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Radford University Carbon Footprint: The Commuter Community



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Foreword

This report is a pilot study on Radford University current carbon footprint¹ due to the commuter community of employees vis-à-vis full-time faculty, part-time faculty and staff. The study maps residential addresses, calculates commuting distances and total miles travelled in a year, estimates the amount of carbon emitted and analyses the spatial distribution of residents who are within the walking and biking distance from the university. The intention is to use the findings to identify areas for improvement in the development of a plan to make Radford University more environmentally sustainable Green Campus.

This report is part of the many fronts that RU had kicked off in its campaign for a Green Campus. At the moment RU is gathering data for its Greenhouse Gas (GHG) inventory. The university is also Investigating LEED certification for all new buildings and renovations¹. As of August 2008, the university's bus fleet was converted into B20 fuel².

Within the broad goal of assessing RU Community and transportation, this report provides partial findings with a focus on analytical GIS and statistical analysis. This report was put together by Dr. Charles Manyara in consultation with Dr. Bernd Kuennecke.

Special thanks to Dr. Dennis Grady, Dean College of Graduate and Professional Studies whom was instrumental in putting the proposal together and Dr. Debbie Templeton, (Assistant Vice Provost & Director of Institutional Research) who was there from the beginning sharing her ideas and whose office was very gracious in providing the data and support necessary to compile the report.

Summary

Scientific evidence indicates that the world is rapidly warming and that historic and current emissions of greenhouse gases are the primary agents of this climate change. In order to avert some of the more catastrophic consequences of global climate change, decisive action is needed to reduce emissions of greenhouse gases. A number of institutions across the country signed the American College and University Presidents Climate Commitment (ACUPCC)³. Signatory institutions (over 640 at present) must establish their carbon footprint within a year and must then develop a strategic plan for becoming carbon neutral.

Radford University is a member of the Association for the Advancement of Sustainability in Higher Education (AASHE)⁴, one of three co-organizers for the American College & University Presidents' Climate Commitment. AASHE is the first North American professional association for those working on campus sustainability issues. It promotes ideas and shares resources among members and their communities.

Using a carbon calculator developed by EPA based on data from a variety of governmental sources, an estimate of carbon dioxide emissions from non-resident commuting staff and faculty at Radford University (RU) Campus based on the 2008-2009 academic year residence addresses was derived.

There are several different gases that contribute to global warming including carbon dioxide (CO₂), methane (CH₄), fluorocarbons, and nitrous oxides (NO_x). The carbon calculator used evaluates all greenhouse gases that are produced while providing a combined output score in (metric) tons of carbon dioxide equivalent emissions (TCDE). This report includes only the TCDE, a singular

¹ A carbon footprint is a "measure of the impact human activities have on the environment in terms of the amount of greenhouse gases produced.

measure of greenhouse gas emissions. Assumptions made for all calculations can be found in the text and the end notes.

The RU estimated footprint for 2008-2009 academic year is 2,539.64TCDE. Approximately 65.02 percent comes from the non-teaching staff, 20.60 percent from full-time faculty and 14.38 percent contribute from part-time faculty.

Mapping Commuters

Of the original list of 1346 commuters only 1239 had street addresses that could be mapped in a GIS environment. The sample for the study was made of 364 full-time faculty, 170 part-time faculty and 705 staff (Figure 1).

From the 1239 addresses, were several out of state residential addresses notably Alabama, Illinois, Massachusetts, North Carolina, and West Virginia(Figure 2). The out-of-state addresses were all except one part-time faculty.

As expected, most university employees are Virginia residents. Although some commuter addresses seemed too far to make a realistic commute distance to and from work each day, most were within a 2-hours one-way or under 150 miles one-way drive (Figure 3). The outliers of this optimum commuting range were very few.

Of all those within driving range over 96% come from nine counties and cities namely Carroll, Floyd, Galax, Giles, Grayson, Montgomery (especially Blacksburg & Christiansburg), Radford, Roanoke, and Salem (Figure 4).

