COMPOSTING PROJECT

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Abstract

My experiment in saving the world, removing one piece of trash from entering a landfill at a time.

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AP Environmental Science

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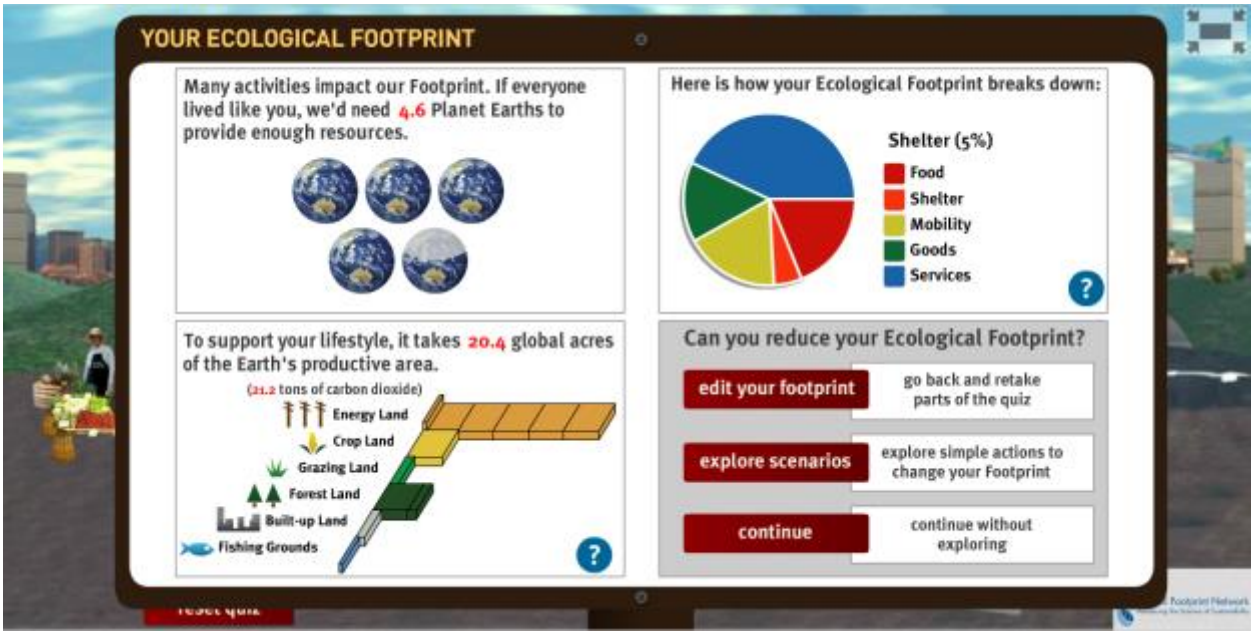
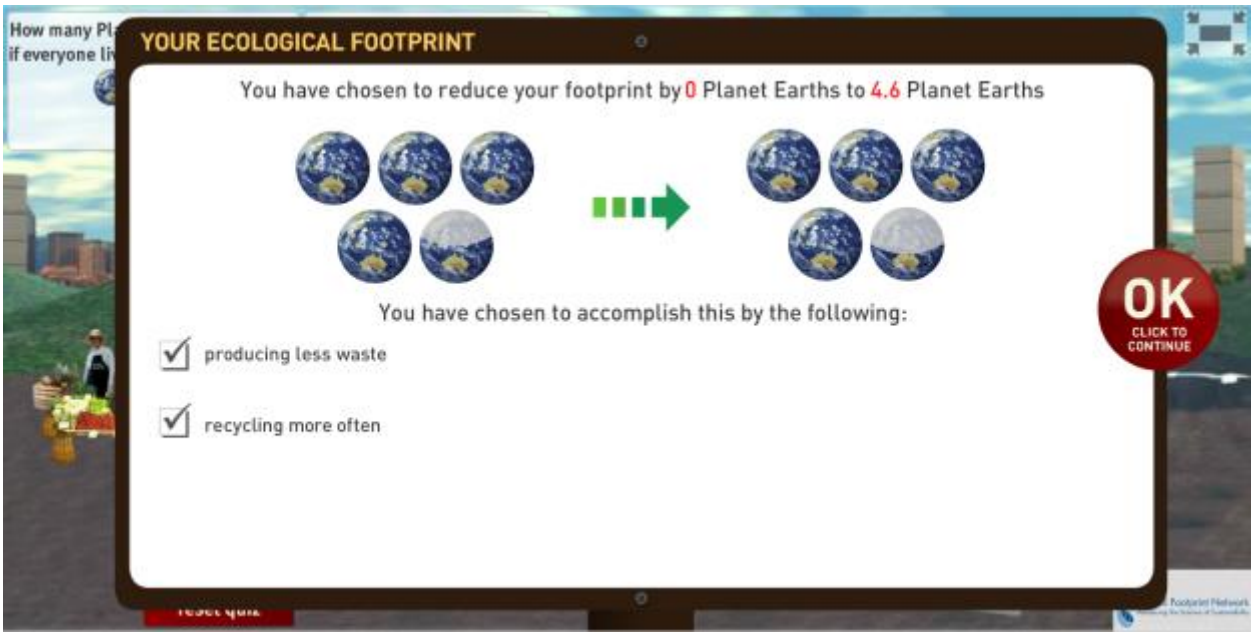
Rationale

