Lafayette College
Environmental Poster Presentation

Fall 2012

Sustainability:

The Grand Challenge

of the 21st Century

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Event Summary

The 2012 Environmental Poster Presentation was the culmination of a semester long assignment in which students researched environmental topics of their choice. Student teams (two, three, or four students) from Dr. Arthur Kney's Environmental Science, Engineering course (CE321), Professor Rachel Brummel's Intro to the Environment (EVST100), Professor Edward Gamber's "The Foods We Choose" (FYS 185), and Dr. Steven Mylon's Environmental Chemistry course (Chem 252) came together to collaborate on numerous Environmental topics.

Students had the opportunity to gain valuable knowledge through their research as well as through hands on experimentation. A number of groups that did hands' on research worked with upper-classmen, whom acted as mentors. Each group then had the opportunity to present their findings at the Environmental Poster Presentation held on Thursday, November 29, 2012 in the Marlo Room and the atrium of the Farinon Student Center from 7:00 to 9:00 pm. This year the poster session showcased thirty-three posters.

Throughout the semester, the student teams gathered data and organized their research and other background information to create posters representing their topics. Over the course of this project, various drafts were submitted for critique to enable the groups to revise their work and produce their final poster.The judges selected for this event were a collection of professionals from the Lehigh Valley along with students who previously took one of the courses. Judges were placed in groups of two or three to evaluate six or seven posters based on specific criteria including presentation, professionalism, and aesthetics of the poster as well as the grammar and organization. Each category is judged on a scale of one to five with one being poor and five being excellent. Each year, prizes are awarded to the top five posters in each respective class.

If you would like more information about the Environmental Poster Presentation or these specific courses, please feel free to contact Dr. Arthur Kney at kneya@lafayette.edu, Dr. Steven Mylon at mylons@lafayette.edu, Rachel Brummel brummelr@lafayette.edu, or Ed Gamber gambere@lafayette.edu.

The Top Six Posters

~ 1st Place ~

"Applying Aquaponics to Wastewater Treatment"
Sandy Hardy, Alexa Gatti, and Sandy Trout

~ 2nd Place ~

"An Analysis of Green Roof Benefits: Rain Water Runoff"
Robyn Henderek, Emily Wool, and Olivia Jurewicz

~ 3rd Place ~

"Lafayette Goes Local"
Ashley Bohenberger, Alexandra Elling, and Christina Marzocca

"Are Plastic Water Bottles Threatening York Masculinity?"
Emily Crossette, Christina Cucinotta, and Nicholas Limburg

~ 4th Place ~

"Land Use and the Lateral Carbun Flux of the Bushkill Watershed"
Joshua Koeber, Annie Mikol, Alexa Maramba and Charlie Timko

~ 5th Place ~

"Environmental Impacts of Perfloudrinated Compounds"
Alec Eidelman, Matthew McMurray and Chris Parker

Poster Summaries and Photographs

Poster Research Topics

#1 Conventional Food vs. Organic Food
#2 Impacts of Nuclear Energy
#3 Coal to Clean Oil
#4 Analysis of Green Roof Benefits: Rain Water Runoff
#5 Rooftop Gardens
#6 Effect of Polycyclic Aromatic Hydrocarbons from the BP Oil Spill
#7 Are Plastic Water Bottles Threatening Your Masculinity
#8 Nutrient Cycling
#9 At a Breaking Point
#10 Mercury in Aquatic Ecosystems
#11 Lafayette Goes Local
#12 Geothermal Energy: Power for the Future
#13 Land Use and the Lateral Carbon Flux of the Bushkill
#14 Geothermal Energy
#15 Applying Aquaponics to Wastewater Treatment
#16 It's Food, Not Waste
#17 The Food Energy and Environment Trilemma
#18 Food Waste in America
#19 Alaskan Oil Drilling: Is it Worth it?
#20 Going Solar
#21 GMOs
#22 LEED Building
#23 Benefits of Farmers' Markets and Local Foods
#24 Algea as a Source of Biofuel and its Sustainability
#25 Environmental Impacts of Perflourinated Compounds
#26 Are You Capturing the Sun's Energy?
#27 Bushkill Creek Watershed Nutrient Analysis
#28 Vegetarians and the Environment
#29 Factory Farming
#30 Organic and Local Foods
#31 Endocine Distrupting Compounds
#32 Nutrients in Sullivan Park
#33 Flood Prevention in Easton