Commuter Mileage

One-way (trip) mileage was calculated for each commuter by averaging the driving distance between the zip code of origin and the RU zip code (24142). It was assumed that aggregating clusters of commuters per group – full-time, part-time and staff - to a distance from their common zip code could give a similar number as though each individual commute trip was measured.

The calculated average two-way (round trip) journey for part-time faculty was 66.18 miles, followed by full-time at 33.21 miles and non-teaching staff at 27.06 miles.

The following assumptions were made in deriving the total commuter mileage:

1. Full-time faculty members commuted to campus an average of four (4) round trips per week for a total of 120 days/year.
2. Non-teaching staff members commute five days a week for a total of 240 days/year.
3. A part-time faculty member makes three (3) round trips per week² for a total of 90 days/year.
4. Every commuter drove a car³ alone and made only one trip per day. The final tally for the distances travelled is shown in Table 1. The total annual commute is 7,041,718.8 miles.

² This is assumed to be minimum rather than average or maximum number of trips.

³ The emphasis on car is intentional since no survey was done and there was no data available on commuter mode of transportation. Further, cars as opposed to trucks or any other form of vehicle vary in average gas consumption.

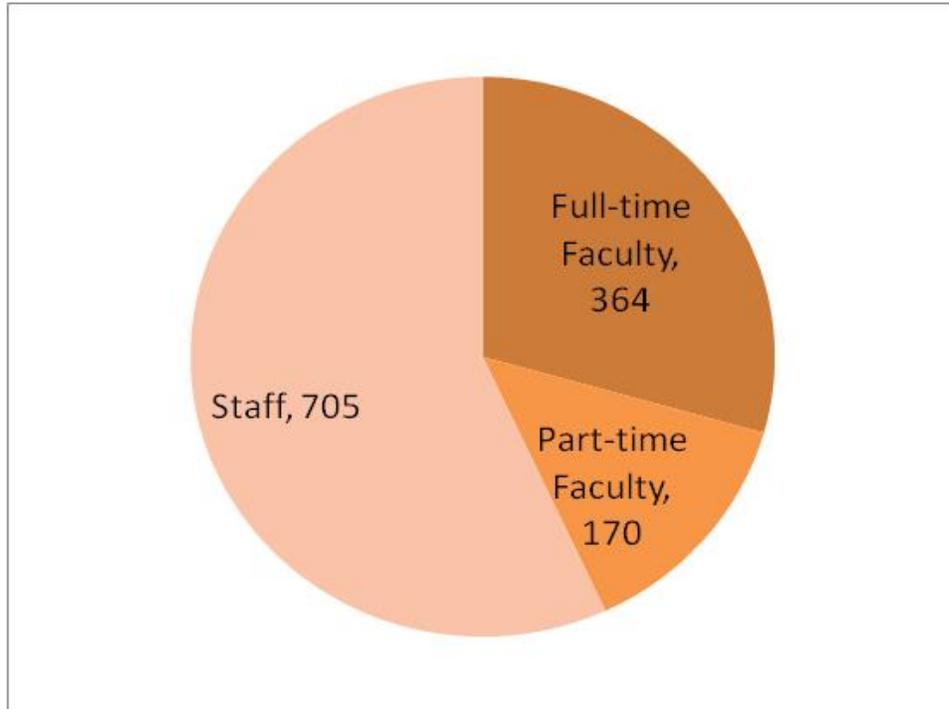


Figure 1. Commuter Community

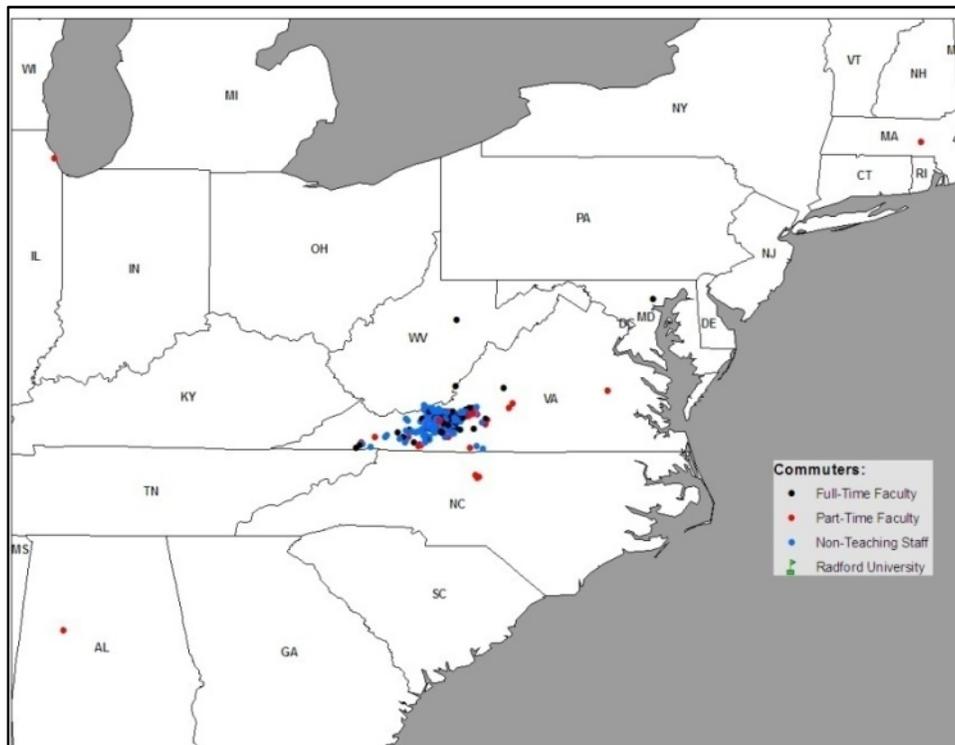


Figure 2. Commuter Distribution

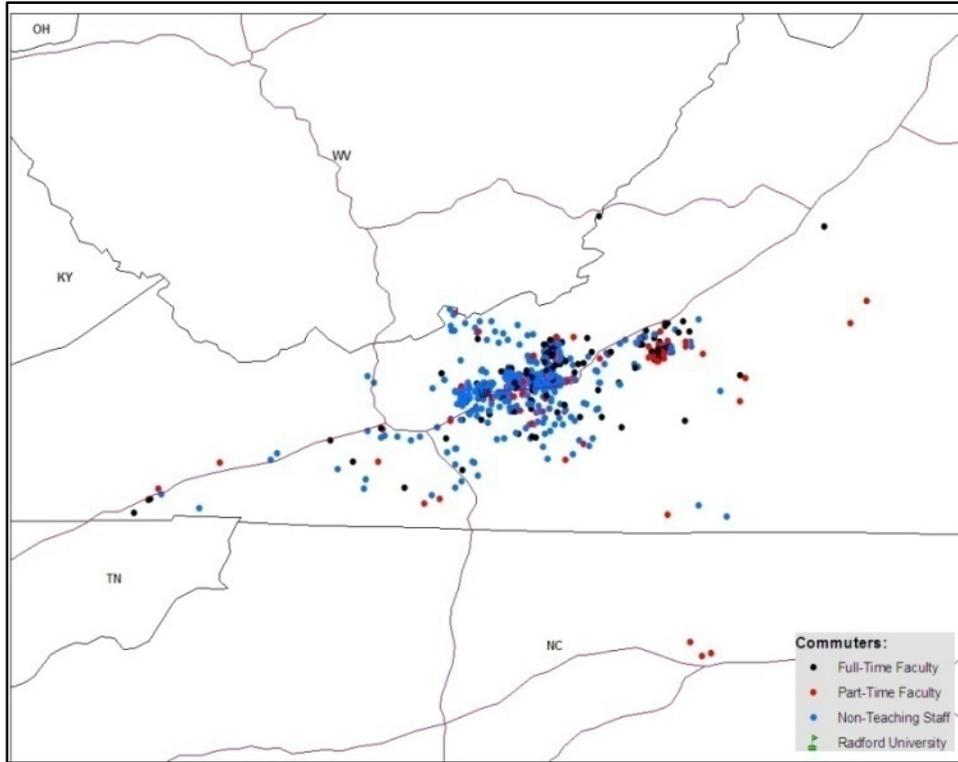


Figure 3. Distribution of Commuters within drive range.