Throwing things away is so customary to me that it seems almost intuitive. Simply tossing waste into the large black bags requires almost no thought in modern society which I am entirely guilty of participating in without much thought into how I am hurting the environment. Composting provides a simple solution to provide realization into how much I unnecessarily contribute to landfills as well as the opportunity to benefit my garden via introducing organic fertilizer that would otherwise have remained unaltered in a landfill.

Item selection was largely based on what I typically throw away on a daily basis and a cross comparison with compostable items from the lists found in my procedure. These items are things I use every day whether it's the brown bag for my lunch or Q tips to clean my ears with.

Ecological Footprint





(Ecological Footprint Calculator, 2015)

Introduction

In my everyday life, I throw away just about everything without thinking twice about where my waste ends up and what effect my actions have on the environment. I do this because of the convenience of tossing anything I don't want on hand in those oversized rolling trash cans found at ten foot intervals anywhere I go. The alternative would be to research and educate myself on items that can be regularly composted, discipline myself enough to not just habitually put items in the garbage can, and then after all that, start carrying my waste around with me until I am able to empty the days garbage into my compost pile at home. And that's exactly what I plan on doing. For better or worse.

There are reasons one would want to limit the amount of trash they contribute to landfills, starting with the idea that they are giving back to the environment so that the same material can become something beautiful as opposed to eternally taking up space in a hole in the middle of nowhere, making nowhere smell inexplicably awful. A local example includes the Gainesville Landfill here in Georgia, which is being sued for violating zoning issues as the smell permeates into residential areas, greatly decreasing property values and quality of life as investigated by the AJC News. (AJC, 2012) Composting also holds the additional benefit of providing free organic fertilizer, reducing the need for chemical fertilizers, and enriching soil for increased plant growth and produce yield. In a survey by diffen.com, a sample of 1000 farmers preferred organic compounds to chemicals 3 stars to 4 stars respectively. (Diffen.com, 2015)

My experiment involves an initial five day period in which I only record the amount of regularly used compostable items as referenced from the compostable items list created via research. This interval will help me understand just how much trash I am contributing to a landfill that could otherwise be helping me grow vegetables. Following my sure-to-be-enlightening normal phase, I will begin another five day period in which those regularly disposed of compostable items will be recorded and additionally kept in a container so as to find the actual weight of biodegradable material that I am keeping out of a trash pile. I am anticipating gathering around 5 pounds of compost by the end of the experiment based on the 2012 average of 4.38 pounds of trash a day per American and roughly 1/4 of waste being compostable per the United States Environmental Protection Agency (EPA, 2014). So, what if everyone took the composting challenge?

