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Reforestation, Renewal, and the Cost of Coal: Opposing a Manichean Worldview in Central Appalachia

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Preface

When I started school at Pomona College in the fall of 2011, many people seemed impressed by my love for my home state. I am from Lexington, Kentucky, a mid-sized university town in the Central-Eastern Bluegrass Region of the commonwealth. My Kentucky has rolling green-grass horse farms, the University Arboretum, the diner downtown where I waitress in the summers. It has my drafty attic bedroom in my childhood home, and long bike rides to the horse park with my father. It has my public high school that looks like some over-grown bomb shelter where I logged so many fantasy hours about college in California. It has the Unitarian church that looks like a spaceship; it has the University of Kentucky's Forestry lab, where I've titrated more water samples than I can count, checking for toxic levels of various ions. In my Kentucky, the county always runs out of salt for the winter roads and textbooks for our history classes, but I love it.

Spending four years away from Kentucky made me question many things about my home that I once took for granted. What was normal for me seemed strange and outdated to many of my classmates. I will never forget how one of my peers seemed outraged when I told her Kentucky only had two Planned Parenthoods in the entire state—one being in Lexington, where I worked during high school. I will never forget a boy I was secretly infatuated with telling me it was a "huge problem" when a touch of a southern accent slipped and I pronounced "night" like "naht" or "laugh" like "layuf." And I will never forget a conversation on my freshmen year dormitory hall, where one of my peers made a claim that I found ridiculous.

'Nobody even likes *coal anymore,'* she claimed. *'We don't even use it anymore.'*

I wanted to go home. In that moment, I was sure that nobody at Pomona had any idea what was going on in my home state. Even worse—I was sure that nobody *cared.*

Now, I see things differently. Every place and pocket in our country has an issue of regional importance that other parts of the country ignore. Now, I see that I am ignorant of so many problems affecting the people and places that ring important for my peers. Now, I am appreciative of every single one of these interactions that at the time made me so uncomfortable. They made me look at things with a critical eye. I had to reevaluate so many of my assumptions of normalcy!

This is essentially the root of my thesis. I come from a place where "Coal Keeps the Lights On" stickers decorate half of the Hondas around town. I come from a place where the vast majority of our power comes from coal, a state affected by every step in the coal production process. Environmental degradation and economic stagnation have become the norm for an entire region. Nobody knows what to do and everyone is tired. Tired of political promises not coming to fruition, tired of being laughed at by the rest of the country, tired of being left behind.

Today, Kentucky faces a host of challenges. I am writing my thesis on just one: what can we do with an old coal mine? This is a question pertaining to over a million acres affected by surface mining across Central Appalachia (Geredien & Appalachian Voices). The vastness of the problem is at times overwhelming. Yet I urge everyone reading this thesis to approach the issue with compassion, and to let go of judgment of the people and place that allows for this scale of

environmental degradation to continue. At times at Pomona, I felt prideful my home because I thought that if I didn't love it, nobody would. In this thesis, I attempt to address serious challenges afflicting the region with a sense of acceptance and hope for future plans. Even if progress is slow, it is still progress.

As I contemplate my graduation from Pomona this May, I look forward to working with an advocacy non-profit to communicate research and scientific issues to the general public. I am hopeful when I think of the changes that may be made, and excited about the potential for success. And I am so thankful for Pomona for providing me with perspective and focusing my passions so as to prepare myself to work for social, environmental, and economic changes.

"…We are all sorry when we are found out. Then we are very sorry. The question is not, are we sorry? The question is, what lesson have we learned? The question is, what are we going to do now that we are sorry?"

J. M. Coetzee, *Disgrace*

"[The] difficulty really is psychological and exists in the perpetual torment that results from your saying to yourself, 'but how can it be like that?' *which is a reflection of uncontrolled but utterly vain desire to see it in terms of something familiar."*

Richard Feynman, *The Character of Physical Law*

"I was ashamed of the fact that Grandpa had made moonshine [during the Great Depression] but when I started interviewing Grandma I found out he once had been a magistrate, he ran a store, he had been a school-teacher, he could repair all kinds of tools, he built barns for people, and cleared ground. I realized he was the type of man who did what he had to do to make a living. In his boots I would have done the same thing. I felt ashamed of myself because I didn't try to understand what she was trying to tell me, which is exactly what people outside of our culture do; they don't understand. I really felt ashamed of myself. Then I began to feel glad because I felt I can be proud of my heritage because they fought to survive."

Hester Mullins, University of Kentucky student from Kite, KY, circa 1977

Excerpt from *Our Appalachia: An Oral History*

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Chapter 1: Understanding Appalachia

The Central Appalachian region of the United States, encompassing West Virginia, eastern Kentucky, southwestern Virginia, and a small piece of northeastern Tennessee, suffers from large-scale land use changes and environmental degradation from surface coal mining (Figure 1). Nearly 1.2 million acres have been surface mined for coal—around 10% of the total area of Central Appalachia (Geredien & Appalachian Voices). Historically, coal mining in some form (underground and surface) has defined the region economically. Central Appalachia provided much of the fuel that allowed America to industrialize and modernize during the twentieth century.[1] The area continues to be actively mined in the present day. In 2011, the area east of the Mississippi region produced 455 million short tons of coal, a sizeable fraction of the 1.09 billion short tons the U.S. consumed as a whole the same year (U.S. Energy Information Agency Annual Energy Report 2012).[2,3] Today, coal provides around 40% of the world's electricity, and demand is increasing on a global level (Clemente 2012). Yet the industry is leaving these eastern mountains. Coal production is decreasing (Figure 2) though mine efficiency is improving from changing technologies (EIA, Reis & Stamm 2013). Coal jobs in eastern KY are at their lowest levels since 1927, when the state first started counting (Estep 2013, EIA). Likely, this is due to

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[1] In 1949, the Appalachian region produced over 444 million short tons of coal, compared to the 483.2 million short tons of coal consumed in that year in the U.S. While the volumes of coal produced at this time are smaller compared to the present-day, coal provided around half of the U.S.'s electricity in 1950 and the U.S. did not rely on coal imports (Ratner & Glover 2014, EIA).

[2] The region "East of the Mississippi" is essentially synonymous with the Appalachian region, as the vast majority of coal mining exists inside of the mountains.

[3] Not all of the coal produced in the Appalachian region is consumed domestically. A portion of the 1.09 billion short tons of coal produced in the U.S. in 2011 was exported, namely to Europe and Asia (EIA). However, it must be noted that Central Appalachia continues to be a source of the U.S.'s energy. For instance, 93% of Kentucky's net electricity generation in 2013 was generated from coal (EIA).

diminishing reserves and increased global supply (Reis & Stamm 2013, Johnson & Raghuveer 2014).

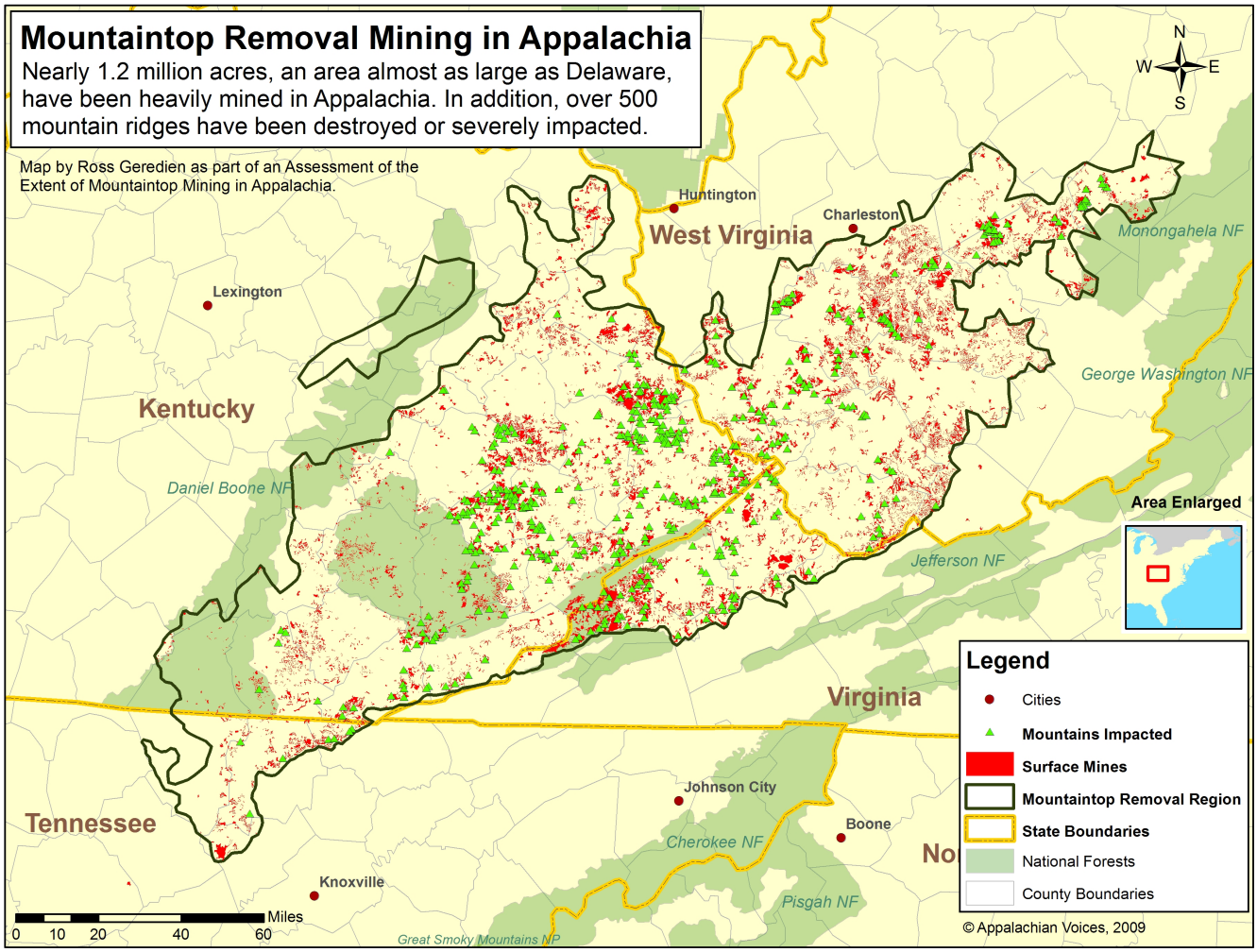

Figure 1. Surface Mining operations in Appalachia extends throughout eastern KY and into West Virginia, and into Virginia and Tennessee. Mining has serious environmental impacts that last decades if not centuries after a mine is closed due to the reclamation techniques used. Retrieved from http://ilovemountains.org, a not-for-profit, collaborative group of environmental advocates dedicated to improving environmental conditions surrounding surface mining in Central Appalachia