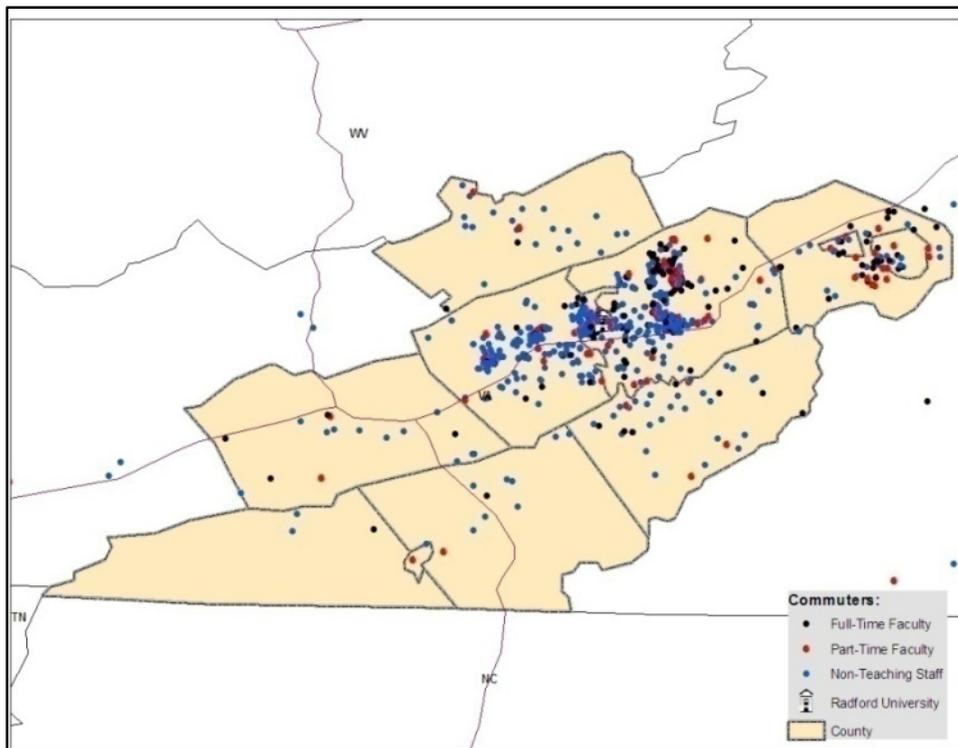


Figure 4. Core Locations

Table 1. Total Mileage

	Number of Commuters	Average Round Trip	Total Round trip Mileage(#Days)		Total Miles
Part-time Faculty	170	66.18	11,250.60	(90)	1,012,554.00
Full-time Faculty	364	33.21	12,088.44	(120)	1,450,612.80
Staff	705	27.06	19,077.30	(240)	4,578,552.00
Total	1,239				7,041,718.80