Poster #1

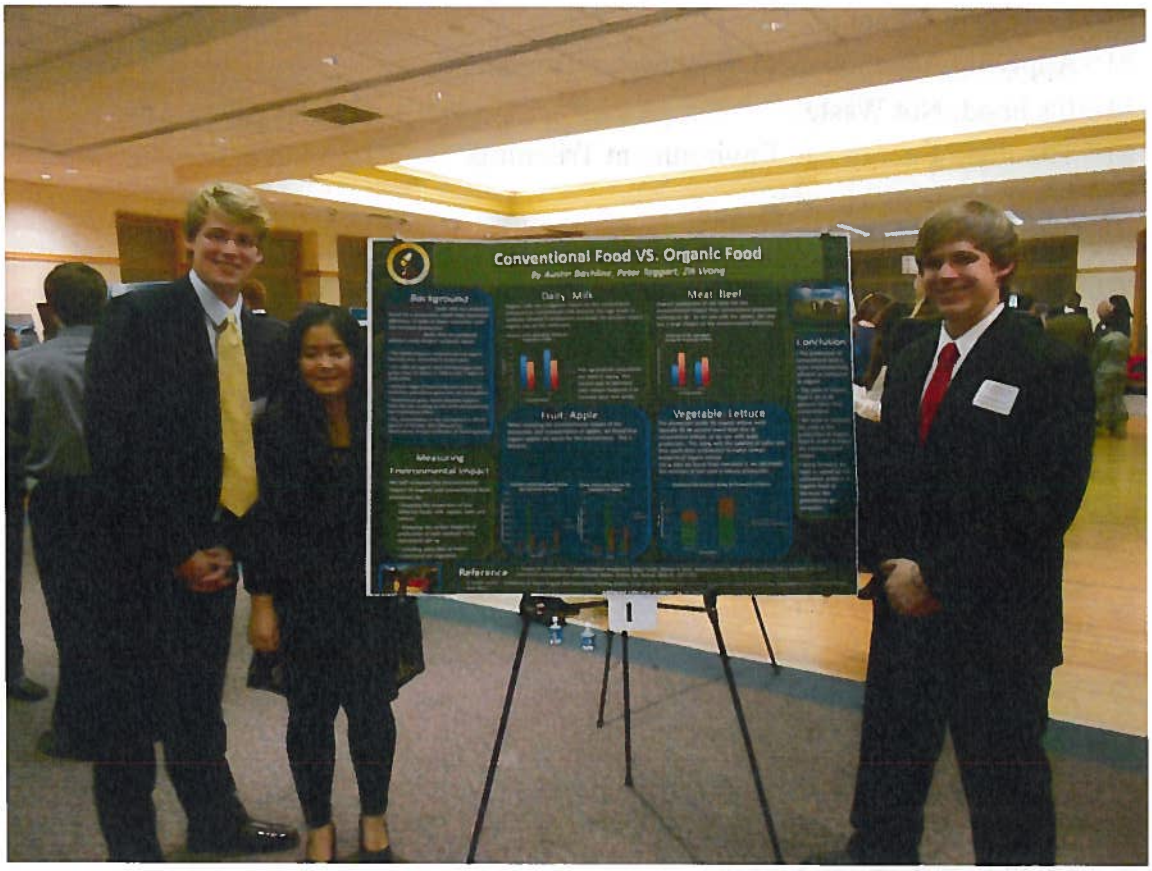
"Conventional Food vs. Organic Foods"

Austin Bashline, Peter Taggart, Zili Wang

The battle between organic and conventional foods has only intensified in recent years. Organic foods have become much more popular than they used to be. Sales of organic food in the U.S. have grown from $1 billion in 1990 to $26.7 billion in 2010. Various stages of food production release carbon dioxide and other greenhouse gases into the atmosphere.

Our group wanted to compare the environmental impact of conventional and organic foods by looking specifically at carbon footprint. We measured carbon footprint in kg of greenhouse gas equivalents produced per kg of food produced. We divided food into four main categories: dairy, fruit, meat, and vegetables. In each category, we picked a specific food to look at. We looked at milk for dairy, apples for fruit, beef for meat, and lettuce for vegetables. We hypothesized that organic foods would have a lower carbon footprint than conventional foods.

Upon analysis of the data, we found that organic foods have a larger carbon footprint than conventional foods. Every single food we looked at had smaller yields for organic than conventional methods. This meant that the carbon footprint for organic would end up being larger than conventional because of the increase in production necessary to meet conventional yields. Furthermore, in order to lessen the environmental impact of organic food we must increase the yields. One possible way we could go about doing this is through better crop management programs, i.e. crop rotation. However we believe the best model for maximizing yield and minimizing environmental impact is found within a mixture of the two processes.