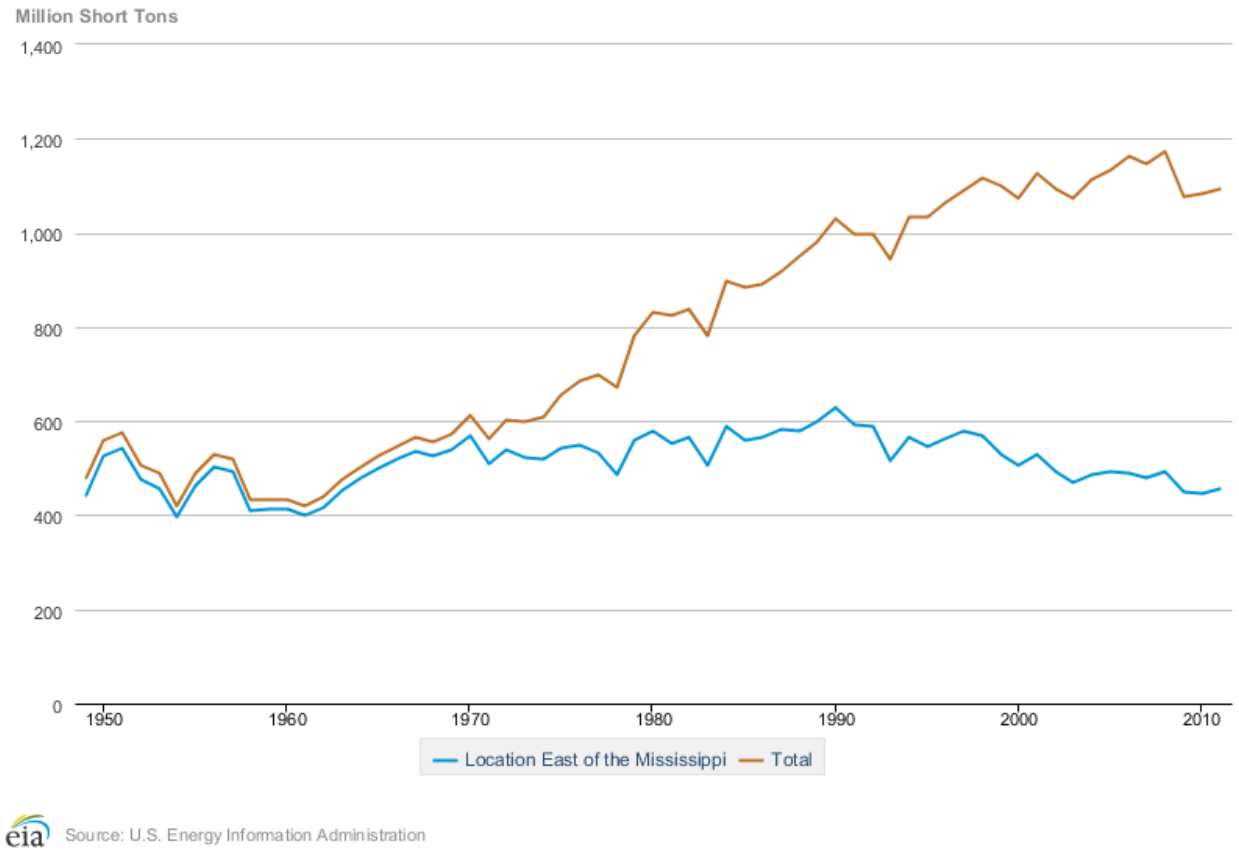

Figure 2. Domestic Coal Production, 1949-2011. Coal production east of the Mississippi peaked in 1990. Production has decreased over the past 20 years, in spite of technological changes that increase mine efficiency. This suggests resource depletion.

While the industry may be leaving in the form of jobs and coal production, the environmental scars from the coal mining process are not. Surface mine reclamation, or the process of restoring mined area to a natural or economically beneficial state, is inadequate across Central Appalachia. Surface mining is an intensive form of land alteration. It involves the removal of the top layers of sediment on mountain ridges with explosives and heavy machinery. This allows for shallow, thinner seams of coal to be accessed in a way that is economically viable (Figure 3). The associated non-market environmental costs are high; surface mining impacts the biosphere, hydrosphere, geosphere, lithosphere, and anthrosphere, resulting in an array of environmental

Figure 3. Active Surface Mine, Central Appalachia. Surface mining results in serious environmental degradation.
Photo courtesy of U.K. Forestry

issues (Table 1). Thousands of miles of stream are buried in Central Appalachia from the inappropriate management of waste rock via valley fills, or spoil rock dumping into the valleys between mountains. This can increase alkalinity of headstreams to toxic levels (Bernhardt & Palmer 2011, Bernhardt et al. 2012). Decades after a mine is closed, acid mine drainage continues to affect the water quality (Wei et al. 2011). This can hurt fish and plant life downstream. Surface mining also causes habitat loss and is a threat to biodiversity, as it requires the destruction of forest and natural habitat as well as the removal of topsoil (Greenpeace International). Reclaimed mine soils have lower porosity and permeability, which challenges natural succession regimes (Bussler et al. 1984). Displaced sediment washes into streams and

disfigures the land, raising flooding risks. Strip mining also causes dust and noise pollution (Greenpeace International). The majority of environmental problems associated with surface mining do not stop when the initial blast is over; the mining is only the start. The environmental consequences of surface mining will be felt for decades after the mine is closed—if not longer—because traditional reclamation practices fail to address most non-market costs.

Table 1. A Summary of Non-Market Costs of Surface Coal Mining in Appalachia.

Anthrosphere	Biosphere	Hydrosphere	Geosphere	Lithosphere
• Opportunity costs of not investing in non-extraction-based industries and jobs • Human health costs	• Habitat loss • Threat to biodiversity • Increased presence of non-native species, changes in community composition • Contamination threat animals' health	• Acid mine drainage • Buried streams • Increased flood risk • Risk of groundwater contamination	• Destruction of mountains	• Removal of topsoil • Reduction of mine soil quality • Reduced permeability and porosity

Current Reclamation Techniques

Surface mine reclamation regulation is dictated by the 1978 Surface Mining Control and Reclamation Act (SMCRA). SMCRA states that active coal mining corporations must "restore the land affected to a condition capable of supporting the uses which it was capable of supporting prior to any mining, of higher or better uses of which there is reasonable likelihood…." Essentially, by saying reclaimed land must be of "higher or better use," mining companies must restore mined land to equal or greater economic value. Yet there is little regard to non-market environmental cost remediation. SMCRA does not require mining companies to restore prior environmental quality—though about 80% of land in Appalachia is forested prior to coal mining operations, only a small fraction of legacy mines are reforested (Zipper et al. 2011). One estimate

suggests that 95% of previously forested land is left deforested after surface mining (Burger 1999). The “equal or greater value” qualification is left for mining companies to evaluate. Typically it is argued that the post-mining flat grasslands are inherently more economically valuable compared to their previous mountainous and forested states. However, this is a false pretense perpetuated in the culture of mining companies, because the environmental and other opportunity costs associated with traditional reclamation are undervalued. Failure to reforest legacy mines results in the perpetuation of many non-market environmental costs.

Traditional mining reclamation works to address pre-SMCRA reclamation concerns, namely land instability, sedimentation, and the contamination of surface water by excavated rock (mine spoils) due to the steep terrain (Zipper et al. 2011). Post-SMCRA reclamation practices include surface sediment compaction using heavy machinery (Figure 4) and the establishment of invasive herbaceous groundcover (Burger et al. 2005). The result is large expanses of unproductive, unmanaged grasslands with unrestored hydrological, water quality, and soil regeneration issues that maintain poor conditions for natural succession. In spite of these costs, Central Appalachia remains committed to coal, both in terms of regional identity and political focus. As a result, the region is severely threatened by a combination of environmental degradation and economic distress.

Figure 4. Surface mines partway through the reclamation process. By use of heavy machinery, the ground is highly compacted (above). While this temporarily improves land stability, it is not a conducive medium for plant growth, especially native tree growth (below).

Socioeconomic Concerns

When assessing the impacts of surface mining, it is essential that the socioeconomic characteristics of the communities affected be a core focus of concern. The sub-regions of Appalachia not affected by surface mining consistently fare better than the Central region, to which Mountaintop Removal is unique. According to the Appalachian Regional Commission's analysis, 90 Appalachian counties rank in the worst 10% in the nation with respect to high unemployment and poverty and low income (Figure 5). The clear majority of these counties belong to the central region. Between 2000 and 2008, Appalachia lost more than 59,000 (15.0%) of jobs in farming, forestry, and natural resources, including coal-related jobs (Appaclachian Regional Commission Economic Overview 2011). The most recent years have seen the hardest hits. In a one-year span from 2011-2012, Eastern KY saw a decrease of 17.0% in surface mine employment (EIA). The effect of these employment patterns is seen in the wellbeing of the Central Appalachian people. In 2009 per capita market income was 47% lower in Central Appalachia compared to the national average. Less than 12% of adults have a college degree. Central Appalachians suffer from higher rates of cancer, heart disease and diabetes; affordable and accessible healthcare treatment is limited (ARC Economic Overview 2011). The small towns and rural communities in Appalachia are moving through a challenging era. And these are the same areas suffering from long-term environmental consequences from surface coal mining. That is, the environmental degradation and economic destitution in Central Appalachia are deeply connected (Figure 6); thus surface coal mining is sometimes considered an issue of environmental justice.