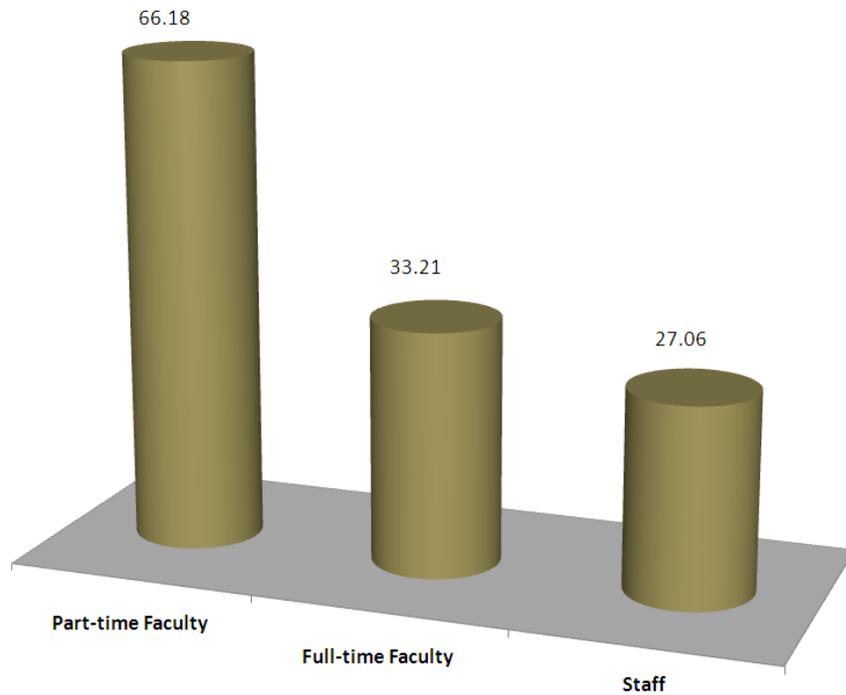


Figure 5. Average Round Trip

Carbon Footprint

To calculate the number of gallons of gasoline used in a year, the Department of Transportation's fleet average⁴ (all cars, old and new)⁵ of 24.4 mpg was used to divide the total miles driven a year. The RU commuter community uses about 288,595.05 gallons/year (Table 2). According to EPA unleaded gasoline has about 19.4 lbs (8.8 kg) of CO₂ per gallon. Multiplying this value with the number of gallons of gasoline equals to 2539636.44 kg. Carbon dioxide emissions are expressed in terms of tons of carbon dioxide equivalent⁵ (TCDE).

The carbon footprint by commuter community sampled in this study therefore is 2539.63644 TCDE per year.

Table 2. Annual Carbon Emission

	Total Mileage Driven/year	# Gallons (Gasoline/year)	TCDE
Part-time Faculty	1,012,554.00	41,498.11	365.18337
Full-time Faculty	1,450,612.80	59,451.34	523.17179
Staff	4,578,552.00	187,645.60	1,651.28128
Total	7,041,718.80	288,595.05	2,539.63644

