THE APPALACHIAN REGIONAL REFORESTATION INITIATIVE AND GREEN FORESTS WORK: BRINGING BACK THE FOREST ON SURFACE COAL MINES IN APPALACHIA[1]

H.Z. Angel[2], C.D. Barton, M. French, and P.N. Angel

Abstract: Created by the Office of Surface Mining Reclamation and Enforcement and the seven state regulatory authorities in Appalachia, the Appalachian Regional Reforestation Initiative (ARRI) re-establishes healthy, productive forest habitat on active mines, abandoned mine lands, and mines that were previously reclaimed to non-forested post-mining land uses in the eastern coal fields. Green Forests Work (GFW) is a nonprofit organization formed out of ARRI as an economic development plan for Appalachia, styled after the Civilian Conservation Corps of the 1930s to restore forest ecosystem services on mine-scarred lands and to create jobs in the process. From 2009 to 2015, ARRI and GFW have partnered with state and federal agencies, watershed groups, coal operators, conservation groups, environmental organizations, faith-based groups, and numerous universities, colleges, and high schools to coordinate 217 tree planting projects/events on surface mines throughout Appalachia. This work has resulted in the planting of more than 1.59 million trees on 2,602 acres of previously reclaimed mine sites where reforestation was not attempted or where the results were undesirable. ARRI's and GFW's role in these endeavors is to facilitate communication, provide technical assistance, and to match funding sources with suitable mined land and volunteer groups. The volunteer tree planting events facilitated by ARRI and GFW engaged 645 partner organizations and 11,701 volunteers and natural resource professionals, who contributed approximately 80,017 volunteer hours. Among the volunteers, a total of 6,225 were 24 years old or under, supporting the Secretary of the United States Department of Interior's Engaging the Next Generation Youth Initiative and the spirit of volunteerism across the United States.

Additional Key Words: Legacy Mines, Forestry Post Mining Land Use, Forestry Reclamation Approach, Office of Surface Mining Reclamation and Enforcement, Surface Mining Control and Reclamation Act.

---

[1] Oral paper presented at the 2015 National Meeting of the American Society of Mining and Reclamation, Lexington, KY ***Reclamation Opportunities for a Sustainable Future*** June 6 - 11, 2015. R.I. Barnhisel (ed.). Published by ASMR; 1305 Weathervane Dr., Champaign, IL 61821.

[2] Hannah Z. Angel, Forestry Graduate Student, Arthur Temple College of Forestry and Agriculture, Stephen F. Austin State University, Nacogdoches, TX 75962; Christopher D. Barton, Professor of Forest Hydrology and Watershed Management, University of Kentucky, Lexington, KY, 40546; Michael French, Reforestation Coordinator, Green Forests Work, Lexington, KY 40546; Patrick N. Angel, Senior Forester/Soil Scientist, Office of Surface Mining Reclamation and Enforcement, U.S.D.I., London, KY 40741.

Journal American Society of Mining and Reclamation, 2015 Volume 4, Issue 2 pp 91-101
DOI: http://doi.org/10.21000/JASMR15020091

Introduction

In 2004, the US Department of Interior's Office of Surface Mining Reclamation and Enforcement (OSMRE) and the seven state regulatory authorities (KY, MD, OH, PA, TN, VA, WV) in Appalachia created the Appalachian Regional Reforestation Initiative (ARRI) to reestablish healthy, productive forest habitat on active and abandoned mine lands in the eastern coal fields (Angel et al., 2005). ARRI's goals are to plant more high-value hardwood trees on surface mines, increase the survival rates and growth rates of those trees, and to expedite the establishment of forest habitat through natural succession. ARRI is comprised of a Core Team and a Science Team. The Core Team was created to facilitate reforestation efforts and works with the coal industry; landowners; university researchers; watershed, environmental, and conservation groups; and State and Federal government agencies that have an interest in creating productive forestland on reclaimed mined lands. The ARRI Science Team ensures that the methods ARRI promote are based on proven science and research and strives to further advance scientific research on forestry reclamation. See the following ARRI website for more information about the reforestation initiative in Appalachia: http://arri.osmre.gov/

