2017 High Elevation Forest Restoration Workshop and CASRI/SASRI Meeting

November 14-16, 2017
Glenstone Lodge - 504 Historic Nature Trail - Gatlinburg, TN 37738

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The 2017 2017 High Elevation Forest Restoration Workshop and CASRI/SASRI Meeting brought to you by:

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2017 High Elevation Forest Restoration Workshop
CASRI/SASRI 2017 meeting

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Azalea and Dogwood I rooms

Day 1 - Tuesday, November 14

Time	Presentation	Speaker
10:00 am	Registration opens	
1:00 pm	Welcome	
1:15 pm	A Pictoral History of 30 Years of Red Spruce Restoration Research by the Appalachian Forest Experiment Station	James Rentch
Restoration efforts—*Moderator: Mike Powell*		
2:00 pm	Red Spruce Restoration – Beyond Planting Trees	Shane Jones
2:30 pm	The Red Spruce Project at SHR: Red Spruce Propagation, Working with SASRI Members, Fundraising, Volunteers, Cone Collection, and Management of Red Spruce on Toxaway Mountain.	Kelly Holdbrooks
3:00 pm	Break	
3:30 pm	Noncommercial Spruce Release: Methods, Results, and Lessons Learned	Ben Rhodes
4:00 pm	Headwater Channel Restoration as a Tool to Aid in Red Spruce Restoration	Pam Edwards
4:30 pm	Extended break	
Poster session 6:00 pm – 8:00 pm		
Collection Methods for Red Spruce Cones		John R. Butnor, Kurt H. Johnsen, Tom Christensen, Bob Eaton, Chris A. Maier
Gene Conservation, Seed Properties and Adaptive Traits of Red Spruce in the Southern Appalachians.		John R. Butnor, Kurt H. Johnsen, Brittany Verrico, Steve Keller, Chris A. Maier, Vic Vankus
Carbon Sequestration Strategies for the Monongahela National Forest		Pam Edwards
Investigating the Role of Underpass Corridors to Connect Fragmented Red Spruce Forests to Promote Habitat Connections for the Federally Threatened Cheat Mountain salamander.		Lauren Merrill and Dawn Washington
CASRI: Past, Present and Future		Haley Hutchins
Noncommercial Spruce Release: Methods, Results, and Lessons Learned		Ben Rhodes
Microgeographic Analysis of Gene Flow and Selection Along an Elevational Gradient for the Boreal Forest Tree, Red Spruce (*Picea rubens*)		Brittany Verrico

Day 2 – Wednesday, November 15

Time	Presentation	Speaker
	Abiotic factors—*Moderator: Chuck Sams*	
9:00 am	Soil and Ecological Findings in the Central Appalachian Red Spruce Ecosystem	Jim Thompson
9:30 am	Disentangling the Complexity Behind Red Spruce Forest Ecosystem Recovery from Acid Deposition	Richard Thomas
10:00 am	Break	
10:30 am	Are Reductions in Acid Deposition and Warming Temperatures Responsible for the Resurgence of Red Spruce in the Northeastern United States?	Paul Schaberg
11:00 am	An Approach to Assessing if Nutrient Base Cations May be Sufficient for Healthy Spruce-Fir Forests	Bill Jackson
11:30 am	Lunch	
	Science Application—*Moderator: Jim Rentch*	
1:00 pm	High Elevation Conservation on Grandfather Mountain	Mallory James and Amy Renfranz
1:30 pm	Visualizing Spruce in a GIS. A Discussion on the Various Spruce Datasets That Currently Exist for the Southern Appalachians and How They Were Used to Prioritize Areas for Spruce Restoration	Mark Endries
2:00 pm	Using Microclimatic Conditions to Model Relative Occurrence Rate of Red Spruce in a small high elevation catchment on the Monongahela National Forest	Adrienne Nottingham
2:30	Break	
	Genetics, Plants, and Wildlife—*Moderator: Kendrick Weeks*	
3:00	Genetic Resource Conservation of High-Elevation Red Spruce (*Picea rubens*) and Fraser Fir (*Abies fraseri*) in the Southern Appalachian Mountains	Will Whittier
3:30	Rare and Endangered Wildlife of Appalachian Spruce-Fir Forests: Considerations for Ecological Restoration	Corinne Diggins
4:00	The Flat Laurel Spruce Collaborative: Putting SASRI Partners and Products Together to Restore Flying Squirrel Habitat	Chris Kelly
4:30	Seasonal Occupancy and Activity Patterns of Appalachian Spruce-Fir Forests by Tree Bats	Mark Ford
5:00	The Ecophysiology and Migratory History of the Disjunct, High-Elevation Outcrop Species, *Kalmia buxifolia*	Ellen Quinlan

