



Accomplishments Report

2021



Earth Day volunteer planting in Canaan Valley © Mark Moody

Table of Contents

Introduction	3
2021 CASRI Admin Team	4
2021 Accomplishments Summary	5
Partnership Highlights	
Fall 2021 Field Trip	7-8
Partner Profiles	9
Mineland Restoration at Sharp’s Knob, West Virginia	10-11
Spruce Release with the TNC Ecological Restoration Team	12-13
Partner Accomplishments	
Tree Plantings	15-16
Spruce Release	16-17
Habitat Restoration	17-18
Research, Surveying, and Monitoring	18-19



*Soon to be planted red spruce at Mower 20.
Courtesy of USFS Greenbrier Ranger District.*

Introduction

The Central Appalachian Spruce Restoration Initiative (CASRI) is a robust partnership between 15+ federal and state agencies, and local to global non-profits dedicated to restoring red spruce (*Picea rubens*) ecosystems in the Central Appalachians. See page four for a full list of CASRI partners. Since its inception in the early 2000s, CASRI partners have restored thousands of acres of red spruce and worked with dozens of local communities to make progress on CASRI's ambitious mission to restore historic red spruce-northern hardwood ecosystems across the high elevation landscapes of Central Appalachia.

Red spruce was once abundant across the high-elevation habitats of Central Appalachia. After large-scale clear-cutting as a result of extensive logging in the early 1900s, these forests are now scattered patches at the very highest elevations. CASRI partners use multiple tactics such as tree plantings, red spruce release, habitat restoration of wetlands, and non-native invasive species removal to help reconnect and extend these isolated forest patches of red spruce. CASRI works on both public and private lands with a multitude of partners to coordinate restoration across the Central Appalachians.



Photo credit: Connor Liu

2021 CASRI Administrative Team

Kathryn (Katy) Barlow, kathryn.barlow@tnc.org

Katy Barlow received her PhD in Ecology at Penn State where she conducted research on the restoration challenges and opportunities resulting from unconventional gas development, and the rhetoric of environmental decision-making tied to reclamation regulations. Katy currently works for The Nature Conservancy's Central Appalachians Program as the Restoration Strategy Manager. *“Red spruce forests are magical. CASRI partners are dedicated and passionate. As I see it, there's no more inspiring forest and partnership to work with than CASRI.”*



Julia Derringer, julia.derringer@gmail.com

Julia earned dual degrees from the University of Michigan in Ecology and Evolutionary Biology and Anthropology in 2020. She is currently an AmeriCorps member with the Appalachian Forest National Heritage Area and the US Forest Service engaged in ecological restoration and outreach. She chose to work with CASRI because she thinks West Virginia ecology is unique and wants to promote native plant restoration. Julia will be heading to The University of Notre Dame to start her PhD in Ecology in August 2022.

Julissa Murrieta, julissa.murrieta@tnc.org

Julissa holds a B.S. in Biological Sciences with a specialization in Ecology and Evolution from the University of Maryland, College Park. She is currently serving as the 2021-2022 Chesapeake Conservation Corps member for the MD/DC Chapter of The Nature Conservancy. She is thrilled to be a part of the admin team because she has the opportunity to learn about all the ongoing efforts in restoring red spruce across the Central Appalachians.



Accomplishments Summary

In 2021 CASRI partners planted approximately **235,000 trees**, including red spruce and native hardwoods, conifers, and shrubs, on over approximately **500 acres** in Central Appalachia. Restoration teams spread **175.5 pounds** and **50 gallons** of native seed at restoration sites. And, partners completed over **460 acres** of spruce release and deep-ripped **218 acres** of land for habitat restoration. In addition to the above, CASRI partners engaged in extensive research, monitoring, and outreach, including salamander surveys, journal publications, and newspaper articles. The stories and accomplishments below give a small glimpse of all that CASRI partners accomplished in 2021.

