mammals, and most of our summertime bird species, like the American robin (*Turdus migratorius*), eastern bluebird (*Sialia sialis*), gray catbird (*Dumetella carolinensis*), northern mockingbird (*Mimus polyglottos*), and northern cardinal (*Cardinalis cardinalis*). Humans, too, enjoy the taste of highbush blueberries, both as foragers, and commercial consumers. This species is a major crop grown in the United States, and many different cultivars have been domesticated for commercial use.

Though not as locally significant as the highbush blueberry, two other species of native *Vaccinium* are present in the Mount Rogers region or tangential habitats. The lowbush blueberry (*Vaccinium angustifolium*) and Blue Ridge, or late lowbush blueberry (*Vaccinium pallidum*) are both low-growing species that take a smaller form than *V. corymbosum*. Neither species grows taller than one meter in height, and both have smaller leaves and fruits than the larger highbush blueberry. The two have also been known to hybridize with each other.

The smaller berries of the lowbush blueberries are also sweeter than those from the highbush species, and some people prefer them for jams and preserves for this reason.

The Blue Ridge blueberry is a colonial species that forms large patches of clones, which spread and grow through connected rhizomes, often in the understory of oak-dominated forests. More than other native *Vaccinium* species, *V. pallidum* can withstand dry soils and thrive in humid climates, allowing it to populate lower elevation habitats.

For a great diversity of native animals–humans included–the native, edible berries of the *Rubus* and *Vaccinium* genera represent a great opportunity for nourishment in the height of summer's bounty. When the berries are consumed, the resource dwindles, and the august highbush clusters in the high country glow with the deep reds and purples of autumn, it is a sure sign of approaching winter, and harder times to come.

Late Summer Mushrooms

If you take a drive down a Forest Service road after a Dog Days storm, a keen eye focused on the rich browns and muted grays of the dense forest floor, some rather overlooked members of the ecosystem may become increasingly apparent. The fleshy, orange trumpets and fronds; pale shelves; and ghostly, white coral-like structures are common late-summer mushrooms that thrive in the damp, dark habitats of our temperate rainforest. These living organisms fulfill vital roles within the ecosystem, and can even be foraged and consumed by humans, given a proper understanding of the different species and their characteristics.

Fungal Fruits

The attractive mushrooms that are easy for us to observe above the ground, on soil, or in or on wood is only a small part of the organism it belongs to. Mushrooms are the fleshy, spore-bearing fruits of fungi, which grow from a structure called a mycelium–a mass of threadlike hyphae that make up the fungus. The mycelium is typically underground, or in decaying wood or dying tree roots, depending on the particular lifestyle of the fungus in question, and can be massive.

Fungi and their mushrooms make up their own kingdom (Fungi), separating them by kingdom from plants and animals. They differ in the way they obtain their nutrients. Plants generally obtain their food through photosynthesis, and animals are heterotrophs that find and eat food, and then internally digest it. All Fungi are heterotrophs, but they differ from organisms in the kingdom Animalia in that they digest their food first, and then eat it. Their mycelium grows into or around their food source, secretes enzymes that digest the food externally, then the mycelium absorbs the digested nutrients.

Appalachian fungi, though often overlooked, are vital members of our mountain ecosystem, performing a variety of critical functions. A group of mushrooms known as mycorrhizal fungi form symbiotic relationships with plants, siphoning off some of the host plant's sugar for sustenance while providing it with much-needed water. Saprotrophic fungi–also called saprophytes or saprobes–are the largest group of fungi, and are essential members in soil microbial communities. They feed on dead and dying organic matter, decomposing sometimes insoluble remains through extracellular enzyme secretions, making them a key player in the carbon recycling process. Parasitic and pathogenic fungi–the second-largest group–feed off of their host and may eventually kill it. They can even attack other fungi. However, these organisms can still serve warranted ecological duties. For example, *Botryosphaeria dothidea*, often referred to as rhododendron dieback, is thought to contribute to the genetic variation of rhododendrons without posing a serious threat to the overall health of the plant. Some mushrooms are even able to filter pollutants. Oyster mushrooms (*Pleurotus ostreatus*), for example, are capable of bio-remediating oil spills, and can absorb toxic compounds such as DDT.

Fungi Foraging

During periods of drought, many species of mushrooms become dormant. With adequate rainfall and appropriate temperatures, mushrooms can produce prolific fruiting bodies during the spring, summer and fall months. In the biologically diverse Mount Rogers area, several hundred species of mushrooms have been recorded. Although a complete inventory is far from complete, DNA studies are on-going, and new species are still being discovered.

For many mushroom lovers, it is the morel (*Morchella*) that attracts the most attention in the springtime. Known locally as "dry land fish" or "Molly moochers," these prized forest treasures are both south after and fought over. However, as delicious as they are, there are many more culinary fungal delights tucked away in the Mount Rogers region, many of which are in abundance in the mid- to late-summer.

For the mushroom hunter, this bounty is both delightful and challenging. While many of our native mushrooms are edible, possessing medicinal qualities and even considered to be gourmet edibles, a large number are toxic if consumed. There are also a handful of deadly mushrooms in the Mount Rogers region, so correct identification is critical. There are no mushrooms native to the area that produce a toxic reaction when touched.

If foraging for edible mushrooms is your intent, there are a few precautions worth mentioning. First, invest in some quality field guides, including those specific to your area. **Never** eat anything that you are not 100% sure of the identity of. Unfortunately, some wild edible mushrooms have toxic look-alikes that must be avoided. If possible, learn from local experts. Local mycology clubs and online communities are good resources.

Mushrooms are more likely to appear after a heavy rain, when their habitat is damp. So try to time your foraging forays with the local weather.

Many mushrooms have mutually beneficial, symbiotic relationships with trees. So familiarize yourself with the mushroom species you are targeting and know these associations, as they will help you to narrow down your search, increasing your chances of success.

When you do find success, before cooking, check the mushrooms for bugs and remove any dirty. Know that you must cook all wild mushrooms before eating them. Some species contain mild toxins that can be removed through cooking. Some people may still experience mild gastrointestinal distress, even from cooked, edible varieties. So always start with small portions.

The legality of foraging varies depending on the ownership of the land you choose to use, but in general, foraging for personal use on public lands is permitted. In the Mount Rogers area, National Forest land allows personal foraging, but requires a permit for commercial harvesting. Wildlife Management Areas also allow personal foraging of berries and fungi, but commercial use is prohibited. Many state parks allow personal foraging, but it is always a good idea to check individual regulations, first. Private lands represent a great opportunity for foragers, given proper permission from the landowner. These lands aren't often foraged by others, as landowners are often unaware of the culinary treasures their land provides. In all of these areas, given the absorptive nature of mushrooms, avoid potentially toxic or chemically treated areas like roadsides and ditches.

Finally, always bring a good field guide, a sharp knife, a porous container like a basket or mesh bag, a first aid kit, sturdy hiking shoes, water, snacks, sunscreen, and bug spray. Depending on how much ground you plan to cover, a GPS unit and map and compass should also be in your kit.

Native Mushrooms

Probably the easiest to find of our native, late-summer, edible mushrooms, due in large part to their bright colors, are the chanterelles. The Mount Rogers area is home to several different species of the genus *Cantharellus*. While the exact number has yet to be clarified, most cluster around the American golden chanterelle (*Cantharellus tenuithrix*). Another genus that shares some common characteristics with the chanterelles is *Craterellus*–the trumpets. There are also many different species of *Craterellus*, but one edible member found commonly in the Mount Rogers area is the black trumpet (*Craterellus cornucopioides*). Both of these groups of mushrooms begin to make an appearance on our forest floor in June, but really take off in July and August. There are several different species to be found, but all are edible and considered to be a gourmet mushroom.

The chanterelles and trumpets both have well-defined caps, flourishing into a vase or horn (or trumpet) shape from a well-defined stem. The spore-bearing surfaces of these species are on the undersides of the caps–or the outer side of the horn–which lack true, blade-like gills, but are instead smooth, wrinkled, or lightly or deeply furrowed. Most of the chanterelles and trumpets are mycorrhizal fungi that have large native ranges spanning most of North American, though the eastern states enjoy more species diversity.

Regardless of the actual species, these mushrooms all have a mild, earthy flavor; stringy texture; and a delightful fruity aroma reminiscent of apricots. They are easy to cook with and very versatile. Both chanterelles and trumpets pair well with dairy, cheese, and pasta.

The red chanterelle (*Cantharellus cinnabarinus*) also makes an appearance during the summer months. "Cinnabars" are smaller than our golden yellow chanterelles, but can still be easy to spot because of their bright color.

Later in the summer, you can find smooth chanterelles (*Cantharellus lateritius*), as well as yellowfoot (*Craterellus tubaeformis*) and *Craterellus ignicolor*, sometimes called the "small chanterelle." Smooth chanterelles lack the gill ridges typical of the other chanterelle species. Yellowfoot chanterelles have a thin flesh and are funnel-shaped and hollow. *C. ignicolor* resembles a golden chanterelle, but owes its common designation to its very small size.

Chanterelles grow from the ground, typically solitary or in small patches. They associate with conifers and oak trees, and can be found near creeks and in disturbed areas.

Chanterelle mushrooms are most commonly confused with either the jack-o'-lantern mushrooms (*Omphalotus olearius*, *Omphalotus illudens*, and *Omphalotus olivascens*) or the false chanterelle (*Hygrophoropsis aurantiaca*). Although not fatal, none should be eaten. These species resemble chanterelles in color and general shape, and therefore can be a little confusing for the beginner forager. However, both look-alikes have gills that appear as close blades, which is the primary differentiating characteristic. Jack-o'-lanterns grow in clusters from rotting wood (exposed or buried), rather than from the ground, and have orange flesh inside, while true chanterelles have white flesh. As their name suggests, the jack-o'-lantern mushrooms also have gills that are bioluminescent–a phenomenon known as "foxfire" in the Appalachians. False chanterelles also have gills and a more orange color.