To promote proper mine land reforestation on active mine sites, ARRI advocates using a set of best management practices called the Forestry Reclamation Approach (FRA) (Burger et al., 2005). The FRA is a five step process consisting of the following steps: 1) create a suitable rooting medium for good tree growth that is no less than 1.2 m (4 ft) deep and comprised of topsoil, weathered sandstone, and/or the best available material; 2) loosely grade the topsoil or topsoil substitutes established in step one to create a non-compacted soil growth medium; 3) use less competitive ground covers that are compatible with growing trees; 4) plant two types of trees including early successional species for wildlife and soil stability and commercially valuable crop trees; and 5) use proper tree planting techniques (Burger et al., 2005).

Focused efforts by ARRI are changing the way surface mines are being reclaimed by the coal industry and regulatory authorities in Appalachia. Since the start of ARRI in 2004, approximately 95 million trees have been planted and approximately 140,000 acres were reclaimed to forest on newly mined land. ARRI is forward-looking with efforts to educate and train the active mining industry and regulatory personnel about the FRA in order to increase reclamation for reforestation on new surface mine disturbances from this point forward.

ARRI is also "looking backward" at the estimated one million acres of non-forested, legacy and abandoned mined lands that could be available for reforestation in the eastern US (Hall et al., 2014). Legacy surface mines were reclaimed using conventional post-Surface Mine Control and Reclamation Act (SMCRA) reclamation practices and not reforested with native trees, whereas Abandoned Mine Lands (AML) were reclaimed using pre-SMCRA practices. A 501(c)3 non-profit organization called Green Forest Works (GFW) was created to restore the native forests of Appalachia on legacy and AML lands. Styled after the Civilian Conservation Corps of the 1930s, GFW strives to bring economic opportunities to Appalachia through reforestation activities. Successful reestablishment of the hardwood forests that once dominated these lands will provide a renewable, sustainable, multi-use resource while enhancing the local and global environment. Economic benefits from the program include job creation for tree seedling providers, equipment operators, tree planters, forest managers, and wildlife biologists, as well as those that may manage these sites for timber production, short rotation woody biofuel plantations and/or climate change mitigation.

Through GFW, local citizens benefit from jobs created to restore native hardwood forests that will sequester carbon, improve water quality, and benefit state and federal species of conservation concern. This program aims to restore healthy, productive forests now rather than leaving these areas as unproductive "scrublands" for extended periods. Ancillary benefits that could develop include certified "green" wood products, ecotourism, biodiversity enhancement, woody biofuels, and other green opportunities. For more information on GFW see www.greenforestswork.org.

Discussion

Legacy Mine Lands

Conventional post-SMCRA reclamation practices often resulted in the land converting to a state of arrested natural succession and highly compromised hydrology due to intentional compaction of mine spoil and hydro-seeding with aggressive exotic grasses, forbs, and shrubs. These practices reduce tree seedling survival and growth and limit the land's suitability for many wildlife species. Deer, elk, and turkey habitat may be enhanced by these practices, but specialist wildlife species like the Cerulean and Golden-winged warblers are not able to thrive on compacted grasslands and shrublands.

GFW and ARRI advocate for the application of a modified FRA for legacy mines and AML sites that mitigates the compaction by deep-ripping the ground with a large bulldozer pulling a 3 to 4 ft. ripper shank, eradicates undesirable vegetation to whatever extent is appropriate and possible, and recommends the planting of a diverse mix of native trees and shrubs (Hall et al., 2014). More than one million acres of Appalachian land have been affected by surface mining. GFW is poised to address those affected lands by reforesting several thousand acres per year if adequate funding mechanisms continue to be secured.