Conventional Food VS. Organic Food

By Austin Bashline, Peter Taggart, Zili Wang

Background

Conventional Food *– foods that are produced based on a production model that maximizes efficiency, in order to lower consumer costs and increase production.*

Organic Food *– foods that are produced without using modern synthetic inputs.*

- The battle between conventional and organic food has only intensified in recent years.
- U.S. sales of organic food and beverages have grown from $1 billion in 1990 to $26.7 billion in 2010 (OTA).
- Various stages of food production release CO_2 and other greenhouse gases into the atmosphere.
- Greenhouse gases absorb infrared radiation from the sun, heating up the earth and producing the Greenhouse Effect.
- CO_2 concentration in the atmosphere is 391.03 ppm as of October 2012 (Mauna Loa Observatory: Scripps Institution of Oceanography)

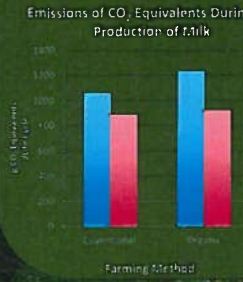
Measuring Environmental Impact

We will compare the environmental impact of organic and conventional food processes by:

- Studying the production of four different foods: milk, apples, beef, and lettuce.
- Analyzing the carbon footprint of production of each method in CO_2 equivalents per kg.
- Including extra data to better understand our argument.

Dairy: Milk

Organic milk has a negative impact on the environment compared to conventional milk because the high levels of methane created in production outweigh the positive impact organic has on CO_2 emissions.

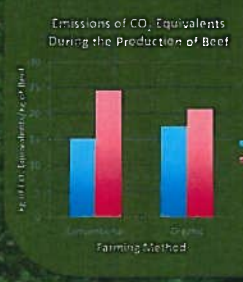


- *Organic milk has a lower yield, which creates more methane via the dairy cow.*
- *Organic cows get more roughage, which creates more methane as well.*

Kite agricultural consultants are cited in saying "the easiest way to decrease your carbon footprint is to increase your milk yields."

Meat: Beef

Organic production of red meat has less environmental impact than conventional production techniques do. As we saw with the apples, the cow has a large impact on the environmental efficiency.

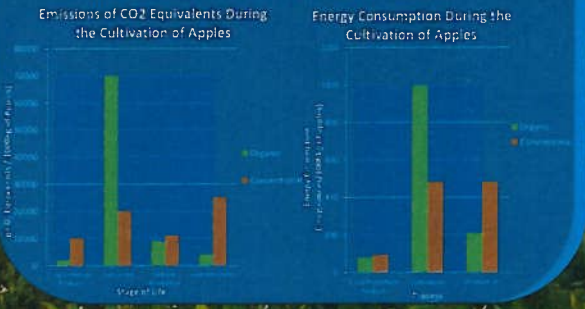


- *Grain fed cows produce less methane than grass-fed pasture cows.*
- *Varying carbon footprint data from different countries may be explained by the changing farm operations from these different countries.*

Fruit: Apple

When analyzing the environmental impact of the production and transportation of apples, we found that organic apples are worse for the environment. This is because:

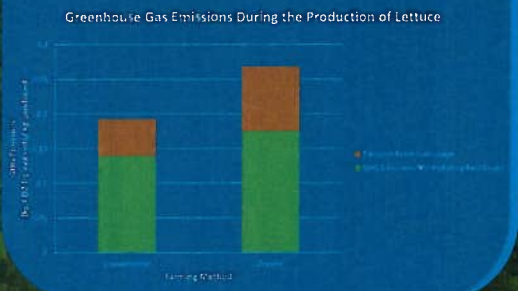
- *Organic orchards have 30 percent less output than conventional orchards do, which increases natural resource consumption.*
- *Organic apples require more labor, which means more fuel consumption and therefore more CO_2 emissions.*



Vegetable: Lettuce

The production yields for organic lettuce were typically 20-80 percent lower than that of conventional lettuce, as we saw with apple production. This along with the addition of sulfur and lime application contributed to higher carbon footprint of organic lettuce.

Using data we found from reference 2, we calculated the emission of fuel used in lettuce production.



Conclusion

- The production of conventional food is more environmentally efficient as compared to organic.
- The yield of organic food is 20 to 80 percent lower than conventional.
- We need to increase the yield of the production of organic food in order to lower the environmental impact.
- Going forward, we need to speed up the cultivation process in organic food to decrease the greenhouse gas emissions.

Reference

1. Gregory M. Peters, Hazel V. Rowley, Stephen Wiedemann, Robyn Tucker, Michael D. Short, Matthias Schulz. (2009) *Red Meat Production in Australia: Life Cycle Assessment and Comparison with Overseas Studies.* Environ. Sci. Technol. 2010,44, 1327-1332.