Day 3 – Thursday, November 16

Time	Presentation	Speaker
9:00 am	Field trip – Chimney Tops Trail, Great Smoky Mountains National Park	Kris Johnson
12:00 pm	Adjourn	

A Pictoral History Of 30 Years Of Red Spruce Restoration Research By The Appalachian Forest Experiment Station

James Rentch, West Virginia University (retired)
jrentch2@WVU.edu

The Appalachian Forest Experiment Station was established by the US Forest Service in 1921 to address forest restoration issues in the then heavily denuded central Appalachian landscape. The red spruce ecosystem, stretching from West Virginia to North Carolina, was an area that received early and concentrated attention. Two key AFES researchers were Clarence Korstian and Leon Minckler. They investigated post-harvest conditions in the area, and then designed and carried out a series of field experiments to determine the best chances of forest restoration success. This presentation will illustrate written research results with a remarkable series of photographs – many never-before published - taken by these two men. This research holds important lessons for contemporary researchers and forest managers.

Notes:

Red Spruce Restoration – Beyond Planting Trees

Shane Jones, USDA Forest Service, Monongahela National Forest, Greenbrier Ranger District
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Exploitative logging and subsequent slash fires during the industrial logging period from 1880-1920 severely altered existing vegetative communities. Fortunately, some fragmented patches of red spruce and red spruce-hardwood forest (reference communities) escaped catastrophic disturbance in areas difficult to access or where slash fire was absent. These patches serve as refugia for rare species such as WV Northern Flying Squirrel (NFS) and also as a seed source for natural red spruce regeneration.

Red spruce restoration on the Greenbrier Ranger District of the Monongahela NF is accomplished by a combination of active and passive management. With regard to passive management, areas that currently exhibit qualities of an older spruce influenced ecosystem (e.g. at least 30% overstory red spruce; thick organic soil horizon; stand structure; etc.) are identified and protected. The goals for active red spruce restoration are twofold: improve composition and structure in appropriate areas that were formerly red spruce. In areas currently dominated by hardwood species, put the area on a trajectory to achieve an overstory composition of at least 30% red spruce. In even-aged forests, take actions to improve stand structure (e.g. downed woody material, standing snags, small canopy gaps, etc.).

Red spruce restoration on the Greenbrier Ranger District of the Monongahela NF currently includes several different techniques, including: mineland restoration; early successional habitat work; noncommercial spruce release (as described in another presentation and poster by the TNC); and commercial spruce restoration.

Notes:

The Red Spruce Project At Southern Highlands Reserve: Red Spruce Propagation, Working With SASRI Members, Fundraising, Volunteers, Cone Collection, And Management Of Red Spruce On Toxaway Mountain

Kelly Holdbrooks, Eric Kimbrel, Southern Highlands Reserve
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Southern Highlands Reserve staff will present years of propagation research: trials, tribulations, opportunities, and successes; discuss working with partners in SASRI and in the community to increase the public awareness of red spruce resonation work; and discuss fundraising: private and public (Blue Ridge Heritage National Grant award and management).

<u>Notes:</u>

Noncommercial Spruce Release: Methods, Results, And Lessons Learned

Ben Rhodes, The Nature Conservancy in West Virginia
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The Nature Conservancy's Ecological Restoration Team (ERT) has spent the past three years implementing spruce release on over 1000 acres of the Monongahela National Forest in West Virginia. Along the way, we've greatly improved our techniques to maximize our efficiency and effectiveness. The core of our system is to carry out the work in two stages: understory release and canopy gap creation. Within that system, we have various criteria for size and abundance of spruce, as well as overall forest composition, that determine where and how we work. By establishing this system, we have more than doubled our efficiency since we started. I would like to share our methods with other organizations that are interested in releasing spruce. Additionally, we have both qualitative and quantitative monitoring methods and results to share.