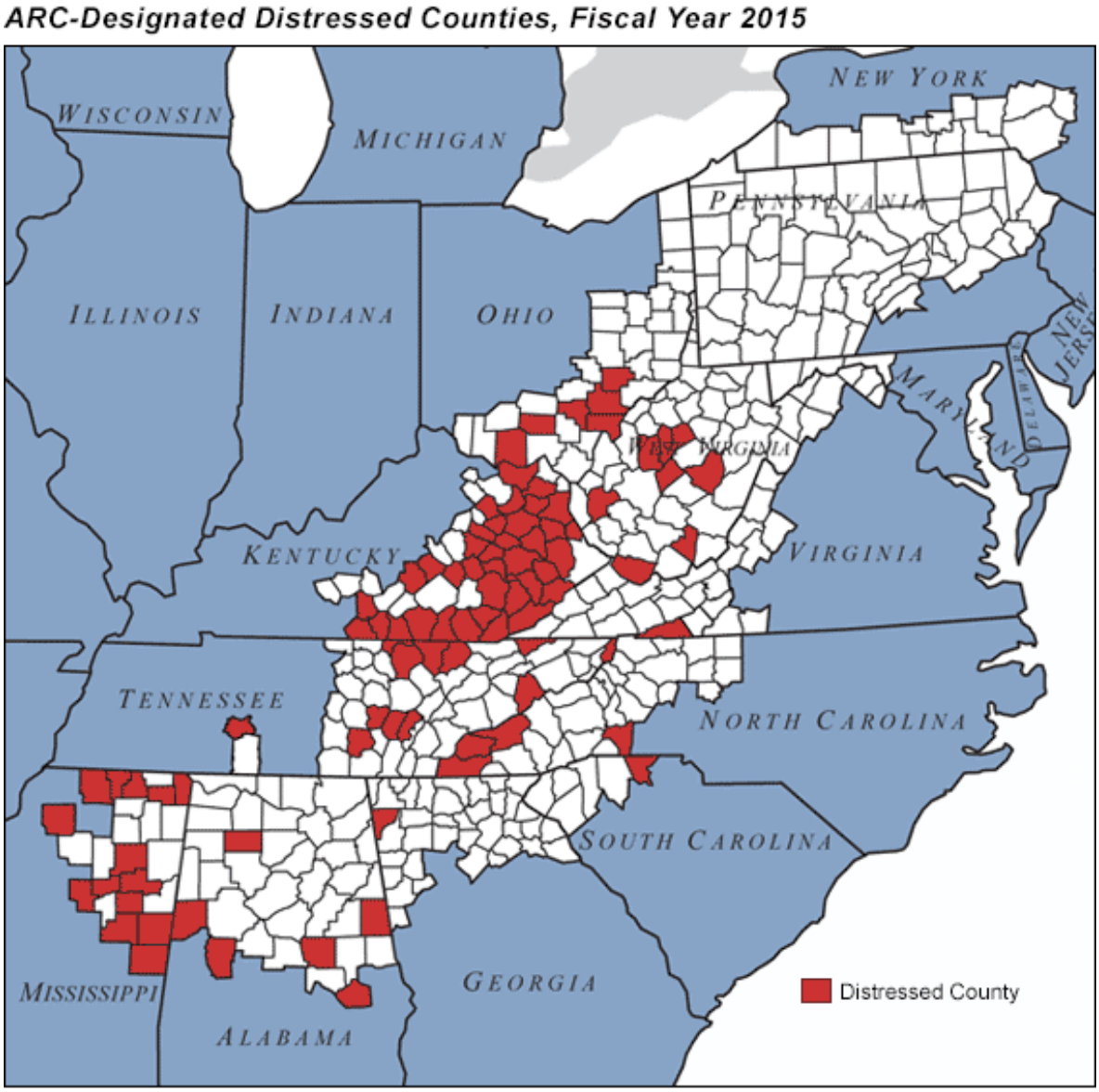

Figure 5: Distressed Counties in Appalachia, as defined by the Appalachian Regional Commission. The ARC uses an index based on poverty, unemployment, and income to classify counties' economic status. "Distressed" counties are counties that are in the bottom 10% nationwide. Eastern Kentucky faces some of the most widespread difficulties—37 counties are classified as economically distressed. Retrieved from http://www.arc.gov/

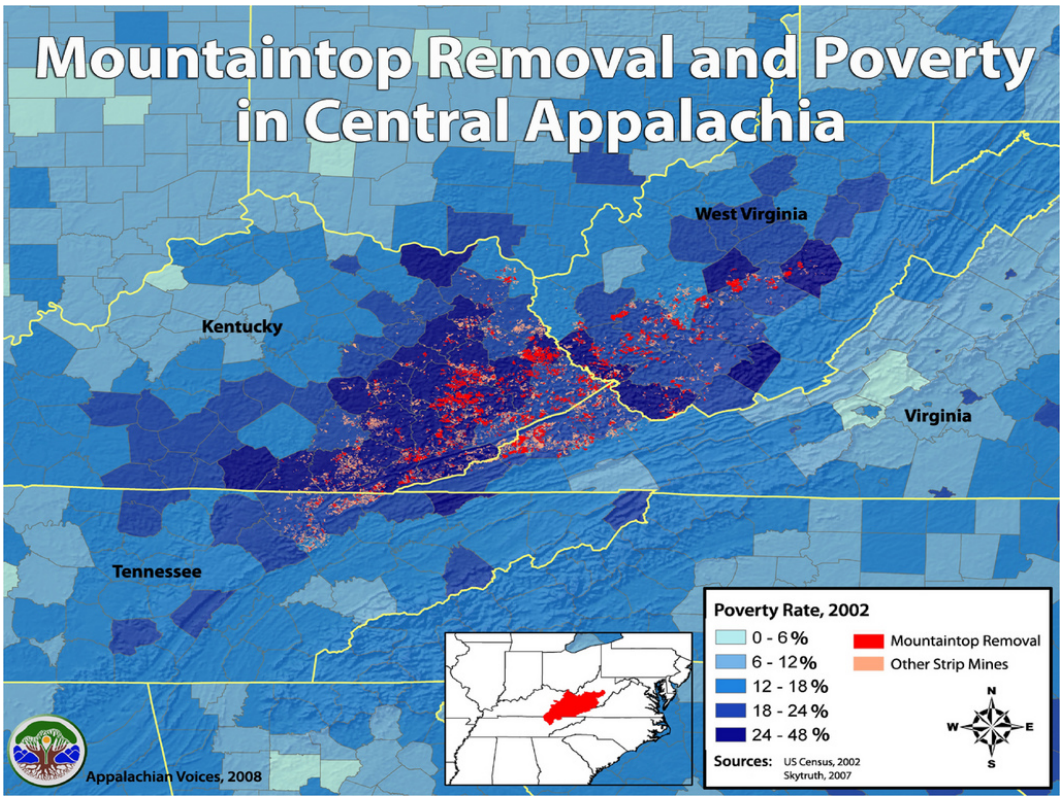

Figure 6. Mountaintop Removal Sites and Poverty Rates in Central Appalachia. MTR is widespread across Eastern Kentucky, in counties with poverty rates above the national average. MTR results in severe environmental consequences, and leave mining communites with challenges with reclamation. Retrieved from http://www.ohiocitizen.org/

These socioeconomic issues are inherently tied to the coal industry. The shift to surface coal mining from underground methods, starting in the 1960s, changed employment patterns. Surface mines increase productivity of individual miners, thereby reducing the average number of miners employed per mine (Figures 7 & 8). However, during this time, coal productivity increased—a greater volume of coal was mined on an annual basis (Figure 2). In this way, the region "progressed" economically, but the benefits are not reflected in the well being of the people. The issue is not that modernization has not occurred, but *how* the modernization has occurred. In this region, modernization goes hand in hand with the expansion of the coal industry. With this, we may reject the Manichean "jobs or the environment" debate occurring across the country.

Through an examination of the general pattern of modernization, we can clearly understand the relationship between the environmental and economic challenges of the region.

Production Capacity Per Miner by Mine Type (total thousand short tons) 2007-2012

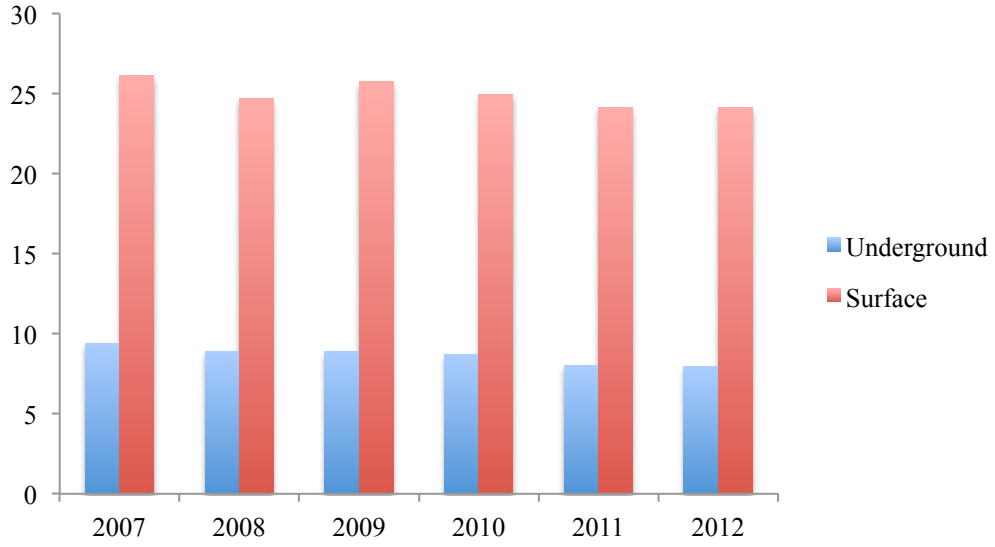

Figure 7. Productive Capacity Per Miner by Mine Type (total thousand short tons) 2007-2012. Surface mines have greater efficiency than underground mines, per miner. This results in lower employment requirements.
Data source: U.S. Energy Information Association

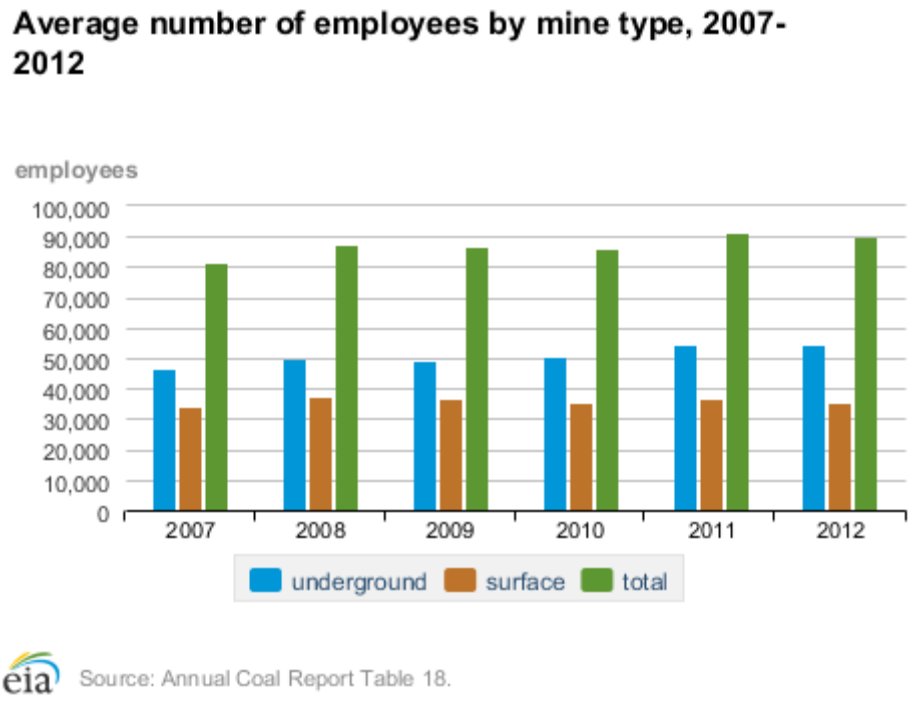

Figure 8. Nationwide employment by mine type. Surface mines employ fewer employees, yet the majority of coal production comes from surface mining. This shift to surface mining has reduced employment opportunities in the mining sector. Overall mine employment, as shown int this figure, is increasing in recent years because of mining expansion in the west of the United States.