Partners

***Bolded partners** contributed information to the 2021 Accomplishments Report (Thank you!)*

Appalachian Forest National Heritage Area (AFNHA)	Natural Resources Conservation Service (NRCS)
Appalachian Mountain Joint Venture (AMJV)	National Wildlife Refuge System
Appalachian Regional Reforestation Initiative (ARRI)	The Mountain Institute (TMI)
Appalachian Landscape Conservation Cooperative (APPLCC)	Marshall University
Canaan Valley Institute (CVI)	The Nature Conservancy (TNC)
Canaan Valley National Wildlife Refuge (CVNWR)	Trout Unlimited (TU)
Environmental Protection Agency (EPA)	U.S. Fish and Wildlife Service (USFWS)
Green Forests Work (GFW)	U.S. Forest Service George Washington-Jefferson National Forest (USFS-GWF)
U.S. Forest Service Northern Research Station (NRS)	West Virginia Division of Natural Resources (WVDNR)
U.S. Forest Service Monongahela National Forest (USFS-MOF)	West Virginia Division of Forestry (WVDOF)
	West Virginia Highlands Conservancy (WVHC)
	West Virginia Land Trust (WVLT)
	West Virginia University (WVU)



2021 Highlights

CASRI Fall Field Trip: Oct 13-15, 2021

October 13, Morning at Canaan Valley National Wildlife Refuge: Cheat Mountain Salamander Research and Protocol - Dawn Washington (US Fish and Wildlife Service) and Donald Brown (West Virginia University)



- Cheat Mountain Salamanders (CMS) are declining in some, but not all, areas where Eastern Red-backed Salamanders are increasing.
- CMS are more likely to be found further away from forest clearings.
- CMS occurrence is higher in areas with more soil moisture.
- US Fish and Wildlife is performing surveys to monitor population numbers and inform management decisions

October 13, Afternoon at Blackwater Falls State Park: West Virginia Department of Agriculture's Treatment of Hemlock Woolly Adelgid - Kristen Carrington (West Virginia Department of Agriculture)

- Since 2004, approximately 1200 biocontrol predatory beetles have been released and over 1,500 individual trees have been treated with imidacloprid in an effort to reduce the impact of HWA.
- WVDA most recently conducted a hemlock mortality survey at BWF in 2014 and found 14% of hemlocks were still healthy, 76% were declining, and 11% were dead.
- WVDA will continue with chemical treatments on high value trees and hopefully allow red spruce to regenerate to fill in areas unable to be treated.

October 14, Morning at Mower Tract (near Bartow, WV): Tour of Red Spruce Restoration on Mower Tract - Mike Elza, Shane Jones, Adrienne Nottingham (US Forest Service) and Anna Branduzzi (Green Forests Work)



- This area was heavily timbered and mined for coal in the nineteenth century, leaving the ecosystem in a state of arrested succession. Soil compaction and planting of non-native tree and grass species (ex. red pine) by coal mining companies have prevented the native red spruce ecosystem from reestablishing.
- Soils formed below red spruce forests (spodosols) have thick layers of organic matter on the soil surface and a subsurface layer with high soil carbon. These characteristics can persist long after drastic above-ground vegetation changes, and as such can be used to plan red spruce restoration efforts.

- Spodosols are important for soil carbon sequestration. They also have increased water holding capacity- a crucial ecosystem service given predictions of less frequent, more intense precipitation in the future.
- Restoration goals:
 - Remove non-native tree species and de-compact the soil (via deep ripping with machinery).
 - Plant a variety of native species (red spruce!). Over 500,000 plants have been planted since 2011.
 - Increase water and sediment holding capacity through soil decompaction and wetland creation.
 - Create early successional habitat, which will develop into a forest that is at least 30% red spruce.
- A total of 1,115 acres have been treated over the last decade, with 256 acres left to complete the project.