Notes:

Headwater Channel Restoration As A Tool To Aid In Red Spruce Restoration

Pam Edwards, US Forest Service, Northern Research Station
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Data from the central Appalachians indicate that ephemeral and intermittent headwater channels have become deeper, wider, and longer (via headcutting) from past, poor management or land misuse. The US Forest Service (Northern Research Station and Monongahela National Forest) along with Trout Unlimited and Canaan Valley Institute are cooperating on a study to restore these streams to their original morphology by using small wood additions in a number of configurations, to slow water and encourage sediment deposition (i.e., aggradation) and organic matter accumulation within the channels. The study is currently in the proof-of-concept phase, but if successful, an outcome of this study will be increased soil water retention in headwater soils, particularly in the near-stream areas. While this technique could provide benefits in most ecosystems, it may be particularly useful for red spruce. Recent modeling efforts focused on red spruce restoration have suggested that cold air drainage ways, which commonly also correspond to locations containing headwater tributaries, are areas that should be targeted for spruce restoration, particularly at mid-elevations (e.g., see Nottingham submission to this meeting). Cold air drainages are areas with cool temperatures and high soil moisture, and thus, may provide important microrefugia for red spruce and associated wildlife species that depend upon red spruce forests. Augmentation of soil moisture may help expand the extent and connectivity of these microrefugia and may make red spruce more resilient to stresses from increasing air temperature by keeping soils cooler as the climate changes.

Notes:

Collection Methods For Red Spruce Cones

John R. Butnor, Kurt H. Johnsen, Tom Christensen, Bob Eaton, Chris A. Maier
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Commercially available pole pruners, hydraulic lifts, firearms, and certified tree climbing personnel are the most common means of collecting single source seeds from individual trees. These methods are highly productive at suitable locations, but have serious shortcomings for collecting red spruce cones at high elevations in both the southern highlands and Northeastern States. Rough, inaccessible terrain precludes hydraulic lifts and makes collections by tree climbers time consuming, while commercial pole pruners are difficult to handle once extended beyond 6–7 m. We present a novel pole pruner that is capable of reaching heights of up to 12 m, expanding the range and ease of use over commonly available pruners. Alternative collection methods are also presented, including cutting cone bearing limbs with specialized chainsaw chains and shaking cones loose from trees with ropes from heights of up to 25 m. Strategies for setting lines and removing and securing cones with ropes are offered.

Notes:

Gene Conservation, Seed Properties And Adaptive Traits Of Red Spruce In The Southern Appalachians

John R. Butnor, Kurt H. Johnsen, Brittany Verrico, Steve Keller, Chris A. Maier, Vic Vankus
jbutnor@fs.fed.us

Red spruce (*Picea rubens*) populations in the southern Appalachians (Tennessee, North Carolina, Virginia) are disjunct from larger northern populations in New York, Vermont, New Hampshire, Maine and the Canadian Maritime provinces. Heavy logging followed by severe fires in the early 20th century resulted in a > 90% reduction in spruce-fir forests in the southern Appalachians. With the exception of Great Smoky Mountains NP, the remaining red spruce populations are highly fragmented and restricted to high elevations. Considering their adaptation to cool, humid environs, they have the potential to become maladapted with predicted climate change. To assess existing populations for adaptive traits (phenology, physiology) we collected seed from half-sib families from several populations in North Carolina, Tennessee, and Virginia with the goal of propagating seedlings and identifying phenotypic differences in common garden plantings. Seed was collected from 15 trees in 2015 and 115 trees in 2016 from elevations ranging from 1036 to 1988 m. Red spruce produces seed in large quantities every 3-8 years making seed collection difficult and subject to finds of opportunity.

Across all 130 families seed mass ranged from 1.0 to 4.4 mg and averaged 2.6 mg per seed. Seed mass and germination rate increased with elevation across all families and the relationship was strongest in trees in close geographic proximity from different elevations. Seedlings are currently being propagated for phenotypic and physiological comparisons (growth, photosynthetic capacity, WUE, bud break, bud set) and will be out planted for continued study. Key findings to date are that red spruce in the southern Appalachians are producing the largest seeds the very tops of the mountains and have essentially run out of elevation to migrate upwards. We hope to identify and deploy families that are suited to survive and regenerate at their proposed planting site (elevation, latitude).

