

Marlboro College's Ecological Footprint Calculator Manual

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Introduction

What is an ecological footprint? In the most basic terms, it's a measurement of our use of ecological services. It measures the impact of each of our different activities as the area required to produce the resources used and absorb the waste generated. The footprint is measured in hectares per year: the amount of land it will take to generate ecosystem services at the same rate that we are using them. Our calculator takes the raw data of our campus's use (like the number of reams of paper we use per year, or the pounds of meat we consume per year) and multiplies this by a conversion factor, which basically says, "X is how many hectare-years we need for each [pound/ream/gallon] of Y." The scope of our footprint development did not allow us to devote time to developing or dissecting conversion factors, and so for this part of the process where we relied heavily on two wonderful resources: the University of Toronto and the extremely informative *Sharing Nature's Interest* by Nicky Chambers, Craig Simmons and Mathis Wackernagel.¹

We (Mia Bertelli, a freshman, and Ellie Roark, a junior) decided to embark on a tutorial with Matt Ollis to measure the ecological footprint of Marlboro College out of a desire to understand Marlboro's environmental impact and take steps toward decreasing it. Based on the research our class had done the semester before, we decided that the ecological footprint—a quantitative approach that went beyond the carbon footprint—seemed like the best option on which to focus our energy. While we had looked at and talked about a more comprehensive, qualitative assessment, we ultimately decided that addressing our impact quantitatively would be more easily summarized and distributed, could more explicitly track our progress from year-to-year, and could better motivate change on campus.

Much of the inspiration, information and even formatting for our footprint came from the gracious and helpful Dr. Tenley Conway of the University of Toronto, who offered up her students' eco footprint of UTM as a model from which to base our own. Most of our conversion factors (as noted in the Methodology section of this manual) have been pulled from the UTM footprint and converted from metric to US standard units. The conversion factors not from UTM's calculator were all found in *Sharing Nature's Interest*, which helped us understand what it was that we were tracking and how to track it, as well as provided us with some important specific information about specific impacts.

This calculator tracks the "**operating** footprint" of the college, that is, the impact of our normal college operation during the academic year. We have set boundaries of time and distance in order to keep the scope of our footprint manageable. Our timeframe is the academic year, because information is not readily available once the Marlboro Music Festival takes over campus in the summer. Our distance boundary includes all travel by college-owned vehicles, as well as average commute by community members, but excludes all other travel.

As wonderful as the ecological footprint may be, it is not perfect. It does not take into account construction projects (building materials, transportation of those materials, etc.) or any other capital improvements that happen on a non-regular basis. It also doesn't track our curricular or community efforts to improve awareness of our impact. By forcing all the data we've collected on to the same sheet and converting it all to hectare years, we have the benefit of

¹ Nicky Chambers, Craig Simmons, and Mathis Wackernagel, *Sharing Nature's Interest: Ecological Footprints as an Indicator of Sustainability* (London: Earthscan, 2000).

being able to compare the impact of our ice cream consumption with our heating oil use, but we lose the specifics of all the components that go into both heating oil and ice cream, in favor of measuring their impact much more broadly. What we've done here is create a big picture of our college's impact, but it is certainly not a minutely detailed picture, nor is it the whole picture of sustainability at Marlboro.

We hope that our calculator and this manual serve as a guide for future Marlboro students to embark on this project again and compare our impacts from year to year. The developing Environmental Studies program at Marlboro, and the cooperation and support of the EAC, have given us—and future students—a platform from which to look critically at Marlboro's sustainability and move forward into the realm of action and change.

Methodology

The goal is to get a good impression of where we are now (2010/11 academic year). For each data point we either used the complete data from the 2009/10 academic year or estimated our consumption for the 2010/11 academic year from partial data. In all cases we were conservative when making estimates.

I. Materials and Waste

Materials

The numbers below were obtained from Susan Caffery of Plant Operations. All numbers reflect total purchasing and consumption for the academic year at the college. The only purchases included in the footprint are paper products. This footprint does not take into account any purchases for the college's bookstore, for supplies for departments beyond paper, or any purchases for electronics—including the purchase of actual electronics and materials used for the maintenance of electronics.

Paper use: This data came from a spreadsheet that Susan Caffery, Assistant Director of Plant Operations, made for us. We use 1080 reams during the academic year. The conversion factor 1.97 hayr/ream is taken directly from the UTM Calculator.

% recycled content (enter as fraction): Refers to the recycled content of our total paper consumption. According to Susan Caffery, recycled content in paper varies depending on which department is purchasing it. Total recycled content of all paper purchased is between 30% and 100%. For the purposes of this footprint, we took the average of these two numbers (65%). The conversion factor (.273 hayr/ream) for this came directly from the UTM calculator, and is 30% of the conversion factor for paper use.

Paper towels, toilet paper, tissues: Another number from Susan. This number came to us in number of rolls or packs, reading: 108 boxes facial tissue, 465 rolls paper towels, 3888 packs interfold toilet paper, 240 rolls toilet paper. We converted these numbers to lbs, by weighing a case of each product. The weights were: - facial tissue: 12lbs/case; 36lbs total - roll paper towels: 50 lbs/case; 1900lbs total - packs of toilet paper: 17lbs/case; 1836 lbs total - rolls of T.P.: 36 lbs/case; 108lbs total The conversion factor for this data point was originally 1.97 hayr/tonne, and we converted it to .0008934 hayr/lb.