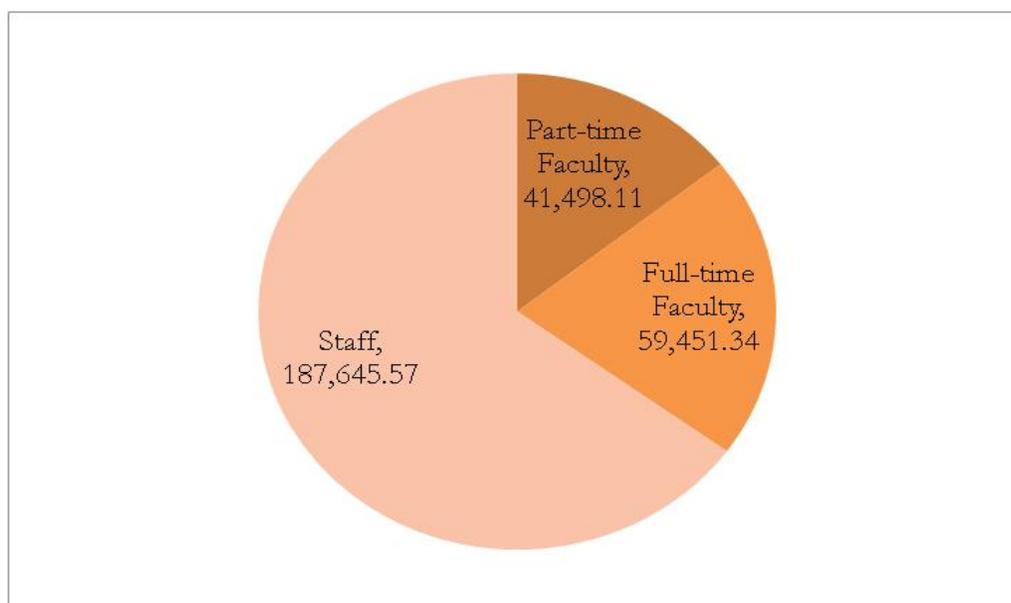


Figure 6. Gallons of Gasoline per year

⁴ Automobiles fuel efficiency (MPG) varies widely so averages are not all that useful. According to the National Highway Traffic Safety Administration (NHTSA) the average fuel economy for cars sold in 2005 is about 25.2 mpg. The newly released Fuel Economy Guide 2009 estimates the average fuel economy for cars to be about 33.625 mpg.

⁵ The international standard is to express emissions in CO₂ equivalents (CO₂e) in metric units. In the past many U.S. sources expressed emissions data in terms of carbon equivalents (CE), a practice that accounted for the carbon in the CO₂ molecule, as opposed to counting the entire molecule.

Walking and Biking

The average walking speed is about 3 to 4 mph, although this depends heavily on factors such as height, weight, age, terrain, surface, load, culture, and fitness. In a city environment the choice to walk or bike as opposed to driving can also be influenced by a host of other factors such as the availability of sidewalks and/or bike lines. The question was to consider the possibility that faculty can afford to walk and/or bike to work. Studies show that while the median trip length is 0.54 miles for Social/recreational or leisure walk, “utilitarian” trips, such as from home to work or home to shopping are 0.28 miles (Ewing, 2003). There is a general reluctance for walking to work and sometimes for good reasons despite the advantages to the environment⁶ and health. It is much different walking to work than it is, say, going out for a leisurely stroll or shopping.

Past studies have shown that the choice and frequency of the bicycle as a commute mode are affected by such factors as; weather, land use density, characteristics of the transportation network (including provision of bicycle facilities), availability of bicycle parking/other facilities at work, gender, distance (or travel time) to work, physical exertion, cost, the necessity of a car for errands before, after, or during work, and population characteristics (Stinson and Bhat, 2002). In addition, several previous studies show that the average biking distance⁷ is about 7.2 miles but can vary from 5 to 8 miles or about 30 minutes.

Concentric rings were developed for each of the modes of transport. For walking the buffers were set at 0.28 miles and 0.5 miles from the main campus perimeter (Figure 7) while the buffers for biking was set at 7.2 mile (Figure 8). The detailed breakdown of the numbers of commuters in each commuting distance and by groups is shown in Table 3.

Table 3. Mode of Transport

Buffer (Miles)	#Commuters	#Commuters (As percent of total)	Mode of Transport
0.28	46	3.7	Walk
0.5	104	8.4	Walk
7.2	494	39.9	Bike

⁶ The National Highway Traffic Safety Administration (NHTSA) estimates that if one out of 10 car commuters would switch to walking or biking, the nation can reduce carbon dioxide emissions by 25.4 million tons a year.

⁷ The average tends to be higher for men than for women.