The current population size of America is roughly 320 million people, and if these stubborn individuals where to miraculously and unanimously agree to compost at the ridiculous rate of only a pound of trash every day, then, according to the non-profit composting council organization, 160 thousand tons of trash would not be able to produce methane in an anaerobic environment, there would be a lower quantity of other potentially explosive gases, and 160 thousand living rooms worth of uncompressed trash space would be conserved, leaving that much more land for sustaining other forms of life. (Composting Council, 2015) This would be among the most prolific revolutions in human history as Earth's life sustaining timeline would be extended for generations into the future.

Limitations of the Plan

Carrying around a bucket/Ziploc bag to ensure items are composted instead of thrown away is somewhat burdensome. The results between the two weeks are not entirely comparable as the trash amounts will differ and instead the overall weight totals must be compared to reduce the bias of which items I used more heavily in each week, which is still somewhat biased as I may have thrown more things away or had more to compost in a given week. This is more the result of the limited time frame and number of trials in the experiment which would need to be extended for more statistical significance.

Contingency Plan

If I am unable to carry around a composting bucket/Ziploc bag and remember to compost the items on my spreadsheet, I will resort to simply recording the number of things I throw away and using averages to estimate the amount of trash that would be composted that is otherwise going to end up in a landfill. From there, I can draw conclusions about the overall effect of composting as it pertains to limiting trash disposed of into landfills.

Background Research

The recent Harris Interactive Study, sponsored by the National Waste and Recycling Association (NWRA), revealed that 72% of Americans do not currently compost even though 68% would separate their compost into a different bin if there was a community composting program available. The largest factor contributing to this discrepancy is the cost of such a program, 62% of respondents would not be willing to pay more for their waste disposal service. In addition, the NWRA admits there is still the challenge of transporting large amounts of food waste as well as the limited number of food waste composting facilities. Sharon Kneiss, CEO of the NWRA replied to those not willing to chip in a little extra for the cause by stating the largest hurdle is the "lack of understanding by the American public about the value of such a change." (Smith, 2014)

The inadequate knowledge surrounding composting also plays a significant role as the actual action of decomposition is more of an exact science than a chore. There are two categories of living beings that break down trash piles: microorganisms such as bacteria and fungi which are chemical decomposers as these organisms alter the composition of the material, and macroorganisms such as mites, snails, spiders, slugs, beetles, ants, and earthworms which are physical decomposers due to natural tendencies to break down the material into smaller pieces. Of all the entities the most important are the aerobic bacteria which can deconstruct a diverse amount of waste in a short interval, but are restricted by the conditions of the environment as factors such as oxygen level, moisture content, temperature, and acidity can cause bacteria to become inactive or even die. Without the presence of the correct setting, such as a landfill where too much trash is confined into too little space without any oxygen, anaerobic organisms attempt to fulfill the role, but the process takes orders of magnitude longer along with the byproduct of gases such as the greenhouse gas methane and hydrogen sulfide which has an awful aroma. (U.I., 2015) Without understanding the principles involved in a compost pile and maintaining the circumstances needed for aerobic bacteria to thrive, all the effort and good intention in the world can be squandered, but taking the time to get educated on composting provides benefits not only for individuals but the world over.

While seemingly disproportionate to the amounts of municipal solid waste produced by industrial sources, American households are responsible for 13% of the municipal solid waste produced in America or 250.9 million tons of garbage. Based on surveys conducted, Americans recycled or composted about a third of the waste, or 87 millions tons of material. The graph of municipal solid waste

created by the Environmental Protection Agency has shown a rise in trash produced over the last 50 years with a doubling in trash produced per person since 1960. The promising aspect is that recent years have shown a slight decrease in the total trash produced as well as waste produced per capita which could be indicative of people starting to do their part for the environment. Of all the municipal solid waste produced, the 3rd and 4th biggest components are newspapers and yard trimmings, both of which can be composted. (EPA, 2014)

Procedure

Phase 1 (Preparation)

