7. Utilizing a Green Revolving Fund for Reforestation on University of Richmond's Pagebrook Property.

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Abstract: The purpose of our climate change senior seminar project is to offset school funded domestic travel by implementing a fee structure to obtain an allocation of funding from different school departments responsible for sending students and faculty to locations around the United States. We need to take measures in creating a fund dedicated to creating sustainability - focused programs in order to maintain our reputation as a progressive and prominent institution. Once we generate money from the fees on our school's travel, our first proposal is to reforest an underutilized piece of land owned by the school for the purpose of sequestering carbon. Our research explores the potential for this property to offset emissions, at what cost it will take to do it, and how it will create a more sustainable future for the University of Richmond.

I. Introduction

In 2013, the University of Richmond directly sponsored 3,076,643 miles of travel for faculty, staff, and student, conferences, engagements and sporting events (Zanella-Litke 2013). This type of travel emits over 2,410 tons of carbon into the atmosphere (Zanella-Litke 2013). This research and proposal recommends the University implement a fee-structure for University-sponsored travel incorporating the cost of travel into travel fees. The money generated from the fee would then be invested into a green revolving fund and the allocated money will cover costs to reforest the University's Pagebrook Property and other sustainability projects. The costs associated with reforesting the Pagebrook Property are reforestation, site-preparation, and seedling cost. After the trees are planted, they will be maintained and monitored and maintained by faculty supervised applied student research.

The exploration of the possibilities of what to do with the Pagebrook Property were assembled by investigating ways the University can reduce its carbon footprint, utilize the land that will maximize the biodiversity of the local ecological community, create wildlife corridors for endangered species, and revitalize water quality within the James and Chesapeake Watersheds while furthering the University's mission of undergraduate education. The suggested best management practices from green revolving funds result from rigorous research of the top 30 liberal arts schools, top 30 national Universities, and all of the peer institutions and institutions with the greatest admissions overlap as identified by the University's Office of Institutional Effectiveness. The ultimate goal of this proposal is to convince the University it can continue to be an innovative sustainable institution by implementing an original solution that will

mitigate the carbon footprint for University sponsored travel and create a unique educational experience for students close to campus.

II. Formulation of Project

The formulation of this proposal was ultimately created by a combination of two separate initiatives: an initiative to set up a fee-structure to offset University sponsored travel, and a project to reforest the University's Pagebrook Property. Both of these initiatives were arrived upon through deliberation between our peers and conversations with faculty and staff members. The Pagebrook Property reforestation proposal was borne out by previous research completed by a University of Richmond junior, Taylor Holden, who conducted a University of Richmond tree survey. Holden measured the biomass of all of the trees on the Westhampton side of campus and then calculated the amount of carbon that trees on campus are currently sequestrating. The initial plan was to utilize this data as a starting point for finding out if the amount of carbon sequestered by the trees offset the school's travel emissions. The meeting with Megan Zanella-Litke on Monday, March 3rd discounted this idea because it did not demonstrate 'additionality', because the trees currently on campus were not directly planted to offset carbon emissions. Rather, the offset of the emissions from trees that are already planted are not considered additional because they would have occurred regardless of the planned offsets. Additionality in terms of carbon offsets involves showing projects reduce GHG emissions below levels of technologies and policies currently in use by the institution (Valatin 2014). The reforestation project must ensure a quality of carbon elimination benefits different from 'business as usual' mitigation measures and safe from carbon unit sale (Valatin 2014).

Zanella-Litke encouraged the research team to focus on how reforestation programs at the University can be implemented to offset local emissions. Given the limited open space on campus, we proposed that reforestation efforts be focused on the dormant off-campus school property called the Pagebrook property. A second meeting with Zanella-Litke discussed the potential for the Pagebrook property to serve as a reforestation site. Assuming there are no legal restrictions on the land use of this property, the field can be proposed for reforestation. We then began to research a carbon offset company called NativeEnergy, a company that is professionally hired to reforest plots of land, and accredit and approve the sequestered amount or carbon. They apply a gold standard criterion verifying the land dimensions and project details, and through this regiment, we can obtain the carbon credits needed to offset local travel for the University (Native Energy 2014).