The Coal Industry as a Colonizer

Across country lines and time periods, communities that develop around extraction industries follow similar patterns. Mining activity may result in more trading and service activities in mining towns, thereby bolstering economic development. But all exploited minerals are a wasting asset; they follow various cycles of decline and resurgence, boom and bust, until they are inevitably exhausted. Mining is a way for a group in power to accrue wealth and resources; thus, mineral wealth may motivate colonial tendencies. In West Africa, the dream of *El Dorado* spurred colonial development in part via gold mines (Durnett 1998). While this colonialism consisted of greater political control and different dimensions, the same colonial framework may

be used to analyze the coal industry's influence in Central Appalachia. The colonial process is defined as system of oppression which involves 1) a forced entry by a power; 2) a rapid change in culture, organized by the party in power; 3) control continued by the dominant group; and 4) social domination where the colonized are deemed 'inferior' to those in power, a condition which rationalizes the exploitation (Lewis 1970). I will outline how the coal industry followed a colonial model in central Appalachia.

Prior to the entry of the coal industry, Appalachian communities were isolated and largely self-sufficient. The average farm was less than 150 acres, and often was subdivided and inherited, passed down through generations (Eller 1982). Extended families and community churches formed the backbone social institutions (Shackelford 1988). People identified very much with home as a specific place. This era and lifestyle should not be romanticized—life was very difficult. Work was tiring. Healthcare was poor, and women were largely constrained to traditional roles with very large families. Poverty was widespread (Eller 1982). The coal industry offered higher wages to workers struggling with subsistence farms. However, the entry of the coal industry should be scrutinized.

Beginning at the end of the 19th century, speculators and industry related to coal and timber initiated rapid industrialization of Central Appalachia. Like elsewhere in the world, development of extractive industries in Central Appalachia was spearheaded not by community leaders but by outside investors. The coal industry leaders included outsiders from Pennsylvania, New York, and Britain; absentee landownership changed stewardship philosophies. Such investors took little stake in local communities and often negotiated unfair land and mineral right deals with the

small landowners and farmers. "Broad Form Deeds" gave companies the right to mine "all minerals and metallic substances and all combinations of the same" using any method "deemed necessary or convenient." These deeds have allowed the mining companies to continue operating surface mines in central Appalachia today (Lewis 1970).

Take, for instance, John Ison, a farmer with property along Kingdom Come Creek in eastern Kentucky. The family relied on small-scale farming and was largely self-sufficient. In 1887, Ison sold the mineral rights to his 1,000-acre farm for $500 (Smith 2010). In a region that may average 5,000 tons of coal per acre, he received a hundredth of a cent per ton.[4] Because industry leaders were outsiders that negotiated deals for mineral rights that were unfair, it is viable to classify coal as a forced entry, characteristic of colonialism.

One key characteristic of colonial economic development is that the revenue generated from mining does not stay in mining communities. This is true in Appalachia. Mine operators are not local, and the vast majority of profits are spent and invested in resources not pertaining to Appalachia. Coal mining has existed here for over a century, and the volume of coal produced peaked in 1990 (EIA, Figure 2). Yet Appalachia has never seen the resulting revenue invested in its communities. This is reflected in the persistence of high poverty rates in Central Appalachia.

After the manipulative entry of the coal industry, culture in the mountains changed rapidly. Higher wages promised from coal mining jobs caused many families to move from rural areas

[4] Though these values expressed are not adjusted for inflation, it is still unfair compensation for Mr. Ison—in 1860, coal sold for about $5.50 per ton in New York City (Economic History Association).

Figure 9. Eighteen-year-old Ray Martin, 1964, near Isom, KY. Taken by LIFE photographer John Dominis. His job provided low wages, with few safety standards—and minimal job security. Retrieved from http://life.time.com/history/war-on-poverty-appalachia-portraits-1964/

into relatively urbanized mining towns. However, the mining companies' unincorporated mining towns were wholly controlled by industry. Mining companies built houses, ran the general stores, and provided healthcare; the firms controlled many aspects of daily life. Traditional social organization was challenged as family farm plots were divided and sold as families moved into the coalmining sector of the economy. Coalmining companies organized and orchestrated this cultural shift. The change was so dramatic, that in 1964 LIFE photographer John Dominis said of the impoverished Appalachian mining towns: "[They] are not country folk but an industrial population who happen to live in the country...." In this way, coal companies may also be classified as a colonial power.

Mining firms maintained control over mining towns after establishment. They organized mining towns to fit their needs, and often did not take miners' health or quality of life interests into account. Firms set wages, prices in company stores, and set care for doctors and healthcare. Firms maintained the power to deduct costs from worker's salaries, which made it possible for miners to end a pay period with nothing (Eller 1982). Industry pushed coal as the most important

piece of regional identity through extensive propaganda campaigns. To this day, coal companies continue to purposefully perpetuate their perceived level of importance in community identity in Central Appalachia (Bell & York 2011, Lewis 1992). Extensive measures were taken for industry to maintain authority within coal mining towns.

It is clear that mining industries act as colonizers. They are able to force entry because of their monetary power. They organized cultural changes, and designed an undiversified industrial economy that allowed them to maintain power over communities. And as these changes took place, outsiders and industrial leaders labeled the Appalachian workers as "others." They were inferior—they deserved the exploitation, and the environmental degradation in their communities was not of concern. This may be illustrated by healthcare, specifically black lung disease. Black lung is an occupational disease that was socially produced with the advent of the coal industry, and coal miners struggled to receive just compensation and control for the illness (Smith 1981). Even today, miners struggle with coal mine operators to receive adequate protection from the disease in the form of dust control (Berkes 2012). There exists a clear discrepancy here between the healthcare of miners and the healthcare of mine operators, who do not suffer from black lung yet continue to disregard health and safety regulation. Health clinic standards lag behind clinics in more prosperous areas. In this way, mining companies chose, and continue to choose, to operate as if the individuals in mining communities were in some way inherently inferior.

By the mid 1900s, after decades of industrialized exploitation of natural resources, Appalachia continued to lag behind the rest of the nation. The region suffered from an inadequate tax base, a low-wage economy and job insecurity, severe environmental degradation and high rates of

corruption in the political system (Eller 2008, ARC Regional Economic Report, Shackelford 1988). In 1960, 11.3% of Appalachians completed only five or fewer years of education; the national average was lower, at 8.3% (ARC). In 1970, high school education completion rates ranged from only 27 to 52% in rural and relatively metropolitan areas within Appalachia, respectively (Isserman & Rephann 1995). Healthcare access was also inadequate. In 1970, infant mortality in Appalachia was twice that of the national average. Doctor and clinic shortages are common phenomenon (Hansen et. al 1970). Coal never created a truly prosperous Central Appalachia. Rather, the rapid economic growth without economic development caused multi-faceted, dynamic changes to daily ways of life.

"There are huge disparities [in Eastern Kentucky's healthcare access and quality.] It is difficult to find healthcare professionals to go to these communities because of resource limitations. Health literacy is extremely poor. With poverty, you get poor health behaviors, you have food deserts…. You [see] no future, you see mixed messages…. We should double our addictions clinics….. It is enormously difficult to escape this environment. And there is so much fear about leaving the environment."

W.F. Hansen, Professor and John W. Greene Chair of Obstetrics and Gynecology
University of Kentucky
(Personal Communication)
Dr. Hansen staffs and organizes outreach maternal fetal medicine clinics in Breathitt and Perry Counties in Eastern Kentucky

Because of the colonial nature of the operations, Appalachian economies did not undergo the same changes as many other parts of the United States during the post-war era. While other regions of the country switched from a manufacturing-based economy to a service economy, Appalachia continued to focus on traditional natural-resource-based industries. Poverty rates declined in other areas, but Central Appalachia continues to suffer

from similar high rates as 5o years ago (Figure 10). Investments are diverted to creating the types of jobs that are disappearing in the rest of the country. However, the wealth produced by coal extraction flowed out of the region and into urban centers. Employees of the mines see little of the profits, yet local and regional political leaders remain committed to developing coal interests.

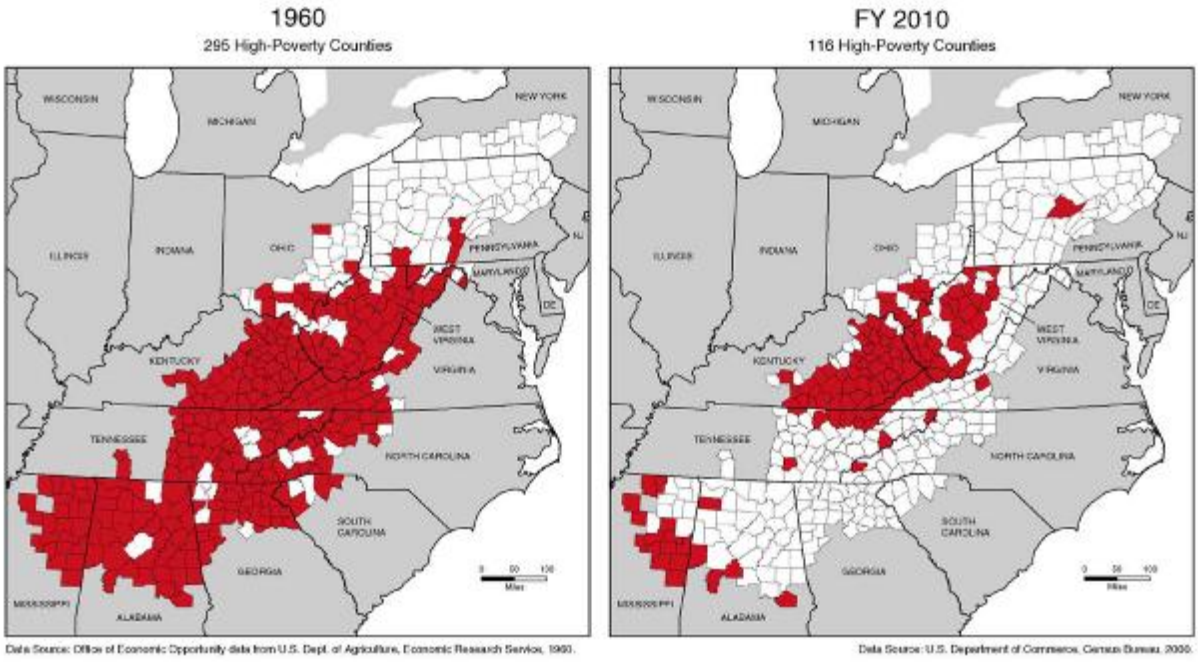

Figure 10. High-Poverty Counties in the Appalachian Region, defined as counties with rates at least 150% the U.S. average, in 1960 and 2010. Central Appalachia's high poverty rates persist while other Appalachian sub-regions saw declines in poverty during this time period.