Another member of the Mount Rogers region's edible fungi clan is a small group of edible, bright orange to yellow, soft-fleshed polypores that lack stems–the genus *Laetiporus*. Commonly referred to as chicken of the woods, members of this genus cause a brown rot of the wood of both conifers and hardwoods, depending on the species. They are both parasitic and saprotrophic, able to fill either ecological role. Polypores do not have true gills or gill ridges. Their spore-bearing surface consists of thousands of tiny pores.

Laetiporus sulfureus and *Laetiporus cincinnatus* can be found during the spring, summer and fall, though they favor the cooler temperatures. *L. sulfureus* grows from well-rotted oak logs, while *L. cincinnatus* is typically found growing from the ground. Both species are edible and delicious when they are quite young and pillowy-soft. Once the "fronds" begin to mature, their vibrant colors begin to fade and they become tougher and more stringy. No amount of cooking can remedy this. Since chicken of the woods tend to fruit from the same log for several years, mushroom hunters will note these spots and visit them regularly. If you happen to miss your window of opportunity, return to the same spot over the next year. Their bright colors make them very easy to spot, even from a distance, and there are really no look-alikes.

Oyster mushrooms (*Pleurotus pulmonarius* and *Pleurotus ostreatus*) are common mushrooms found throughout the Mount Rogers region. They are saprobes that can be found growing from dead or dying hardwood trees. They have smooth caps that are white to light brown in color and oyster- or fan-shaped,

and often grow in overlapping clusters in a shelf-like formation. Oysters have white gills attached to and running down the cap and stem. They smell faintly of licorice and have a mild flavor with a silky texture.

Pleurotus pulmonarius has many common names, including Italian oyster, Indian oyster, phoenix oyster, and lung oyster. These mushrooms are more common during the warm summer months, whereas *P. ostreatus*, also known as the pearl oyster, typically enjoys cooler temperatures and is fairly common during the fall months. *P. pulmonarius* is also typically smaller and more pale than *P. ostreatus*, and commonly grows more of a stem.

The lion's mane mushrooms (*Hericium erinaceus*, *Hericium americanum*, and *Hericium corraloides*) are an easy-to-identify native edible that takes on both saprobic and parasitic roles in our mountain ecosystem. These mushrooms are white and do not have caps. Mature species of *H. americanum* and *H. corraloides* have spines that resemble icicles hanging from branched structures, while mature *H. erinaceous* species simply form a large clump of spines. Immature specimens that have not yet developed spines are a little more difficult to identify.

Hericium species have been found as early as March and as late as October in the Mount Rogers region on several different host trees, including American beech (*Fagus grandifolia*), birches, and oaks. Similar to chicken of the woods, lion's mane will fruit form the same tree year after year until its food source is exhausted.

The fruiting body of lion's mane is dense and firm with a slight mushroomy flavor and some shellfish-like qualities. Their flavor and texture has been compared to crab meat, which it mimics well. Some foragers make *Hericium* mock crab cakes using the sweet, mild chunks from *H. corraloides*, also known as coral tooth, as you would use crab meat.

Fungi represent an entire kingdom of discovery for both naturalists and foragers, alike, and are responsible for a whole host of ecological processes that are essential to the function of our landscape. Foraging for their fruits is an educational way to enjoy the natural world that comes with some rich culinary benefits.

Invasive Species

On a stroll through the woods, or drive down the road, today, the casual observer will notice, and begin to become familiar with, the usual assemblage of plants and animals that populate our region. It is easy to assume that all of these species have called our region home for millenia, co-evolving as a cohesive community, native to our specific geographic region and climate. However, in a globalized world, this is far from the case. Though European starlings (*Sturnus vulgaris*) eating the fruit from a wineberry (*Rubus phoenicolasius*) cane is a common sight in the heat of a Mount Rogers summer, neither of these species evolved in our ecosystem, but are imports from other continents. These invasive species are joined by numerous other invaders from points abroad, causing varying levels of destruction to our ecosystem.

Invasive vs. Non-Native

Species labeled as "invasive" are organisms that are not native to the ecosystem they currently inhabit and cause, or can cause, economic, environmental, and/or human health harm. Other species labeled as

"non-native" are species that have been introduced to an ecosystem different from where they evolved, either accidentally, or by human intention, and do not hinder the survival of adjoining native species. The terms "non-native" and "invasive" are not synonymous. Non-native species can exist without causing harm, and often become established to the point that they are considered commonplace. For instance, the agricultural system in the United States is dependent on non-native fruit and vegetable species, which are commonly grown throughout the country, but do not have the capacity to escape cultivation. These non-native species are considered agriculturally advantageous, do not uncontrollably alter the environment, and therefore are not considered invasive. Alternatively, kudzu (*Pueraria montana* var. *lobata*), an aggressive vine that was originally imported from Asia for erosion control, has swallowed up large swaths of land wherever it has been planted. Though introduced with good intentions, this invasive species was able to quickly establish itself and outcompete native plants, often resulting in a monoculture of ever-growing and reproducing kudzu vines.

When an invasive species is introduced and begins to establish itself, the balance of the invaded ecosystem is disrupted. This disruption occurs because invasives have not developed coevolutionary relationships with the other organisms in their new ecosystem. This gives the invasive an unfair advantage, such as a lack of predators to control populations, leading to extensive proliferation. With little to no constraints, an invasive will outcompete or kill native plants and animals, ultimately resulting in population decline.

Anthropogenic Invasions

There are a number of invasive species within the Mount Rogers region that have resulted from escaped horticultural plantings, and many species that are even still commercially available. Japanese barberry (*Berberis thunbergii*) is a thorny shrub with foliage that turns a crimson color in the fall and boasts bright red berries. These bushes have been prized as ornamentals for their compact nature when pruned into hedges, but have spread to natural areas–most likely through birds consuming their berries and seeds–where they have spread to create sometimes impenetrable thickets. Uprooting and preventing soil contact is a suitable way to eliminate these invasives.

Another commonly sold non-native species–though not officially recognized as invasive in Virginia–that has a habit of escaping cultivation and can be seen creeping out of control within the Mount Rogers National Recreation Area is common periwinkle (*Vinca minor*). This evergreen, herbaceous groundcover truly lives up to the term "groundcover." Where established, common periwinkle spreads quickly and readily chokes out native plants. Periwinkle can be pulled easily, but will resprout from any roots left behind, making complete eradication a challenge.

Other less common, but still present, invasive species that can be purchased commercially include english ivy (*Hedera helix*), autumn olive (*Elaeagnus umbellata*), and Callery pear (*Pyrus calleryana*), to name a few, all of which can be found disrupting the ecosystems within the Mount Rogers region.

Many species of invasives currently wreaking havoc on native ecosystems were once highly favored for their landscaping appeal, such as tree-of-heaven (*Ailanthus altissima*). This now-invasive tree was introduced for the same reason it is noxious today–its rapid growth. Tree-of-heaven has one of the fastest growth rates of trees found in the country, it does well in a range of soil chemistries, and when its leaves fall to the ground and begin decomposing, they release a toxin that inhibits future plant growth below their canopy. Lacking proper ecological regulations, tree-of-heaven can easily overtake an area and if one

attempts to cut it down, or even if the tree feels stressed, it can send out new growth through its roots, spreading its cover. Uprooting tree of heaven can be a good removal strategy if the majority of the roots can be successfully pulled out, dried out, and prevented from touching soil, lest it reroot.

Though some invasives were introduced purposefully without full understanding of their future implications, some were introduced by accident. For instance, Japanese stiltgrass (*Microstegium vimineum*) can be found along almost any forested trail, road, or disturbed area in the region, and more largely in the eastern part of the country. This annual grass thrives in low light and multiplies rapidly, creating dense mats on the forest floor that crowd out native plant species and prevent native seeds from reaching the soil to germinate. Japanese stiltgrass was most likely introduced in the early 1900s as discarded packing material, and has since spread widely. Japanese stiltgrass can be pulled easily, but is often so expansive and has such a well-supplied seed bank, that eradication can feel like an impossible feat.

This region also has an unfortunate collection of invasive invertebrate invaders. For instance, the emerald ash borer (*Agrilus planipennis*) is an invasive beetle that has nearly brought about the complete destruction of ash trees (*Fraxinus* spp.) in Virginia. As larvae, emerald ash borers devastate ash trees by boring tunnels (galleries) just under the bark that prevent the tree from transporting water and nutrients, killing the tree in two to four years. While not introduced in the United States until the 1990s, first observed in 2002, and first reported in Virginia in 2003, the emerald ash borer has already killed hundreds of millions of trees in 35 states, including Virginia. This spread has largely been facilitated by humans transporting infected ash for firewood, and can be stunted by using local resources. Though emerald ash borers do not create a monoculture of exclusion, such as invasive plants often do, they fundamentally alter the habitats in which they inhabit. Though a localized beetle population's demise likely only awaits the eradication of a complete stand of ash trees, this alteration of habitat is a lasting one.

Fraser fir (*Abies fraseri*) is an endangered native tree species–a remnant boreal species left isolated to the highest peaks in the Southern Appalachians following the last ice age. Situated atop Virginia's highest peak, Mount Rogers, these trees have not been able to escape the invasive balsam woolly adelgid (*Adelges piceae*), a small sucking insect introduced from Europe on nursery stock that, similar to the hemlock woolly adelgid (*Adelges tsugae*) that preys upon hemlocks (*Tsuga* spp.), bites into the trees and sucks out water and nutrients. Though the hemlock woolly adelgid feasts at the base of hemlock needles, killing the needles and buds, the balsam woolly adelgid's main target is the tree's trunk, resulting in stunted terminal growth, swollen buds and branch nodes, and a lack of successful cone production. Once infected, it takes years for the trees to succumb, and usually only occurs due to efforts of the adelgid along with other pests, fungi, and diseases. The balsam woolly adelgid infestation on Mount Rogers' limited and isolated population of Fraser firs caused great initial mortality to the larger trees, fundamentally altering the habitat, but the true, long-lasting impacts on the younger regenerative trees has yet to be fully documented, as they are less susceptible to the insects. Biological controls in the form of predaceous beetles and chemical treatments have both been implemented with varying success.