October 14, Afternoon near Gaudineer Knob: The Nature Conservancy's Non-commercial Spruce Release Efforts - Will Evans and Todd Miller (The Nature Conservancy)

- Non-commercial spruce release is a targeted, low-impact method to allow spruce to reach the forest canopy. TNC's long term goal is to release spruce to form 30% of the canopy within each release unit.
- Audience members noted that the level of spruce release completed is determined by individual management goals. TNC's goals focus on establishing West Virginia Northern Flying Squirrel habitat and cultivating enough Red Spruce density for the species to act as an ecosystem engineer. 30% canopy spruce was the number that best achieved both goals.
- Release work is completed with a focus on canopy diversity, keeping trees with ecological and wildlife value, and expanding existing stands of red spruce.



October 15, Morning at Pharis Knob: Red Spruce Riparian Restoration - Katy Barlow (The Nature Conservancy), Chad Landress (US Forest Service), Dave Saville (WV Highlands Conservancy)



- The Nature Conservancy partnered with the Monongahela National Forest, West Virginia Highlands Conservancy and the Universities of Vermont and Maryland to create climate-adapted solutions for red spruce forests of the future. In West Virginia, in spring 2021, over 47K red spruce from genetically diverse populations, 25K native hardwoods, and 1.6K Balsam fir were planted in headwaters critical for climate refugia in the WV highlands.

- The project areas encompass a potentially contiguous spruce corridor across the headwaters of three river systems. Despite their high elevations, these river systems are temperature stressed due to lack of canopy cover at the riparian zone. Restoration work will provide future stream shading to cool these critical headwaters. These future forests also provide streambank stability and wood

deposition that improve aquatic habitat. Red spruce and balsam fir forests develop dense shade and deep soils; perfect conditions for providing cold, clean water and dampening extreme flood and drought effects.

Partner Profiles 2021

This section is dedicated to showcasing some of our dedicated CASRI partners. Thank you for your hard work!

The Nature Conservancy, Maryland - Deborah Landau

Deborah holds a Ph.D. in Entomology and Plant Biology from Louisiana State University, an M.S. in Entomology and Plant Pathology from the University of Tennessee, and a B.S. in International Environmental Studies and Agriculture and Environment from Rutgers University. Currently, she is the Director of Ecological Management at the Maryland/DC Chapter of The Nature Conservancy (TNC). In this role, Deborah dedicates her time to restoration at TNC's preserves, where she plants native plants and performs prescribed burns.



Deborah first became involved with CASRI when she learned of the Cranesville Swamp conservation plan, which listed red spruce restoration as a high priority. From here, she determined suitable areas for planting that were also easily accessible to volunteers. Deborah recently celebrated 20 years at TNC. She looks forward to continuing as a CASRI partner. One of her favorite parts of CASRI is learning about the growth of spruce in different habitats. Additionally, Deborah finds it really rewarding to get involved with others who are doing similar work across the Appalachians.

Southern Appalachian Highlands Conservancy - CASRI Collaboration

The Southern Appalachian Highlands Conservancy (SAHC) is a Land Trust based in Asheville, North Carolina. SAHC has protected more than 75,000 acres in the mountains and continues to conserve and restore rare habitats in their flagship "focal area", the Roan Mountain (6,286 ft.) region on the Tennessee/North Carolina border. In 2019, SAHC took advantage of the periodic cone crop of the Red Spruce in the area and collected seeds. CASRI partners were able to help them with the process of getting the seeds into production. In spring 2021, they planted the first Red Spruce grown from those seeds. To learn more about their efforts contact Marquette Crockett - Highlands of Roan Stewardship Director. Phone: (828) 253-0095 ext. 210, www.appalachian.org

Mineland Restoration at Sharp's Knob, West Virginia

Sharp's Knob, an isolated mountaintop located in Pocahontas County, West Virginia, is the site of a productive red spruce reclamation partnership between CASRI partners Green Forests Work, US Forest Service, and The Nature Conservancy. This area was mined in the 1960s with the "shoot and shove" method, where



Heavy machinery in an area on Sharp's Knob that has been ripped of red pine. Anna Branduzzi, GFW.