% recycled content (enter as fraction): Our paper towel rolls have 40% recycled content, while our toilet paper is made from 100% post-consumer content. The weight of recycled content (total) is 2704 lbs, which makes up 69.6% (rounded to 70%) of our total paper products consumption.

Cleaning products (oz?): Although this number is not featured in the footprint because we could not find an appropriate conversion factor, we collected this data from Susan. The numbers: - 96 quarts of Best Bet - 36 gallons of Comet with Bleach - 8 Liters of Daily Disinfectant - 4

gallons of Floor Care Soap pH7 - 120 L of foam soap - 4 gallons Murphy's oil soap - 10 gallons Sno Rx

Waste

The numbers below were obtained from Cliff Inman, our recycling and trash collector. These numbers are an average of the waste generated over the course of the entire academic year. Cliff estimates that for both rubbish and recycling, about 60% is made up of paper products, and the remaining 40% is roughly an equal amount of glass, aluminum, plastic, and other materials. As with the other areas of our ecological footprint, these are conservative estimates. The conversion factors are all featured in hectare years per pound (hayr/lb). While we do not have a section for compost, we believe its impact is represented in the rubbish number by virtue of its capacity to decrease the amount of rubbish.

Rubbish Produced: Cliff estimates that he collects an average of 12.95 tons of rubbish per month, but for the sake of remaining conservative with our estimates we rounded down to 12.5 tons per month. We converted tons to pounds using the ratio of 2,000 lbs per ton, resulting in 25,000 lbs per month, which became 212,500 lbs per year when multiplied by 8.5 months of the school year. The conversion factor 0.001905 hayr/lb is an average of the four separate conversion factors provided by the University of Toronto for paper (.0028 hayr/kg), glass (.001 hayr/kg), plastic (.0036 hayr/kg), and aluminum (.0094 hayr/kg). These four numbers averaged come out to .0042 hayr/kg, which we converted to hayrs/lb using the ratio of 2.2046 lbs per kilogram, resulting in our final conversion factor .001905 hayr/lb. While Cliff estimated that 60% of the rubbish he collects is paper products, we chose not to weight the average because the conversion factors were so similar. In the future we hope that with this foresight, materials can be differentiated for greater accuracy.

Recyclables produced: Cliff estimates that he collects an average of 500-600 lbs of recycling per week, from which we chose the middle ground of 550 lbs per month and multiplied by 8.5 months of the school year to result in 18,700 lbs per year. The conversion factor .000487 hayr/lb is an average of the four separate conversion factors provided by the University of Toronto for paper (.002 hayr/kg), glass (.0008 hayr/kg), plastic (.0011 hayr/kg), and aluminum (.0004 hayr/kg). These four numbers averaged together come out to .001075 hayr/kg, which we converted to hayrs/lb using the ration of 2.2046 lbs per kilogram, resulting in our final conversion factor of .000487 hayr/lb. While Cliff estimated that 60% of the recycling he collects is paper products, we chose not to weight the average because the conversion factors were so similar. In the future we hope that with this foresight, materials can be differentiated for greater accuracy.

II. Transportation

This category includes information given to us by Susan Caffery, information gleaned from observation on campus and information taken from a survey put together by Matt Ollis's Fall 2010 "How Environmentally Sustainable is Marlboro College?" class. We mean to measure here the impact of commuters to and from the school, and our fleet's gas consumption. This does not measure the impact of the Moover, or of any travel by students, faculty and staff in service to the college not done in one of the campus-owned fleet vehicles. This includes things like flights to and from campus at the beginning and end of the semester, admissions travel, faculty led academic trips abroad, etc.

Regular College Fleet

Unleaded gas consumption: 8486.02 gallons. This number was obtained from Susan Caffery, and accounts for all the gas purchased during the academic year for our fleet. The conversion factor is .002929 hayr/gallon, which was converted from UTM's conversion factor of .0007 hayr/L.

diesel fuel consumption: We use no diesel fuel for our fleet. This conversion factor was also taken from UTM as .000867 hayr/L and converted to .00328 hayr/gallon.

Personal Vehicles

Number of Commuter Cars: This number was taken from an average of multiple days counting cars in the parking lot. 89 is the total number of cars.

Average miles per car: 19.84 miles per car. This is an average from the mileage estimates of their round trips that 98 commuting community members wrote when responding to the HESIMC class survey. The conversion factor came from UTM, and read .0000928 hayr/km. We converted this to miles, so that it now reads, .00014934 hayr/mile.

III. Food

The scope of this category extends only to food purchased via our food service (by Richie). We decided not to include our very small-scale science building snack bar, or food brought onto campus by individual members of the community. Richie Brown purchases all food for the college Dining Hall and the coffee shop, the former of which serves all community members, the latter of which primarily serves students. Not every community member partakes in consumption of these resources; only an average of 357 meals are consumed per day in the Dining Hall. All data about food consumption was collected through conversation and calculation with Richie Brown, General Manager of Food Services. All numbers have been extrapolated from average weekly purchases to make an informed estimate of yearly consumption. We do not include any allowance for food that goes uneaten, though we believe this will be accurately represented in the compost data within the "Materials and Waste" category. All numbers are featured in pounds, unless otherwise noted. All conversion factors are expressed in our report as hectare years (hy) per pound (lb). For each line in the spreadsheet we give the data in the form we collected it, the corresponding number we entered in the spreadsheet, the original conversion factor and a source for it, and any calculations we've made to adjust the conversion factor units. Most categories and

conversion factors come from the UTM footprint calculator, with the exception of "local roots and vegetables," which came from *Sharing Nature's Interest*.² We feel our categories are an accurate representation of food consumption at Marlboro, but we note that they exclude some items, such as condiments, corn starch, cooking oil, etc., figures for which would most certainly affect our end result.

