RESTORING A FORMER COAL MINE IN APPALACHIA USA

START DATE: JULY 2022
END DATE: OCTOBER 2027

GREEN FORESTS WORK'S MISSION

Green Forests Work's (GFW) mission is to re-establish healthy and productive forests on formerly mined lands in Appalachia.

VISION

GFW's vision is to create a renewable and sustainable multi-use resource that will provide economic opportunities while enhancing the local and global environment by converting reclaimed, non-native grasslands and scrub lands into healthy, productive forestland.

Our reforestation projects provide jobs for equipment operators, nursery workers, and tree planters, and improve the environment by eradicating exotic species and restoring ecosystem services. With the help of our partners and volunteers, this vision is quickly becoming a reality.

Since 2009, we have planted over six million trees on more than 11,500 acres.

BACKGROUND

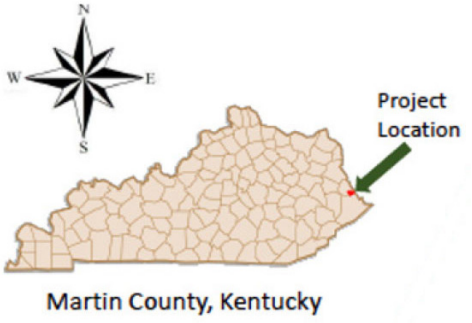
GFW is a 501(c)(3) nonprofit organization housed at the University of Kentucky. In 2022, we initiated a new partnership with the Priceless Planet Coalition (PPC) and Conservation International to plant 100,000 trees on a former coal mine in Martin County, KY. The PPC has a goal of planting 100 million trees on the planet by 2025 and we are one of eighteen global projects helping them reach that goal. From water and food shortages to extreme weather devastations, the PPC is striving to engage citizens to help with change, impact environmental policies and make a tangible difference. This report covers activities that were performed in the first year of project implementation (2023) and will serve as the establishment report for the planting.

A seedling is planted in mine soils on a former surface coal mine in Appalachia.

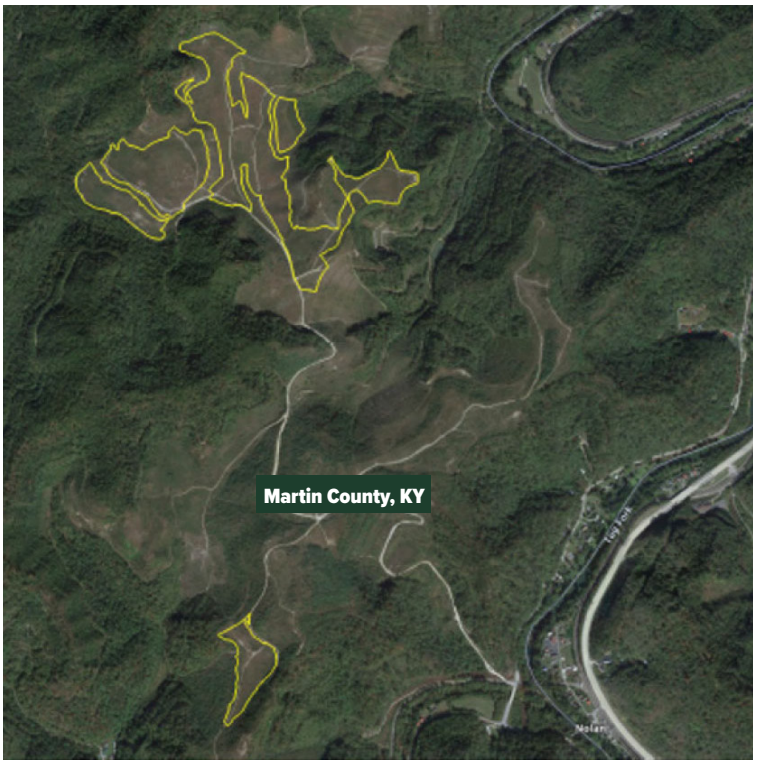
Project partners discuss site preparation prior to project implementation.