This post-reclamation reforestation effort on legacy mines and AML sites has the additional benefit of outreach and awareness that is being created for proper mine land reforestation with the public, industry, and regulatory authorities. Ripping and tree planting partnerships with several mining companies on some of their previously reclaimed mine lands have led them to embrace the FRA on their active mining operations. Many state and federal regulators involved in tree planting projects have expressed positive attitudes for the forestry post-mining land use and are promoting the implementation of FRA on the front-end of the reclamation process instead of a post-reclamation fix.

Restoring American Chestnut

GFW and ARRI are partnering with The American Chestnut Foundation (TACF) through the planting of potentially disease-resistant American chestnut trees, along with other native hardwood seedlings, on tree planting projects. American chestnut (*Castanea dentata*) was formerly a major component of forests throughout the Appalachian coalfield and beyond (French et al., 2015). Chestnut's strong, lightweight wood was naturally rot-resistant, making it a preferred timber tree for many purposes. Unlike many other nut-producing trees that flower early in the year, American chestnuts flower in June and July, so they were less susceptible to a late freeze or frost that could damage the flowers. Due in part to its late flowering, American chestnuts produced a reliable and abundant nut crop that was an important source of nutrition for wildlife, livestock, and humans. However, American chestnut has suffered severe decline throughout the USA; today, few living and mature American chestnut trees remain (French et al., 2015).

Beginning in the early 1900s, an introduced fungus known as the chestnut blight (*Cryphonectria parasitica*) devastated chestnut populations (French et al., 2015). American chestnuts were virtually eliminated as a canopy tree throughout its native range by the 1950s.

TACF focused on a breeding strategy to create a population of chestnuts that would incorporate the disease resistance of Chinese chestnut (*Castanea mollissima*) and retain the form and functional characteristics of American chestnut. This strategy crosses Chinese chestnuts and American chestnuts, then takes those offspring through a series of backcrosses and intercrosses to create trees with American traits and high levels of disease resistance. At each step of the process, trees are intentionally infected with the disease so that only trees with high levels of disease resistance and American characteristics are used for further breeding. In 2005, TACF began producing trees that are approximately 15/16 American chestnut, 1/16 Chinese chestnut in character and should have a high level of disease resistance. TACF is calling this generation "Restoration Chestnuts 1.0", which implies that breeding efforts will continue to improve both disease resistance and American characteristics into the future. TACF is now testing Restoration Chestnuts 1.0 for their disease resistance and other characteristics (French et al., 2015).

The TACF's strategy for chestnut restoration includes early establishment of small populations throughout the chestnut's former range (French et al., 2015). These initial groups of trees (hereinafter founder populations) are intended to serve as seed sources and to aid natural dissemination to other areas. Establishing founder populations of chestnuts on mined lands has been of interest to TACF researchers for numerous reasons. The first is the overlap of American chestnut's native range and the Appalachian coalfield. Furthermore, many mining disturbances occur on upper slopes and ridgetops where chestnuts were formerly a dominant component of the forest, potentially making former surface mines ideal locations for chestnut introduction. In addition, research has demonstrated that chestnut can be successful when planted on mines that have been reclaimed using the FRA. Also, mining disturbances reclaimed using the FRA may limit the establishment of root-rot pathogens (*Phytophthora spp.*) that have hindered TACF's breeding efforts in the southern Appalachians (James, 2011). *Phytophthora* is a water mold that favors wet soils or those with high water holding capacities; the well-drained soils created by the FRA may limit *Phytophthora* establishment. Lastly, surface mines reclaimed with the FRA are essentially "blank slates", where conditions benefitting chestnut establishment can be created (French et al., 2015). Vegetative competition for nutrients, sunlight, and water can be reduced through the proper implementation of step 3 of the FRA (Burger et al., 2009), whereas chestnuts planted in existing forests and old fields face competition from established vegetation.