Invasive species pose a daunting threat to the overall health of the ecosystems within the Mount Rogers region. Whether these species were introduced intentionally or accidentally, humans have almost exclusively been the facilitators of their spread. As such, the responsibility to control and monitor their populations falls squarely on our shoulders.

FALL

September, October, November

Weather Stats

Average Temp	51.8℉
Max Temp (avg.)	64.7℉
Min Temp (avg.)	43.7℉
Average Humidity	78%
Average Precipitation	5.7”
Average Snowfall	0.4”

Fall Migrations

Many are familiar with the fall migration of monarch butterflies. The insects take to the wind in early fall, usually departing in late September through early November, bound for Mexico. Once there, they enjoy the warm weather and plentiful flowers while they wait out the winter months. Finally, come March, the butterflies mate and prepare for their return flight. Females, holding fertilized eggs, will stop at young milkweed plants as they follow the warm weather North. These females may be carrying up to 300 fertile eggs, but will only leave one per plant she visits. In the Blue Ridge, this generation of butterflies usually does not make the entire return trip. However, their children- the spring generation- complete the migration, recolonizing the Northern reaches of their native range. There are two generations of summer monarchs; these individuals rarely live more than a month after achieving adulthood. Finally, a new generation of fall monarchs emerge in early fall. The colder weather and shorter days trigger a different morphology in the insects. Individuals who emerge from their chrysalis this time of the year are much larger, have substantial fat stores in their abdomen, and are much longer lived- many will survive up to nine months!

The monarchs that call these mountains for half the year actually experience four distinct generations annually. The two summer generations are short lived and will only know this land. However, the second generation of summer butterflies propagate a fleet of fall migrants that will make the journey their great-great grandparents made only a year prior. The females of this generation disperse eggs across the American southeast, and their children, the spring generation, complete the trip and return to the mountains.

There are still many questions entomologists have about this life history. The first regards how the fall migrants navigate to the same location as their ancestors four generations removed. There are also questions how the fall generation is able to cover such significant distances. It is believed that they take advantage of air currents to help conserve energy. The migrants need to stop often to feed on nectar, and this generation grows larger than others as caterpillars, starting their adult life with a significant fat storage.

As caterpillars, monarchs feed and live exclusively on milkweed. Females seek healthy and preferably unoccupied plants to lay a single egg on. This caterpillar grows up on the leaves of the plant, which contain terpenes that are toxic to most other animals. The caterpillar retains these toxins in its own tissue, making the insect toxic to predators. As adults, the butterflies rely on the nectar of a variety of flowers.

The charismatic bright orange of monarchs is an example of aposematism. In nature, many animals use bright colors, also called warning colors, to signal toxicity to would-be predators. This discourages animals from attacking the butterfly.

Fall monarchs face many dangers during their migration. The decreasing temperatures of fall is an important indicator for the caterpillars to develop into the migrant type rather than another generation of small and short lived summer monarchs. Abnormally warm temperatures in fall can interrupt the development of large migrant butterflies. Changing temperatures also can affect flowers' bloom time. Monarchs depend on plenty of nectar being available to fuel their flight, so if the flowers become uncoordinated with their flight, the butterflies are at risk of starving. Weather is always a risk for migrating populations, and one additional effect of climate change is less predictable and more severe storms. Finally, monarchs are extremely sensitive to habitat loss. As caterpillars, monarchs depend entirely on milkweed. If the habitat that milkweed grows in is struggling, there will be fewer of these important host plants. As said above, the migrant generation depends on nectar sources along their entire route. A long stretch without wildflowers can spell death for these butterflies.

Helping monarch populations can be an easy feat for anyone with the lawn space to grow a few native plants. Research some local long-blooming wildflowers, especially those that provide plenty of nectar and bloom through fall. Asters, columbine, vervain, mountain mint, and many others are fairly low maintenance native wildflowers that are great nectar sources for pollinators, including monarchs. Milkweed prefers to have a fair amount of space and well drained soil that gets plenty of water. However, there are several varieties that prefer different conditions, so researching a variety that would do well in your area is a great way to support the monarch population.

Beavers and the Landscape

As summer fades in the shadow of Mount Rogers, and the aquatic grasses and forbs of highland wetlands begin to die back, some of the region's richest aquatic habitats bustle with activity. The signs are obvious. The chewed, pointed stumps of saplings begin to populate the landscape, as those responsible for their harvest wake across the surface of self-made reservoirs, and in and out of their impressive, stick-built lodges, storing caches of woody food for winter. The North American beaver (*Castor canadensis*) is a keystone species, and one of the most environmentally influential organisms on our landscape. Often referred to as nature's engineer, beavers alter their environment to build their homes, initiating a cascade of ecological effects.

Aquatic Adaptations

Beavers have several important adaptations that assist in their semi-aquatic lifestyle. Their characteristic rusty-orange teeth, colored by iron compounds, are essential tools for felling trees to build and eat. Beavers nibble on large trees to sharpen their teeth. They also have the added benefit of the inner portion of their teeth being slightly softer than the outer portions. As the beaver closes its teeth, the inner side of the upper teeth are filed down by the outside edge of the lower teeth. Such maintenance is required, as beaver teeth, like those of all the members of the order Rodentia, grow continuously throughout their life.

A number of aquatic adaptations facilitate the mammalian beaver's life in an aquatic environment. Their lips, for instance, close behind their front teeth, allowing them to carry wood in their teeth underwater, while

keeping their mouths closed. Their nostrils, eyes, and ears are all stacked in-line on the top of their head, which allows them to poke just the top of their head out of the water to investigate their surroundings. While underwater, beaver ears and nostrils also have the ability to close like hatches, preventing water from entering. They also have a see-through nictitating membrane that protects their eyes as they swim. To assist in waterproofing and maintaining body temperature, beavers use a preening nail, located on the second toe of their hind feet, to spread castoreum–a yellowish secretion from their castor sacs–over their coat. To aid in swimming, beavers have webbed hind feet that do most of the propelling, and a tail that acts as a rudder. Their tail also allows them to regulate their body temperature and store fat, and acts as a support, allowing them to stand upright. The tail is also used to slap the surface of the water, warning of nearby danger.

For nutrition, beavers will consume herbaceous forage, including aquatic grasses, but also chew wood for the sugary layer of cells called the cambium just beneath the bark–a food source that becomes increasingly important as summer wanes. They are rather discerning in their preferences for woody food, however. Typically, they eat twigs and branches under three quarters of an inch in diameter, saving larger pieces for dam and lodge building and tooth sharpening. Of the smaller branches, they have a particular appetite for aspen, birch, cottonwood, willow, oak, and maple. While coniferous trees are often spared from eating, they are used in building, or selectively harvested to clear the way for their more preferred snacks. To aid in the digestion of these hardwood foods, beavers possess a fermenting bacteria in their intestines that digests 30% of the cellulose in their diet. Because this process leaves 70% of the cellulose they ingest undigested, beavers are also coprophagic, meaning they ingest their feces, to gain more nutrients.

Ecosystem Engineers

When the time comes for homemaking, beavers leave their birth colony to scout for a suitable location to build. Most beavers seek out slow-moving water in the form of streams, lakes, and marshes, with a grade of around 1-2%, in an area with plentiful building material and food. However, they can be found building in less ideal conditions. Beavers use wood, mud, rock and vegetation to construct their dams, which typically stand three to five feet tall and generally span less than 50 feet in length. However, dams can be much larger. Deep within Wood Buffalo National Park in Canada, a secluded dam runs 775 meters long on its front face, and its entire perimeter measures 2000 meters long.

Beavers construct lodges out of the same woody materials. These living quarters take on a large mound shape, featuring an underwater tunnel that is used as the main exit and entrance. In their lodges, beavers take shelter from the elements and predators while raising their kits to join the colony. As winter approaches, beaver activity increases on the landscape, as they accumulate caches of woody food to carry them through the frozen moths. If their wetland habitat freezes, they will spend the entirety of the season inside their lodge, not truly hibernating, but huddling together to stay warm in total darkness.

Beavers construct dams to provide a favorable setting for their lodge, but in doing so, they alter the habitat such that the entire ecosystem changes around them. Slowed and built up behind the dam, running water expands outward into low-lying floodplains, and underground to recharge ground water. This redistribution of water facilitates the creation of wetlands which store a reserve of water above ground for plant and animal life; assists in times of drought, ensuring consistent water supply; and slows large surges of water from storm runoff, preventing flooding.

The resulting wetland provides habitat for a whole host of grasses, sedges, shrubs, and willows, which then provide habitat and food for small mammals, fish, insects, and birds. For instance, silky willow (*Salix sericea*) takes advantage of the new wetland environment to grow, then provides food for the beaver, which prunes branches creating a bushy understory. This understory then supplies shelter and protected pathways for small mammals, reptiles, and amphibians to live in. In beaver-made wetlands, aquatic plants flourish, feeding insects that in turn feed fish. Once they break down, aquatic plants form a detritus that feeds bottom dwellers and small fish, which then feed larger fish, which then are caught and consumed by predators. The plants also provide shade, cover, and food for waterfowl when nesting, and stabilize banks, preventing erosion.

Beaver-created wetlands also provide a number of ecosystem services that benefit water quality. When not being used as habitat or food, wetland plants are hard at work filtering water of chemical and biological contaminants like runoff from agricultural and residential lands. The dam-slowed water also allows for physical filtration of sediment and downstream erosion control. This not only provides a clean environment for habitation but also benefits human water interests.

Fashionable Furs

Although beavers are essential to the ecosystems they create and maintain, humans have historically harvested them for their fashionable furs. In Eurasia, beaver fur was traded as early as the ninth and tenth centuries by Scandinavian and Rus Viking traders. The Eurasian beaver, Castor fiber, was sought after for its pelt so intensely that by 1600 its population was considered effectively extinct. As the supply dropped, the demand for felted beaver furs went through the roof. Beaver hats had developed a societal significance in social hierarchy, just as European countries began to sail to North America.