During this time of rapid change, Appalachia maintained a regional identity, albeit one that is challenged and changed. Rapid industrialization threatened traditional values of family and self-sufficiency. Appalachia is seen as "backwards." Outsiders have christened residents with labels such as our "modern-day ancestors," and the region has been called "the other America" (Lewis 1970). These labels are deceptive and harmful. The struggles of Appalachia reflect the social divisions throughout America from modernization. Traditional values are challenged; historic economies are overturned. The result is economic destitution, environmental degradation, and a

growing sense of desperation (Figure 11) for various communities that are left behind—in this instance, virtually the whole of Central Appalachia.

Figure 11. Responses from the residents of Bell County, KY when asked the question: "What are three words that describe you county?" Bell County in Southeastern, KY, suffers from low incomes, high unemployment, and widespread poverty. The local economy has yet to diversify from coal in significant ways, and surface mining has left severe environmental degradation. Desperation exists among Appalachian residents. Taken from ARC's "Strategies for Economic Improvement in Appalachia's Distressed Rural Counties."

The sense of desperation in Central Appalachia is substantial yet explicable. Inequality within Appalachia is growing, and historically, investments are diverted to attempt to create the same types of jobs the manufacturing and primary production jobs. The coalfields are tied to global markets more than ever because of the focus on externally controlled business and growing overseas demand for coal. Mining communities are seriously affected by the many externalities of the coal mining process. The strong regional identity acts as a pretext for resisting change.

Additionally, the past exploitation of mountain people by outsiders has cultivated general distrust of outsiders.

Consider, for example, Bell County, in Southeastern KY. Unemployment is at 15.1%; per capita income is $14,111 (U.S. Census Bureau). Welfare dependence is widespread. Over 11% of Bell County residents are dependent on SSI disability income; almost 10% of these individuals are under the age of 65 (Social Security Administration). The population of the county has been declining since the 1980s, mostly because the local coal industry has fled the county. Local jobs are scarce, and most local jobs only offer part-time or temporary employment. Local residents complain of a lack of planning and entrepreneurship for the county's downtown areas. However, the county is currently working to stimulate economic development through building a coal-fired power plant at a remediated mine site (Ezzell et al. 2010). While coal is important to the community's identity, residents have few answers when asked about post-coal future.

Reforestation as a Piece of the Answer

In economically depressed areas, communities are more likely to prioritize economic development over environmental quality. Mining communities work to market coal as a job-creator despite the long-term patterns showing that coal mining is not associated with dependable long-term employment. Mining is not the job creator it once was because of changing technologies and resource depletion. The fear is that if there are stricter environmental regulations, there will be even stronger losses in job numbers. Historically, organized labor has

been unsupportive of environmental regulation[5] (Montrie 2000). Many feel as if environmental regulators are working against mining communities rather than working for or with them. One mining town residents rebuked government officials: 'you're the Environmental Protection Agency. You're not protecting me" (Waters 2003). This attitude impedes improvements to environmental quality. Environmental and community advocates must ask how environmental quality could be improved by meeting mining communities on their own terms as much as possible. Reforestation might be practical because it may garner support both those who support mining and those in opposition to it.

[5] Between 1945 and 1975, the United Mine Workers of America perceived environmental regulation to be in competition with job security and worked to limit environmental protection standards. In the 1960's, UMWA favored state regulation. In the early 1970s, UMWA briefly supported federal regulation, but by the mid-1970s reverted back to state regulation. State regulation means that states with coal interests may develop their own regulations that are less strict. The changes in union support show an initial interest in conservation of resources (and improved working conditions) through federal regulations, but ultimately promoting more limited state regulation in the interest of saving jobs.

"It was hard for a child to imagine that such a solid community could fall into decay, although as a wiser adult with perspective, [my father] could easily foresee that all the great little cities…were approaching their demise. He told me that the economic fate of those communities was dependent almost entirely on …mining, said that the mines were beginning to 'play out,' and soon they would become ghost towns surrounded by poor rock piles…. [My] Dad wasn't a miner, although some of the timber he was responsible for harvesting went into the mines to help prevent cave-ins in those …mines. He was a forester. Organizing logging jobs was more than a vocation to him; it was a way he could make a modest living being out in his beloved woods. He was so happy to show me how the beautiful hardwood stands that had grown up since our land had been clear-cut and burned-over a 100 years ago were now ready for selective logging. He really loved to teach me how forests renew themselves. He understood…why it was important for us to go on planting trees: '... even though I'll never live long enough to see them mature, you will, son.' As usual, he was right. Our forests have renewed and matured. Last year we cut some pulp wood and some timber. Those logs went to a small local saw mill and a paper mill in little Northwoods communities that haven't changed much in the past 75 years. The contrast to the mining towns is dramatic. The towns based on rational use of a renewable resource have survived. They were never affluent, but they are stable."

Personal recollections about growing up in boom-and-bust mining communities.
Written by the thesis author's father, Alfred Roy Hansen, born in 1942.
Resident of Eisenstein, WI, a logging town; and Ironwood, MI (Upper Peninsula), a mining town.
Personal Communication.
Small mining communities across the country suffer from environmental degradation and the threat of localized economic collapse.

Chapter 2: Forestry Reclamation

The combination of deforestation from surface mining and inadequate reforestation reclamation efforts leaves Central Appalachia in a difficult place economically and environmentally as coal mining leaves the region. Communities struggle to manage legacy mines so as to maximize economic opportunity and minimize long-term environmental consequences. Ideally, previously mined land may continue to offer communities some valuable products. Industry leaders often advertise surface mining as an opportunity to increase flat topography that may be used for development in the post-mining era. Proposed development opportunities include industrial parks, county fairgrounds, federal prisons, golf courses, airports, and hospitals. Though the majority of surface mines are reclaimed under the law, as of 2010 89.3% are reclaimed with no verifiable post-mining development, excluding forestry and pasture. The vast majority remains in various stages of unmanaged shrubland or grassland (Geredien & Natural Resource Defense Council). Economic development is clearly not restricted by the availability of flat topography. These observations show that it is unlikely that development of coal mines in this way is likely to expand in future years. Because economic development so infrequently occurs post-mining, mine operators should not be allowed to use such development as justification for mining practices as it is not compliant with the "reasonable likelihood" qualification dictated by SMCRA. The persistence of unmanaged grasslands is a failure to maximize benefits from land use choices, environmental or economic.

And so, Appalachia is left struggling in perpetually difficult times. Today, generations of mountain people live with little hope for improved economic opportunity. Environmental degradation is normalized to a terrifying degree. Education lags behind the national average;

drug addiction rates soar (Dunne 2013). Innovative solutions are needed to combat both the economic depression as well as the pressing environmental issues, specifically those inflicted by over a century of coal mining.

Clearly, no single solution is available to solve issues of such breadth and depth. Multiple innovative solutions are needed to piece together a new future for Appalachia—to break the current complete dependence on coal, and to improve the environment and local communities.

> **"It's tough on everybody up here."**
> Jim Ward, Letcher County Judge-Executive, about economic destitution and persistent poverty in Eastern KY
> (Estep 2013)

One important piece of that solution is reforestation of surface coalmines in central Appalachia.

Reforestation for surface coalmines offers a variety of ecosystem services to communities that once depended on mining, as well as to the surrounding areas. Benefits of reforestation include improvements in native biodiversity, improved water and air quality, reduced flash flooding, climate change mitigation, and habitat restoration for threatened species (Agouridis et al. 2012, Angel et al. 2009, Groninger 2007, Marahaj et al. 2007, Taylor et al. 2009, Wei et al. 2011, Barnishell 2011). Reforestation works to combat the non-market environmental costs discussed previously (Table 1). Additionally, reforestation will provide high-value timber for future economic development through sustainable logging and forestry cooperatives. Reforestation develops better environmental stewardship.

To date, over a thousand acres of areas deforested through surface mining have been replanted successfully (GFW); however, millions of acres remain unmanaged and unproductive. That is,

reforestation has yet to take root as a mainstream reclamation practice due to technical and cultural barriers with mine reclamation laws and practices. This status quo is outdated; reforestation will gain traction moving forward. Industry, government agencies like the Office of Surface Mining, and researchers collaborated to design a successful reforestation protocol, "The Forestry Reclamation Approach."

The Forestry Reclamation Approach

The Forestry Reclamation Approach (FRA) is a method designed by researchers to reclaim coal-mined land to forest while following the Surface Mining Control and Reclamation Act (SMCRA). The FRA has been tested; it is supported by scientific knowledge and experience (Burger et. al 2005, Zipper et al. 2011, Angel et a. 2009). The FRA can be implemented in a cost-effective manor for coal operators, and will generate forests of values for landowners.

The FRA consists of five steps, as outlined by the Appalachian Regional Reforestation Initiative in their Forest Reclamation Advisory:

1. Create a medium conducive to tree growth. A suitable rooting medium should be at least four feet deep composed of topsoil, weathered sandstone, or the best available material.

Mining is a destructive process. After mountaintop removal, it is difficult to secure soil media with physical and chemical properties that are favorable for tree growth and survival (Bradshaw 1997). Mining involves materials with high alkalinities, as well as highly acidic and toxic materials that may affect soil quality (Singh 1988). Tree survival and growth may be hindered to altered soil pH. Growth media should maintain an equilibrium pH of 5.0 to 7.0, and low pyritic sulfur content. This may be done by carefully selecting growth media. If the top layers of

overburden sediment are restored, plant communities and hydrology are restored more effectively, and water quality is shown to have lower measures of Total Dissolved Solids (Angel et al. 2008).