Legacy surface mines and AML sites are also potential launching points for blight-resistant chestnut introduction, although less work has been done to identify establishment methods that are most suitable for such sites (French et al., 2015). Restoration Chestnut 1.0 plantings on AML sites in 2012 and 2013 have used a limited number of seed and seedlings and early success varied from 32 to 100% survival after one season (French and Edwards, unpublished data). Bauman et al. (2013a) found that a cross-ripped legacy site in Ohio had 73% survival of bare root chestnuts after six growing seasons and that the chestnuts began producing nuts in the fourth growing season. Similar observations of chestnut seed production by the fourth or fifth growing season have been made by the authors and ARRI collaborators on active FRA sites in Ohio, Kentucky, Tennessee, and West Virginia. Mitigation of compaction on a legacy mine in Ohio enabled greater colonization of chestnut root tips by beneficial mycorrhizal fungi, which likely led to higher survival and growth rates when compared to the untreated controls (Bauman et al., 2013b).

TACF considers efforts by ARRI and GFW to create productive and biodiverse forests on active mining operations, legacy mines, and AMLs a high priority (French et al., 2015). As larger numbers of Restoration Chestnuts 1.0 are produced, TACF intends to contribute more for reclamation projects, especially those projects that engage volunteer tree planters to enhance the public outreach component of TACF, ARRI, and GFW. However, demand for blight-resistant chestnuts will outpace supply for many years to come. Full implementation of the FRA will be important to TACF decisions concerning allocation of blight-resistant chestnut stock for mine reclamation plantings (French et al., 2015).

Outreach and Community Engagement

From 2009 to 2015, GFW and ARRI partnered with state and federal agencies, watershed groups, coal operators, conservation groups, environmental organizations, faith-based groups, and numerous universities, colleges, and high schools to coordinate 217 tree planting projects or events throughout Appalachia. These events involved 645 partner organizations and resulted in the planting of over 1.59 million trees on 2,602 acres of previously reclaimed mine sites where reforestation was not attempted, or where the results were undesirable (Table 1). The number of trees planted during each of the seven years during that period is shown in Table 1. The number of participants engaged by GFW and ARRI since 2009 has been 11,701 and the amount of time invested by those volunteers is estimated to be approximately 80,017 hours (Table 1). Among the volunteers, a total of 6,225 were 24 years old or under, supporting the Secretary of the United

States Department of Interior's Engaging the Next Generation Youth Initiative. These events not only provide community service opportunities, but also help to raise awareness of a serious environmental issue and empower young Americans to take action toward the restoration and beautification of mine-scarred lands. The cultural barriers that have existed for decades for planting trees on surface mines are gradually being broken down as we engage thousands of young Americans in the mitigation of site conditions that impedes natural succession and reforestation on legacy mines. As a result, the public is embracing forestry as the post-mining land use of choice, and conventional grassland reclamation methodologies are gradually being replaced by the Forestry Reclamation Approach. GFW's and ARRI's role in these endeavors is to facilitate communication, provide technical assistance and supplies, and to match funding sources with suitable mined land and volunteer groups. Working with ARRI Core and Science Team members, GFW foresters coordinate site selection and evaluation, herbicide treatments, ripping activities, species selection, tree planting, and follow-up surveys.

Table 1 – Summary of the efforts led by GFW since its creation in 2009.

Year	Trees Planted	Acres Planted	Partners Involved	No. of Volunteers	Volunteer Hours
2009	35,155	36.6	72	558	3,944
2010	145,285	203.8	102	931	9,176
2011	352,516	670	156	1,663	13,304
2012	228,249	321	190	2,577	19,490
2013	256,182	380.78	198	1,949	11,049
2014	200,181	361.8	199	1,941	13,912
2015	374,038	628.85	231	2,082	9,142
Total	**1,591,606**	**2,602.83**	**645**	**11,701**	**80,017**