Fueled by the high demand for beaver fur, the European discovery of the North American beaver, which had similar fur to the Eurasian species, allowed the explosion of the fur trade in North America. Without protections, and with great profits to be had, the population of beavers in North America plummeted. Pre-Columbian estimates placed the North American beaver population somewhere between 60 and 400 million individuals, and by 1900, Castor canadensis was nearly extinct. As a result, an estimated 195,000 to 260,000 square kilometers of United States wetlands dried up. However, conservation efforts started to gain steam around the turn of the century, some more peculiar than others. In 1948, Idaho Fish and Game had too many beavers in urban areas and not enough in their remote mountain region. With excess parachutes from WWII, a plan was devised in which wooden boxes containing trapped beavers would be parachuted into the wilderness to establish populations and assist in the management of water. Of the 76 airdropped beavers, only one perished due to the beaver chewing through the wooden box. The surviving “paracastors” went to work and re-established their population in the mountains. Through this, and other less alternative methods, beaver populations have rebounded to around six to twelve million individuals in North America.

Despite sometimes being perceived as pests, beavers are highly specialized native rodents that live quiet, yet highly important lives in our mountains. As a keystone species, beavers and their conservation produce a ripple effect that sets into motion a host of beneficial processes, and benefits all members of the ecosystems they engineer, including humans. Their industry is admirable and fascinating, particularly with a naturalist’s understanding of its implications.

Mosses and Lichens

In the deep, rich forests of our Appalachian Mountains, incredibly prevalent groups of rather cryptic organisms often go unnoticed as they grow to blanket the forest floor, covering rocks, tree trunks, and logs–sometimes even growing within each other. Mosses and lichens, though they fill similar niches and are often confused with each other, are very different organisms. To understand their differences, we need to first understand their anatomy and life history.

The Lichens

Lichen are a species made up of species–a symbiotic relationship between fungi and algae. A symbiotic relationship is a close, prolonged association between two or more different biological species. There is some debate about what kind of symbiotic relationship the two have, however. In a mutualistic relationship, both species benefit from the association. In a parasitic relationship, one benefits while the other is harmed. In lichens, the fungi provide structure and protection, while also contributing minerals and nutrients by breaking down their substrate. They allow algae to survive in a drier environment than would be possible for them alone. The photosynthetic algae provide food, taking in sunlight, water, and carbon dioxide to create sugar and release oxygen. So both receive benefits. However, algae actually does better on its own, making the relationship a form of controlled parasitism initiated by the fungi.

To understand the structure of lichen, it helps to understand the basics of fungal and algal structure. When most people think of a fungi, they think of the fruiting body–the structure that sticks out of the ground, releases spores, and sometimes tastes good. Those structures are only present during reproduction. Every other day of the year, fungi look like a white tangle of strings underground. These "strings" are called hyphae. They are a filamentous network that release digestive enzymes to break down organic and inorganic molecules into nutrients and minerals. Even the fruiting bodies are made of tightly packed hyphae.

Algae can be both single and multicellular. The algae in lichen are single-celled. Having chloroplasts with chlorophyll allows the algae to perform photosynthesis if they have access to light.

The entire body of lichen is called a thallus. Its outermost layer, the cortex, is usually composed of fungal hyphae. They provide protection for the algae underneath, and are thicker and more tightly packed than fungal cells elsewhere on the lichen. When wet, sometimes these cells become semi-transparent. When dry, the color of the lichen is most likely the color of the fungi. Underneath the cortex is the algal zone. The algae or cyanobacteria are protected by the cortex, and have access to sunlight for photosynthesis. When green algae is present, it gives the lichen a green color. If there is already a green algae layer, cyanobacteria may be present on, or in pockets of, the upper cortex. They give lichen a dark green, brown, or black color. The next, and largest, layer is the medulla. Loosely packed hyphae with thin cell walls, it almost looks cottony up close.

Lastly, there are two possible ways that lichen attach themselves to their substrate. Rhizines are many fungal filaments that extend from the medulla, while a holdfast is an extension of the entire tightly-packed thallus. Both of these structures do not move water or nutrients. Their job is to hold the lichen to its surface.

Identifying lichen can be difficult, but sorting it into the three basic types is much easier. Crustose, or crusty, lichen is pressed flat against its substrate. They are very flat, and often bumpy looking. Foliose, or leafy, lichen often appear flat, thin, and leafy like lettuce. They always have two distinguishable sides- an upper and a lower. Some only have one attachment point despite a large surface area. Fruticose, or shrubby, lichen can be cup-like, hair-like, or both. Beard lichens are a fruticose lichen, and their name is very indicative of their appearance.

The Mosses

A major difference between lichens and mosses is that mosses are, in fact, non-vascular plants. A nonvascular plant cannot perform vertical water transportation. It lacks structures like a xylem and phloem, which use positive and negative pressure to move water around a vascular plant. Therefore, these plants can not get very tall. Moss also reproduces with spores, not seeds. It spends most of its life in the haploid stage of its life cycle, with only one set of chromosomes. These two characteristics make moss a bryophyte along with liverworts and hornworts.

Mosses have two phases of life–the gametophyte and sporophyte phase. They spend most of their life in the gametophyte phase, which is also broken into two stages. When a spore lands on a new substrate and begins to germinate, it forms the protonema. It looks very similar to green algae or crusty lichen, and is also photosynthetic. Eventually, it will sprout a stalk, leaves, and rhizoids and become the gametophore. Unlimited gametophores can emerge from a protonema as long as conditions are right. The stalk often has thick-walled cells for support and cells that are used to transport water. Most mosses have spirally-arranged leaves that are only a single cell layer thick. They are highly specialized, and most mosses have a midrib in their leaves called a costa. Like the lichen, their rhizoids are only for attaching to their substrate, they do not absorb water or nutrients. You never find just one moss stalk. They always form large, sprawling colonies. When most people think of a moss, they think of the gametophyte phase–the fluffy mats of green.

Mosses reproduce both sexually and asexually. If a piece of moss breaks off of the main mat, it can re-establish itself somewhere else. This is asexual fragmentation. When a moss is ready to undergo sexual reproduction, it enters the sporophyte phase. Male or female reproductive organs will appear at the tip of gametophyte stalks, surrounded by specialized, cup-like leaves. These leaves can be brightly colored, giving it a flowery appearance. Sperm travels to the egg via water, which is facilitated by the cup-like structure. After fertilization, a capsule will form at the tip of the stalk, surrounding the zygote. It will then elongate, held above the leafy gametophyte stalks by a leafless seta. Inside the capsule, the zygote is diploid, with two sets of chromosomes. It undergoes meiosis to become spores. When the haploid spores are ready to disperse, the operculum, or cover, will open and release them to the wind. Knowing this background information gives insight into what phase of life a moss is in.

Adaptations

Both mosses and lichen are able to absorb moisture from the air given adequate humidity levels. Without thick cell walls, they can't retain water, but can absorb it directly through osmosis. They can also absorb liquid water. Because both require moisture to survive, in its absence they undergo a process called poikilohydry. When moisture is available, they absorb and perform photosynthesis, allowing them to grow. When it is dry, they "turn off" and become brittle. No photosynthesis can be done. They oscillate between

these two states depending on weather conditions. This is an important adaptation for surviving drought and a changing climate. However, when dormant, they cannot grow.

Just like all other living organisms, lichens and mosses need nutrients like carbon, oxygen, and nitrogen to survive. The hardest to get is nitrogen. Luckily, some lichens have a partnership with cyanobacteria, in which the cyanobacteria "fixes" nitrogen by converting it from an unusable to a usable form. Studies have shown that mosses can absorb nitrogen from soil, even with their limited rhizoid system and lack of vascular system. Other studies have shown that in some ecosystems, mosses also have an association with cyanobacteria due to their ability to hold moisture.

Because of these two adaptations, lichens and mosses are both able to survive on almost any substrate, or surface, as long as it sits still long enough for them to attach. Trees, rocks, soil, and even old human structures are fair game. The most important factor for a substrate is whether or not it has access to sunlight for photosynthesis.

Ecosystem Services

Plants are associated with carbon-sequestration, and moss is no exception. Mosses sequester around 6.43 billion metric tons more carbon in the soil than is stored in bare patches of soil without any plants. In a study comparing plots with soil moss and plots with plain soil, the plots with moss had higher levels of vital nutrients, accelerated rates of organic matter decomposition, and fewer soil-borne plant pathogens. Moss also protects against erosion by holding onto small particles of soil and absorbing water to prevent flooding.

Mosses and lichen are both pioneer species. They can survive and thrive in areas that would be considered barren to other species, such as rocky outcroppings. A build up of moss on a substrate leads to a collection of organic material that eventually becomes soil. The minerals and carbon they store in the soil are ideal for the soil microbiome. Wet, spongy moss can act like a nursery to growing plants. They may compete initially for limited nitrogen in the soil, but plant roots reach significantly deeper than moss rhizoids and can access nitrogen that they cannot. Thick mats of moss insulate the ground, keeping it warmer in winter and cooler in the summer. Species like salamanders, for which the Blue Ridge Mountains are a biodiversity hotspot, can use moss and lichens as cover, staying hidden underneath their thick layers.

Because of their high absorptive capabilities, mosses and lichens are also used to measure air quality. They have a low tolerance for pollution, especially heavy metals, nitrogen dioxide, and sulfur dioxide. Nitrogen dioxide is a byproduct of car engines and machinery, while sulfur dioxide is a byproduct of coal burning. Exposure to pollution can lead to reduced photosynthesis, bleaching, and death if prolonged and severe enough. Over time, sensitive lichen are replaced by tolerant lichen. Because of this, the species of lichen present in an area can tell you the current or historical air quality. Scientists can even extract the toxins from a lichen's thallus in order to determine the levels in the surrounding atmosphere.

Mosses and Lichen in the MRNRA

Sometimes bacteria, cyanobacteria, fungi, lichens, and mosses form what is called a biocrust on the ground. Biocrust serves as an intermediate layer between the soil and the air, and is especially important in drylands to increase fertility with water and nutrients and prevent erosion. Here in the Mount Rogers

National Recreation Area (MRNRA), Whitetop Mountain's balds host a biocrust layer. Driving to the highest parking lot on the mountain, if you stop along the way, you can observe the biocrust of mosses and lichens that cover the ground. Biocrust layers are extremely fragile. Stepping on them can destroy those communities, and they willl wait years before attempting to re-colonize.