MARTIN COUNTY, KY

The project is on a reclaimed coal mine in Martin County, Kentucky. The site exhibited an early succession habitat dominated by exotic plant species growing in excessively compacted soils. The site was logged in the early 1900s and again in the mid to late 1990s. Subsequently, the site was surface mined for coal from 2005 – 2015. The site was revegetated by 2016. However, the land was not managed, and the high-maintenance forages quickly collapsed and reverted to a landscape of weedy and undesirable species.



Martin County, Kentucky



Location of Martin County, Kentucky tree planting site. Yellow polygon

Clockwise from top left: A Komatsu 61PX bulldozer removes unwanted vegetation at the site. Freshly ripped and uncompacted soil is ready to be planted. Tree planting crew busy at work.

SITE PREPARATION AND PLANTING

Site preparation, including deep ripping with a bulldozer and removal of exotic shrubs, of 147.3 acres was performed in early 2023 to reduce soil compaction and non-native plant competition. Soils on reclaimed coal mines are often very compacted which creates conditions that prohibit rainwater infiltration and promotes runoff. The runoff oftentimes accelerates erosion and creates water quality issues in receiving streams. The lack of trees also reduces canopy interception of rainwater and lowers total evapotranspiration, which can lead to local flooding issues due to the increased runoff. Ripping of the soil to reduce compaction promotes water infiltration and provides a good rooting medium for the planted trees. As the trees grow, they will utilize more water, reduce the energy of precipitation, and thereby reduce runoff and potential flooding.

A total of 140,215 seedlings were hand planted in the project area in late winter/early spring, exceeding our goal of 100,000 trees. In addition to the trees, 87 pounds of native warm-season grasses and wildflower seeds were sown across the reforestation area. The site was planted with tree species from a declining forest type (i.e., shortleaf pine-upland oak woodland) that will help to improve air and water quality, enhance forest resiliency, mitigate climate change through increased carbon accumulation, provide multi-seasonal pollen and nectar sources for pollinators and make the area more productive for wildlife.

TREE SPECIES

Tree species planted at the site are listed in Table 1. All species planted are native to Kentucky and would have been found at the site prior to mining. We planted both early (ex. black locust, sycamore, yellow poplar) and later succession (ex. oaks and hickories) species, as the original seedbank was lost during the mining operation and we wanted to ensure that a diverse mix of species occupies the site after restoration. We received 842 American chestnut (*Castanea dentata*) seedlings from the American Chestnut Foundation and planted them at the site in hopes of restoring this iconic species to its original range. We also received a donation of over 40,000 American hazelnut (*Corylus americana*) seedlings from a nursery and these were interplanted throughout the site to increase plant density. Species such as the American chestnut and hazelnut, as well as the oaks and hickories, are good hard-mast producers that will benefit local wildlife species. Soft-mast species planted at the site, such as wild plum, American crabapple, persimmon, and elderberry, are also beneficial to local wildlife.

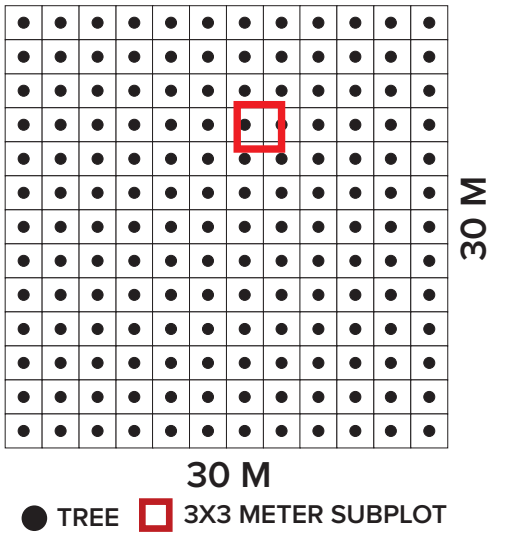
Table 1: Species and number of trees planted at the Martin County, Kentucky site in 2023.