Professor Salisbury was opposed to the idea of hiring an outside company to reforest the property because it would have less of an impact on influencing the general student body about important environmental issues. The next course of action was brainstorming a way to make a reforestation project connect with the school's student body as either a class or an experiential learning component of the environmental studies or geography program. Our class seeks to not only improve the university administration's consideration of climate mitigation strategies , but increase student awareness of these issues, as students have the most potential to influence and benefit from future sustainability decisions. Therefore, the reforestation project has the prospective of offsetting local emissions while creating hands-on activities for students to work outdoors, gaining technical skills for environmental career paths, and increasing personal satisfaction by creating real contributions to fighting climate change.

The next step was to determine the quantity of carbon needed to offset, how to implement an offset plan, what species of trees to use, and how many are needed to sequester the school's local carbon output over a designated timeframe. As a starting point for visualizing how to approach these questions, we met with Professor Hayden, a botanist and naturalist of the Biology department. His expertise in plant growth seemed to hinder the hopeful idea of growing trees in an abandoned grassland field, pointing out several issues such as soil quality, water availability, guaranteeing nursery level care giving to seedlings for 1-2 years and herbivory from deer. Despite his skepticism, he suggested it can be possible with the right species and planting technique. Ultimately, he helped us decide that loblolly pines (*pinus taeda*) were the best trees to plant as a reforestation project for sequestration because the growth of loblolly pine stands, from sapling to maturity, is faster and larger than common associates like hardwoods. (Burns 1983). Additionally, loblolly pines have been consistently planted as means of carbon sequestration projects in the south because they are native, grow year round, and require little maintenance. (Johnson 2004).

The green revolving fund aspect of this project evolved out of the search for local programs that the University could sponsor to offset its carbon footprint. Our initial research focused on finding colleges and Universities that helped sponsor local sustainability projects that could mitigate their carbon emissions. Examples of the projects that we were researching in the beginning of the semester were at colleges like Middlebury College who implemented a biomass gasification plant (Biomass at Middlebury 2009); Colorado College who worked to create a local cogeneration system (Colorado College Cogeneration System 2012), and Oberlin College who uses their discarded organic debris to fuel a local electricity production station (Oberlin College Organic Electricity 2010). After talking to members of the GreenUR Student Group on campus,

they suggested that we turn our focus to on-campus sustainability projects that are currently being pursued through the use of a green revolving fund.

II. Why the University of Richmond Should Implement this Proposal

The University of Richmond has taken an aggressive stance against combatting global climate change by setting an ambitious goal of carbon neutrality by 2050. Figure 1, see below, displays the University's greenhouse gas emissions profile for the past several years. This image shows that a substantial component of the University's greenhouse gas emissions are from University sponsored travel, shown on the dark blue bar on the graph. University sponsored travel currently accounts for close to 6% of the University's greenhouse gas emissions (Zanella-Litke 2014).

In 2013, the University sponsored 3,566 trips for faculty, staff and students to go to conferences, engagements and athletic competitions. Our emissions as an institution are therefore a major problem in our effort to reform the school into a more sustainable and environmentally sound way. In order to mitigate our carbon footprint, as the University strives to reduce its emissions by 30% by 2030 and become carbon neutral by 2050, we are suggesting that the University transform the Pagebrook Property into a carbon sequestration project.