<u>Notes:</u>

Carbon Sequestration Strategies For The Monongahela National Forest

Pam Edwards, U.S. Forest Service, Northern Research Station
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The US Forest Service's Northern Research Station and the Monongahela National Forest have partnered to develop strategies for increasing below- and above-ground carbon sequestration. This approach involves a number of steps or phases that build upon one another. Initially, maps of current soil carbon stores and carbon stores for forests are being developed from intensive collections of soil pit and soil chemistry data, and forest stand data. Simultaneously, literature searches are being developed from which three state-of-the-science literature reviews will be written describing (1) management techniques (e.g., soil amendments, silvicultural approaches, fire, etc.) to increase soil carbon sequestration, (2) management techniques to increase above-ground carbon sequestration, and (3) how carbon sequestration influences other ecosystem services (e.g., rate of tree growth, wood quality, water availability, wildlife populations, etc.). Based on the literature reviews, on-the-ground studies will be initiated to study the effects of the most promising management techniques in eastern forests and to develop prescriptions for increasing carbon storage. Examination of the effects of these techniques on other ecosystem services will be part of these studies, as positive changes to ecosystem services will likely be the "hook" by which land managers and land owners would become interested in increasing carbon sequestration. Red spruce forest types will be of particular interest for applying these techniques since these ecosystems have the greatest potential for soil carbon storage in the central Appalachians, and increasing carbon storage also may create conditions more conducive for red spruce restoration.

Notes:

Investigating The Role Of Underpass Corridors To Connect Fragmented Red Spruce Forests To Promote Habitat Connections For The Federally Threatened Cheat Mountain Salamander

Lauren Merrill and Dawn Washington, U.S. Fish and Wildlife Service, Canaan Valley NWR and AFHA AmeriCorps
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In 2016, a wildlife underpass was constructed by the Friends of the 500th on Three Mile Trail of Canaan Valley National Wildlife Refuge. From the months of December to April, this trail is used by skiers of White Grass Ski Touring Center and is heavily traversed. On either side of this trail is red spruce forest, habitat to the Cheat Mountain salamander (CMS), a federally threatened species endemic to only 5 counties in West Virginia. CMS breathe through their skin and lining of their mouth, relying on cool, moist habitat in order to do so. Three Mile Trail is exposed to sunlight, creating xeric conditions which the CMS cannot thrive in. As such, the trail is thought to separate two populations. Fragmented populations risk declining genetic diversity and health. The underpass was created to alleviate the fragmentation and promote a connection.

In the spring of 2017, leaves, woody debris, and rocks were placed underneath and along the underpass in an effort to replicate CMS habitat. However, CMS require a specific microclimate to survive. In order to ascertain the utility of the underpass, refuge staff and volunteers performed habitat assessments, salamander searches, and mark and recapture surveys. Habitat assessments will evaluate the constructed microhabitat beneath the underpass. If it deviates from measurements of the surrounding area and from historical data, surveyors will be tasked with improving the habitat.

CMS searches will be conducted in July, and August 2017, after sunset and within 48 hours of a rainfall event. Visible implant fluorescent elastomer will be used to mark captured CMS along their legs. Two different colors will be used, one for the uphill and one for the downhill side of the underpass. If CMS are found underneath the underpass, or are found to have crossed the trail, it would suggest that the bridge is connecting the populations.

__Notes:__

CASRI: Past, Present And Future

Haley Hutchins, CASRI
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The CASRI poster will provide general information about how CASRI began, the partners, our accomplishments, what we've learned, and our next priorities.

Notes:

Noncommercial Spruce Release: Methods, Results, And Lessons Learned

Ben Rhodes, The Nature Conservancy in West Virginia
brhodes@tnc.org

The Nature Conservancy's Ecological Restoration Team (ERT) has spent the past three years implementing spruce release on over 1000 acres of the Monongahela National Forest in West Virginia. Along the way, we've greatly improved our techniques to maximize our efficiency and effectiveness. I would like to share our methods with other organizations that are interested in releasing spruce. Additionally, we have both qualitative and quantitative monitoring methods and results to share. Qualitative observations like visual estimates of spruce growth and understory light levels suggest that the ERT's work is having the desired effect. With only two years' worth of data, our quantitative monitoring is still inconclusive. However, the baseline data has shown that our work area contains much more understory red spruce—particularly in the 5-15m height range—than was originally thought.