2. Grade topsoil or substitute to a non-compacted growth medium.

Traditional reclamation involves excessive soil compaction that creates a media poorly suited for tree growth (Figure 4). High compaction is intended to reduce land sedimentation and stability issues. However, it limits root penetration and growth even if the soil's chemical properties are conducive to plant growth. Loose soils aids restoration of plant communities, soil habitat infrastructure, and water infiltration that may restore hydrology and improve water quality (Skousen et al. 2009). This separation of overburden layers is achievable with standard mining practices by making small changes that are feasible for coal mine operators (Angel et. al 2009). These steps include: dumping and leveling in separate operations; limiting compaction during the leveling process by using lightest equipment available, limiting the number of passes on equipment, and leveling in dry conditions; and not storing equipment on leveled areas once the operation is completed (Figure 12).

3. Seed with ground covers only if they are compatible with growing trees.

Grasses and other herbaceous land covers are planted to promote land stability and deter serious sedimentation concerns. However, in the long-term, tree growth will offer more protection against excessive erosion than herbaceous cover. Ground covers will compete with seedling trees for light, water, nutrients and space; trees will do better without them (Skousen et al. 2009). Ground covers should not be able to out-compete seedlings. Tall aggressive plants such as lespedeza should not be used. Proper selection of ground cover will aid native species recovery.

Figure 12. Reforested mine cite with no compaction. Mine spoils were dumped, and not compacted at all prior to tree plantings. Reforestation was largely successful at this site. Starfire Mine, Perry County, KY.
Photo courtesy of U.K. Forestry.

4. Plant two types of trees: early successional species and commercially valuable crop trees that are slower to mature.

Selecting the right species of trees to plant is essential to effective reforestation. Researchers suggest that one-fifth of trees planted initially should be of species able to survive on newly reclaimed sites and that improve soil conditions. Such species include redbuds and locusts. These species should be mixed throughout the sites rather than planted in single-species blocks so as to distribute their benefits. Other species selected should have the potential to be valuable timber trees, or trees otherwise conducive to the landowner's post-mining forest-management goals.

Such species may include oaks, sugar maples, and ashes. FRA steps also allow for seeds carried by wildlife processes to be established.

5. Plant trees with proper techniques.

Improper handling or planting of tree seedlings seriously impacts survival rates. Seedlings may not dry out or freeze prior to planting. Experienced, well-trained crews are recommended for large-scale tree planting operations (Angel et al. 2009).

The FRA is designed so it is compatible with current SMRCA standards and regulations. It is not designed to work against corporations or mining communities; rather, it is compatible with both coal mining communities' economic and environmental needs. Mining communities need to diversify their local economies, and reduce the environmental degradation caused by mountaintop removal. And while coal corporations have executed colonialist operations in Central Appalachia while degrading the environment on an unprecedented scale, collaborating with coal corporations with improving the reclamation practices will lead to the most success, in terms of recovery. Reforestation is possible, scientifically; economically, it is also possible to make reforestation part of the reclamation process completed by corporations. And as coal corporations continue to close operations in Central Appalachia, they will leave behind another opportunity for economic growth through sustainable logging, and they will mitigate some of their environmental degradation.

Challenges to Reforestation

Reforestation efforts face cultural and technical barriers to large-scale implementation. Millions of acres of mined area remain deforested throughout Appalachia. Only a few thousand acres have been reforested. It is important to understand these challenges so they may be addressed.

There are no significant legal barriers to reforestation. The Office of Surface mining and state agencies agree that FRA reclamation is consistent with SMCRA. Since the majority of mined land is forested prior to mining operations begin, it is clear that reforestation satisfies this requirement. In fact, reforestation of surface mines fulfills the law to its full extent. Traditional reclamation of highly compacted unmanaged grasslands neither are reminiscent of their prior state of existence nor are they conducive to "higher or better uses of which there is reasonable likelihood." Some corporations argue that flat land is of inherently higher economic value because it is hypothetically easier to develop. On flat lands, communities can build shopping centers, golf courses, or airports. However, this assumption violates the "reasonable likelihood" qualification of SMCRA. Almost no such development actually occurs. With millions of flattened acres, another solution is needed.

Technical barriers exist because there is a lack of a transfer of knowledge of how to successfully re-establish forests on legacy mines. Researchers must work to communicate knowledge to industry. If done incorrectly, trees will have very low survival rates, and growth will be stunted. Organizations such as the Appalachian Regional Reforestation Initiative work to publish studies depicting FRA practices and diffuse information of better reclamation to mining industry. Developing successful reforestation protocol with mining industry and training planters is

possible on a larger scale than is currently implemented. Further scientific research is needed to continue to develop the most successful reclamation techniques, and improved communication between researchers and industry is needed to maximize success.

Cultural barriers exist within the mining industry. These are perhaps the stickiest barriers hindering reforestation. Industry often labels mine reforestation as expensive or destined to fail, or that reforestation reclamation is illegal under SMCRA. Improving scientific communication with both industry leaders and the public may combat this. Executing reforestation successfully is essential here; incompetent planting, or other mistakes that may deter reforestation success, may lead mine industry to label reforestations as wasteful or impractical. However, when done following FRA guidelines, it is clear that reforestation is possible with very high success.

Reforestation projects are beginning to make changes throughout central Appalachia. One such mine reclamation reforestation project is at Laurel Fork mine in the Robinson Forest Research Area in Perry County, Kentucky. The Laurel Fork site shows the various ecosystem services that reforestation may bring to mining communities.

Chapter 3: Laurel Fork—A Case Study of Reforestation and Carbon Sequestration

Laurel Fork mine is a legacy mine in the Buckhorn Creek watershed in Breathitt County, KY, located by Twin Hollers between Clayhole and Rowdy, KY. Though this particular mine was relatively small, it is only a very small piece of Breathitt County's mining legacy. The county maintains strong ties to the coal industry even as the county suffers from high unemployment and widespread poverty. Breathitt County, population 13,545 in 2013 U.S. Census Bureau estimates, has a poverty rate of almost one-third.[6] Mining employment levels suffered a major hit when a major mine closed in 2011. The county is yet to see a major economic turn-around.

In the 1990s, the University of Kentucky sold timber and mining rights to ~4,000 acres in the Robinson Forest (Lambert 2003). One portion of this mined area is the Laurel Fork mine. The site was mined using mountaintop-removal techniques. The Laurel Fork sites were later reclaimed under FRA guidelines in collaboration with the University of Kentucky's Department of Forestry, U.K.'s extension reforestation non-profit Green Forests Work, the Appalachian Regional Reforestation Initiative, and the American Chestnut Foundation. During mine closure, the area was compacted not within FRA guidelines. The plots were planted with three species of trees: Loblolly Pine (*Pinus taeda)*, Northern Red Oak (*Quercus rubra)* and American Chestnuts

[6] Breathitt County's socioeconomic difficulties are particularly pronounced in its residents' challenge to receive adequate healthcare. The county's major clinic is located in a strip mall complex, and access to its limited services still requires a difficult, long drive from many people's homes. According to the Foundation for a Health Kentucky, 44% of Breathitt County adults are missing six or more teeth from gum disease and tooth decay (Foundation for a Healthy KY). Though the county is often marketed as one of Kentucky's most beautiful, the area struggles with serious socioeconomic and environmental issues, ultimately tied back to the mode of modernization brought on by the development of the coal industry.

(Castanea dentate). However, Chestnuts has 0% survival[7], and for this study, I will focus only on the first two species of trees. These trees maintain different qualities.

Tree Species Selection

Loblolly pines (LLP) are native to the southeastern United States. Their native range does not extend as far north as Kentucky. Pines are likely the world's most important timber trees. The Loblolly Pine is relatively fast to mature; as timber, it has a wide range of uses from pulpwood to plywood to lumber. For these reasons, it is one of the most important commercial timber trees in the U.S. (Petrides 1998).

The Northern Red Oak (NRO) is a large tree, with a native range that spans from the Southeastern United States into Southeastern Canada, including Appalachia. Oaks are relatively slow to mature. However, this species is also an important tree for timber, and can have higher value as lumber and veneer; oaks provide around half of the annual production of hardwood lumber in the U.S. (Petrides 1998).

As important timber trees, both species may provide environmental and economic benefits to surface mines and their respective communities. However, the species may exhibit different levels of success relative to different ecosystem services, as will be described shortly.

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[7] The poor survival of Chesnut trees is a result of blight. *C. dentate* were once one of the predominant species in eastern hardwood forests. The chestnut blight disease was first seen in the U.S. in the early 1900's. Within 50 years about 3.6 million hectares of American chestnut trees were dead or dying from the chestnut tree blight fungus *Cryphonectria parasitica* (Anagnostakis 1987). Currently, efforts exist to restore the American chestnut through focusing on the natural blight resistance of the few surviving tress, as well as introduction of the Asian chestnut, which is naturally blight resistance, into American chestnut (Griffin 2000).

Reforestation serves as a method of carbon sequestration. As climactic shifts progress on a global level, some models suggest that oak-pine type forests may increase as climates warm (Iversan & Prasad 2001). Tree species such as the Loblolly Pine might extend their range farther north. Since reforestation projects extend and develop over decades, future climactic modeling must be taken into account when deciding which species of trees to plant.

At Laurel Fork, I measured both tree growth and survival. I also took soil samples to measure composition and ionic presence. We will use these to measure carbon sequestration.

Methods

Field Methods

In July 2013, we measured the diameter at breast height (DBH) and height for each tree in LLP and NRO plots (Figure 13). We measured only trees planted during the initial reforestation effort; we ignored trees that had seeded-in naturally in our calculations. We measured all tree heights by using a telescopic measuring stick.

In August 2014, we collected surface soil samples 0-10 cm in depth. Composite soil samples (n=3) were chosen randomly within the forested plots. In particularly rocky plots, samples were sometimes taken closer to trees where there existed a greater accumulation of organic material. Visible leaves, stems, and roots were removed from the samples by hand. Samples were then dried and crushed using a ball mill, sieved, and mixed homogenously.

Figure 13. Measuring LLP and NRO on site at Laurel Fork Mine with a telescopic measuring pole. Author pictured. July 2013. Photo courtesy of Professor Chris Barton, U.K. Forestry.

We also collected herbaceous ground cover samples, using a single $1m^2$ samples per cell (Figure 14). Herbaceous ground cover (excluding the invasive, highly competitive *Lespedeza*) was cut with a sickle or shears and collected. Samples were dried and weighed.