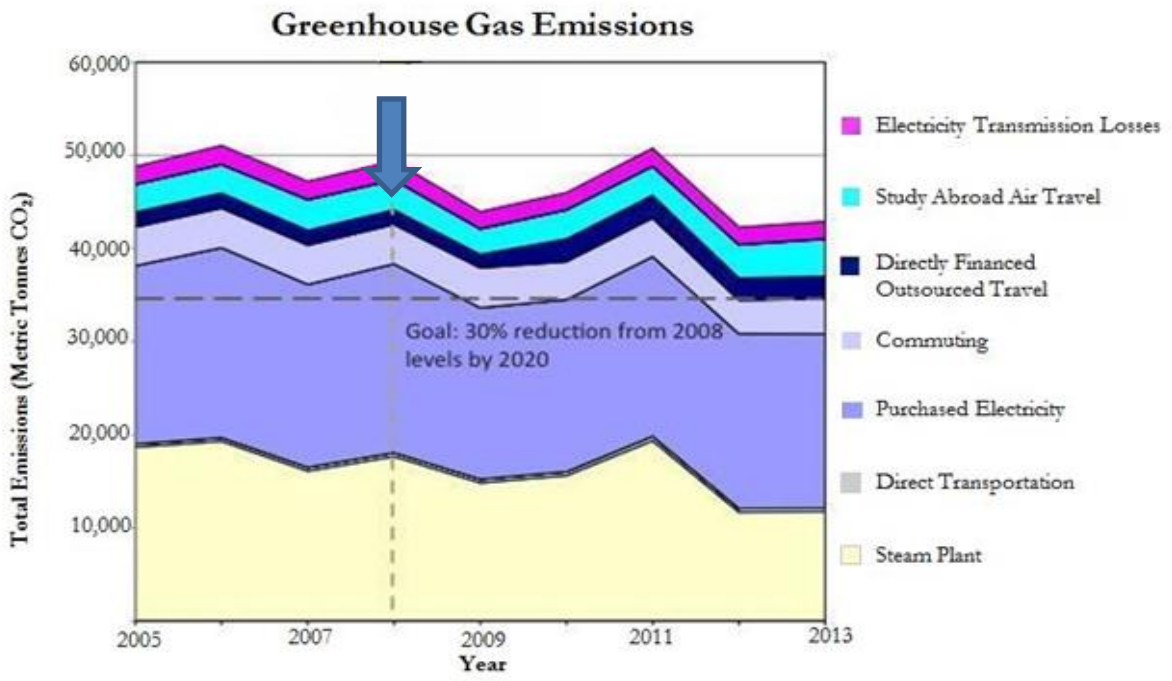

Figure 1: University of Richmond greenhouse gas emissions profile for 2013. The dark blue bar, University-sponsored travel, accounts for 6% of total University emissions

Reforestation of underutilized lands is a popular way for land owning companies to offset carbon and obtain carbon credits, which can be deducted from their carbon footprint and sold in the carbon market exchange. Voluntarily offsetting carbon is more cost effective than paying a carbon tax or complying with government regulations and it is an effective way for an institution to make a difference in setting a trend of slowing carbon emissions as a community, city, nation, and global community.

Pagebrook property was originally purchased in 2001 as a site of unspecific future development of Richmond's campus. In 2005, it was clear-cut and utilized by the Virginia Department of Transportation as a dumpsite of excess dirt from the construction of Route 288. Since then the field has remained in a fallow savannah occasionally harvested for hay. The property contains roughly 19 hectares, or 47 acres, of grassland that has no current practical purpose. The cross-country team at Richmond attempted to transform the empty field into a

course used for workouts and races, but its abundance of potholes and uneven surface proves to be less than ideal for running. There is evidence of trash and piles of dirt dumped on the land. The savannah's outer boundary has been plowed but the majority is tall grass.

The school is currently maintaining the tract as a 'land use' status, meaning it is immune to development, as the original agreement for its ownership is tax-exempt under the condition it is not sold for school building or real estate development. If land is sold or used for development, the cost in taxes will be accumulated for the previous 5 years in addition to the current year, resulting in a bill of around $550,000 tax dollars. This is a price the university wants to avoid, and thus, our carbon offset program may benefit the interests of the administration, by proposing a renewed naturalized property that is implemented at minimal costs and does not interfere with the current ownership conditions.