Common Name	Species	# Planted
Virginia pine	*Pinus virginiana*	4,181
Eastern white pine	*Pinus strobus*	12,542
White oak	*Quercus alba*	21,700
Chestnut oak	*Quercus montana*	8,519
Northern red oak	*Quercus rubra*	8,549
Black oak	*Quercus velutina*	4,257
Yellow poplar	*Liriodendron tulipifera*	4,226
Black cherry	*Prunus serotina*	4,303
Shagbark hickory	*Carya ovata*	3,644
Mockernut hickory	*Carya tomentosa*	1,045
Persimmon	*Diospyros virginiana*	2,117
Sweet birch	*Betula lenta*	2,117
Hackberry	*Celtis occidentalis*	2,090
Red mulberry	*Morus rubra*	2,103
Sycamore	*Platanus occidentalis*	2,100
Black locust	*Robinia pseudoacacia*	2,100
Red maple	*Acer rubrum*	2,099
Sugar maple	*Acer saccharum*	2,090
Wild plum	*Prunus americana*	2,099
American crabapple	*Malus corornaria*	2,090
Hazelnut	*Corylus americana*	41,211
Gray dogwood	*Cornus racemosa*	2,090
Silky dogwood	*Cornus amomum*	2,099
American chestnut	*Castanea dentata*	842
Total		140,215

Figure legend: Seedlings at the reforestation site. Top: American chestnut (*Castanea dentata)*; Middle: Eastern white pine (*Pinus strobus*); Bottom: Red oak (*Quercus rubra*).

MONITORING

During the summer and early fall we went back to the site and established monitoring plots to evaluate biodiversity, natural regeneration, and survival rates of planted trees. Following methods outlined in the *PPC Monitoring Framework: Step by Step Guide to PPC Tree Monitoring* document and based upon site characteristics and the uniform nature of soils at the project site, we choose to establish 27 permanent plots and one control plot. We generated GPS coordinates for the plot locations and preceded to the site for plot installation. At the site, we created 30 x 30-m plots and all four corners were marked with a stake painted fluorescent orange. GPS coordinates and pictures were taken at every corner. Since there were no trees in the project area with diameter at breast height (DBH) greater than 10-cm, we randomly nested a second 3 x 3-m subplot within each of the 30 x 30-m plots. Inside the nested plots, we counted and identified by species all trees present (both planted and naturally colonized). At the original planting density of 1,700 trees per hectare, we would only expect to find on average 1.5 seedlings per subplot With the increased planting density of 2,400 trees per hectare, by including the donated hazelnuts, the average number of trees per subplot was 2.15. Given the rocky nature of the soil, uniform plant spacing was not achievable and the subplots could contain more than two seedlings. A crew of three to four foresters performed the census and all information was recorded in KoboCollect. Table 2 outlines the distribution and number of species found in each plot.



Schematic of the plots.

Table 2. Number of planted and naturally colonized tree species in each monitoring subplot.

Species	C	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27
PLANTED																												
Pinus virginiana							1														1							
Pinus strobus		1		1						2						1	1								1			
Quercus alba																						1		1				1
Quercus montana									1											2	1							
Quercus rubra			1	1																								
Quercus velutina															1													
Liriodendron tulipifera																						1						
Prunus serotina		1								1			1							1			2					
Carya ovata																												
Carya tomentosa																												
Diospyros virginiana																												
Betula lenta																												
Celtis occidentalis																												
Morus rubra																												
Platanus occidentalis			2	1		1																						
Robinia pseudoacacia									1																			
Acer rubrum						1																						
Acer saccharum																												
Prunus americana							1						1					1										
Malus corornaria																												
Corylus americana												1	2	3	3	2	1	2	1		1	3				2	1	1
Cornus racemosa																												
Cornus amomum			1																									
Castanea dentata																												
NATURALLY COLONIZED																												
Platanus occidentalis		27	3		1	1																6			5	1	3	
Rhus typhina						1																						
Rhus copallinum							3																					

***C = control; # = plot number**

The tree density in sampled subplots was high for most species, but several species with low planting density rates were not captured in the baseline assessment. Noting the lack of several species in the census, we have decided to go back to the site in May 2024 (after leaf-out and prior to excessive groundcover growth) and perform a survey of the 30 x 30-m plots. This additional survey will provide a better platform for monitoring survival than what we can get using the subplots. Interestingly, natural colonization of the plots by native trees that we didn't plant was also high, suggesting that site preparation activities had effectively broken the arrested succession at the site. We will continue monitoring at the site for the foreseeable future.