topsoil is blasted off and then pushed over the side of the mountain. The coal seam revealed below is then harvested. Coal companies were required to reclaim the land by replanting the area, but at the time there were little regulations on which species they could plant. The extracted areas - now lacking in topsoil and compacted by heavy machinery - were planted with non-native cool season grasses and non-native conifers such as red pine and Norway fir. On the surface, the destroyed mountaintop looked ecologically restored. However, by replanting with non-native plants, the coal companies created non-optimal habitat for wildlife and drastically altered the landscape from its native red spruce-northern hardwood ecosystem. Decades later, CASRI and its partners are dedicated to reclaiming Sharp's Knob and transforming it into the healthy and productive red spruce ecosystem that it was historically.

In 2018, US Forest Service - Monongahela National Forest (MNF) South Zone Ecologist Amy Lovell decided to start addressing the issues she saw on Sharp's Knob. Amy started on the MNF in 2011 as a biological sciences technician, and worked summers assisting with botanical surveys. She also caught a glimpse into the world of mineland restoration with the Mower Tract spruce reclamation project in the north zone of the MNF. After a short stint as a high school science teacher, in 2016 Amy was selected for a Pathways

and by replanting with non-native plants, the coal companies created non-optimal habitat for wildlife



AmeriCorps member and USFS employees next to tree seedlings on Sharp's Knob. Anna Branduzzi.

internship with the US Forest Service where she was mentored by the MNF forest ecologist while completing her graduate degree. By July of 2017, Amy had been hired as the South Zone Ecologist on the MNF, where she knew one of her first projects would be implementing mineland restoration techniques on the south zone of the MNF similar to those she saw at Mower Tract. Sharp's Knob was the ideal place to start, as it was a textbook case for needing restoration.



*Contractors planting seedlings on Sharp's Knob, spring 2021.
Anna Branduzzi.*

Nearly four years later, 169 acres of Sharp's Knob have been ecologically restored. After heavy machinery moves through the area, using ripping shanks to pull out the towering non-native red pine and decompact the soil, contractors come to plant a suite of plant species to provide better wildlife habitat and reinvigorate the ecosystem as whole. To date, 94,285 individual plants have been planted across 169 acres, 38,182 of which are red spruce seedlings. The remaining 56,103 plants include native species such as black cherry, red maple, chokecherry, yellow birch, and speckled alder. Additionally, 103

wetlands have been created and planted to create wildlife habitat. Fauna such as migratory birds, Eastern Newt, Cheat Mountain Salamander, Water Shrew, and West Virginia Flying Squirrel have already been observed or are predicted to return with the restoration of their red spruce habitat. Amy projects the Sharp's Knob project will wrap up in 2023, after restoring 462 total acres of soil-compacted, non-native plant ecosystems.

The Sharp's Knob restoration project represents CASRI's mission because it is a tangible effort dedicated to red spruce reforestation in an area that historically had red spruce. It is but one successful effort working to reconnect disparate red spruce habitat pockets in the central Appalachians. Additionally, this work could not be completed without strong partnership between Green Forests Work, the US Forest Service, and The Nature Conservancy. By restoring areas such as Sharp's Knob from non-native, desert land to productive habitat, CASRI and its partners show that with collaboration and passion, ecological restoration is realistic and essential in our imperiled red spruce habitats.

Spruce Release with the TNC Ecological Restoration Team

Will Evans is the leader of The Nature Conservancy's Ecological Restoration Team (ERT) based out of Elkins, WV. Continue reading for a look at what the ERT does. Will's glad to give the ERT more visibility!



1. What is the Ecological Restoration Team (ERT)?

The ERT is the TNC Ecological Restoration Team, and I'm the ERT leader. The team is composed of me, as a full time year-round employee, with crew members in the summer. The ERT serves as a field component of TNC in WV. As it relates to CASRI, this means doing spruce release. 95% of the work we do is spruce release. There are other restoration field crews in the area, but we are the only one focused exclusively on spruce. There are actually very few groups doing on-the-ground spruce release - I know some private contractors and some state agencies have done release, and the Appalachian Conservation Corps may be engaging in spruce release this upcoming field season.