The unique hemiboreal habitat of the MRNRA has allowed a variety of lichen and moss species to survive here, including some that are incredibly rare to the region. Hypotrachyna virginica is a critically endangered lichen whose area of occupancy and extent of occurrence are predicted to decline by more than 80% in the next 3 generations. It is endemic to high elevations in Southern Appalachia and is found on Mount Rogers, specifically in spruce-fir forests and balds. *Pycnora praestabilis* lichen was not previously reported in any other location in eastern North America before it was found in the MRNRA. Similarly, *Psilolechia clavulifera* is from a lichen taxon that had only ever been reported in one other place in eastern North America. *Heterodermia erecta* lichen was only found in a small region of Georgia/North Carolina before it was discovered in the MRNRA.

Because there are only single recordings for the following rare/threatened mosses, more research is needed to confirm their presence and proliferation in the MRNRA. Appalachian haircap moss (*Polytrichastrum appalachianum*) is considered critically imperiled, which means it is at a very high risk of extirpation in the area because of a restricted range, few populations, steep declines, or severe threats. Its single occurrence in the area was on the north face of Whitetop mountain. Narrowleaf peatmoss (*Sphagnum angustifolium*) is also a critically imperiled species. Polytrichum formosum was found at the summit of Whiteop in 1892, but is considered lost to the state now.

Despite their humble appearance, mosses and lichens are incredibly complex organisms that do a great deal of good for our ecosystems. Because of their cryptic nature, more field research and surveys may reveal the presence of species currently believed to be absent from our region, or even some previously undescribed.

Fall Leaf Change

Many of the trees in the Mount Rogers region lose their leaves as fall transitions into winter. These trees, called deciduous trees, differ from evergreen trees, which have special adaptations allowing them to keep their leaves through the winter. Before deciduous trees drop their leaves in autumn, they put on an incredible color show, turning all shades of red, orange, yellow, even purple! These colors are a hallmark of fall, especially here in the Blue Ridge, where many people travel from far away just to see the vibrant fall foliage we get once a year. But have you ever wondered why some trees go through the trouble of changing their leaves' color, dropping them, and growing new ones every single year?

With the onset of winter comes freezing temperatures, which pose a vital threat to most living things. When water freezes, it expands. In cells that are full of water, this expansion can lead to them exploding like tiny, overfilled water balloons. Also, as ice freezes, it tends to form sharp needles, which can cause even more damage by shredding parts of the cell. Animals have many adaptations to cope with the freezing temperatures of winter. Some migrate to warmer places, others find somewhere sheltered to hibernate, and some simply lay eggs and die, letting the next generation start the following spring. Trees, which live many years and lack the ability to move, have to find other ways to cope.

As small, water-filled extremities, a tree's leaves are the most susceptible organ to freezing damage, and it would take an incredible amount of energy to insulate them from the cold. So instead, deciduous trees drop them once temperatures start to fall. However instead of dropping good, healthy leaves, the tree absorbs every helpful nutrient it can from them first, avoiding any waste. Most of the cells' contents are digested and turned into starch, proteins, water, and other nutrients.Throughout the tree, sugars are converted into starch, which is harder to use for quick energy but is very compact and stable–perfect for long-term storage. The tree's phloem pulls these products down into the roots where they will stay through the winter. When spring arrives, these nutrients are transported back up to leaf buds where they will jump start new leaf growth.

When tissues in the leaves are being broken down, chlorophyll is digested and leaves lose their green color, allowing other colors to show through. Many trees contain carotene, another photosynthetic pigment, as well as chlorophyll. Since chlorophyll is much more abundant and is easier to reabsorb, trees "cut their losses" and leave carotene behind to focus efforts on the chlorophyll. Carotene appears yellow, so once it is the only pigment left in the leaf, they appear bright yellow, as you can see in trees like birch, hickory, and ginkgo. As sugars are converted to starch, some byproducts may form. One byproduct is a class of sugars called anthocyanins, which are red or purple in color. When a lot of sugars are being processed in direct sunlight, more of the sugars convert into anthocyanin, turning the leaf more red in color. Maples, oaks, and sumac all turn shades of red and orange depending on ambient sunlight. Anthocyanin color is also dependent on soil pH, with less acidic conditions giving anthocyanin a purple hue, as can sometimes be seen in sweetgum (*Liquidambar styraciflua*) and sourwood (*Oxydendrum arboreum*).

After most trees finish digesting the contents of their leaves, they are shed. A thin disk of cells at the base of the leaf severs the leaf from the tree in a process called abscission. This ensures that the leaf breaks off at the right location, and not until after the tree has reabsorbed all the nutrients it can from the leaf. However, some trees exhibit a strange adaptation called marcescence. In these trees, the abscission disc seals off the leaf from the stem, but does not sever the leaf. In trees like beeches and some oaks, the dried leaves remain on the branches into winter and sometimes into spring. The advantages are not fully understood, but there are several theories as to why a tree would be marcescent. One prominent theory is that the dried leaves provide protection for the plant. The dead leaves are mostly made up of lignin and cellulose, two plant starches that are very difficult to digest and lack nutrients. However, the branches the leaves are attached to are very high in nutrients. By keeping the leaves, the branches may be protected from herbivory, as would-be consumers find the leaves unpalatable. The leaves may also provide leaf buds protection from the elements. In beech trees, the leaves usually are not dropped until the following spring, when leaf buds break open and develop.

Other trees, the evergreens, have different adaptations that allow them to keep their leaves throughout the winter. Evergreen leaves sport a waxy coating that helps prevent water loss in the dry winter air, and provides some insulation. Furthermore, the leaves are usually darker shades of green allowing the leaves to capture more light energy during the shorter days of winter. Evergreen wood is often softer than deciduous (hence the commonly used descriptions "softwood" and "hardwood"). This slight sponginess of the phloem means that in extreme cold, some of the water can freeze inside the plant without causing as much damage. Many evergreens have small needles or scales instead of broad leaves, and have conical canopies. These features reduce the surface area of the leaf, making them easier to maintain. This leaf shape also prevents snow from piling up on the leaves, which would otherwise block light and break branches under its weight. Members of the pine family also have thick resin in addition to their sap. Resin

acts like antifreeze because it is more concentrated with sugars and terpenes. While all trees have sap flowing in the phloem to assist in the transportation of sugars and nutrients throughout the plant, resin fills the xylem and collects in the heartwood of pines and their cousins.

Many people would place trees into one of two groups: deciduous, broadleaf, and hardwood trees; or evergreen, conifer, and softwood trees. However, these terms are not interchangeable. “Deciduous” and “evergreen” describe the tactics trees use to cope with winter–whether they invest effort into growing new leaves each year or maintaining leaves even through long and difficult winters. Broadleaf trees have flat, wide leaves to maximize sunlight capturing, while conifers are trees who produce seed-bearing cones and have needle-like, or scaly, leaves that minimize surface area. Finally, hardwood and softwood are names timber harvesters use to describe trunk toughness. While most trees fit into categories where the three groups align, there are many exceptions. For example, hollies are evergreen broadleaf trees, and cypress are deciduous conifers.

Winter is a tough time for all organisms that live in seasonal regions. These two groups of trees have developed very different, but effective, strategies to survive through to the next growing season, and we are lucky that they both have such beautiful ways of doing it!

Terrestrial Salamanders

The Southern Appalachian Mountains that we call our home is the most ecologically rich region in the temperate world, thanks in large part to a great diversity of habitat types, and ample annual rainfall. In particular, herpetologists recognize Mount Rogers as a global biodiversity hotspot for salamanders, containing more salamander species than any other area of a similar size on Earth. Virginia alone is home to 52 recognized species of salamander, and as molecular testing improves, new species are still being described.

Cryptic Amphibians

Salamanders are ectothermic, or “cold blooded,” organisms, though the latter term has fallen out of favor with biologists. This means that they do not internally regulate their body temperature. Instead, they have adapted to function at environmental temperatures and seek out warm sun or cool, damp shade when they need to adjust their body temperature.

It is estimated that salamanders make up more biomass in the mountaintop ecosystems of the Mount Rogers region than all of the birds and mammals combined. However, they are a fairly cryptic species, and can easily be missed if you are not familiar with their habits. Since they are very sensitive to desiccation, they require damp habitats to maintain moisture. During the day, most salamander species spend less than 20% of their time exposed. The remainder is spent sheltering in underground burrows, beneath rocks in or near streams, and hiding under damp logs and leaf litter. They also tend to be much more active on foggy; drizzly; and cool, cloudy days, rather than hot, dry days. Most salamanders are also nocturnal, and can often be seen crawling on top of leaf litter and even climbing trees at night, when their reflective eye shine is a great way to locate them.

If you decide to go herping–that is, searching for salamanders–there are a few important rules to keep in mind. Salamanders have extremely thin, sensitive skin, and handling them can be dangerous for the

salamander. Oils, lotions, and soap residue can all be absorbed by amphibians' skin and harm them. Dry skin is equally dangerous, as it can wick away the crucial moisture they must maintain. Before herping, rinse your hands very well without soap to prevent contaminating the salamanders. Just before attempting to hold a salamander, rub your hands in wet soil to create a protective layer between your skin and theirs. Keep in mind that the skin on salamanders' backs are the most sensitive, so the best method is to try to corral the salamander to crawl onto your open palm, rather than pinching them from above. Of course, most salamanders are surprisingly agile and strong jumpers, so this is easier said than done. Finally, try to return salamanders to wherever you found them. Carefully replace any logs or stones after looking beneath them, and disperse leaf litter that was moved aside to avoid destroying their habitat.