Food is sourced from the following companies, in order of those we order the most from: US Foods (based in Albany, NY) Black River Produce (based in Windsor, Vermont) Windham Organics (all local, based in Westminister, VT) Garelick Farms (all milk, based in NH) Green Mountain Coffee (teas and coffee) Vermont Bread (where we purchase all our bread, based out of Brattleboro.)

Dining Hall

Fish: We are basing the yearly number of 1,500lbs off of our average weekly consumption of 50lbs of fish. The original conversion factor .0045 hy/kg was taken from the University of Toronto's ecological footprint calculator and does not include any allowances for more local or less local fish. (i.e. Sometimes it comes from Alaska and sometimes from Maine and we don't make allowances for the difference between the two). We have converted UTM's conversion factor from kilograms to pounds using the ratio of 2.2046lbs per kg, resulting in .00204 hy/lb. We have measured in pounds.

Other Meat: We are basing our yearly number of 16,680 lbs off of the average weekly consumption of 556lbs of other meat. This weekly number consists of:

- 150lbs chicken
- 135lbs hamburgers
- 90lbs bacon
- 50lbs ground beef
- 50lbs pork
- 33lbs turkey
- 20lbs sausage
- 15lbs gyro meat
- 13lbs ham.

The original conversion factor .0069 hy/kg was taken from the University of Toronto's ecological footprint calculator and does not include any allowances for more local or less local meat. Only rarely do we purchase thoroughly local meat, such as for special occasions like Community Dinner. We have converted UTM's conversion factor from kilograms to pounds using the ratio of 2.2046lbs per kg, resulting in .00313 hy/lb. We have measured in pounds.

Non-local Roots and Vegetables: Since our purchases of local produce are not consistent throughout the year or easily separable from non-local purchases, we needed to make some educated estimations in order to calculate this number. Richie Brown estimated that depending on the season, about 10%-30% of the roots and vegetables we purchase are local. Therefore, in

² Ibid.

order to calculate the yearly average of non-local vegetables, we chose the middle ground of 20%, divided the total number of roots and vegetables accordingly, and include the remaining 80% here. Thus, the total yearly consumption of 40,680lbs of roots and vegetables per year (including fresh, frozen, and canned vegetables), based off of our weekly consumption of 1,356lbs, became 32,544lbs of non-local vegetables per year. The total number was estimated based on our average consistent purchases of staple vegetables with added allowance for periodic extraneous purchases. The original conversion factor .0004 hy/kg was taken from the University of Toronto's ecological footprint calculator. We have converted UTM's conversion factor from kilograms to pounds using the ratio of 2.2046lbs per kg, resulting in .0002267 hy/lb. We have measured in pounds.

Local Roots and Vegetables: Since our purchases of local produce are not consistent throughout the year or easily separable from non-local purchases, we needed to make some educated estimations in order to calculate this number. Richie Brown estimated that depending on the season, about 10%-30% of the roots and vegetables we purchase are local. Therefore, in order to calculate the yearly average of local vegetables, we chose the middle ground of 20%, divided the total number of roots and vegetables accordingly, and include that 20% here. Thus, the total yearly consumption of 40,680lbs of roots and vegetables per year (including fresh, frozen, and canned vegetables), based off of our weekly consumption of 1,356lbs, became 8,136lbs of local vegetables per year. The total number was estimated based on our average consistent purchases of staple vegetables with added allowance for periodic extraneous purchases. The conversion factor .000136 hy/lb was taken from "Sharing Nature's Interest." It is worth noting that local can mean anything from a few hundred feet down the hill on the college farm, to a few hundred miles away. We have measured in pounds.

Bread, grains and grain products: We are basing our yearly number 16,500lbs off of the average weekly consumption of 550lbs of bread, grains, and grain products. This weekly number consists of:

- 445lbs bread and wheat products
- 70lbs grains (about 65lbs of which is rice)
- 20lbs cereal
- 12lbs oatmeal
- 3lbs grits.

The original conversion factor .0017 hy/kg was taken from the University of Toronto's ecological footprint calculator. We have converted UTM's conversion factor from kilograms to pounds using the ratio of 2.2046lbs per kg, resulting in .000771 hy/lb. We have measured in pounds.

Milk and dairy (including eggs): We are basing our yearly number of 39,787.8lbs off of the average weekly consumption of 1,251lbs milk, dairy, and eggs per week. This weekly number consists of:

- 751.05lbs milk
- 180lbs eggs (60lbs of which is liquid eggs)

- 117lbs cheese
- 75.105lbs half and half
- 75.105lbs ice cream
- 60lbs butter
- 48lbs yogurt
- 10lbs sour cream.