2. How does red spruce release fit into the scheme of red spruce restoration?

Red spruce release compliments planting. In some areas, we have a ton of red spruce seedlings in the forest that came from a parent tree that evolved in this ecosystem. These trees are genetically able to deal with unique soils and weather. There's lots of mid-story spruce already here! What we're doing is giving them a boost to try and get them to the overstory. If you have a two or three year old seedling, it will take a long time for that tree to get to the over story and provide ecosystem services. But if you have a decades-old midstory tree and take out its competitors, it will get to the canopy much more quickly.

Spruce isn't projected to do well with climate change, making our restoration efforts even more important. Spruce planting is good for areas that historically had spruce but don't now and for restoring forests to unforested land.

Working in an area where there are already established sub-canopy spruce gives us a head start on our restoration goals.

When doing release work, the tree has already proven itself to be capable of surviving, we just help it break through the canopy.



3. How does spruce release fit into preparing red spruce for further climate change?

Release is one tool in a bigger toolbox for addressing climate change, resiliency, and ecosystem health. This also speaks to the role of the ERT in CASRI. The ERT is a specialized small group, informed by science done by

researchers, who get ideas from practitioners. It all feeds into itself. The ERT is not the end-all be-all for spruce restoration, it's just a targeted component.

4. What is your background as it relates to what you're doing now? What led you down this path?

I did my undergrad in environmental policy and government. After undergrad, I went to work as an environmental consultant in transportation jobs in the Boston area. I found that work to not be very rewarding. It just felt like I was checking the box, not pushing the needle forward. After I decided to leave that job, I hiked the Appalachian Trail, where I really realigned my priorities. I knew I had wanted to work in conservation since college, and I knew TNC was where I wanted to work. Hiking the AT reaffirmed the fact that I needed to be



outdoors more. Being outdoors and finding purpose in my work is important to me. With my job at TNC, I kill two birds with one stone. After I hiked the AT, I did AmeriCorps for 9 months, with Virginia State Parks. This was kind of a crash course in conservation- I helped with prescribed fire, trail building, water quality monitoring, invasive insect monitoring, and invasive species treatment. After that, I got a job in the same office as an employee, supervising the AmeriCorps crew. Then, the ERT lead position opened with TNC and I jumped on it. At that point, I had both herbicide and general conservation experience. This is the first time I've been able to dive deep into a particular

ecosystem. Being more focused and less broad has both its pluses and minuses. I love driving into the forest for work. I'm definitely an outdoors person who thrives in the field rather than behind a desk. Also, I'm in grad school right now at Colorado State University, getting my MS in natural resource stewardship and restoration ecology.

5. How does the work of the ERT fit in with CASRI's mission?

The ERT, while based out of TNC, operates on US Forest Service land. TNC has a strong partnership with the Forest Service - the ERT has remained throughout turnover in both groups. This cooperation is a great example of partnership. CASRI is about getting like-minded folks together to build a brain trust. These people may have slightly different objectives, but CASRI brings them all together. This has driven a lot of the ERT's work. When we make a management prescription change, we consult with both TNC and FS before we do anything. We are also starting to work with academic partners - Ben Rhodes, former ERT lead, is at The University of Kentucky working on a planting monitoring protocol. Also, the impact of ERT work is well beyond getting spruce up to the overstory - it speaks to hydrology, endangered species, etc. The ERT is an example of boots on the ground, dirt on your hands brand of conservation; going out into the field and implementing positive ecological change guided by science.