Plethodon Aplenty

The majority of our terrestrial salamanders belong to the family Plethodontidae, a name that literally translates to "many teeth." These amphibians have a cluster of teeth at the back of their mouths that help them swallow their prey, which includes insects, worms, isopods, and nearly any small animal that they can catch. Members of this family are lungless, even as mostly terrestrial adults. Salamanders breathe via cutaneous respiration, allowing oxygen to diffuse across their skin. While this is very convenient for an animal that spends most of their life between land and water, it unfortunately makes them very sensitive. They can easily absorb toxins through their thin skin, and have to remain in wet environments, as they can not retain their own moisture.

Following the Pleistocene–the last ice age–many species of the New World Plethodontids were forced to retreat up the mountains to higher elevations. They had adapted to the cool, damp conditions that were once much more widespread. As their preferred climates were found at higher altitudes, populations were corralled to mountain ranges, divided from one another. Millenia later, these disjunct populations became distinct species from one another in a classic example of allopatric speciation. We can thank this process for the incredible diversity of plethodontid salamanders found in the Blue Ridge Mountains.

A large genus within this family is the nominal genus, *Plethodon*. These species are fairly terrestrial, with many species laying eggs in nests beneath leaf cover, logs, moss, and other high-humidity habitats. Although this is the most diverse salamander genus found in the Blue Ridge, these salamanders have a unique life cycle among amphibians. Young undergo direct metamorphosis, in which they bypass an aquatic larval stage. Young are born resembling the adults, without the large feathery gills present on most amphibian larvae. Members of this genus also tend to have round tails, used for balance while walking and climbing.

The most abundant salamander on Whitetop Mountain is the gray-cheeked salamander (*Plethodon montanus*). They are estimated to make up about a third of the total salamander population on this mountain. Their habitat extends as far north as the Clinch Mountain range, and south halfway down the North Carolina/Tennessee border.

Another species with a very limited range is the Yonahlossee salamander (*Plethodon yonahlossee*). These salamanders are fairly abundant within their range, but are limited to the mountain tops from Pulaski County of Virginia to Mitchell County in North Carolina. Although they were described over 100 years ago, herpetologists still have a lot to discover about this species. It is hypothesized that they nest deep

underground, and young spend the first year or more in these burrows, as there has not been a recorded observation of Yonahlossee eggs or young.

The Weller's salamander (*Plethodon welleri*) has only been found on 22 of the highest peaks between Whitetop Mountain and Grandfather Mountain in North Carolina. Its normal habitat is found at elevations above 4600 feet, but can be found as low as 4300 feet on north-facing shaded slopes. The small salamanders have dark, slate-colored skin with distinctive gold speckling across the back.

This salamander comes with a very interesting story. In 1930, a young herpetologist from Cincinnati, Ohio was visiting Grandfather Mountain on his summer break after his sophomore year of high school. On this trip, he discovered a salamander he did not recognize. Upon returning to Cincinnati, he wrote to several herpetologists describing the salamander. Unfortunately, since he did not return with a specimen, he was unable to confirm it as a novel species. In the following year, he led a backpacking trip with the members of the Cincinnati Junior Society of Natural Sciences. During one of the nights, he left camp alone to search for the salamander, expecting they would be more active at night. The other campers recalled the night being very foggy. They would not notice his absence until the following morning. Four days later, a search party discovered he had fallen down a ravine, and unfortunately had not survived the accident. In his pocket, they found a collection bag with several specimens of the salamander (which also had not survived). The specimens were sent to Charles Walker, a herpetologist at the University of Michigan, who confirmed they were a novel species. He decided it would be fitting to name the salamander after its discoverer, Worth Hamilton Weller.

The vast diversity of salamander species found in Mount Rogers and the greater Southern Appalachian region is a clear biological highlight, often hidden from plain sight under rocks and leaf litter. It is a marvel worth celebrating, with wet hands and care, on a cool, damp day–or night–atop Virginia's highest peaks.

Dragonfly Migration

When thinking about migrations, the first animals that may come to mind for most are birds. Geese, with their iconic V formations cover incredible instances with apparently little effort. Hummingbirds, who seem to simply disappear one day in the fall, only to suddenly appear over a thousand miles south in central America. Some may even think of the great Monarch migration, where millions of individuals flock together and depart for Mexico. One migration that many overlook are the dragonflies. Only some species migrate, the darners and the skimmers. Most damselflies and the rest of the dragonflies die at the end of fall, leaving behind eggs that will hatch come spring. Aquatic nymphs can survive over winter in standing water below the sheet of ice. Non-migratory species will spend a few years as nymphs, only emerging as flying adults for a single summer.

Most migrating insects, such as the iconic monarch butterflies, fly hundreds to thousands of feet above the ground, riding the south-blowing winds high in the atmosphere generated by the Ferrel convection cell. These winds allow the insects to simply glide along the current with little effort, covering great distances. Dragonflies, however, are very strong fliers with voracious appetites. They migrate at slightly lower elevations, picking off smaller insects they pass.

Dragonflies share their migration route with falcons and hawks, rather than the routes of smaller birds. This is likely an attempt to avoid predation by small insectivorous birds. For the larger carnivorous birds, a much

more appropriate meal would be small mammals and other birds. That said, hungry falcons are known to catch a small snack from time to time out of their travel companions.

Migrating dragonflies have a slightly modified life cycle. These dragonflies are multivoltine, meaning they have several generations per year so that the individuals who return from migration are the children or even grandchildren of the individuals who left the previous fall. As nymphs, these species tend to develop very quickly, and live proportionately longer adult lives so they can cover such great distances.

Researchers don't yet fully understand the intricacies of dragonfly migration. Dragonflies migrate across every continent except Antarctica, and there are at least 16 migrant species in North America. The primary migratory dragonfly species are: common green darner (*Anax junius*), wandering glider (*Pantala flavescens*), spot-winged glider (*Pantala hymenaea*), black saddlebags (*Tramea lacerata*), and variegated meadowhawk (*Sympetrum corruptum*).

The best-known of these is the common green darner, *Anax junius*. Green darners are exceptionally large, for dragonflies and have been found to travel from 300 miles to as much as 1,500 miles in migration. Studies of their migration from species collections has shown a three-generational cycle. The first generation emerges in the southern United States, Mexico, and the Caribbean. This generation travels hundreds of miles north in the spring. The second, northern generation reaches maturity in summer/fall and then reverse the path of their parents, migrating back south to lay eggs. The third generation emerges in the south and is non-migratory, going through the entire life cycle in one place. The dragonfly offspring of this third generation begin the first-generational cycle again.

Another notable dragonfly migrant sometimes spotted is the wandering glider (*Pantala flavescens*). This yellowish-orange dragonfly with red eyes is quite a bit smaller than the above mentioned darner. The wandering glider is the global insect long-distance champion and may migrate more than 11,000 miles in search of pools to lay their eggs. The larger surface of their wings enables wandering gliders to ride prevailing winds at high altitudes. They feed on tiny airborne plankton along the way as they stroke then glide for long periods, expending minimal energy.

Dragonflies are exceptional aerialists and are able to hover, dive, fly backwards or upside down, and reach speeds of up to 30 miles per hour. Each of their four wings acts independently, meaning a dragonfly can be missing one wing and still carry on. It's likely that you've seen dragonfly migration, especially if you have participated in a hawk migration count. It's not a bad way to spend some time on a warm fall day; looking to the sky and watching for these winged wonders.

Getting Outside

PLACES TO FISH, HUNT AND VIEW WILDLIFE

Mount Rogers National Recreation Area

Located in southwest Virginia and the Blue Ridge Mountains, the Mount Rogers National Recreation Area (NRA) manages approximately 200,000 acres of National Forest land near Mount Rogers.

It contains four wilderness areas; the Virginia Creeper Trail; the 50 mile Mount Rogers Scenic Byway and the 5,000-acre Crest Zone featuring elevations over 4,000 feet that include rock formations, balds and spruce-fir forests. It is also home to 60 miles of the Appalachian Trail as part of the 500 miles of trails within the NRA.

Many activities are available in the area including camping, picnicking, wildlife viewing, trout fishing, hunting, hiking, bicycling, horseback riding, cross-country skiing, and swimming.

Fishing

Nestled in the heart of Southwest Virginia and the Blue Ridge Mountains on the western boundary of the MRNRA, warmwater fishing opportunities abound on the New River. This ancient river awaits the angler searching for smallmouth bass, walleye, and musky.

Further west, within the headwater streams of the New River and upper Tennessee River Watershed tributaries, the angler will be delighted to find smallmouth bass and a number of trout species, both wild and native. Brown and rainbow trout have been stocked in these streams for decades, and now naturally reproduce in many of the waters within the Recreation Area where cold, clean water with suitable spawning habitat flows year-round.

In the upper reaches of all of these watersheds, there are ample high-mountain “blue line” streams where one can find Virginia’s only native Salmonid. The Southern Appalachian Brook Trout is a species genetically unique to the region, and its physical features can vary from stream to stream.

Both native brook trout, and wild rainbow and brown trout can be found in many of the streams that course our corner of the Blue Ridge, including Whitetop Laurel, Big Wilson, Little Wilson, Fox, and Cabin Creeks, and Straight Branch.

Hunting

Hunting in the mountains of southwest Virginia, particularly in the designated Wildlife Management Areas (WMA), offers a unique and immersive experience for outdoor enthusiasts. These vast and rugged terrains, enveloped by the Blue Ridge Mountains, provide a diverse ecosystem that supports various game species and fosters responsible hunting practices.

As you embark on your hunting expedition, you will find yourself traversing through dense woodlands, climbing steep slopes, and navigating babbling streams. The WMAs in this region are carefully maintained

to strike a balance between conservation and the sustainable harvest of game, ensuring the health of both the ecosystem and the hunting tradition.

One of the primary game species sought after by hunters in these areas is the white-tailed deer. These deer roam the hills and valleys, their natural behaviors shaped by the undisturbed wilderness. With the changing seasons, hunters may find themselves adapting to the unique challenges presented by the terrain, from the crisp autumn leaves rustling underfoot to the snow-covered landscapes of winter.

Black bears are another notable presence in these mountains, adding an element of excitement to the hunting experience. Patient hunters might spot signs of bear activity, such as claw marks on trees or scat along the trails. The thrill and challenges associated with hunting a black bear in its natural habitat makes for a memorable experience.