A typical example of a volunteer tree planting project on a legacy mine site in Appalachia is on the University of Kentucky's Robinson Forest in Breathitt County, Kentucky where spring break college students, boy scouts, members of conservation groups, and the general public contributed to the planting of about 36 acres of mined land (Table 1). The Robinson Forest project was made possible by a grant from the National Fish and Wildlife Foundation (NFWF) and the USDA Forest Service's State and Private Forestry organization (USFS). It provided forest restoration on an old, degraded surface mine site near Rowdy, Kentucky. The NFWF and USFS partnership funded similar reforestation projects on mine land in five other Appalachian coal states

through a program called the Appalachian Forest Renewal Initiative. Often braving mud and cold rain, students from the following schools planted trees at the project event: Appalachian State University, Berea College, Drew University, Elon University, Emory University, Georgetown University, Mitchell College, University of Kentucky, University of North Carolina-Chapel Hill, and Warren Wilson College. The students were joined by members of the Cumberland Chapter of the Sierra Club and seven different Boy Scout Troops from across Kentucky. Over a period of two weeks in March 2015, about 140 volunteers contributed to the planting of over 23,000 trees.

Figure 1. Appalachian State University, Drew University, Emory University and Mitchell College students planting trees at the Robinson Forest legacy mine site.

Another example of a reforestation project on a legacy mine where volunteer tree planters were recruited from the general public is the Flight 93 National Memorial near Shanksville, PA. United Airlines Flight 93 crashed on a 1,000 acre reclaimed surface mine site during the terrorist attacks of September 11, 2001, killing all 40 passengers and crew members. The National Park Service (NPS) built a memorial at the crash site. In 2011, the NPS asked OSMRE for technical assistance on the reforestation of the previously mined and reclaimed land surrounding the memorial. OSMRE provided assistance on the project through ARRI and GFW. The NPS wanted to naturalize the surrounding area and provide a windbreak for the memorial on this high elevation site. Since 2012, more than 70,000 seedlings have been planted by more than 1,900 volunteers at

the Flight 93 National Memorial. Volunteers have been recruited from the general public and up to 400 planters worked for two days in April, planting between 20 and 30 acres each year. Tree species mimic the white pine - red oak - red maple cover type that would naturally occur at this site. Over 20 native species of tree seedlings have been used so far, all common to this cover type. In addition, TACF donated 3,000 Restoration Chestnuts 1.0 and the US Forest Service donated Dutch Elm Disease resistant American elms. Most of the seedlings have been donated by the Pennsylvania Bureau of Forestry. Funding for this project came from the NPS and the National Park Foundation. More than 50 ARRI and GFW partners have been involved with the restoration project thus far including GFW. A US Department of Interior grant was secured in 2015 to encourage youth involvement at Flight 93. Through this grant, Indiana University of Pennsylvania will monitor the planting for growth and survival. VISTA's (Volunteers In Service To America) worked under the Appalachian Coal Country Team and students from Penn State Altoona and Penn State Dubois assisted with the planting in 2015 through this grant (Fig. 2). Additional planting events are planned for each year well into the future with about 200-250 acres remaining to be reforested. In total, ARRI and GFW have successfully completed over 200 projects involving a diverse range of over 600 partners from both public and private lands (Fig. 3).

Conclusion

Forests are a renewable resource. By reestablishing forests where no forests currently exist, the economic opportunities provided by GFW and ARRI will not only provide for the Appalachian people today, but they will also put those lands on a trajectory that will ensure that a forest is available for use by future Appalachian citizens. The Appalachian forest is one of the most beautiful in the world. It is one of the region's most valuable assets and has played an integral part in the rich cultural heritage of the mountain people. The volunteer tree planting projects and events facilitated by ARRI and GFW has been enthusiastically embraced by partner organizations, volunteers, and participants across the eastern coalfields. GFW can proceed in developing a skilled green workforce to restore, protect, and manage this natural resource that is so vital to the region's current and future prosperity.

Figure 2. Penn State Dubois students at Flight 93 National Memorial.