2021 CASRI Accomplishments in Photos



Crew planting red spruce and native hardwoods in tributaries of Gandy Creek, on the Cheat-Potomac Forest Service District (Chad Landress, USFS)



New lady slipper at a spruce planting (West Virginia Land Trust)



Drone view of red spruce growing on a 2015 restoration site at Mower Tract (Chris Barton, UKentucky)



Participants in spruce planting at Kumbrabow State Park (WVDOF)



Mower Tract planting crew (Anna Branduzzi, GFW)

2021 CASRI Accomplishments

Tree Plantings

Canaan Valley National Wildlife Refuge

- ***Red Spruce and Canaan Fir Planting*** - Canaan Valley National Wildlife Refuge, with monetary help from TNC and volunteers, planted 4,000 red spruce and Canaan fir seedlings on 15 acres in and around Cheat Mountain salamander habitat and 5 acres along the Freeland Run riparian buffer

George Washington-Jefferson National Forest

- ***Red Spruce Planting*** - 7,500 red spruce seedlings were planted by contractors in April 2021 over 10 acres, in the Laurel Fork area.

Green Forests Work and USFS Greenbrier Ranger District of the Monongahela National Forest

- ***Mower Tract, Mower 21 Planting*** - The U. S. Forest Service, in partnership with Green Forests Work (GFW), Komatsu, Arbor Day Foundation, Mennen Environmental Foundation, Appalachian Stewardship Foundation, USDI OSMRE, Appalachian Regional Reforestation Initiative, and WV Highlands Conservancy, planted 116,192 red spruce, native hardwood seedlings, and wetland shrubs of 32 species on 184 acres of reclaimed mine land that was deep ripped in 2020. An additional 600 willow, 150 ninebark, and 50 swamp rose live stakes were planted, as well as over 50 gallons of hawthorn, speckled alder, and winterberry holly seed were spread.
- ***Mower Tract, Appalachian Conservation Corps*** - A 6-person Appalachian Conservation Corps (AmeriCorps, Conservation Legacy) hand crew, in partnership with Green Forests Work (GFW) and the U. S. Forest Service, planted or transplanted 3,526 trees and shrubs on 3.2 acres, and spread 138 lbs. pounds of native grass and pollinator seed on 11 acres of mine restoration area on Mower 21.

USFS Greenbrier Ranger District of the Monongahela National Forest

- ***Riparian Planting*** - TNC led an effort with support from the Forest Service and Trout Unlimited to plant over 74,000 red spruce, balsam fir, and northern hardwoods and shrubs on 194 acres of open riparian areas. The restoration was focused on an interconnected landscape at the headwaters of contiguous three river systems: Dry Fork, Gandy Creek, and Big Run of the North Fork South Branch Potomac. High elevation connectivity is critical in these landscape positions both for the spruce ecosystem and the coldwater ecosystem that spruce help support.

Green Forests Work and USFS Marlinton - White Sulphur Ranger District of the Monongahela National Forest

- ***Sharp's Knob, Sharp 21 Planting***— The U. S. Forest Service, in partnership with Green Forests Work (GFW), Appalachian Regional Reforestation Initiative, Appalachian Headwaters, Argosy Foundation, Arbor Day Foundation, The Nature Conservancy, and Appalachian Conservation Corps (AmeriCorps, Conservation Legacy), planted 25,175 red spruce, native hardwood seedlings, and wetland shrubs of 17 species on 47 acres of reclaimed mine land that was deep ripped in 2020.
- ***Sharp's Knob, Appalachian Conservation Corps*** - A 6-person Appalachian Conservation Corps (AmeriCorps, Conservation Legacy) hand crew, in partnership with Green Forests Work (GFW) and the U. S. Forest Service, planted 1,279 trees and shrubs on 5 acres.
- ***Sharp's Knob, Volunteer Planting*** - The Willage and Lane families of Chicago, Illinois planted 349 spruce in July 2021.

West Virginia Department of Forestry

- ***Kumbrabow State Forest*** - DOF employees conducted a tree planting event on the Oxley Run area of the forest with the Randolph County 4H/Cloverbuds attending. About 2,000 seedlings were planted by 27 volunteers.