The original units in which we purchased milk, half-and-half, ice cream, and eggs--by the gallon and by the dozen--we converted to pounds using the ratio 8.345 gallons per 1lb for the former, and 1 dozen eggs per 1lb for the latter. The original conversion factor .0011 hy/kg was taken from the University of Toronto's ecological footprint calculator and does not include any allowances for more local or less local dairy (i.e. most of the time we purchase Vermont-made cheddar cheese, and our milk comes from within New England, but the majority of our other dairy products come from farther away.) We have converted UTM's conversion factor from kilograms to pounds using the ratio of 2.2046lbs per kg, resulting in .000499 hy/lb. We have measured in pounds.

Fruits: We are basing our yearly number of 17,910lbs off of the average weekly consumption of 597lbs of fruit. Our staple fruits include pineapple, cantaloupe, honeydew, grapefruit, apples, oranges, bananas, and raisins, with periodic purchases of strawberries, grapes, pears, and other seasonally available fruit. The original conversion factor .0005 hy/kg was taken from the University of Toronto's ecological footprint calculator, and does not make any allowances for more or less local fruit, or any difference between frozen and fresh fruit. We have converted UTM's conversion factor from kilograms to pounds using the ratio of 2.2046lbs per kg, resulting in .000227 hy/lb. We have measured in pounds.

Processed foods: We are basing our yearly number of 21,417.91lbs off of the average weekly consumption of 713.93lbs of processed foods. This weekly number consists of:

- 233.66lbs juice concentrate
- 216.97lbs soda concentrate
- 100.14lbs soy milk
- 66.76lbs salad dressing
- 51lbs veggie burgers
- 20lbs coffee
- 12lbs potato chips
- 8lbs corn chips
- 5.4lbs tea bags

The original units in which we purchased salad dressing, juice concentrate, soda concentrate, and soy milk--by the gallon--we converted to pounds using the ratio 8.345 gallons per 1lb. The number 5.4lbs of tea bags was calculated from Richie's estimation that we go through about 900 tea bags a week; there are 25 tea bags per box, and each box holds 2.4oz of tea. Thus 900 tea bags per week divided by 25 tea bags per box equals 36 boxes, and 36 boxes multiplied by 2.4oz equals 86.4oz of tea. Ounces were then converted to pounds using the ratio of 16oz per lb, resulting in 5.4 lbs of tea bags per week. The original conversion factor .0003334 hy/\$ was taken

from the University of Toronto's ecological footprint calculator. We have converted UTM's conversion factor from dollars to pounds by estimating the amount of money spent on these processed foods per week (\$305) and dividing that number by the total weekly lbs (137.76) to achieve an average price per pound of processed food (\$2.21 per lb.) We then multiplied .0003334 hy/\$ by \$2.21/lb, which resulted in our final conversion factor of .000737 hy/lb. It is worth noting that many processed foods are not included in this category and are instead a part of other categories which we thought suited them best for our purposes, such as french fries, chicken nuggets, and cereal. It is also worth noting that we have included beverages in this category because we could not find a separate conversion factor for them, but we believe they all fit into the category of processed foods and contribute a significant amount to our final ecological footprint. However, we believe it is worth continuing the search for a conversion factor for beverages for future calculations, because our conversion factor for processed foods is an estimate based on dollars which constantly shift in value. We have measured in pounds.

Coffee Shop

All food for the Coffee Shop is ordered separately, with the exception of fresh vegetables and bread products, which the Coffee Shop takes from the Dining Hall. We have only included those things which are not a part of the Dining Hall's order below. However, it is worth noting that the Coffee Shop uses about 25lbs of fresh vegetables and about 60lbs of bread products per week from the Dining Hall.

Meats: We are basing our yearly number of 1,800lbs off of the average weekly consumption of 60lbs of meat. Of this weekly number, 30lbs is beef, and 30lbs is chicken. The conversion factor is the same as that used for "Other Meat" in the Dining Hall. We have measured in pounds.

Fruits: We are basing our yearly number of 300lbs off of the average weekly consumption of 10lbs of frozen fruit. The conversion factor is the same as that used for "Fruits" in the Dining Hall. We have measured in pounds.

Milk and Dairy: We are basing our yearly number of 1,260lbs off of the average weekly consumption of 42lbs of milk and dairy. This number includes ice cream, sour cream, butter, and cheese. The conversion factor is the same as that used for "Milk, Dairy, and Eggs" in the Dining Hall. We have measured in pounds.

Processed foods: We are basing our yearly number of 10,186.875lbs off of the average weekly consumption of 339.5625lbs of processed foods. This weekly number includes 8 lbs of corn chips, 100lbs of frozen items (such as french fries, mozzarella sticks, guacamole, veggie burgers, etc.), and 231.5625lbs of various canned and bottled beverages. As with the beverages for the Dining Hall, we have included them here due to the lack of a separate conversion factor, and because we believe they fit into this category and contribute a significant amount to our final ecological footprint. All beverages purchased by the Coffee Shop come in individual cans and are measured by the ounce, so we converted our data from its original form of 3,705oz of beverages per week to pounds, using the ratio of 16oz per pound. The conversion factor is the same as that used for "Processed Foods" in the Dining Hall. As with "Processed Foods" in the Dining Hall, we believe it is worth continuing the search for a conversion factor for beverages

for future calculations, because our conversion factor for processed foods is an estimate based on dollars which constantly shift in value. We have measured in pounds.