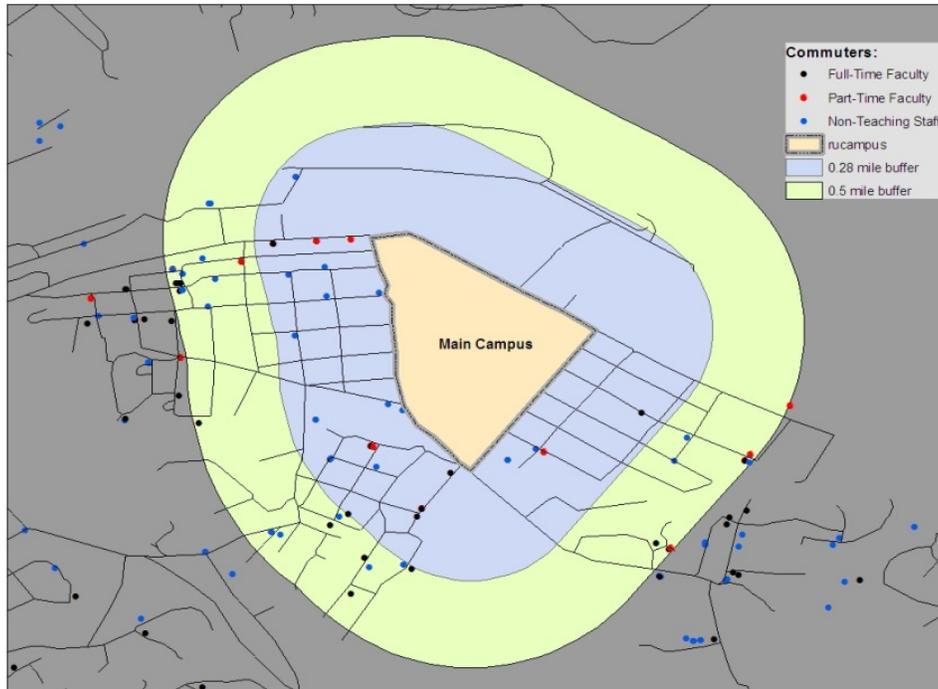


Figure 7. Walking distance Buffers- 0.28 miles and 0.5 mile radius from campus.

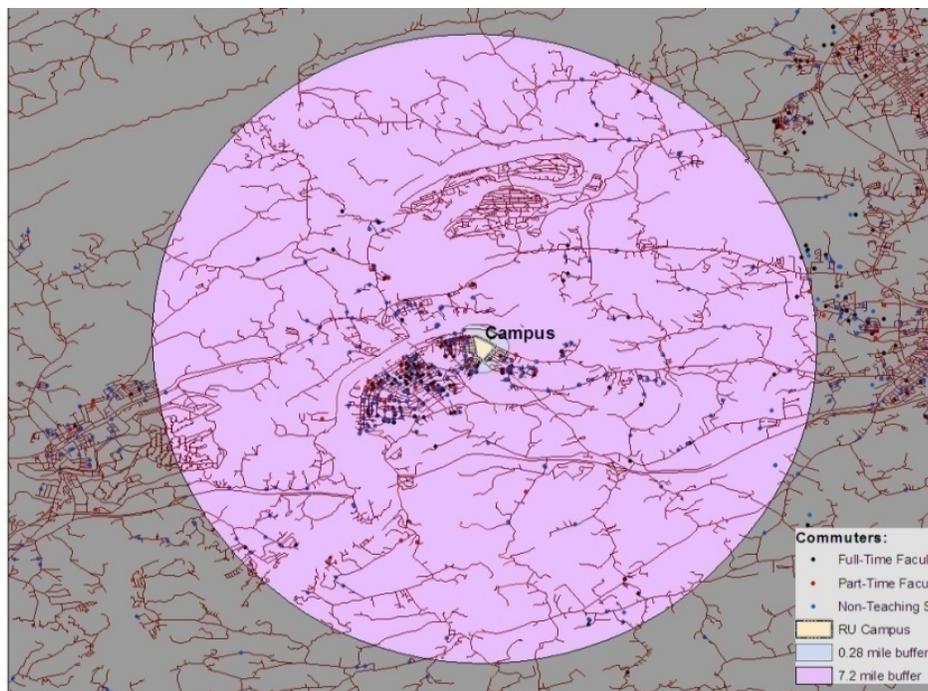
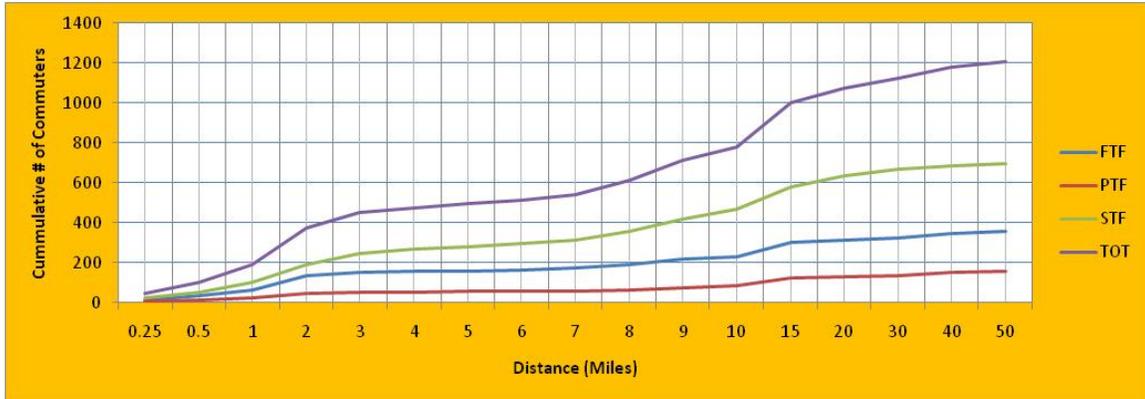