West Virginia Land Trust (Spring 2020)

- ***Red Spruce Planting*** - The West Virginia Land Trust initiated red spruce restoration activities on the organization's Yellow Creek Natural Area, just north of Davis, the spring of 2020. WVLT's community partners (including families in the Mountain Laurel Learning Cooperative, WV Master Naturalists, and private land neighbors) and staff planted approximately 600 red spruce seedlings in the third growth hardwood forest and openings along Yellow Creek and its spring-fed tributaries near the trail to Moon Rocks.

Spruce Release

Green Forests Work

- ***Mower Tract, Appalachian Conservation Corps***— An 8-person Appalachian Conservation Corps (AmeriCorps, Conservation Legacy) saw crew, in partnership with Green Forests Work (GFW) and the U. S. Forest Service, felled or girdled 9.7 acres of exotic, stunted tree plantations on the Mower Tract mine lands, roughly 75% of which resulted in the release of red spruce growing in the understory.

USFS Gauley Ranger District of the Monongahela National Forest

- ***Spruce Release*** - Spruce release was completed on 185 acres of land on the Gauley District in 2021.

West Virginia Department of Forestry

- ***Spruce Release*** - In 2021, WVDOF finished harvesting the Buck Knob 22 timber sale, which contained a substantial amount of red spruce release silviculture, approximately 45-50 acres. This site will serve as a location for future tree planting events to expand the footprint of spruce in this area.

The Nature Conservancy

- ***Spruce Release*** - The Nature Conservancy's Ecological Restoration Team (ERT) completed red spruce release work across approximately 406 acres of the Upper Greenbrier North (UGN) project area. The goal of the UGN spruce release project is to expand and connect existing patches of mature spruce. To that end, the United States Forest Service (USFS) has identified distinct spruce release units, prioritized by their proximity to mature spruce stands and the prevalence of well-developed but suppressed mid-story spruce. The ERT releases spruce from competition by selectively culling competing hardwoods, reducing resource competition, allowing target spruce to increase grow rates and eventually reach the canopy.

Habitat Restoration

Canaan Valley National Wildlife Refuge

- ***Beech Brush Removal*** - Canaan Valley National Wildlife Refuge manually cut 2 acres of beech brush on Cabin Knob in sensitive Cheat Mountain salamander habitat where understory spruce is working its way into the mid story. It is our hope that cutting this beech brush occasionally will get the red spruce saplings into the mid-story and ultimate the overstory faster.

Green Forests Work and USFS Greenbrier Ranger District of the Monongahela National Forest

- ***Mower Tract, Mower 22 Site Preparation*** - 171.5 acres of mined land were decompacted on Mower 22 of the U. S. Forest Service, Greenbrier Ranger District, in partnership with Green Forests Work (GFW), in preparation for planting of red spruce, native hardwoods, and wetland shrubs in spring 2022. 180 wetlands of various sizes were created (3.16 acres of wetland habitat).

Green Forests Work and USFS Marlinton - White Sulphur Ranger District of the Monongahela National Forest

- ***Sharp's Knob, Sharp 22 Site Preparation***— 46.5 acres of mined land were decompacted on Sharp 22 of the U. S. Forest Service, Marlinton Ranger District, in partnership with Green Forests Work (GFW) and Appalachian Headwaters, in preparation for planting of red spruce, native hardwoods, and wetland shrubs in spring 2022. 78 wetlands of various sizes were created (2.5 acres of wetland habitat).
- ***Sharp's Knob, Sharp 21 Seed Dispersal*** - Appalachian Conservation Corps members spread 10 pounds of native grass and pollinator seed on 7.5 acres of mine restoration area on Sharp 21.

USFS Marlinton - White Sulphur Ranger District of the Monongahela National Forest

- ***Native Seed Dispersal*** - WVDNR Botanist and Chicago Botanic Gardens Conservation Land Management Intern dispersed 27.3 lbs of hawthorn (*Crataegus* sp.) fruit, 6 oz of bog goldenrod (*Solidago uliginosa*) seed, 1.5 oz of northern bush honeysuckle (*Diervilla lonicera*) seed and 0.3 oz of gentian (*Gentiana* sp.) seed over 0.14 acres on Sharp's Knob in November of 2021.