Notes:

Microgeographic Analysis Of Gene Flow And Selection Along An Elevational Gradient For The Boreal Forest Tree, Red Spruce (*Picea Rubens*)

Brittany Verrico, University of Vermont
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Pervasive gene flow across fine spatial scales has the potential to overwhelm and impede genetic divergence and local adaptation, especially at range limits. However, even at microgeographic spatial scales, strong selection and reproductive isolating mechanisms can allow for local adaptation. High elevation spruce-fir forests in the northeastern U.S. are prime examples of forest ecosystems where trees are distributed across steep climatic gradients that span the low and high elevation range limits of physiological adaptation across spatial scales of a few km. Red spruce (*Picea rubens* Sarg.) is a dominant tree species in this ecosystem and has demonstrated climatic sensitivity to winter freezing injury events that are known to vary in intensity with elevation. One hypothesis is that spruce at high elevations show locally adaptive resistance or tolerance of winter freezing injury, but also face potential swamping of local adaptation by maladaptive gene flow from low elevation pollen and/or seeds dispersing upslope. In this study, we use red spruce as a focal species to investigate if extensive gene flow may limit the ability of this species to respond to selection along a local elevation gradient. We seek to address this hypothesis with a population genomic analysis using genotype-by-sequencing (GBS) to detect SNPs for two different cohorts: established trees (>2cm dbh) and regeneration seedlings (<2cm dbh). We will use these data to a) model recent gene flow, b) look for signatures of local adaptation, and c) determine if differences in reproductive phenology exist as a potential mechanism to deter maladaptive gene flow from low to high elevations. These results will help inform how the tension between gene flow associated with upslope migration and selection in response to climatic tolerances may be shaping the evolutionary trajectory of local populations under climate change.

Notes:

Soil And Ecological Findings In The Central Appalachian Red Spruce Ecosystem

Stephanie Connolly, US Forest Service; and James Thompson, West Virginia University
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Soil surveys have provided baseline data for land use planning in the United States since the early 20th century. Ecological Site Descriptions (ESD) are complementary land management tools that integrate historic and local knowledge of ecosystems paired with field data to describe ecological dynamics. Often, USDA-NRCS soil surveys are used as the foundation for many ESD. Recent work by NRCS and USFS staff identified significant acreage of previously unrepresented Spodosols in areas associated with historic and current red spruce forests on the Monongahela National Forest (MNF) and surrounding privately held lands. Since 2010 several MLRA Soil Survey projects have been conducted in Pendleton, Pocahontas, and Randolph Counties, WV, resulting in over 300 soil profiles descriptions which focused on identifying spodic morphology. As a result, one new soil series (Wildell, a Haplorthod) was developed and one existing soil series (Mandy) was reclassified as a Spodic Dystrudept. Consequently large tracts of land in WV were remapped to reflect these changes. This remapping effort also supported the development of ESD in this region. This presentation discusses the development of two ESD in historic red spruce habitat in West Virginia, and how those ESD were used to inform land management decisions. The development of these ESD was and continues to be essential for land management planning to support red spruce restoration, soil carbon management, and expansion of Cheat Mountain Salamander (*Plethodon nettingi*) and Virginia Northern Flying Squirrel (*Glaucomys sabrinus fuscus*) habitat while simultaneously allowing for targeted profitable timber management.

<u>*Notes:*</u>

Disentangling The Complexity Behind Red Spruce Forest Ecosystem Recovery From Acid Deposition

Richard Thomas, West Virginia University
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In the 45 years after the legislation of the Clean Air Act, there has been tremendous progress on reducing air pollutants in the Eastern U.S., yet there is limited evidence that cleaner air has improved forest health. We demonstrate that increased growth of a key indicator tree species of forest health, red spruce, at three locations in the Central Appalachian Mountains is related to ecosystem recovery from acid deposition since *ca.* 1991. Chronologies of tree ring $\delta^{13}C$ and $\delta^{15}N$ provide the first evidence that concurrent changes in C and N cycling, including greater photosynthesis and stomatal conductance of trees and increases in ecosystem N retention, are consequential to ecosystem recovery. Increases in atmospheric CO_2 and warmer spring temperatures likely contributed to tree recovery once acid deposition was reduced. This study documents the positive impacts that landmark environmental legislation has had in facilitating the recovery of forest ecosystems from air pollution.