IV. Water

Our total water usage was obtained from Jeff Putnam. This number is a measurement in gallons of total water usage for our main campus during the academic year (September to mid-May). This number includes water consumption over breaks (both mid-semester and between semesters). We obtained our total use number by adding up the monthly water consumption totals for the academic year. We looked at only the total for each month except May, for which we only added the first 16 days. The original conversion factor, $0.000008 \text{ m}^3/\text{ha-yr}$ was taken from the University of Toronto calculator. We converted this to gallons, so on the calculator it now reads: $0.0000003 \text{ hayr/gallon}$

V. Energy

Total grid-derived energy use: This number came from a spreadsheet from our Director of Plant Operations. The information was compiled from monthly totals of kWh, and so reflects the addition of these monthly totals from September-May. It does not take into account breaks, or our 30-week academic year schedule, which was used to compile numbers for food. The number we used is the total kWh from the 2009-2010 school year. The conversion factor for total electricity use is taken from the weighted percentages of each type of electricity use. We got the conversion factors for the individual components from the UTM calculator, where they read: Nuclear, 174; Hydroelectric, 42.5; Natural gas, 94; Coal/oil, 174; Wind, 6; Solar, 24; Biomass, 36.5; Geothermal, 8.4. We converted these from hayr/gWh to kWh so they now read:

- nuclear: .000174 hayr/kWh
- hydroelectric: .0000425 hayr/kwh
- natural gas: .000094 hayr/kwh
- coal/oil: .000174 hayr/kwh
- wind .000006 hayr/kwh
- solar: .000024 hayr/kwh
- biomass: .0000365 hayr/kwh
- geothermal: .0000084 hayr/kwh.

We pulled the percentages of our electricity mix from the 2011 Sierra Club Survey answers submitted on behalf of the EAC by Matt Ollis. They are:

- nuclear: 55%
- hydroelectric: 38%
- natural gas: 0%
- coal/oil: 3%
- wind 0%
- solar: 0%
- biomass: 4%

- geothermal: 0%

Propane: This number also comes from a spreadsheet maintained by Dan Cotter, and is the total purchase of propane for January-May and September-December for 2010. It should be noted that while this number was taken in the hopes of getting a footprint using data collected mostly from 2010, our total propane usage this year seemed low in comparison with years past. No propane use was recorded on the spreadsheet from June-September. Our conversion factor here came from UTM's footprint calculator, and originally read: .000361 hayr/L, but was converted to .0000953 hayr/gallon.

Heating Oil: This number came from yet another spreadsheet of data collected by Dan Cotter. Again, the total number you see on the footprint (81899.7 gallons) was obtained from adding monthly totals from 2010 (January-May and September-December) to determine total usage during the academic year. The conversion factor was originally taken from *Sharing Nature's Interest* (p. 82) and read 59 hayr/Gwh. This was converted to hayr/gallon using the conversion factors of 1 gWh=3,412,000,000 Btus and 1 gallon of #2 oil= 125,000 Btus. We determined from this that 1 gWh=27296 gallons, and so 59 hayr/gWh = .00216 hayr/gallon.

VI. Land Use

All numbers in our land use category were obtained from Dan Cotter, Director of Plant Operations at the College, this year. Some numbers were pulled from the "How Environmentally Sustainable is Marlboro College?" class's assessment. These numbers account for the basic area of campus that is built up, but do not contain any information about the environmental cost of construction or building on campus. Again, this is our operating footprint.

Building Footprints: Our building footprint comes from adding the total ground floor square footage of every building on campus. This number is based on an estimate by Dan Cotter, who made the estimate by looking at the overall square footage on campus (roughly 250,000 sq ft) and divided the total sq. footage for each building by the number of floors. While this isn't a perfect estimate, as some buildings have different first, second and third floors, it is as close as we could come with the data readily available. According to this calculation, Dan determined our building footprint was roughly 114,446 sq ft. I rounded this down to 114,000 in keeping with our commitment to conservative estimates. The conversion factor was obtained from the UTM Calculator. They measured their footprint in square meters, and the conversion factor read: 0.000283 hayr/sq m. We converted this to square feet, which made the conversion factor .00002629 hayr/sq ft.

Roads and Impermeables: This data was obtained with cooperation and assistance from Dylan Knaggs using a combination of physical measurement (with a measuring tape) and estimates made from Google Maps. We began by splitting the campus up into several different areas based on rough road width, and set out to take the length of road areas by estimating from a Google Map image, and multiply that by the width of each road area, which we would measure physically. The sections were measured as follows:

- science building to the dining hall (including library): L-650 ft , W-17 ft

- dining hall to South Rd.: L-220 ft, W-32.5 ft
- dining hall/Mather inner loops: L-350 ft, W-17 ft
- South Rd (from the kiln shed to Persons Auditorium): L-1000 ft, W-23 ft
- the road to Whittemore: L-1350 ft, W- 22ft
- Commuter lot: L-172 ft; W- 58.5 ft
- middle lot: L-99 ft, W-56 ft
- upper lot: L-195 ft, W-55 ft

All length measurements were obtained from Google Maps, and all road widths were measured physically, with the exception of the Parking lots, which were all measured entirely by hand to determine our margin of error by using Google Maps. We determined that our margin of error was probably in the realm of 5ft, which, for the purpose of this footprint, we felt was appropriate. The Google Maps estimates are conservative. The original conversion factor, .000283 hayr/sq m (taken from the UTM calculator) was converted to square feet, making it .00002629 hayr/sq ft.