The Nature Conservancy - WV, MD, VA Chapters

- ***Habitat Restoration*** - TNC's Ecological Restoration Team completed 51 acres of NNIS removal on the Widney grazing allotment.

West Virginia Division of Natural Resources

- ***Policy Signing*** - In February, a new WV Natural Areas Policy was signed by WVDNR Director Stephan McDaniel, establishing authority to designate Natural Areas on state lands. In April, the first two Natural Areas (NA) were designated in Canaan Valley Resort State Park: Canaan Valley Wetlands NA and Bald Knob NA. The Canaan Valley Wetlands NA (1,996 acres) protects globally rare conifer swamps (red spruce, balsam fir, eastern hemlock) and other high elevation wetlands in the valley bottom. The Bald Knob NA (210 acres) protects globally rare upland red spruce forests and heath barrens on the mountaintop.

Research, Surveying, and Monitoring

Canaan Valley National Wildlife Refuge

- ***Cheat Mountain Salamander Monitoring***—Canaan Valley National Wildlife Refuge conducted Cheat Mountain Salamander surveys with a new protocol developed by USGS that focuses on detection probability. All 121 survey points were visited twice in the spring and fall. In addition, habitat data was collected at all survey points. This will aid in determining where CMS are and if we need to do any habitat restoration in the areas. In addition, genetic sampling was completed at a fifth location on the Refuge and were sent for analysis at WVU's wildlife genetics laboratory for analysis. In addition, we continued our mark and recapture study for the 3-mile trail under pass where we are trying to determine if CMS are crossing the trail via the underpass.

CASRI Research Committee

Research is a slow and deliberate process, red spruce is a slow growing species, and soils form on geologic time.

- ***Lacy Rucker, WVU*** - Progress was made in 2021 on Cheat Mountain salamander (CMS) research, monitoring, and interagency cooperation. The updated CMS habitat suitability model has been finalized and is being used by stakeholders through ArcGIS online. Lacy Rucker, West Virginia University graduate

student, led a study to quantify the impacts of a linear forest clearing for creation of a ski slope on local colonization and extinction probabilities in adjacent forested habitat for CMS. This work built upon long-term data (1988 to 2021) initiated 3 years after forest clearing for the ski slope. The authors found that edge effects of the linear forest clearing had negative impacts to CMS suggesting that extensive linear habitat fragmentation could result in degraded habitat for CMS in the adjacent forest, and that potential for interactions with competitor species is increasing in fragmented high elevation forest stands. The work was published in the journal *Forest Ecology and Management* and can be found here -

<https://doi.org/10.1016/j.foreco.2021.119847>. A manuscript describing the CMS long-term monitoring design and first year results is nearly complete and will likely be published in spring 2022.

- ***James Lenard, WVU*** - James Lenard, a graduate student at West Virginia University, made significant progress in 2021 with 65 new soil profiles dug and described, for a total of over 100 pits in spruce-dominated forest types. All soil samples from these pits have been analyzed for soil organic carbon and he and his collaborators are working on an analysis of carbon stocks to be included in the Ecological Site Descriptions for red spruce communities. James's graduate work included developing a spodic Intensity raster map layer for the entire extent of the Monongahela National Forest with a near final product completed in 2021.

Marshall University

- ***Updated Spruce Map*** - In May 2021, Dr. Anne Axel and Dr. Kyle Palmquist of the Department of Biological Sciences at Marshall University received a West Virginia NASA Space Grant Consortium Research Initiation Grant of \$30,000 titled **Data integration for red spruce management: using NASA products to resolve scale mismatches and produce an updated red spruce map**. The award will support an evidence review of existing red spruce data products and result in a decision tree describing applicable uses for each product. This project is in collaboration with Marshall University graduate student Katie Biggert and members of the CASRI Research Committee.