Notes:

Are Reductions In Acid Deposition And Warming Temperatures Responsible For The Resurgence Of Red Spruce In The Northeastern United States?

Paul Schaberg, USDA Forest Service Northern Research Station
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Starting in the 1960s, red spruce in the northeastern United States experienced wide-spread reductions in growth and increases in mortality attributed to acid deposition-induced calcium depletion, which predisposed trees to foliar freezing injury and disrupted tree carbon relations. The last severe region-wide winter injury event was in 2003. Since then, red spruce have experienced a marked increase in woody growth. I will report on this growth surge and describe two studies using increment cores to examine how acid deposition and climate warming may be associated with changes in growth over time. The first study evaluated how the growth of 441 trees in 37 plots across Vermont and New Hampshire related to modelled pollution critical load exceedance (sulfur and nitrogen deposition projected to result in net calcium depletion). Compared to plots not in exceedance, trees on exceedance plots had lower growth over the 60-year chronology and during decades of repeated or severe winter injury. Trees on exceedance plots also had a more modest recovery from the 2003 winter injury event. The second study related the growth of 661 red spruce in 52 plots across New York, Vermont, New Hampshire, Maine and Massachusetts to temperature, precipitation, pollutant deposition and atmospheric CO_2 data from across the region. Various temperature metrics (especially warmer temperatures in the fall, winter and spring) were positively associated with growth. This is consistent with red spruce's niche as a temperate conifer that can photosynthesize year-round given favorable conditions, and suggests that the species may be benefitting from an extended growing season in the North. Growth was also negatively associated with nitrogen (and to a lesser extent sulfur) pollution, which is consistent with red spruce's known sensitivity to acid deposition. The relationship between nitrogen deposition and growth has recently decreased, suggesting that growth is rebounding as pollutant inputs decrease.

<u>Notes:</u>

An Approach To Assessing If Nutrient Base Cations May Be Sufficient For Healthy Spruce-Fir Forests

Bill Jackson, USDA Forest Service
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Adequate supplies of soil base cations (such as calcium) are essential for healthy spruce-fir forests. Base cation availability at any location is dependent on the annual weathering from the soil parent material. The metamorphosed granitic rocks found across the mountain ridges of the southern Appalachians, have far less base cations then soils derived from limestone. Parent material weathering is caused by carbonic acid in rainfall and formed from carbon dioxide released during microbial and root respiration. Weathering releases base cations into the soil water solution for root uptake and movement to streams to support heathy brook trout and other aquatic biota populations.

In the late 1800's, soil base cations were reduced due to removal from timber harvesting, and soil erosion due to poor logging practices and in some locations following severe wildfires. Beginning with the industrial revolution, forests also received acid deposition originating from burning fossil fuels. Deposition increased to the 1990's and excessive levels of acid deposition caused an acceleration of base cation loss from watersheds, far greater than losses occurring from the presence of carbonic acid. Even though acid deposition has plummeted, base cation loss is continuing due to the release of previously stored sulfur from acid deposition.

In this presentation, I want to begin a conversation among the participants on how we should assess spruce-fir areas for base cations deficiency or adequacy. Spruce restoration is a long-term investment that requires adequate base cations for healthy trees, especially under the conditions of a changing climate. I will describe current, and future, modeling results, and how to use them as tools to assess if an area is at risk. Areas at risk due to insufficient base cations should have soil and/or stream samples collected for chemical analysis. The USDA Forest Service has spatially compiled chemistry data, that the participants will find useful when deciding where and how to restore spruce-fir.

Notes:

High Elevation Conservation on Grandfather Mountain

Mallory James and Amy Renfranz, Grandfather Mountain Stewardship Foundation
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Grandfather Mountain's employees are working hard every year to be the best stewards they can of the great mountain they call home. The naturalists work especially hard by conducting relevant and forward-looking research that will benefit Grandfather Mountain and its ecosystems.The naturalists of Grandfather Mountain partner with agencies like the US Fish and Wildlife and the North Carolina Wildlife Resources Commission in order to share our research and have a bigger impact. Grandfather Mountain Naturalists, Mallory and Amy, will share about Grandfather Mountain's mission, recent collaboration with Mark Endries on ground truthing Red Spruce distribution on the mountain, along with other high elevation research the naturalists have been conducting.