III. How UR Should Do It

The total project cost for reforesting the Pagebrook Property is just under $9,000, using cost estimations for seedling, planting and site preparation costs (Nepal et al. 2010). The costs are broken down as follows:

Seedling Cost = $31.18/acre x 47 acres = $1,269.00
Planting costs = $60.06/acre x 47 acres = $2,822.82
Site preparation = $103.94/acre x 47 acres = $4,885.18
Total project cost = $8,977.00

However, if this project were to be implemented, the costs actually could be cheaper because the horticulturalist of the University, Steve Glass, mentioned to our project team that we could get the plants at a cheaper cost through a deal with the Virginia Department of Forestry.

The University can sponsor this project, amongst many others, by using a fee-structure that would funnel money from fees placed on University-sponsored travel, and funnel them into a green revolving fund. In order to create the fee-structure that internalizes the cost of carbon from University sponsored travel, we conducted a meta-analysis of online carbon calculators that provide offsets for carbon dioxide emissions. We examined eleven carbon calculators that offer offsets for different types of transportation or provide information on travel costs.

We used eleven different types of calculators because we wanted to get an accurate and representative cost per vehicle mile traveled for three different types of modes of transportation. Even with similar inputs, however, these calculators can generate varying results, often by as much as several metric tons per annum per individual activity (Padgett *et al.* 2008). Each calculator uses a different methodology to calculate the cost of carbon emitted into the atmosphere. Because of the varying methodologies, we decided to gather all of the data across all of these firms and average it out to create the fee for each different transportation mode. Figure 2 shows the information about the 11 different types of carbon calculators, and the costs associated with each passenger mile traveled for trains/buses, cars and planes. We decided to group trains and buses together because they yielded similar results.

Type of Calculator	Train/Bus	Car	Plane	Website
Carbon Fund	0.001864	0.00355	0.00286	http://www.carbonfund.org/individuals
Carbonica	0.001365	0.00333	0.00453	http://www.carbonfootprint.com/offset.aspx?o=0.044&r=CalcFlight&defra=true
Carbon Footprint	0.001232	0.00503	0.0054	http://www.carbonfootprint.com/offset.aspx?o=0.044&r=CalcFlight&defra=true
Carbon Neutral Calculator	0.001434	0.00304	0.00345	http://www.carbonneutralcalculator.com
Choose Climate	0.001023	0.00239	0.00893	http://www.chooseclimate.org/
Climate Friendly Calculator	0.001297	0.00295	0.00832	http://www.climatefriendly.com/Personal/Calculators/AirTravel/
Atmosfair	—	—	0.00327	https://www.atmosfair.de/en/kompensieren/flug?departure=richmond&arrival=los%20angele
Virgin Atlantic	—	—	0.0053	https://virginatlantic.myclimate.org/add_to_cart
United Airlines	—	—	0.00833	http://co2offsets.sustainabletravelinternational.org/ua/offsets/trip
Berkeley Carbon Calculator	0.001023	0.00394	0.00733	http://coolclimate.berkeley.edu/carboncalculator
AVERAGE	0.001319714	0.003461429	0.005772	

Figure 2: Meta-Analysis of Carbon Footprint Calculators

With this information we created a fee-structure that would charge $0.006/passenger mile for air travel, $0.004/passenger mile for car travel, and $0.001/passenger mile for train travel. Given these fees placed on all University sponsored travel, the University would have received $17,280.37 in 2013 to put towards green revolving fund projects. Here is the breakdown per vehicle mile traveled:

Air Travel Fee = $0.006/ passenger mile x 2,707,943 miles = $16,247.66
Car Travel Fee = $.004/passenger mile x 221,337 miles = $885.35
Train Travel Fee = $.001/passenger mile = 147,363 miles = $147.36
Total Fee Charged for 2013 = $17,280.37