Figure 14. Herbaceous ground cover sampling. Herbaceous ground covers were collected within the confines of a $1m^2$ sample cell, randomly selected for each plot.

Results and Discussion

Herbaceous Groundcover

Herbaceous groundcover volume was significantly higher for NRO and Control plots compared to LLP plots ($p<<0.01$). While herbaceous groundcover does provide some benefits from carbon sequestration, it is nominal if tree growth is also expressed. Additionally, the primary ground cover plant (though not cut during sampling) was the invasive *Lespedeza*. Plots with less tree growth thereby experience increased growth of invasive species.

Tree Growth and Survival

Loblolly Pines experienced far more growth in height than Red Oaks ($p<<0.01$). This is reflected in measures of survival, tree height, and tree diameter. Survival rates were higher for LLP than NRO. LLP experienced overall survival rates of >95%, with all losses stemming from 2 of the 24 plots. RO experienced much lower survival rates of <81%. While LLP are naturally faster to mature, this may not explain all of the height variation between LLP and NRO, and does not explain the survival differences. Though Northern Red Oaks are native to the region, the local environment has been seriously degraded and changed. Loblolly's may be more suitable to the challenging conditions of reclaimed mines, and mature more quickly, especially with legacy mines with highly compacted sediment. LLP may be more profitable for timber and other forest products because their forest volume is much higher compared to NRO. Additionally, LLP's greater forest volume is associated with much higher carbon sequestration than the grassland Control plots or NRO plots.

Chemical Properties of Soil

Carbon and Nitrogen

Soil sample analysis indicates that total carbon content was higher in LLP than in NRO plot or control plots. Similarly, total nitrogen content was highest in control plots and lowest in LLP plots. This is reflected in C/N ratios, which were significantly higher for LLP than control plots ($p<0.05$) (Figure 15**)**. NRO plots did not have C/N ratios that were statistically higher than the control plots. However, this is easily explained by the low growth and success of NRO trees in general, and thus an overall similarity between NRO and Control plots.

The total C/N ratio increased as tree growth and thus root penetration increased. This may be attributed to root turnover, wind-blown material, and contribution from spoil materials, as soil development (Marahaj 2007). Control plots and, to a somewhat lesser extent, NRO plots, were essentially still "rock piles" with herbaceous ground cover but assumedly low appreciable Surface Organic Carbon (SOC) due to the lack of soil development. Thus the overall C/N pattern may be attributed to greater soil development in LLP plots.

Table 2: **Average carbon/nitrogen values for soil samples**

Species	Total N (%)	Total C (%)	C/N
Control	0.197	3.129	16.40
RO	0.137	2.490	19.35
LP	0.108	2.172	20.42

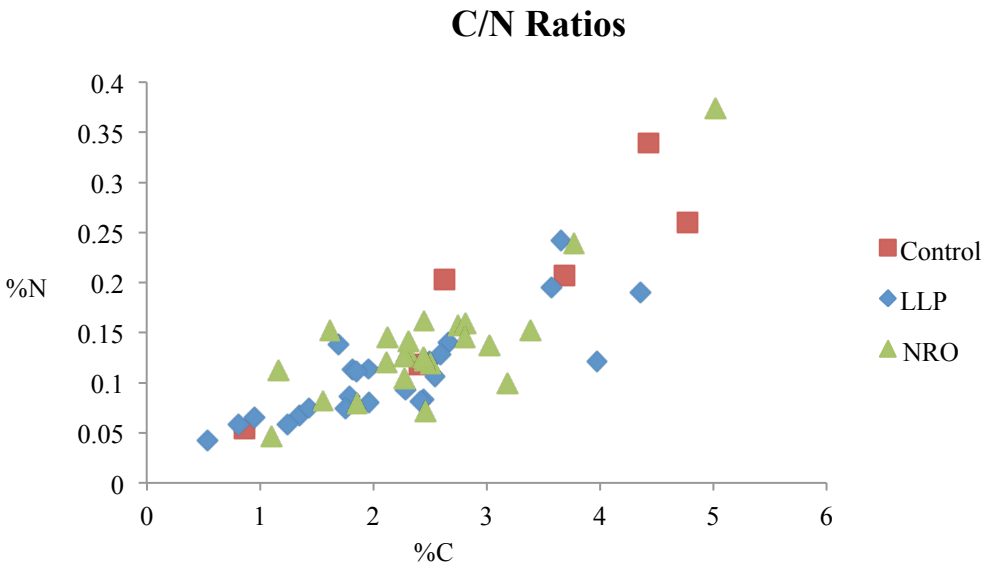

Figure 15. C/N of surface soil samples. Control plots had the highest average C/N ratios while Control plots had the lowest. This is indicative of greater soil development on LLP plots, which saw greater reforestation success with respect to tree growth and survival.

Total N is lowest in LLP and highest in Control plots. This may be indicative of an increase in N-fixing microbial biomass also associated with greater soil development. Again, this suggests initial improvements to soil quality associated with more tree growth.

Ionic Presence and Cation Exchange

For P, Ca, Mg and Zn, concentrations were highest in Control plots and lowest in LLP plots. For K, concentrations were significantly lower in LLP plots than Control plots (Table 3). This is illustrated comprehensively through cation exchange rates (Figure 15). Control plots have cation exchanges that are lower by a statistically significant amount compared to LLP and NRO combined ($p<<0.01$). Control plots also show a much greater ionic presence compared to LLP alone ($p<0.01$).

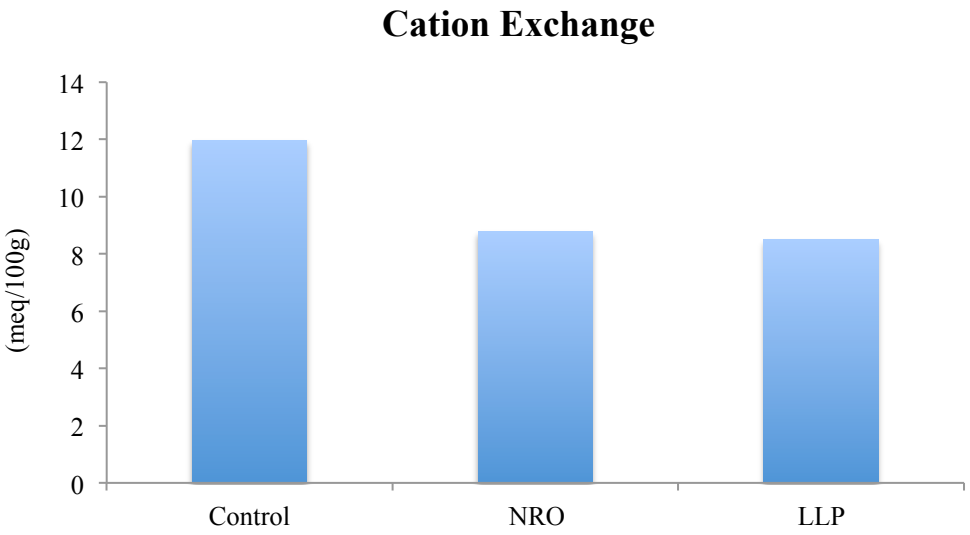

Figure 16. Cation Exchange. Values are highest for control plots and lowest in LLP plots

These results imply that the chemical properties of soil change under forest aggradation. Soil quality improves as forest cover increases and ages on reclaimed mines. It suggests that with increasing tree growth on mine spoils, there are decreasing carbonate fractions and an increase in organic soil material. As trees grow, root growth allows for greater water infiltration and physical weathering or geologic material, leading to lower solubility of primary minerals.

Table 3. Ionic concentrations of various cations from surface soil samples (mg/kg)

Averages	P	K	Ca	Mg	Zn
Control	19.5	66	1255	213.5	5
LP	8	63	640	170.5	3.5
RO	11	66.5	723	179	4

This study suggests that LLP growth leads to the greatest amount of improvement of soil quality, compared to NRO or no plantings. The measured chemical properties in the soil show that LP are able to grow under the poor initial soil conditions (similar to the control plots) and are able to cause the most positive change in soil quality with respect to ionic presence and carbon and

nitrogen content, which means that growth is likely to continue at the Loblolly plots. The LLP are likely to mature until they are economically viable to harvest, and they will improve soil quality so that the next trees to be planted or the next plants to seed in are more likely to mature at normal, healthy rates to healthy sizes.

These results suggest that carbon sequestration is greatest in LLP plots and very low in control plots. Carbon sequestration is important in mitigating emissions of CO_2 and combating climate change. Planting LLP maximizes the benefit of carbon sequestration.

Conclusions

Forestry reclamation is not an over-night solution. Because it is a process that may span decades, future climate modeling and carbon sequestration benefits should be considered for FRA planning. LLP, though technically non-native, have experienced higher survival and more normal growth patterns compared to NRO. LLP clearly do more to restore soil health in a shorter amount of time. They may be used initially as a first round of reforestation mitigation. In future decades, improved soil quality may lead to more diverse plantings or natural seed-ins that require higher soil quality to thrive. If native NRO were planted exclusively, the soil would improve slower, and the possible benefit from forest product harvest would be lower and slower to accrue. However, the results from this study should not imply that NRO should not be used in reforestation efforts. Rather, they are not the hardiest tree when planted in highly compacted sediment; other species may do more for soil regeneration and carbon sequestration.

Chapter 4: Future Plans

It is evident that coal and social inequity are linked in Central Appalachia. One day, inevitably, coal will be exhausted—if not this century, the following. We live in a world with finite resources and physical constraints, and so we are forced to accept that the coal industry cannot last forever. We must face the changing era with bravery, compassion, and faith in our own ingenuity and resilience. We must attack the regional environmental, economic, and social concerns with a combination of local, state and nation-wide focus. Today, many pioneering individuals have already taken the first steps towards progress.

Reforestation

Reforestation is one piece towards solving the environmental and socioeconomic issues in the region. We are in possession of a library of research informing us of the best way create healthy, productive forests that may offer significant environmental and economic benefits. We need more investment in this process. Surface mining removed over a million acres of native Appalachian forest; since 2010, Green Forests Work has planted less than 2,000. It is unfeasible to hand-plant and reforest all mined areas. However, the new regional sustainable forestry economy is multi-faceted. Reforestation is a way to invest in carbon-sequestration, high-value timber, food production, biofuels, and recreation (Green Forests Work). The knowledge acquired by researchers must now be assimilated into widespread practice; we must see a diffusion of knowledge about reforestation reclamation.