Wild turkey are abundant in the mountains of southwest Virginia, and ruffed grouse, though not present in great numbers, today, exist in relatively strong numbers within the Mount Rogers region, providing upland hunters with the willingness to cover miles of steep terrain in search of a flush an opportunity to participate in a rich Appalachian tradition . The echoing calls of gobbling turkeys or the sudden flutter of wings as a grouse takes flight create a dynamic and engaging atmosphere for upland bird hunters. These experiences are not only about the pursuit of game but also about immersing oneself in the sights and sounds of the mountains.

WMAs in the region are managed with a focus on habitat preservation and conservation. Hunters play a vital role in this ecosystem by participating in regulated hunts, adhering to bag limits, and respecting the natural balance of the environment. The careful stewardship of these lands ensures that future generations can continue to enjoy the thrill of the hunt while preserving the integrity of the mountains.

Wildlife Viewing

Venturing into the Blue Ridge Mountains of southwest Virginia is like stepping into a natural tapestry where wildlife thrives in harmony with the pristine wilderness. As you navigate the trails and forests, a plethora of creatures unveils itself, each contributing to the rich biodiversity of this region.

One might encounter the white-tailed deer, a symbol of grace and resilience. These creatures graze in open meadows or move silently through the shadows of the woodland, adding a touch of enchantment to the landscape.

And keep your eyes peeled for the elusive black bear, an icon of the Appalachians. These majestic creatures, with their thick fur and powerful stature, might amble through the forest, foraging for berries or exploring the mountainside. Observing a black bear in its natural habitat is a humbling and awe-inspiring experience, emphasizing the need for conservation and coexistence.

The region is also home to a variety of avian wonders. In the early morning, songbirds create a symphony that resonates through the valleys. Scarlet tanagers, indigo buntings, and warblers add a burst of color to the foliage, while predatory raptors like red tailed hawks and eagles soar high above. Spring is an amazing

time to witness warblers as they migrate in from central and south america in search of mates and breeding grounds with the fall being the time to watch the raptors move southward to warmer climes.

Nesting in the hollows of trees, the woodland box turtle is another resident of these mountains. These slow-moving, resilient creatures symbolize the longevity of the ecosystem.

Near babbling brooks and pristine streams, the amphibians add their voices to the chorus. Salamanders, frogs, and toads thrive in the cool, moist environments, their vibrant colors and intricate patterns adding to the mosaic of life in the Blue Ridge. The rivers and streams themselves are teeming with aquatic life. In the deeper pools, the elusive eastern hellbender—a large aquatic salamander—might find refuge, a testament to the purity of the waterways.

The biodiversity of wildlife within the Mount Rogers region is sure to provide visitors with ample opportunity to view both rare and common species of birds, mammals, amphibians, and invertebrates. Though the entire recreation area plays host to a great number of species, certain hotspots are all but guaranteed to provide worthwhile wildlife viewing opportunities for the eager naturalist.

Easy access to the region can be found at Whitetop Mountain, the highest navigable road in the state. Virginia's second-highest peak, Whitetop Mountain rises to 5,525 feet above sea level. Second in height only to Mount Rogers, this sky island peak is home to many endemic species that utilize the northern hardwood forests, balds, and red spruce forest.

Other easy access spots include Elk Garden Trailhead, Helton Creek trail, Beartree Lake, Grindstone Campground, Hurricane Campground, and the Scales, as well as numerous USFS roads that traverse the local public lands. There is also Grayson Highlands State Park with its many vistas and trail systems.

TIPS AND TOOLS FOR EXPLORATION

Exploring nature ethically involves respecting the environment, wildlife, and other outdoor enthusiasts. As you take to the field, consider these tips and tools to help you engage in responsible and sustainable outdoor activities.

Tips

Familiarize yourself with Leave No Trace ethics and incorporate them as they apply to your outdoor adventure.

Primarily, pack out all of your trash, including food scraps and biodegradable waste, minimize campfire impact and use established fire rings where available, respect wildlife by observing from a distance and not feeding them. Keep a safe distance and use binoculars or a camera with a telephoto lens for close-ups, stay on designated trails, stick to established trails to minimize your impact on vegetation and wildlife habitats and avoid creating new trails, as this can lead to soil erosion and damage to fragile ecosystems.

Educate yourself. Learn about the ecosystems, flora, and fauna of the area you're exploring and be aware of any specific regulations or guidelines for the particular area. If you plan to use an area to harvest berries, mushrooms, or other wild edibles, assuming that it is legal and you have the proper permitting, follow sustainable harvesting methods to ensure the long-term survival of the stand or population. Do not pick all of a given resource that can be found in an area, but pick sporadically, taking a small percentage of what is available. When harvesting mushrooms, it is a good idea to carry them in mesh bags, which allow the spores to disperse as you tote them through the woods.

Practice responsible fishing and hunting. Adhere to catch and release practices when fishing. If hunting, follow all regulations, obtain necessary permits, and practice ethical hunting methods. Hunting and fishing regulations are carefully designed to allow humans to enjoy these pursuits without over-consuming a delicate resource, and are set by regional- and state-level wildlife and fisheries biologists. Respect these rules so that you, and others, may continue to enjoy these activities for a long time to come. For the MRNRA and surrounding lands within the state of Virginia, consult the Virginia Department of Wildlife Resources (VDWR) for updated hunting and fishing regulations.

Minimize noise pollution. Keep noise levels to a minimum to avoid disturbing wildlife and other visitors. Enjoy the natural sounds of the environment.

Camp responsibly. Use established campsites when available and consider using biodegradable products and reusable or sustainable camping gear whenever possible. Biodegradable soaps and detergents are a must for washing dishes and yourself. Still, when disposing of these products, it is best to do so more than 200 feet from water, and in a dispersed manner, to avoid significantly impacting stream or soil chemistry.
use eco-friendly products.

Tools

Having the proper tools while in the field can greatly enhance your experience while keeping you safe and comfortable and allowing you to follow Leave No Trace ethics.

Perhaps the most important tools in any field exploration kit are those used for mapping. Digital maps and GPS units are great resources for casual and intensive trips, allowing you to stay on designated trails and avoid getting lost. However, these devices should never be your sole method of orientation and navigation, as they can become ineffective when batteries die or cell service is non-existent. As a primary defense against these threats, ensure that devices are properly charged before embarking on a trip, and in the case of handheld GPS units, pack spare batteries.

As backup, or primary navigational tools, always carry maps for the area you'll be using and a compass to help orient yourself on that map and make navigational decisions, and know how to use them. Water- and tear-proof maps are particularly valuable, as paper maps can be ruined by life in the field. A great resource is the 318: Mount Rogers High Country Map [Grayson Highlands State Park], which can be purchased online or in local outdoor supply shops.

Field guides are also a great resource to carry with you, as they can help identify flora and fauna, enhancing your understanding and appreciation for the natural world. They can also be a safety tool when foraging, particularly for mushrooms with toxic look-alikes.

Binoculars, spotting scopes, and cameras with telephoto lenses are also valuable tools to have in the field that can enrich your experience while allowing you to respect wildlife by observing from a distance without causing a disturbance.

Reusable water bottles and containers help keep you hydrated and sustained without producing a great amount of waste. Consider toting a water purification system–in the form of iodine tablets or a water-purifying pump system–to allow you to refill water bottles from natural water sources safely. Today, there are some very compact options on the market that integrate water filtering technology into reusable water bottles, making the entire process incredibly simple.

Because you never know what might happen when exploring in wild places, and being prepared is a fundamental principle, a first aid kit might be the most important tool to have in your pack. Always keep it well-equipped, inspecting and refilling it after long trips or periods of usage, and know how to use the items in it. To that end, basic first aid, and more intensive wilderness first aid courses can be an incredibly valuable tool that does not take up space or weigh down your pack.

There are a number of apps available to smartphone users that can prove valuable tools in the field. Perhaps the most important are weather apps, which can help you to stay informed about weather conditions as they develop and change, and to make decisions to ensure your safety and the safety of others. Other apps provide information about Leave No Trace principles, local regulations, and trail conditions or maps, and can serve as secondary references to hikers.

By integrating these tips and tools into your outdoor adventures, you can help preserve the natural beauty of the areas you explore while fostering a culture of responsible outdoor recreation. Some incredible experiences await you in the outdoor world, but pursuing them safely and responsibly should be of paramount concern, and can even enrich the experience!

COMMUNITY SCIENCE

Science in the Blue Ridge Mountains is not restricted to those who have university degrees or work as scientists professionally. The future of science is in the hands of the individual who is passionate about learning. Modern technology allows scientists to communicate closely with those who live and explore the areas they study. Formerly known as citizen science, community science is the practice of enabling volunteers from a wide variety of backgrounds to contribute to scientific pursuits they care about themselves, without doing heftier, more specialized research reserved for those who are formally trained.

Natural history community science has a long history in the mountains. In the Blue Ridge, geography often creates connections between field researchers and members of the community. Steep ridges and valleys cause people to congregate in the same spaces, surrounded by the same beautiful mountain vistas. While these connections are positive, there can be a discourse between all members of the community.

Discussions between landowners and researchers have existed as long as public land has been in the mountains. Discourse between members of the community and scientists such as ethnobotanists, folklorists, archaeologists, and geologists have persisted as long as people have existed in the mountains, and especially since the onset of Western scientific models. The Blue Ridge Mountains have harbored a diverse array of local cultures, as well as traveling researchers who travel here to learn more about the mystery and global implications of this area. Those knowledgeable of the land continue to share their insight and observations with the researchers who arrive in the area to explore the Blue Ridge highlands. Today, by vehicles, boats, hiking boots, and even remotely through cyberspace, many researchers do the same.