Forested Land: Our number of forested acres is 266. This number was obtained from our Current Use plan for campus. See "Note" at the bottom of this page for more information.

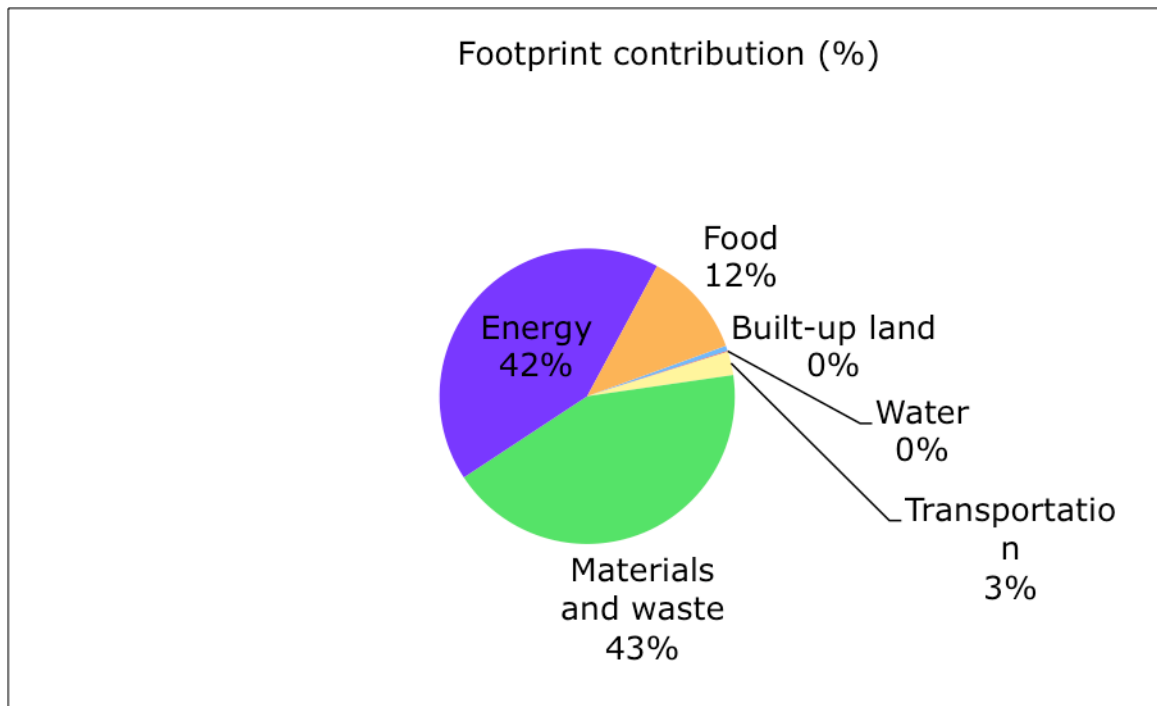
Cultivated Land: This is an estimate based on assumptions from the farm committee. The number was first obtained in Fall 2010 as part of a qualitative assessment of campus sustainability done by the "How Environmentally Sustainable Is Marlboro College?" class. This number only measures our currently active farm, and does not measure the amount of land occupied by our apple trees, or take into account the plans for farm expansion onto the southern soccer field slope.

Note: Cultivated and Forested land do not have conversion factors because they do not contribute (except in ways that are already measured elsewhere) to our ecological footprint. We believe these could be some kind of credit to our eco footprint, though we are still working out the details of how to fit that into our calculation.

Results

Marlboro College's Total Ecological Consumption Footprint is 971 global hectares per year. As Marlboro sits on 130 hectares of land, this means we use more than 7 times of the area of campus per year, based on our consumption this year. There are 390 campus community members, thus the footprint per campus community member is 2.5 global hectares per year.

The pie chart below represents the proportions that each category takes up in our total ecological footprint. We recognize that this manner of presenting data does not reflect the actual quantitative or qualitative damage that we do, and therefore will not reflect any increases or decreases in our ecological footprint over time, only changes between categories that will always add up to 100%.



Materials and Waste accounts for 418 global hectares of our total footprint. We were a bit surprised by this number and had not expected it to be quite so big. However, this is perhaps telling, for it suggests that perhaps this category is as big a contributor as it is because we are the least aware of our habits to use and discard materials. This number is also likely larger in actuality, because it currently represents only paper-based materials, rubbish and recycling.

Energy accounts for 409 global hectares of our total footprint. We had expected this number to be the biggest, as it is in most other college's ecological footprints. Our energy use essentially breaks down to electricity and heating oil, of which the former is a bit more than half and the latter is a bit less than half.

Food accounts for 113 global hectares of our total footprint. We had expected this number to be fairly large, and perhaps a bit larger than it is but not much so.

Transportation accounts for 25 global hectares of our total footprint. We had definitely expected this number to be a larger contributor than it is. One reason it came out to be so small may be that by virtue of the size of our campus, nearly all transportation around campus is walking, biking, skiing, or snowshoeing. Another reason may be that we chose to count only regular transportation to and from campus and travel made with the college fleet of vehicles; we did not include things like flights to and from campus at the beginning and end of the semester, admissions travel, faculty led academic trips abroad, and the impact of the MOOver, which serves many commuters to and from campus. Additionally, just because this number is small in comparison to energy, waste, and food, does not mean that it is less important to pay attention to and make efforts to decrease.