Figure 8. Biking (7.2 miles) and Walking (0.28 mile) buffers



(a)



(b)



(c)

Figure 9. Distance- Commuter frequency graphs (a), (b), (c).

The way forward

This was a preliminary exploration of the potential impact of the RU commuter community on the current campus carbon footprint. As with most campuses across the nation, the average employees commuting distances can be long, increasing emission of carbon dioxide and other greenhouse gases. Walking and biking are attractive options but they too have their limitations. At this point the only information available is the number of commuters within walking or biking distances. More needs to be known to assess effectively the gain that can be made in switching from one transport mode to another. The study will benefit immensely if more data over the years was used to monitor the trend. It will also be important to include students in a more comprehensive commuter study. Commuter transportation is only one aspect of the many areas that are and will be explored to make RU more environmentally sustainable Green Campus. The distance-commuter frequency graphs provide a starting point for developing carpooling initiatives in the future

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End Notes:

¹ The Leadership in Energy and Environmental Design (LEED) is a voluntary, consensus-based national rating system for developing high-performance, sustainable buildings. LEED certification provides independent, third-party verification that a building project meets the highest green building and performance measures. All certified projects receive a LEED plaque, which is the nationally recognized symbol demonstrating that a building is environmentally responsible, profitable and a healthy place to live and work. Read more about LEED at the US Green Building Council website; <http://www.usgbc.org/DisplayPage.aspx?CMSPageID=222>.

² Biodiesel is a mono-alkyl ester based oxygenated fuel made from vegetable or animals fats. It is commonly produced from oilseed plants such as soybean or canola, or from recycled vegetable oils. Biodiesel has similar properties to petroleum diesel fuel and can be blended with petroleum diesel fuel at any ratio. The most common blend rate is 20 percent biodiesel, 80% petroleum diesel. This mixture is referred to as "B20". Pure or neat biodiesel is termed B100. Biodiesel is non-toxic and biodegradable. It is proven that B20 reduces particulate matter (PM) emissions by 8%-22% when compared to conventional diesel fuel. The variation is a function of the type of biodiesel used.

³ RU is reviewing options for joining the ACUPCC. You can read more about ACUPCC at <http://www.presidentsclimatecommitment.org/html/signatories.php>

⁴ RU joined AASHE on August 9, 2008. See <http://www.aashe.org/>.

⁵ Energy Information Administration – Voluntary Reporting of Greenhouse Gases.

<http://www.eia.doe.gov/oiaf/1605/coefficients.html>. The average mpg for cars/trucks (2004) is 24.5; EPA: 20 lbs CO₂/gal .