1) Using a reliable source to ensure environmental safety, decide which regularly used items are compostable
   - Green Thumb Compostable Items List https://www.greenthumbcompost.com/compostableitems
   - 163 Things You Can Compost http://www.plantea.com/compost-materials.htm
   - 100 Things You Can (and Should) Compost http://www.smallfootprintfamily.com/100-things-you-can-compost
2) Record regularly used compostable items in list on a Google Spreadsheet in a column labeled "Compostable Item"
3) Create an adjoining column labeled "Number of Times Thrown Away"
4) Create a third adjoining column labeled "Number of Times Composted"
5) Print out the spreadsheet for ease in recording data
6) Be sure to retain spreadsheet along with writing device on hand so as not to miss counting compostable items disposed of
7) Obtain a bucket/Ziploc bag with a closeable lid for use
   - A large plastic ice cream pale with included lid and handle is ideal
8) Weigh the bucket/Ziploc bag ahead of time to ensure accurate measurement of weight of compost material

Phase 2 (Week 1)

1) Record the number of times items on the compostable items list are thrown away in a week
2) Upon the conclusion of the week, transfer data to the Google Spreadsheet

Phase 3 (Week 2)

1) Instead of disposing of compostable items, add items to compost bucket/Ziploc bag
   - This step might be impractical for current setup, in which case the contingency plan can be observed
2) Record the number of times items on the compostable items list are composted in a week
3) Upon the conclusion of the week, transfer date to the Google Spreadsheet

Phase 4 (Analysis and Presentation of Results)

1) Weight the bucket/Ziploc bag filled with the compost material, subtracting the initial weight of the bucket/Ziploc bag, and record on the Google Spreadsheet
2) Create new columns on the spreadsheet for the average weight (in grams) of the compostable items
    - The average item weight can be found either experimentally or by searching for the weight online
    - The step might be complicated and is not necessary for a basic analysis of amount of composted material
3) Create a total column and multiply the number of items thrown away by the average weight of the items
4) Sum the total of the weights of the items which can be compared to the experimental compost weight found
5) Report findings on the amount of material composted and present conclusion to audience
    - Consider how many metric tons of trash would never enter a landfill based on data found in experiment multiplied by the US population