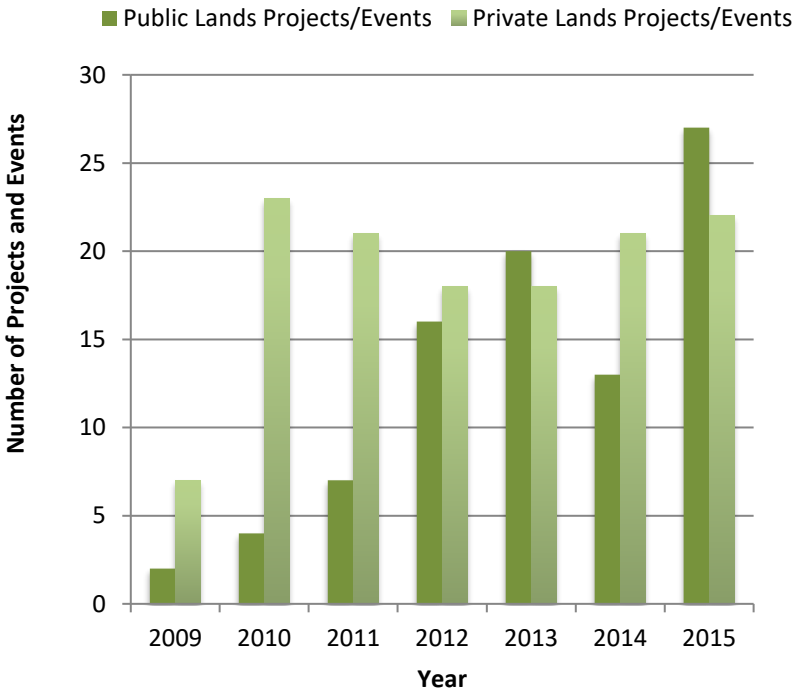

Figure 3. Number of reforestation projects on public and private lands from 2009-2015.

Literature Cited

Angel P., V. Davis, J. Burger, D. Graves, and C. Zipper. 2005. The Appalachian Regional Reforestation Initiative. Forest Reclamation Advisory No. 1. US Office of Surface Mining, ARRI.

Bauman J.M., C. Cochran, B.C. McCarthy, and C.H. Keiffer. 2013a. American chestnut's role in the ecological restoration of coal-mined landscapes. The Journal of The American Chestnut Foundation 5:27 15-18.

Bauman J.M., C.H. Keiffer, S. Hiremath, B.C. McCarthy. 2013b. Soil preparation methods promoting ectomycorrhizal colonization and American chestnut Castanea dentata establishment in coal mine restoration. Journal of Applied Ecology 50: 721-729. http://dx.doi.org/10.1111/1365-2664.12070

Burger J., D. Graves, P. Angel, V. Davis, and C. Zipper. 2005. The Forestry Reclamation Approach. Forest Reclamation Advisory No. 1. US Office of Surface Mining, ARRI.

Burger J., V. Davis, J. Franklin, C. Zipper, J. Skousen, C. Barton, and P. Angel. 2009. Tree compatible ground covers for reforestation and erosion control. Forest Reclamation Advisory No. 6. US Office of Surface Mining, ARRI.

French, F., C. Barton, B. McCarthy, C. Keiffer, J. Skousen, C. Zipper, and P. Angel. 2015. Re-establishing American chestnut on mined lands in the Appalachian coalfields. Forest Reclamation Advisory No. 12. US Office of Surface Mining, ARRI.

Hall, N., M. French, R. Dyer, C. Barton, P. Angel, and S. Eggerud. 2014. Green Forests Work: Planting now for the future of Appalachia. Reclamation Matters. Spring 2014: 36-39.

James, J. 2011. *Phytophthora*: the Stealthy Killer Part 2 The Challenge to Develop a *Phytophthora*-Resistant Chestnut. The Journal of The American Chestnut Foundation. 4:25 4-8.