The money generated from the fee-structure would be placed into the green revolving fund that the University currently has in place. A green revolving fund is a financial investment mechanism that provides financing to parties within an organization for implementing energy efficiency, renewable energy, and other sustainability projects that generate cost-savings (Indvik *et al.* 2013). Cost-savings take the form of a reduction in the need for production or purchase of electricity. These capital projects take the form of high-performance campus design, operations, maintenance, and occupant behavior projects (Indvik *et al.* 2013). These savings are tracked by

setting a constant utility price, identifying the reduction in price, and then using those savings to replenish the fund for the next round of green investments (Indvik *et al.* 2013). Basic project eligibility guidelines for most University green revolving funds that projects must reduce the University's environmental impacts and have a payback period of five to ten years or less (Indvik *et al.* 2013). This process occurs iteratively, thus establishing a sustainable funding cycle while cutting operating costs and reducing environmental impact (Indvik 2013). There are other Sources of GRF seed capital are diverse and include administrative budgets, endowment assets, alumni donations, and student fees (Sharp 2002).

After a 2008 campus wide energy audit, the University put money into investing in improving campus efficiency through the creation of a revolving fund. The Energy Master Plan that Eneractive Solutions created, identified and prioritized numerous opportunities for energy and environmental improvements with the lowest cost and highest payback (Eneractive Sol., 2013) The master plan is broken down into three phases that will be implemented in the next 20 years (Zanella-Litke 2014). The projects in phase one have short payback periods, and are less capital intensive, whereas the future projects have higher costs, complex implementation requirements, and the of emerging technologies. The dollars saved from the projects up to the cost of the project, plus interest, will be repaid to the fund.

Our research of other peer institutions found other institutions (i.e. Yale University, Macalester College, and William and Mary) that had voluntary fees in place for domestic travel that contributed to green revolving funds. In order to determine other institutions that have implemented similar projects, we compiled a list of all of the top 30 liberal arts schools, top 30 national Universities, and all of the peer institutions and institutions with the greatest admissions overlap as identified by the University's Office of Institutional Effectiveness. After researching

these projects, none of them had *mandatory* fee structure in place that levied fees for University-sponsored travel. The only schools to have voluntary programs were Yale University, Macalester College, and the College of William and Mary.

The Yale Community Carbon Fund (YCCF) is a joint project of the Office of Sustainability and the Center for Business and Environment at Yale to support local carbon mitigation projects that go beyond Yale's immediate campus. When money is donated, the YCCF staff invests it in ways that enable low income people or organizations in New Haven to become more energy efficient and save money. The projects that have currently been implemented are the installation of energy serving equipment such as CFL lightbulbs, programmable thermostats, and low-flow showerheads in campus residence halls; a program that beautified streets of New Haven by planting trees to sequester carbon; implementation of programmable thermostats in faculty houses; and a low-income home insulation project (Community Carbon Fund 2013). The YCCF continues to fund projects that reduce emissions and promote community engagement (Projects and Event Contributors 2013).

The College of William and Mary has a carbon offset program where individuals can contribute money toward carbon reduction projects that offset their personal consumptive lifestyle (Carbon Offset 2011). The funds paid to the offset program go towards funding energy reducing projects on campus (Carbon Offset 2011). The offsets are calculated using the methodology provided by carbonfund.org, which was used to indicate how much money it would take to offset common vehicular and air transportation choices (Carbon Offset 2011). The money that has been donated to this fund has been put into energy-saving projects in the central library, two academic buildings, and two residence halls (Carbon Offset 2011).

Macalester College has a voluntary fee in place specifically for University-sponsored travel. Departments can choose to offset their emissions by participating in carbon offset programs sponsored by the firm that they travel with (i.e. United Airlines or Virgin). Their other option is to pay a personal fee that would go directly to funding sustainability projects on campus (Cullenbrand 2009). Some of the projects that have already been implemente are a 20 kW solar-array on the roof on the gym, a machine that measures the feasibility of having a wind turbine on campus, and the implementation of low-flow sinks and showerheads in bathroom revnovations across campus (Cullenbrand 2009).