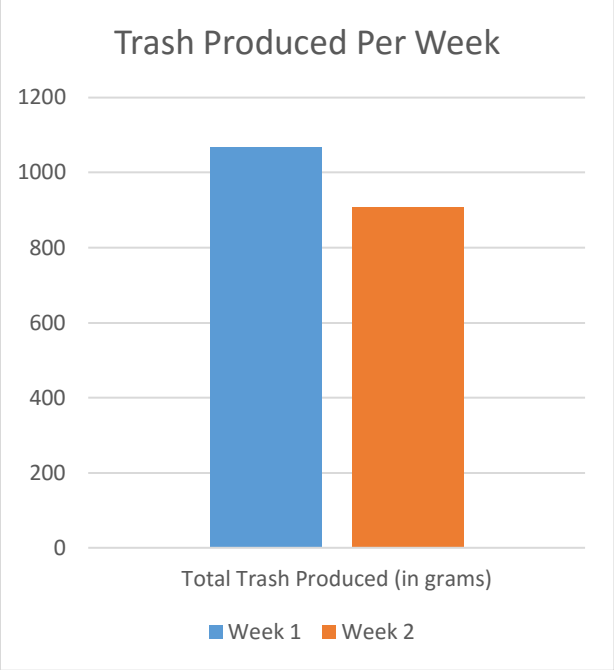
Spreadsheet

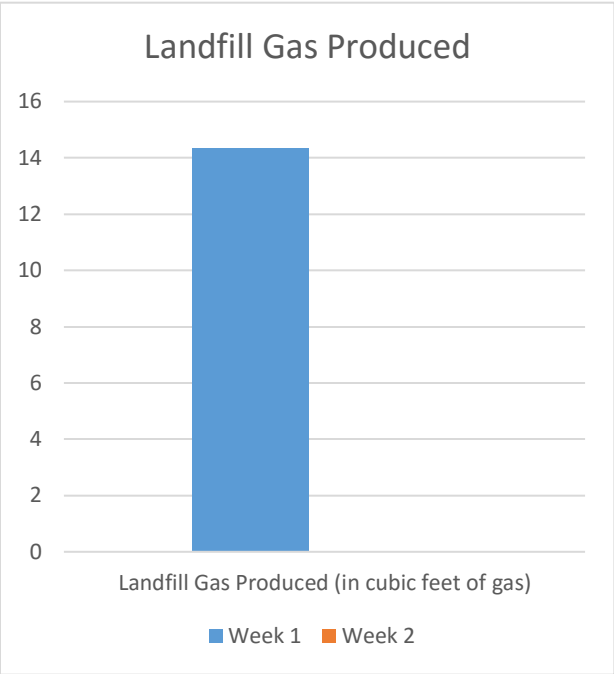
Compostable Item	Number of Times Thrown Away					Number of Times Composted				
	5/3	5/4	5/5	5/6	5/7	5/8	5/9	5/10	5/11	5/12
Banana Peels	0	1	1	0	1	1	0	0	1	0
Apple Cores	1	0	0	0	1	1	0	0	1	1
Potato Peels	0	0	0	0	0	0	0	0	0	1
Carrott Peels	0	1	0	0	0	0	0	0	0	0
Egg Shells	4	0	0	0	0	0	0	0	0	0
Dryer Lint	1	0	0	0	1	0	2	0	0	0
Coffee Filters	0	0	0	0	0	0	0	0	0	0
Coffee Grounds	0	0	0	0	0	0	0	0	0	0
Newspapers	0	0	1	1	0	0	1	0	0	1
Card Board	1	0	1	1	0	0	0	1	0	1
Post It Notes	0	0	0	0	0	0	0	0	1	1
Paper Napkins	1	1	0	1	2	1	0	1	2	1
Paper Towels	0	1	1	3	1	2	1	1	0	1
Q-Tips	0	1	2	2	1	1	1	1	2	0
Brown Paper Bags	0	1	1	1	1	1	0	0	1	1

Compostable Item	Number of Times Thrown Away					Estimated Item Weight	Estimated Item Weight Total
	Sun	Mon	Tue	Wed	Thu		
Banana Peels	0	1	1	0	1	30 grams	90 grams
Apple Cores	1	0	0	0	1	25 grams	50 grams
Potato Peels	0	0	0	0	0	16 grams	0 grams
Carrott Peels	0	1	0	0	0	13 grams	13 grams
Egg Shells	4	0	0	0	0	6.5 grams	26 grams
Dryer Lint	1	0	0	0	1	12 grams	24 grams
Coffee Filters	0	0	0	0	0	5 grams	0 grams
Coffee Grounds	0	0	0	0	0	71 grams	0 grams
Newspapers	0	0	1	1	0	220 grams	440 grams
Card Board	1	0	1	1	0	120 grams	360 grams
Post It Notes	0	0	0	0	0	0.5 grams	0 grams
Paper Napkins	1	1	0	1	2	4 grams	20 grams
Paper Towels	0	1	1	3	1	3 grams	18 grams
Q-Tips	0	1	2	2	1	1 gram	6 grams
Brown Paper Bags	0	1	1	1	1	5 grams	20 grams
						Estimated Weight Total	1067 grams

Compostable Item	Number of Times Composted					Estimated Item Weight	Estimated Item Weight Total
	Sun	Mon	Tue	Wed	Thu		
Banana Peels	1	0	0	1	0	30 grams	60 grams
Apple Cores	1	0	0	1	1	25 grams	75 grams
Potato Peels	0	0	0	0	1	16 grams	16 grams
Carrott Peels	0	0	0	0	0	13 grams	0 grams
Egg Shells	0	0	0	0	0	6.5 grams	0 grams
Dryer Lint	0	2	0	0	0	12 grams	24 grams
Coffee Filters	0	0	0	0	0	5 grams	0 grams
Coffee Grounds	0	0	0	0	0	71 grams	0 grams
Newspapers	0	1	0	0	1	220 grams	440 grams
Card Board	0	0	1	0	1	120 grams	240 grams
Post It Notes	0	0	0	1	1	0.5 grams	1 gram
Paper Napkins	1	0	1	2	1	4 grams	20 grams
Paper Towels	2	1	1	0	1	3 grams	5 grams
Q-Tips	1	1	1	2	0	1 gram	5 grams
Brown Paper Bags	1	0	0	1	1	5 grams	15 grams
						Estimated Weight Total	901 grams
						Initial Bucket Weight	9 grams
						Actual Weight Total	907 grams