Notes:

Visualizing Red Spruce In A GIS. A Discussion Of The Various Spruce Datasets That Currently Exist For The Southern Appalachian Mountains And How You Can Help wWth An Accuracy Assessment

Mark Endries, U.S. Fish and Wildlife Service
mark_endries@fws.gov

Geographic Information Systems (GIS) allow people to view, interact, and analyze spatial data. Often, it is challenging to know what spatial data is available for a specific task or project. For this talk I will discuss the spatial data viewable in a GIS that exists for red spruce (*Picea rubens*) in the Southern Appalachians. This will include recent efforts to digitize spruce habitat information from historic maps, the publically available digital datasets that identify spruce habitats, and the newly created Southern Appalachian Spruce Restoration Initiative (SASRI) Spruce Units dataset. This polygon geospatial dataset depicts the distribution and abundance of spruce across the Southern Appalachian Mountains, excluding the Great Smoky Mountains National Park. For each spruce unit identified, a variety of overstory and understory characteristics were estimated, including the density of spruce in the overstory, the composition of the overstory, the presence of spruce in the understory, and other features. A total of 13,603 polygons and 8,505 individual spruce tree point locales not included in a polygon were digitized. Lastly, I will discuss efforts that are being made to conduct an accuracy assessment of the spruce unit dataset by crowdsourcing the work through data collection applications created for mobile devices.

Notes:

Using Microclimatic Conditions To Model Relative Occurrence Rate Of Red Spruce In A Small High Elevation Catchment On The Monongahela National Forest

Adrienne Nottingham, U.S. Forest Service, Monongahela National Forest
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High elevation red spruce (*Picea rubens*) ecosystems of the central Appalachians are the focus of many restoration efforts due to the valuable ecosystem services these forests provide. Studies have attempted to model the best locations to focus red spruce restoration efforts, but often microclimatic data are not utilized or low resolution, modeled climatic surfaces are used. Microclimate data may provide better model results given that microclimate is known to affect both species composition and distribution. In this study, local air temperature, soil temperature, and soil moisture data were collected at 20 randomly-located plots in a small (5.4 km^2), high elevation (>700 meters above sea level) watershed for approximately one year. Microclimatic data were then summarized into variables that might affect red spruce presence. These variables, in conjunction with topographic data and a red spruce presence-only data set were used in a species distribution model, Maximum Entropy, to model the spatial distribution of red spruce. The objectives of this research are two-fold: determine microclimatic variable importance to red spruce presence, and evaluate the effect that microclimatic variables have on the relative occurrence rate (ROR) of red spruce presence in comparison to ROR generated using only topographic variables. Interestingly, the highest relative occurrence rate of red spruce within the watershed (for both models) was predicted at the lower elevations in cold air drainage ways rather than on higher elevation ridgetops.

Notes:

Genetic Resource Conservation Of High-Elevation Red Spruce (*Picea Rubens*) And Fraser Fir (*Abies Fraseri*) In The Southern Appalachian Mountains

Will Whittier, Camcore/North Carolina State University
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The Camcore program at North Carolina State University, in partnership with the USDA Forest Service Southern Region National Forest System, has been tasked with collecting germplasm from both Red Spruce and Fraser Fir from natural populations located across the southeastern United States. A portion of collected seed has been placed in long-term cold storage while the remaining seed is slated for establishment in seed orchards and related research objectives. This presentation will outline our progress from the project's inception in 2014 through 2017, a discussion on successes and difficulties to date, plans for additional collections, potential future uses of collected material and opportunities for collaboration.