IV. Methods

In order to find out what type of impact this project would have on the University's carbon footprint, we had to make a model utilizing the information that was currently available. We assumed a 1% growth rate for University sponsored travel over the 50 year time horizon because the mechanisms used to report data will become more accurate (Zanella 2014). We anticipated that the loblolly forest growth will remained unthinned and have maximum growth over 50 years, leading to the total amount of carbon sequestered at 300 tons of CO2 tons/acre (Nepal et al. 2010). With a 47 acre plot, the total amount of carbon sequestered per year, for a 50 year time period, would be 282 mtCO2e. Given the 1% growth rate in University sponsored travel over a 50 year time period, this project would offset the carbon for 5.64 years between2014-2064. The calculations for this are as follows:

Total Carbon Sequestered over 50 years= 300 ton/mtCO2e /acre x 47 acres = 14,100 mtCO2e
Carbon Sequestered per year = 14,100 mtCO2e / 50 years = 282 mtCO2e
Total Years offset assuming FY2013 offsets = 14,100 mtCO2e / 2500 mtCO2e/year =
5.64 years of carbon offsets for University sponsored travel for $9,000

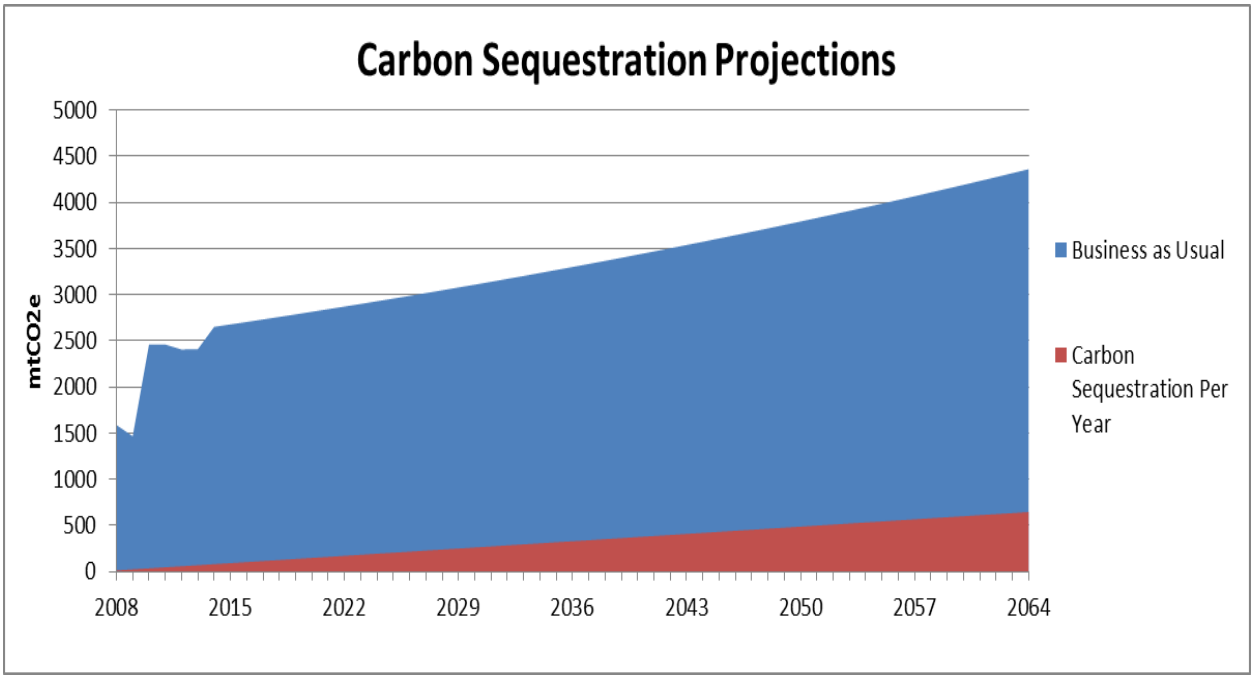

Figure 4: Carbon Sequestration Projections and impact of Pagebrook Property project