Data Analysis





*Based on Estimated Trash Output Weights
**Based on Ramsey-Washington Counties Landfill Gas Calculations (Ramsey-Washington Counties, 2015)

Despite the nearly identical amount of trash produced in the two five day weeks, there is no landfill gas for the compost pile due to aerobic bacteria decomposition as opposed to the 14.35 cubic feet of gas I produced by throwing my trash away. By simply collecting a few items and adding them to my compost pile I was able to reduce the amount of landfill gas I produced to zero emission. In addition, I produced organic fertilizer which will be used to grow vegetables in my garden all while consuming approximately the same amount of compostable items. In Laymen's terms, I did not change anything about my lifestyle besides collecting 2 pounds of garbage and I prevented 14.35 cubic feet of a greenhouse gases methane and carbon dioxide from entering the atmosphere.

As I collected data I did find a tendency to start to throwing something away before realizing I should compost it during Week 2 of my data collection which may be the reason for the slightly lower actual weight as I only counted compostable items in my Ziploc bag and could have potentially thrown a few compostable items away. This is only a minor detail which could also be based on the randomness of the sample as I may have consumed more or less than normal for either the Week 1 or Week 2 sample. The results remain statistically significant in both cases.

The largest disagreement I found was between my hypothesized value of 5 pounds of trash collected for composting during Week 2 and the 2 pounds I actually collected. Upon returning to my research, I realized that this was largely because of the absence of other compostable items, largely yard trimmings which I did not have the ability to collect for my experiment. I also saw that most of the items I did collect were smaller and light in weight which is the main data point need to calculate the amount of landfill gas produced.

Assuming my data is realistic, extrapolating my findings to the United States population (320 million people) results in preventing 335,216 cubic feet of landfill gas from being produced annually. (14.35 cubic feet of gas / 5 days * 365 days *320 million people) This is significantly lower than the estimated 712,480 cubic feet of landfill gas that wouldn't be produced if the U.S. population were to compost 1 pound of trash per day, but still a meaningful result. (6.10 cubic feet of gas *365 days * 320 million people)

Conclusion

I was amazed at how easy it was to make such a big difference in my environmental impact. All I had to do was remember to put a few compostable items into a Ziploc bag instead of the trash can which I emptied into a section of my garden and promptly forgot about. Although I did not collect as much waste as I anticipated, the results of my limited action speak for themselves. This is definitely something for everyone to try for themselves as it requires a minimal amount of exertion and it just feels good to know you are making a difference.

As a follow up question, I think using landfill gas as a power source could be a good way to compensate for the municipal solid waste already in landfills and wouldn't mind learning about how much energy the average landfill could be producing.

Annotated Bibliography

"Calculations for Theoretical Production of Landfill Gas." Ramsey - Washington Counties, n.d. Web. 10 May 2015.

Using calculations found in experimenting on 100 pounds of municipal solid waste, the amount of landfill gas emission per pound was found by Ramsey and Washington county authorities. This article relates the chemistry involved in creating such a calculation to ensure the accuracy along with the large amount of trash used to make sure there was the trash decomposed properly without adding the bias of a small quantity of waste.

"Chemical Fertilizer vs Organic Fertilizer." Diffen.com. N.p., n.d. Web. 6 May 2015.

Diffen.com conducted a survey comparing the preference for chemical fertilizers and organic fertilizers among farmers with over 900 respondents. With such a high sample size, there is low variability although there is potential for response bias in the results as the survey was conducted online and those who feel strongly about organic fertilizers might be more inclined to respond. The results show that farmers had a partiality toward organics with the average ranking being 4 stars to 3 stars, although there were exceptions on either side.

"Composting for Facilities." EPA. Environmental Protection Agency, 27 June 2014. Web. 10 May 2015.