Built-up land accounts for 5.7 global hectares of our total footprint (0.58%). It is important to note that this is only a square-foot, one-time consumption footprint. It does not account for the materials used to construct a building, nor does it average out the impact of a building over time. Additionally, as with transportation, just because this number is small in comparison to energy, waste, and food, does not mean that it is less important to pay attention to and make efforts to decrease. Efforts made to improve the efficiency of a building will show up as a large contributor in a consumption ecological footprint such as this one, but over time will have significant effects on reducing other categories, such as energy and water.

Water accounts for 0.9 global hectares of our total footprint (0.09%). We found this number surprisingly small. However, just because this number is small in comparison to the other categories does not mean that it is less important to pay attention to or make efforts to decrease. Indeed, much of the impact of our water use is represented in the energy category, for a great amount of energy goes into circulating the water around campus and heating water for showers and the kitchen's dishwashers.

For full details, see our ecological footprint calculator spreadsheet.

Discussion

Where do we go from here?

As we mentioned in the introduction, ideally the calculator and this accompanying document will be updated and built upon by future Marlboro students. Because we've painted such a big picture, there's room to incorporate a more detailed sketch of the individual data points. (For example, our current number for heating oil does not include degree-days.) In case student interest wanes, we hope that the EAC, in conjunction with the Environmental Studies faculty, will keep this document in our institutional memory for interested students to pick it up and continue the assessment.

Even with only one year's worth of data, a completed ecological footprint for the college allows us to move forward in two important ways: comparing ourselves to other institutions, and taking action on our campus to decrease our impact and increase our sustainability.

Comparing ourselves to other institutions

Although assessments with a national registry that are specifically tailored to colleges and universities may be a more effective way to compare ourselves to other institutions, there are several schools using the ecological footprint as a way to track their own efforts/impacts. Because each of these other institutions varies drastically from Marlboro in their size and program, their total footprint is not a useful point of comparison; instead we can use the per-capita footprint to compare ourselves. Our per capita footprint is ~2.5 hayr/person.

University of Toronto:

Our calculator owes much to the UTM model, so comparison with UTM can be done more closely than with other institutions. Because we used similar categorical divisions, data points and boundaries, this is perhaps the best comparison of our footprint that can be made to any institution. Though our footprint is modeled from UTM's in many ways, we varied from the larger school in a number of ways. Because of the similarities in our approach to the project, we expected our categories to be weighted roughly similarly to their categories, but found instead that the Transportation and Waste categories were drastically different at both schools.

UTM, because of its heavy commuter population and constantly running circuit of buses to transport students from one end of campus to another, came out with a transportation footprint that was proportionally much higher than ours. The Materials and Waste category, on the other hand, made up less than 3% of their total footprint. In the companion to their footprint calculator, the students who developed the footprint explained that there'd been concerted efforts to reduce the amount of trash on campus. The UTM footprint also seems to only account for plastic, paper, glass and metal that gets thrown away, but does not measure any kind of trash beyond those categories in a discernable way. Needless to say, we were still a bit shell-shocked when our own campus waste turned out to be roughly 42% of our footprint.

UTM's total per-capita footprint was 1.042 hayr/person in 2006. Ultimately, we believe that this number comes from the fact that there's much less land per capita at UTM, and two of our largest contributing factors (heating oil and waste) were not something UTM had to account for or did account for in the same way we did.

Ohio State University:

Ohio State's total footprint per capita for 2007 was 8.66 hayr/person—more than three times our own. Most of this is attributed to transportation, specifically: cars alone, which made up ~72% of their footprint. Electricity was the second largest contributor, and in her notes on the footprint she developed for OSU, Jaclyn Janis suggests that OSU take steps to reduce its footprint by using CFLs instead of incandescent bulbs—a step Marlboro has already begun to take. Like our footprint and that of UTM, OSU's footprint was based on regular operation and spending, and did not contain any allowance for construction of buildings, parking lots or garages.

Colorado College:

Colorado College's 2002 footprint is slightly less than ours (2.24 hayr/person), but has a different categorical break down than our own. There doesn't seem to be any account of waste at all. It is listed under "uncalculated impacts" with a note about how it would necessarily be a high number if it were measured. Without a waste component, CC seems to have roughly similar proportions to Marlboro: relatively low numbers in the transportation department, and relatively high numbers in the energy category. Our food's contribution to our footprint was significantly higher.

Turning numbers into actions

Finally, we reach the goal: the part of the process where information turns into productivity on campus! The data we've collected goes a long way in pointing out specific things we can work on to decrease our campus's ecological footprint. This data suggests that we take action on 4 main fronts: electricity, heating oil, food, and waste. In addition, we suggest a 5th front, which includes the smaller categories within the footprint, and activities that fall outside the scope of the footprint calculation, such as building design and academic initiatives.