The community science platform iNaturalist is one of the most well-known and useful projects worldwide for documenting biodiversity in the 21st century. A simple, nonprofit website, anyone can upload photos and sounds to a global database monitored by other "community scientists" worldwide. Computer vision, a developing form of artificial intelligence, is used to generate potential identifications from uploaded images. Amateurs and experts alike review these observations and draw conclusions to help identify these observations or confirm their identity, converting them into "research grade" samples visible to researchers. State and federal wildlife agencies frequently use the records for information about particular areas that might be a priority, as do private land stewards such as the Nature Conservancy.

The reach of scientists and habitat management personnel is limited, and often inundated with a constant stream of important work and information. Individuals independently exploring or recreating can contribute data many scientists would be unable to obtain otherwise. An angler might capture a trout with a strange disease, and a simple photo can alert researchers and wildlife managers of the presence of an introduced pathogen in a new stream. A meteorologist might encounter a timber rattlesnake while checking on a portable weather station, locating a new gestation site. A strange, inconspicuous insect at a backyard picnic might be the first record of an undescribed species, or a large moth might visit back porch lights, lost in migration from a distant tropical region, making a first state record.

Other community science projects are more regimented. The state sometimes requires hunters, with voluntary or mandatory implications, to submit certain artifacts (bear teeth, rabbit skulls, etc.) to gather data pertinent to specific management concerns; the spread of specific diseases; or the understanding of certain life history mechanisms, such as the relationship between age and growth in different species. Volunteers with local research organizations, from university-affiliated field stations to non-profits, are often recruited to help with tasks such as building and installing nest boxes, collecting seeds of rare plants, and contributing specimens for preserved reference collections.

Many projects also require more involved efforts. Christmas Bird Counts, organized by the Audubon Society, and the Breeding Bird Survey, managed by the United States Geological Survey, are great chances for more experienced volunteers to gather important data and learn essential skills in data gathering processes. Other government agencies, such as the United States Forest Service, create occasional public opportunities to participate in research during electrofishing surveys and BioBlitz weekends.

Community science is an essential, and highly effective, tool in the modern world, allowing for an unprecedented volume of biological data to be collected by an enormous workforce of amateur and trained naturalists, alike. As a secondary benefit, this process ensures that there is an ongoing dialogue between

researchers and the community that surrounds their research, creating a more informed and engaged culture of nature-lovers.

About Us

HISTORY OF THE BLUE RIDGE DISCOVERY CENTER

Blue Ridge Discovery Center (BRDC) was incorporated as a grassroots nonprofit in 2008 with the drive to connect our community with nature and teach critical thinking skills. Without a founding endowment or initial land contribution, the organization relied on dedicated volunteer efforts to begin building programs. BRDC has formed core principles which are relied upon today: interest-driven, hands-on, and experiential activities. As grants and contracts were secured, BRDC programming began to develop. From building bird houses at elementary schools and leading discovery walks, to aquatic macroinvertebrate studies, field trips to unique habitats, and programs that combined art and science, the program slate expanded rapidly. Today, BRDC works with 8 different schools to provide programming in elementary, middle and high school grade levels. Branching out of in-school programs Blue Ridge Discovery Center offered our first summer camp in 2014 and expanded each year, now having camps throughout the summer. After having sponsored community naturalist walks in the past, BRDC took on responsibility of the storied Mount Rogers Naturalist Rally in 2012, expanding the event to four times a year and providing over 60 professionally guided hikes. In 2016 BRDC opened the door to direct impact research and restoration projects in partnership with the USFS.

In 2017 the historic Konnarock Training School property, located at the base of Whitetop Mountain in the Mount Rogers National Recreation Area, was gifted to the BRDC. Previously, between 1925 and 1959, the school provided basic education and domestic skill training for girls in the surrounding rural area. Later, the school was used as a summer youth retreat by the Lutheran Church, then sold to the US Forest Service, and in 1997 added to the National Register of Historic Places.

Over the last 5 years (2017-2022), BRDC has raised the funds needed to restore the schoolhouse that now includes a commercial kitchen, library, auditorium, classroom and residential facilities to accommodate up to 70 children/adults for overnight stays. The 12-acre BRDC campus includes streams, a restored wetlands area with accessible trails and boardwalk, a field house, and a pollinator rain garden.

Today, BRDC is a world class residential education facility, biological field station, and soon to be interpretative Visitor Center at the base of the highest mountains in Virginia. We will be the catalyst to reconnect our community with one of the greatest natural treasures in North America.

Our Mission

BRDC inspires curiosity, discovery, and stewardship through the wonders of the Blue Ridge.

Our Vision

We envision a world with deep appreciation and understanding of place.

- BRDC provides opportunities for people to discover the wonders in their own backyards, parks, forests, fields, rivers and mountains.

- BRDC fosters a community-based interest in sharing biodiversity with others through guided education activities.
- BRDC brings the principles of ecology, sustainability, and discovery to the next level through collaborations with various educational and established outdoor institutions.

WHAT INSPIRED US

Our interpretive approach is unique because it focuses on a single globally unique macro-habitat, the Blue Ridge Ecoregion. Our purpose is to further an understanding of the rich natural history of this Ecoregion. The beauty and the treasures of this region have the potential to inspire the world.

A 6,000-foot increase in altitude is similar to driving 1,000 miles north. A trip from the James River, at an altitude of 650 feet, to the 5,729-foot summit of Mount Rogers in Virginia's southern Blue Ridge is the rough ecological equivalent of a drive from the James River to the shores of Canada's Hudson Bay. Depending on the route to Mount Rogers, the traveler would pass through a variety of forest communities. These might include a silty lower flood plain, wetlands and bogs, cove hardwoods, shale barrens, oak-hickory forest, oak-pine forest, northern hardwoods, grassy balds, boulder fields, and muskegs, ending in an alpine spruce-fir forest. Each community has plant and animal species especially adapted for survival.

The Blue Ridge Ecoregion, as defined by the Omernik Ecoregion System of classification, extends from southern Pennsylvania to northern Georgia, and varies from narrow ridges to hilly plateaus to more massive mountainous areas, with 125 peaks reaching over 5000 feet. The mostly forested slopes, high-gradient, cool and clear streams, and rugged terrain occur primarily on metamorphic rocks with very few areas of igneous and sedimentary geology. The Blue Ridge is a province of the larger Appalachian Mountain chain and is defined on the east by a transition to Piedmont terrain and the west by its transition to the valley and ridge province.

- The forests of the Southern Blue Ridge are the most ecologically rich in the temperate world - scientists estimate that 100,000 species exist in Great Smoky Mountains National Park alone.
- There are over 4,000 known plant species in the Southern half of the Blue Ridge alone, 250 of which are found nowhere else in the world.
- Spray cliffs, fens, bogs, seeps, glades, swamp-forest bog complexes, upland pools, and granite balds serve as important nodes of species diversity.
- There are 34 known species of salamanders. The Mount Rogers area contains over 20 species, which is a diversity in Salamanders unmatched anywhere on earth in an area of that size.
- Elevation ranges from 580 feet to 6,684 feet within the Blue Ridge Ecoregion. These extremes in altitude also enhance species diversity. It has been estimated that each 1,000 feet in elevation is accompanied by a 3.6-degree Fahrenheit decrease in temperature.
- Over 400 endemic species have been identified in the Blue Ridge Ecoregion, more than any other ecoregion in North America.
- The region’s streams and rivers contain the largest variety of fish, fresh-water mussels and crayfish in the temperate world. More than 230 fish species have been documented, and new species continue to be discovered.
- The large and undisturbed tracts of land within the Blue Ridge provide habitat for a large number of rapidly declining neotropical migrant songbirds. It is here that they find refuge.
- The Blue Ridge gives birth to what is regarded to be one of the oldest rivers in the world, the New River. Geologists believe that the river is older than the Blue Ridge Mountains themselves.

LOCATION

Blue Ridge Discovery Center (BRDC) is located at the base of Whitetop Mountain along Route 600 in Smyth County Virginia. Our Physical Address is:

6402 Whitetop Rd,
Troutdale, VA 24378

DIRECTIONS

From I-81, take exit 35 (Chilhowie). Turn south (toward Hardee's) and continue for 11.2 miles. Route 762 will become Route 600 (Whitetop Rd) and will cross over Iron Mountain. When you reach the intersection of Whitetop Rd (RT 600) and RT 603 (Laurel Valley Rd), the BRDC Campus, FIeld Station and parking will be on the left. Turning left to continue on Whitetop Rd, the Schoolhouse will be your first right driveway.

CONTACT

BRDC can be reached by phone at 276-388-3155; email at info@blueridgediscoverycenter.org or through our website at www.blueridgediscoverycenter.org.

BRDC is exempt from Federal Tax under section 501(c)(3) of the Internal Revenue Code, We are a nonprofit organization with Tax ID 26-3378442.

Partners

The creation of the Narrative was made possible through the collaborative efforts of dedicated partners, staff and volunteers who generously contributed their time, expertise, and passion. These individuals and organizations played a pivotal role in shaping the content, providing valuable insights, and ensuring the Narrative's accuracy and relevance. Their commitment to the project reflects a shared commitment to the goals and values it represents. The diverse skills and perspectives brought forth by everyone enriched the Narrative, making it a well rounded resource.

We extend our heartfelt gratitude to each and every one of you for your contributions to this endeavor, recognizing that your collective impact extends far beyond the pages of this Narrative.

Volunteers

Claiborne Woodall - *Fire Ecology*
Phil Shelton - *Mount Rogers*
Arthur Mreschat - *Geology*
Allen Boynton - *Birds and Migrations*
Nancy Adamson - *Pollinators and Blooms*
Doug Miller - *Winter Weather*
Cade Campbell - *Insects, Snails, Shrubs*
Mark Archibald - *Trees and Identification*
Harry Pavulaan - *Butterflies*
Susan McClellan - *Orchids*
Lee Diggs - *Mushrooms*
Emily Thorne - *Mammal Mating*
Carol Broderson - *Spring Ephemerals*
Bruce Grimes - *Dragonflies*
Kevin Hamed - *Salamanders*
Bill Dunson - *Cryptic Species*

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Matt Reilly (writer/editor)

Organizations

United States Forest Service
Virginia Department of Conservation and Recreation
Virginia Master Naturalists: Holston Rivers Chapter