This is an extremely broad resource regarding composting including basic information, types of composting, the composting process, waste production, and rules and regulation for waste management. The wide range of topics regarding composting made this source ideal for finding information about American habits with data to support findings.

"Footprint Calculator." Footprint Calculator. Global Foodprint Network, 16 Apr. 2015. Web. 18 May 2015.

The Global Foodprint Network made this activity for people to be able to visualize their energy use with respect to global sustainability. It reveals just how over utilized the environment is and the absolutely ridiculous amount of waste produced for seemingly mundane tasks. It also helps to inspire

users to reduce their carbon footprint by giving suggestions and allowing an individual to make changes and directly see the results of their actions.

"Keeping Organics Out of Landfills." (n.d.): n. pag. Compostingcouncil.org. US Composting Council. Web. 7 May 2015.

The Composting Council created an exceptionally well written article regarding the benefits of composting with respect to limiting the byproducts created in landfills. Trash dumps are exposed as unsustainable practices that have serious repercussions that the world will be forced to endure in the future and are only growing worse with each passing moment. The details regarding emissions were especially useful, as the enormous quantities of gases such as methane entering the atmosphere are described in full.

"Municipal Solid Waste Generation, Recycling, and Disposal in the United States: Facts and Figures for 2012." Environmental Protection Agency. Environmental Protection Agency, Feb. 2014. Web. 10 May 2015.

The formation of the Environmental Protection Agency in 1970 brought about the beginning of mass data collection specific to the environment. This included the municipal solid waste produced by the United States which has been further divided into production sources, waste types, and analyzed to find trends in environmental action.

"Smelly Landfill in Gainesville May Have Zoning Issues." Ajc.com. AJC News, 14 Nov. 2012. Web. 6 May 2015.

This article, published by the Atlanta Journal Constitution, talks about a real world problem with the expansion of a landfill in southern Georgia. The foul business practices have led to residents being forced to smell an awful odor at all times and the politics of business fighting to expand the landfill while citizens of the area wish for the landfill to be further regulated.

Smith, Ernie. "Study: What Could Get Us To Compost More?" Associations Now. N.p., 13 Jan. 2014. Web. 18 May 2015.

The biggest problem with composting in America is the inevitable laziness of Americans who are under the impression out-of-sight-out-of-mind when the environment is at stake. The attribute of individuality is uncovered in why American refuse to compost as factors such as cost and lack of knowledge come into play even though the environment is a collective resource that everyone must share in referencing the National Waste and Recycling Association.

"The Science of Composting." Composting for the Homeowner. University of Illinois, 2015. Web. 18 May 2015.

The actual science of composting is illustrated by the University of Illinois including the function of both micro and macro organisms within compost piles. The proper conditions for composting have been careful researched and stated along with reasoning for each one as it pertains to the average person's compost pile. The chemical nature of composting is explained in a simple fashion with suggested items to add if the composition isn't quite right and the recommended volume can be calculated using the information provided in this article.

Website URL's

Ramsey-Washington Counties Landfill Gas Calculations

http://www.co.ramsey.mn.us/NR/rdonlyres/E1025837-8DD4-4045-B19E-5C63C573E70C/5608/PC_Meth_Calcs.pdf

Diffen.com Survey

http://www.diffen.com/difference/Chemical_Fertilizer_vs_Organic_Fertilizer

EPA Composting Information

http://www.epa.gov/compost/

Footprint Calculator

http://footprintnetwork.org/en/index.php/GFN/page/calculators/

Composting Council Landfill Article

http://compostingcouncil.org/admin/wp-content/uploads/2011/11/Keeping-Organics-Out-of-Landfills-Position-Paper.pdf

EPA Municipal Solid Waste Production

http://www.epa.gov/solidwaste/nonhaz/municipal/pubs/2012_msw_fs.pdf

AJC Article on Smelly Landfill in Gainesville

http://www.ajc.com/news/news/smelly-landfill-in-gainesville-may-have-zoning-iss/nS6FY/

American's Inability to Compost

http://associationsnow.com/2014/01/study-what-could-get-us-to-compost-more/

University of Illinois Science of Composting

http://web.extension.illinois.edu/homecompost/science.cfm