Notes:

Rare And Endangered Wildlife Of Appalachian Spruce-Fir Forests: Considerations For Ecological Restoration

Corinne Diggins, Virginia Polytechnic Institute and State University; and W. Mark Ford, U.S. Geological Survey
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Appalachian spruce-fir forests are considered one of the most endangered forested ecosystems in the United States. They host a variety of rare species that are either endemic to the region or are disjunct populations of northern latitude species at their most southern distribution. Due to past logging, wildfire, acid precipitation, introduced pests, and anthropogenic climate change, the extent and quality of these forests were greatly reduced. As a result, many of the species associated with Appalachian spruce-fir forests are rare and of conservation concern on the state and/or federal level. Accordingly, the management driver to conserve existing spruce forests or to recover spruce-fir typically ties back to the sensitive, rare, or endangered wildlife within. Successful conservation and ecological restoration require an understanding of wildlife response across a gradient of structural, temporal, and spatial scales. In turn, this information is important when designing restoration treatments, as well as the scale and frequency on which they occur. Herein, we will focus how differing life history traits and habitat condition associations for three species (Appalachian northern flying squirrels, *Glaucomys sabrinus*; snowshoe hare, *Lepus americanus*; and spruce-fir moss spider, *Microhexura montivagans*) and how these species present opportunities and challenges for resource managers.

Notes:

The Flat Laurel Spruce Collaborative: Putting SASRI partners and products together to restore flying squirrel habitat

Chris Kelly, N.C. Wildlife Resources Commission
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SASRI's first spruce restoration project begins autumn 2017 on the Pisgah Ranger District. A goal of the project is to restore spruce to its natural abundance in an ecologically appropriate location where canopy density has been reduced. This will improve habitat for Carolina northern flying squirrel by increasing the spruce component and connectivity of habitat. Partners developed this project using a variety of tools, including logging history, SASRI's map of current spruce, the Southern Appalachian Spruce Restoration Plan, and pre-treatment plot data from Warren Wilson College. NCWRC collected flying squirrel and bird data before treatment to establish a baseline. Initial environmental review covers planting, with future NEPA planned to cover additional treatments. Partners, including area college students, will plant up to 2,000 seedlings propagated by the Southern Highlands Reserve.

Notes:

Seasonal Occupancy And Activity Patterns Of Appalachian Spruce-Fir Forests By Tree Bats

W. Mark Ford, U.S. Geological Survey; and Corinne A. Diggins, Virginia Polytechnic Institute and State University
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Bat species in the United States are becoming the focus of increasing conservation concern due to population declines from White-nose Syndrome and wind energy development. Within the southern Appalachian Mountains, data on bats from high-elevation systems is lacking as little monitoring and research have been conducted in these areas. We conducted a seasonal study (May, July, October) at 10 sites within red spruce (Picea rubens)-Fraser fir (Abies fraseri) forests in the southern Appalachian Mountains of western North Carolina during 2015. We surveyed sites for 10 nights per season (N=300 survey nights) to determine seasonal occupancy of three tree bat species: red bat (Lasiurus borealis), hoary bat (Lasiurus cinereus), and silver-haired bat (Lasionycteris noctivagans). Consistent with our prediction, spring, summer and fall occupancy of hoary bats (Ψ = 0.72, 0.86, and 0.94) and silver-haired bats (Ψ = 0.69, 0.83 and 0.94), respectively, were high, as was relative activity, indicating that these habitats supported summer residency. Red bat occupancy and relative activity was low across seasons particularly when compared to "ridgetop" recording stations in the central Appalachians to the north. High occupancy rates for hoary bat and silver-haired bats in these forests may highlight the importance of these forests to these bats and merits further investigation, as records for these two species at lower elevation sites are minimal in the region. Additionally, we will discuss potential monitoring and management schemes for bats in high-elevation systems in the Appalachian Mountains and implications for understanding migration and potential wind-energy impacts.

Notes:

The Ecophysiology And Migratory History Of The Disjunct, High-Elevation Outcrop Species, *Kalmia Buxifolia*

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Kalmia buxifolia (Sand Myrtle, Ericaceae) is most closely related to the alpine species *K. procumbens* but is disjunct among high-elevation outcrops of western NC, the monadocks of the Carolina Piedmont, the Carolina's Coastal Plain, and the NJ Pine Barrens. Although widely separated, these sites share commonalities in their microclimates, such as alternately wet and dry conditions, poor soil water retention, and nutrient poor, acidic soils. High-elevation rock outcrop communities, however, are unique in their dependence upon frequent cloud immersion (fog) to help ameliorate temperature and water stress, which is predicted to decrease with climate change. In this talk, I will discuss our current work to understand variation in water-use efficiency (WUE) in *K. buxifolia*, how it relates to the migration pattern along its current range, and how that might inform restoration practices.

Notes:

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