Our efforts should include:

- 1.) The reduction of waste from both ends, i.e., increased efforts to both generate less waste by consuming less and using materials more thoroughly, and increased efforts to reuse, recycle, and compost the waste we do produce. Great strides are already being made regarding composting and recycling, and the recent switch to refillable salt and pepper shakers and the elimination of paper cups from the dining hall are significant steps forward in reducing materials and waste from both the input and output. However, as our footprint reveals, even greater strides are needed.
- 2.) Reduction of energy use in all the various forms that can take, i.e., more efficient buildings, appliances, and increased awareness of/efforts to decrease our consumption. We have already taken great steps to increase the efficiency of our buildings through our Thermal House audit and the improvement of many buildings on campus. This kind of initiative is one that should continue as we move forward. We should also continue to discuss the best way to address individual and institutional habits surrounding electricity on campus.
- 3.) Continued efforts to produce and store more of our own food, purchase more items in bulk, and purchase more locally and sustainably grown food. This is also an area which has received

increased attention recently, and our footprint is another confirmation that we should keep going full steam ahead. In addition to its effect on decreasing our environmental impact, growing our own food can be felt immediately in the community, the dining hall, and individually. Who doesn't love a homegrown strawberry, fresh from the garden?

Additionally, it should be said that though the numbers for built-up land, water, and transportation are smaller in comparison to energy, waste, and food, it does not mean we need no work in those areas. Water conservation, for example, remains important despite its low contribution to our footprint, both for its own sake and because decreased water usage will be reflected in other categories such as energy, much of which goes into heating water for our showers, washing machines, and dishwashers. Furthermore, work done to improve the efficiency of our buildings will show up large on a consumption footprint like this, but will have a significant effect on reducing our energy use over time.

Ultimately, we hope that this footprint analysis will spark conversation, thoughtfulness, and increased awareness of all aspects of our operation as a community and as individuals who make up that community. We hope that this report will establish a framework for future sustainability efforts that this footprint calculator continues to be used as a method of tracking these efforts.

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Marlboro College Ecological Footprint Calculator

by Mia Bertelli and Ellie Roark, Spring 2011.

with enormous gratitude to the University of Toronto for the model on which we based our calculator,
and to Matt Ollis for guiding us through this project.

Category		Enter Value	Conversion Factor	Footprint (hectare years)
Materials and Waste				
	Paper use (# reams)	1080	1.97	
	% recycled (enter as fraction)	0.65	0.273	2.152427586
	Paper towels, toilet paper, tissues (lbs)	3880	0.0008934	
	% recycled (enter as fraction)	0.7	0.000268	1.7678056
	Total Waste produced (lbs)	212,500	0.001905	404.8125
	Total Recyclables produced (lbs)	18,700	0.000487	9.1069
Transportation				
College Vehicles	Total Unleaded gasoline consumption (gallons)	8,486.02	0.002929	24.8555258
	Diesel fuel consumption (gallons)	0	0.00328	0
Personal Vehicles	# of commuter cars	89		
	Average daily commuter mileage	20	0.00014934	0.263698598
Food				
Kitchen	Fish (lbs)	1500	0.00204	3.06
	Other Meat (lbs)	16680	0.00313	52.2084
	Non-local Roots and vegetables (lbs)	32544	0.0002267	7.3777248
	Local Roots and Vegetables (lbs)	8136	0.000136	1.106496
	Bread, grains and grain products (lbs)	16500	0.000771	12.7215
	Milk and dairy (including eggs) (lbs)	39787.8	0.000499	19.8541122
	Fruits (lbs)	17910	0.000227	4.06557
	Processed foods (lbs)	4132.8	0.000737	3.0458736
Coffee Shop	Meats (lbs)	1800	0.00313	5.634
	Fruits (lbs)	300	0.000227	0.0681
	Milk and Dairy (lbs)	1260	0.000499	0.62874
	Processed foods (lbs)	3720	0.000737	2.74164
Water				
	Water use (gallons)	3007004	0.0000003	0.90210123
Energy				
Off-campus generation	Total grid-derived electricity use (KWh)	1954674	0.00011853	231.6875092

Electricity mix for your area:	Nuclear (enter as fraction)	0.55	0.000174	
	Hydroelectric (enter as fraction)	0.38	0.0000425	
	Natural gas (enter as fraction)	0	0.000094	
	Coal/oil (enter as fraction)	0.03	0.000174	
	Wind (enter as fraction)	0	0.000006	
	Solar (enter as fraction)	0	0.000024	
	Biomass (enter as fraction)	0.04	0.0000365	
	Geothermal (enter as fraction)	0	0.0000084	
On-campus energy	Propane (Gallons)	4554.3	0.0000953	0.43402479
	Heating Oil (gallons)	81899.7	0.00216	176.903352
Land Use	Building footprints (square ft)	114,000	0.00002629	2.99706
	Roads + impermeable (square ft)	101566	0.00002629	2.67017014
	Forested Land (acres)	264.4		
	Cultivated Land (acres)	1		

Total Campus Footprint (ha)

971.0652583

Footprint per Campus Community Member

2.489910919

Category	Footprint contribution (%)
Built-up land	0.58
Water	0.09
Transportation	2.59
Materials and waste	43.03
Energy	42.12
Food	11.59
TOTAL	100.00

NOTES:
 This calculator uses conservative estimates. When a range of values for a conversion factor was given, the lower value was taken.
 This calculator tracks the footprint of the College's undergraduate campus during the academic year.
 This is our "operating footprint," which tracks regular spending and regular consumption.
 Marlboro's bookstore consumption not included.

Number of students (incl. residents)	270
Number of staff	80
Number of faculty	40
Total Campus Community Members	390

Footprint contribution (%)