V. Other Benefits

Sequestering carbon via reforestation has multiple benefits in addition to direct monetary incentives, such as ecosystem services such as improving air quality, rehabilitation of wildlife habitat, water filtration/riparian buffer, and recreational opportunities. A loblolly pine forest would create a wildlife corridor for charismatic species such as the Red-Cockaded Woodpecker, an endangered native bird, and the Delmarva fox squirrel, a rare but celebrated forest creature. The reforestation would effectively prevent construction and expansion of Richmond's buildings. These are sources of nonpoint source pollution and without them we can guarantee the water quality of a small James River tributary neighboring the boundaries of the tract.

The reforestation project will be implemented as an independent study option for environment studies, geography and biology students interested in pursuing the concepts of silviculture, botany, or forest ecology. Theory of forest ecosystem management can be tested by monitoring the regeneration growth rate and changes in species composition of trees and native

animal species over time. Reforestation would provide an interactive learning experience for environmental studies and biology students to participate in hands-on carbon offsetting. This is a valuable experience that can manifest a passion for applying carbon mitigation measures at the local and personal level.

The outcomes of planting trees have distinct beneficial impacts on different geographic scales. Our main objective, sequestering carbon, has the obvious global connection of playing a small role in mitigating CO2 contributing to global warming. The minuscule bearing our small reforestation project on world's CO2 sequestration efforts does not diminish the significance of its worth and intention. As a prominent university in the United States, within a growing network of existing green revolving funds, we can send a message to people, schools and businesses within our national and international scale of influence. In accordance with the IPCC policy makers report, we would be taking an initiative in changing consumption and lifestyle patterns to more sustainable and carbon neutral management just by offsetting a small part of our institution's emissions (Metz *et al*. 2007). The fee structure's surplus accumulation of funds would increase our ability to invest in more carbon mitigation measures, which will help propel our sustainable influence.

We integrate the regional scale using the additional benefits of reforestation, habitat restoration and water quality. As noted above, planting a dense patch of forests would make a wildlife corridor, a growing popular tool toward adapting to the impacts of climate change and development on regional habitats of rare species. In a forestry study compiled by Burns (1983), the loblolly pine plantation is an ample food source for bird and rodent species. The endangered woodpecker and rare Delmarva squirrel species are excellent examples of animals adapting to habitat fragmentation by increasing mobility across landscapes. As studied by Opdam and

Wascher (2004), these species need natural vegetation areas they are adapted for in order to migrate north in the event of usually hot temperatures on the southern end of traditional latitudinal range.

The local scalar importance of this project can be rationalized as a fulfillment of place attachment. Our reforestation project furthers the involvement of environmental studies students in our local contribution to climate mitigation by allowing them to partake in the hands-on activities of offsetting and making a convenient site for forest ecology research studies at Richmond. In a study done by US Foresters Williams and Vaske (2003), they found place attachment was more strongly associated with measures of environmentally responsible behavior. By having a carbon offset project so close to campus, it is more likely for students involved to develop a passion for sustainability and environmental conservation. This reforestation project will inspire our community to think more critically about how the decisions we make will impact our environment and how we can reduce our carbon in our daily lives, thereby assimilating the local, regional, and global scale to our project.

VI. Conclusions

The University of Richmond's administration and student body will mutually benefit from the reforestation of this property. This project provides a tax deductible plan to conserve a natural area and an opportunity for undergraduate students to visualize carbon offsetting and participate in hands on ecological field work. Additionally, the reforestation of this area is a low-cost strategy for offsetting carbon as compared to other projects that have been paid for in recent years. The project has the capability to offset almost 6 years of University sponsored travel, over

a 50 year time period given annual emissions of 2,400 mtCO2e, for only $9,000. The reforestation of this area will provide a unique learning opportunity for students to learn about forest ecology, carbon sequestration, landscape rehabilitation, and sustainability on the University's campus.

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