Table 3. Approximate planting density and actual density sampled for each species at the Martin County site.

Species	Planting Density* (trees per ha)	Sampled Density (trees per ha)
PLANTED		
Pinus virginiana	60	82
Pinus strobus	210	288
Quercus alba	360	123
Quercus montana	142	165
Quercus rubra	142	82
Quercus velutina	70	41
Liriodendron tulipifera	70	41
Prunus serotina	70	246
Carya ovata	60	0
Carya tomentosa	15	0
Diospyros virginiana	35	0
Betula lenta	35	0
Celtis occidentalis	35	0
Morus rubra	35	0
Platanus occidentalis	35	165
Robinia pseudoacacia	35	41
Acer rubrum	35	41
Acer saccharum	35	0
Prunus americana	35	123
Malus corornaria	35	0
Corylus americana	650	741
Cornus racemosa	35	0
Cornus amomum	35	41
Castanea dentata	15	41
NATURALLY COLONIZED		
Platanus occidentalis	NA	1,934
Rhus typhina	NA	41
Rhus copallinum	NA	123

*Rounded to approximate whole number.

PROJECT OUTCOMES

CLIMATE

Planting trees will sequester carbon both above and below ground. Our research has shown, from a site near the project area, that the reforested mines sequester approximately 1.5 metric tons of carbon per hectare per year. In 50 years, we estimate that the project will have sequestered over 11,000 metric tons of carbon.

COMMUNITY

Stakeholder Engagement Impact

If planned correctly, the project area could become a community asset. Currently, the area is a scar on the landscape with little ecological or economic value. Converting this area back to the splendor of the natural, productive ecosystem that once existed will contribute to the beauty of the area and attract tourists.

EMPLOYMENT

Site prep was performed by local contractors. Professional tree planters were used to plant trees. Green Forests Work has hired another Forester to help with projects in Kentucky, including this one. Undergraduate interns from the University of Kentucky, paid by another entity, have participated in the monitoring.

SOCIAL/CULTURAL/DEI

Several posts to GFW social media have been made regarding the project. As the trees mature, we will showcase the site with tours and demonstrations. We often use the sites as outdoor classrooms.

ECONOMIC

The Appalachian Region of the U.S., once dominated by the mining, forestry, agricultural and chemical industries, consists of 13 states stretching from New York to Mississippi. Unemployment in Appalachia is at a higher rate than in the U.S. overall, with Kentucky having the highest unemployment rate in the region. Martin County, Kentucky, where coal jobs have been a staple of the economy for decades, and are at an all-time low, is classified as a "distressed county"– meaning that it is in the bottom 10% of the nation's most economically depressed counties. In addition to restoring the

Soil ripping and scarification not only reduces compaction but provides a condition more suitable for natural colonization of plants.

forest, this project will support the development of new opportunities for the region providing workforce training and development opportunities leading to stable rural agricultural and regenerative jobs with expected direct benefits to workers displaced from the declining coal industry.

BIODIVERSITY

The project helped increase plant biodiversity through the planting 24 species of trees and sowing of 19 species of native warm season grasses and wildflower. In addition to the planted trees and sown seed, we have observed that the ripping and scarification of soil have made the area more conducive to natural colonization by seed carried to the site by wind or animals.

CONTACT US

CHRIS BARTON
President
859.619.1532
barton@greenforestswork.org

MICHAEL FRENCH
Director of Operations
812.447.3285
michael.french@greenforestswork.org

MAY MAY BARTON
Director of Marketing & Communications
859.806.8753
maymaybarton@greenforestswork.org

ANNA MARIA BRANDUZZI
Reforestation Coordinator
412.996.0517
branduzzi@greenforestswork.org

BREEZEY SNYDER
Reforestation Coordinator
484.639.7883
briana.snyder@greenforestswork.org