As addressed earlier, cultural barriers must be addressed in order to spread reforestation efforts. Legal barriers are non-existent. There is no legal infrastructure in place currently protecting

status-quo reclamation over forestry reclamation. Yet SMCRA is continually interpreted to support traditional grassland reclamation. Only cultural barriers stand in the way; it is hard to change reclamation practices that are widespread.

Once, when Abraham Lincoln was asked how he dealt with the large number of death threats he received as president, he was reported to remark: "there is nothing like getting used to things." Across Appalachia, communities have grown used to the degradation. The scars of coal mines crisscross the country, and no longer inspire scorn or anger in the same capacity that they inspire in people completely new to the mines. There is a skewed perception for normalcy; there is a fatalistic acceptance of what is acceptable and "normal." This shifting baseline must be addressed if reforestation efforts are to experience more widespread success. It has yet to be made completely clear to much of the public how reforestation may benefit communities.

Cultural and technical barriers towards reforestation may be addressed through a combination of legal infrastructure and community outreach. There is no reason why mining operations should be allowed to continue to deforest land without any attempt to restore or mitigate this loss of habitat and biodiversity. To say that the non-native rocky grasslands meet SMCRA's guideline of "equal or greater economic value" compared to the pre-mining forested land is a stretch at best and a lie at worst. The scale of deforestation from surface mining is massive, and it is not practical to plan to reforest all affected areas in a short amount of time. It may also be inefficient to attempt legally to require mining companies to reforest all mined area. However, we must change the legal framework for mine reclamation to mandate reforestation in some capacity. We must expand coal production taxes on mine operators to increase funds for the Abandoned Mine

Reclamation Program, and develop a Payment for Environmental Services (PES) system. Developing a PES system will provide small-scale landowners with the resources and incentive to protect the public goods provided by reforestation (such as erosion and flood control); it may work public goods into a market system, preventing their undervaluation (Patanayak 2010).

A PES may be used in conjunction with other market- and non-market-based regulation. We may require legally that mining companies reforest a certain portion of their mines. This could be done through an industry wide permit program, where mines may receive permits to not reforest their land. This may ensure that the forestry reclamation projects maximize cost-effectiveness. We may institute a tax on not reforesting land. We may subsidize firms' reforestation programs, including the technical training of teams of tree-planters. As stated above, a major barrier to reforestation is that the knowledge of the FRA has not yet made it into the hands of the public. People do not know *how* to effectively replant a coal mine. Training teams of tree-planters will help gain public support for reforestation, as it will provide stable employment in a straggling economy.

This approach addresses a fundamental issue. In Central Appalachia, many people believe that one cannot be "for" the environment without also being "against" economic growth. Environmental action is often met with resistance, because people struggling in local coal economies feel as if they are being swept under the rug in order to protect an aesthetic. Across the globe, communities and governments are shown to permit higher levels of environmental degradation in the course of development; people are willing to sacrifice environmental health if it means economic sustenance. Training community members as reforestation teams allows for a

breakdown of this false dichotomy. It allows for alternative employment opportunities that also mitigate environmental damages. The job opportunities will create a skilled workforce, and with widespread deforestation, employment may be long-term as long as funding remains available.

Expanding reforestation efforts may also lead to the expansion of sustainable forest product industry. Sustainable forestry may act as a cornerstone for healthy economic development through the development of a regional forestry co-operation. Expanded forestry initiatives must take into account community planning and discretion in ways that the coal industry failed to do.

Reforestation is an important step because it is a possibility in the current political climate. Pragmatically, Kentucky may not yet be ready to give up on coal. The recently passed November Senate election is indicative of this; both the incumbent Republican Mitch McConnell and the Democratic challenger Allison Lundergan Grimes took strong pro-coal stances. As described earlier with the Bell County case, it is hard to challenge coal when nobody has yet described an economic alternative. Reforestation may begin while coal mining continues in some capacity. While political and industry leaders continue to fight for a continuation of pro-coal policies, reforestation may begin to foster economic alternatives and greater environmental understandings.

Reforestation may also be a way to unite outside environmental groups with community needs in a greater capacity. MTR has received outside attention from various environmental groups; however, community solidarity against environmental issues remains a challenge for many of these groups. Reforestation may be a way for “Mountain Justice” groups expand, and a way to

get people to start considering futures built on alternatives to coal. It may be a way to push more people towards "no coal" futures.

Reforestation should not be misinterpreted as a fix-all solution. Rather, it is a small piece to a bigger solution. It must be recognized that the full benefits of reforestation will not be met for decades to come. Forests are not grown overnight. Loblolly Pines, a species classified as quick to mature, are generally not harvestable for decades; other profitable species take even longer. Planting trees may provide work in the mean time, as could the expansion of sustainable forestry work in non-mined areas. Other alternative employment opportunities must be considered as well.

Mountain Justice Movements and the Potential for Expansion

Some anti-coal environmental groups are beginning to fight coal from the reclamation perspective, not just the active mining portion. One such organization is I Love Moutains. I Love Mountains is a collection of smaller not-for-profits working to stop MTR. Organizations include Appalachian Voices, Kentuckians for the Commonwealth, the Stay Together Appalachian Youth Project, and the Sierra Club. Because of the combination of local, state and regional organizations, I Love Mountains can work from different perspectives to stop mining practices. While the organization's ultimate goal is to stop MTR, one current collaborative campaign is against the "failure" or current reclamation practices. Specifically, I Love Mountains fights "Big Coal" on their claim that mined land is used for "economic development." Using satellite data, an estimated 89% of MTR mines are not used for economic development, excluding pastureland and forestry initiatives (Geredien & Natural Resource Defense Council).

Unlike industry leaders and academic researchers, organizations like I Love Mountains are specifically fulfilling the advocacy role with reclamation. While scientific research should never bend to the aims of social and environmental advocates, it is clear that the forestry scientific literature supports the claims and concerns of Mountain Justice groups. Grassroots advocacy may be expanded with reforestation to get outside political pressure to expand such efforts. If we expand an advocacy focus on effective reclamation, it may be possible to get more political traction and see further environmental mitigation.

Hope for the Future

Appalachia is a place loved by its residents and romanticized by outsiders. While is struggles with serious economic and environmental threats, the region is full of pride in its history and in its historic ties to self-sufficiency and independence. While coal mines leave ugly scares, while over 500 of the oldest mountains on the continent have been blown away in the extraction process, while these mines remain desolate grasslands rather than the diverse forests they once were, Appalachia is still a beautiful place. And while coal mine reclamation is not an overnight solution, it is inspiring to think of the changes that may be made over a decade, two decades, or a century. Today we may plan for solutions that will not reach fruition for a long time—but that time will come.

In mid-Summer 2014, I walked out to the middle of a mine site reclaimed by U.K. Forestry. The scientists moved around massive amounts of what used to be a valley fill to restore a once-buried stream. The immediate bank of the stream was planted a year prior, with a combination of trees

and native wetland plants. The Sycamores were stunted, with leaves beginning to wrinkle on the edges from sun-stress. Some of the mountain hibiscuses were in bloom, but not near the edge of the creek, which was dry for relatively long stretches. The sun beat down on the exposed dirt, and while I knew the cite had been reclaimed according to the best practices with the most care, I felt much more as if I was on a coal mine than in a wetland.

As I strolled across the cite carrying my field clipboard and calipers, I did not feel particularly hopeful about the future of my site. I looked at my stunted Sycamores and I sighed. *'All this for* what,' I thought, and I kicked the dirt.

Perhaps my sunglasses shaded my disappointment from my boss, a professor at U.K. that had long worked on surface mine reclamation. He took a look around the stunted juvenile trees and the unnaturally sunny terrain and grinned.

"This is going to look amazing in a hundred years. In just a century, this is going to be a forest," He said. "That's not so bad."

He was so right. In that moment, he embodied not just optimism but proper perspective. There was nothing wrong with the site; there was only a problem with how I was choosing to look at the site. Perhaps the trees were not as tall as they could be if planted in the middle of the Daniel Boone; perhaps the site would not be truly forested for years to come. But given the current reality, this was the best possible outcome. It was imperfect, but it was true progress. And in

order to understand the level of success, it is necessary to maintain perspective, and to remember that it takes decades for a tree to grow. That is something that cannot be hurried.

Appendix: Letters Between Friends

The letters' author worked on reforestation efforts in West Virginia and Eastern Kentucky. Shared upon request; reprinted with permission from the letter's author (a work acquaintance of the thesis author.) Names changed.

Dear Cal,

Just got back from work. I was working at the biggest strip mine in the state…it's absolutely humongous-- something like 25,000 football fields. It just goes on forever. Pieces of normal-mountain are still around; little sections of forest clutch to unnatural-looking cliff faces, where everything else was blown away. The coal trucks are massive, and the roads are dusty. I don't think it's what you would expect a mine to look like though. There is something that will surprise you everywhere.

For instance, locals let their cows loose at the mine because they see it as free pastureland. There are dozens of cows of all colors and ages, tagged and untagged, wandering around. Occasionally someone will come out of the washing station or somewhere and say 'shoo now' to steer them away from the equipment, but otherwise they just roam. When their owners decide the time is right, they come back and shoot them and take them home. Technically this is illegal but nobody cares.

Work can be tedious, but what work is perfect all the time? Being a part of reforestation projects is really beautiful. I mean, yes, the trees are beautiful. I love the trees, even when they are stunted juveniles that will never grow. But mostly it's so beautiful because the places I go are just so off. If you look, the mines hold everything on a spectrum from ghastly to great, and somehow the distinction between these two opposite things gets fuzzy and it all becomes just something else but I don't know what to say. There are periwinkle flowers and emaciated horses and old bright-gold school buses to transport miners to different jobs. Some of the valley fills look like ancient ruins, and some of the old family cemeteries (which do exist within the mine property lines) seem like they could have sprung up yesterday. Do you know what I mean?

Hey, I really hope you're having a good time…. I just wanted to let you know what I'm seeing.

Rose

Dear Cal,

Coal mines have a hundred different smells. Sometimes it smells like you would expect: oil, a bit like swimming pool chemicals. Cigarettes, black smoke. Dust. Gray mud. Hot earth. Where the cows sleep, it smells overwhelmingly like a barn. In some places it doesn't smell like anything at all. The pine stands smell just like a pine stand anywhere; you could completely forget where you were except at 4 o'clock you hear the sirens go off, like an ambulance, and then some gunshots and then a boom.

Boom!

Interestingly, the girl I'm working with has no sense of smell. She lost it in a botched sinus surgery.

Thank you, many of my trees will grow. Are growing. A lot will die, or are dying. (Have you ever noticed how many things in a forest are decaying?) But hey that's why we overplant.

Please take care of yourself.

Rose

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