2. Kumar Venkat. *" Comparison of Twelve Organic and Conventional Farming Systems: A Life Cycle Greenhouse Gas Emissions Perspective."* Taylor & Francis Corp. CleanMetrics Corp. Portland, Oregon. Print 2012

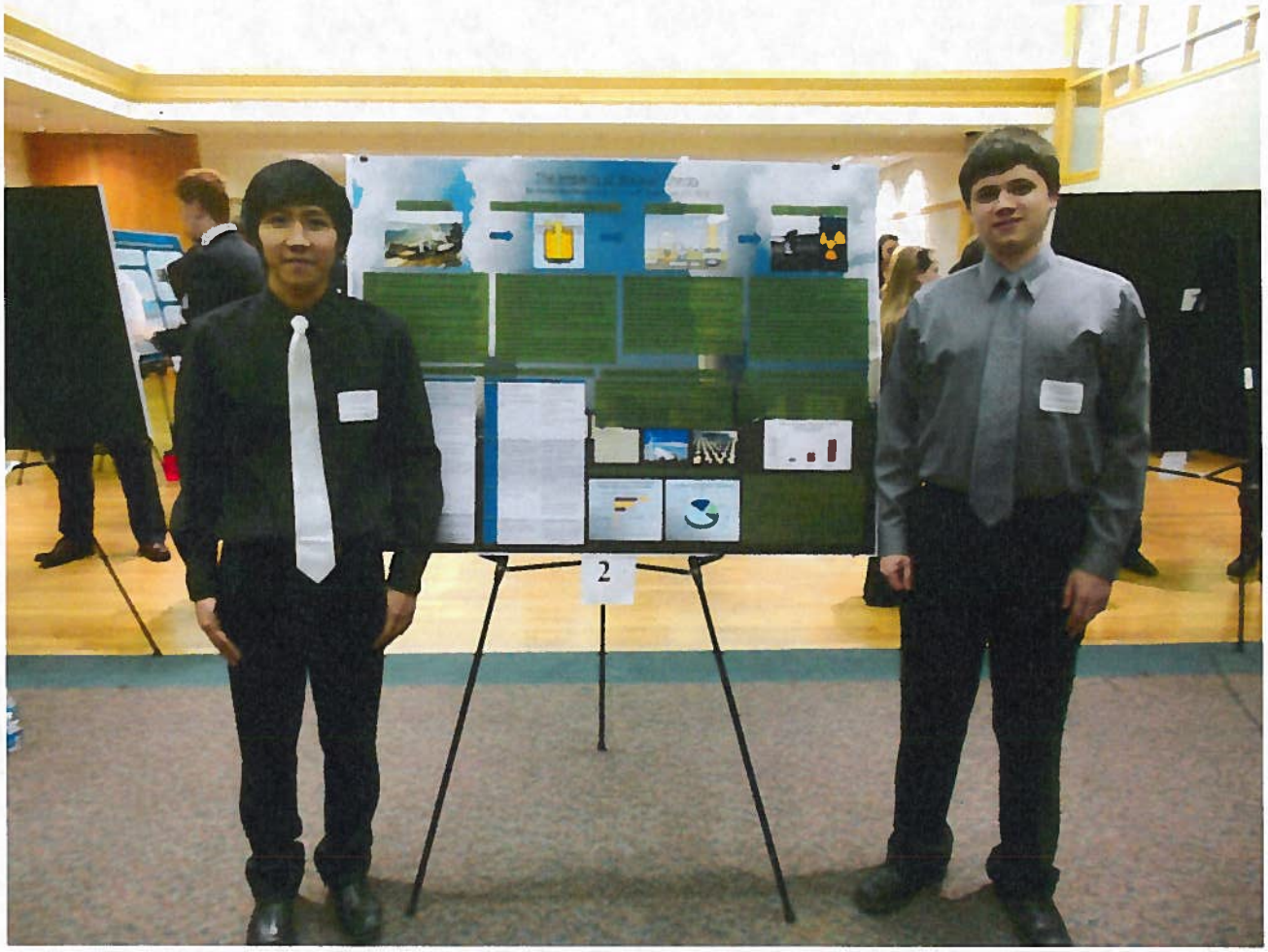
Additional references available up on request

Poster #2

"Impacts of Nuclear Energy"

Daniel Kaufmann and Thwin Zan

We researched nuclear energy, focusing on the nuclear fuel cycle and comparisons between it and other energy sources. Our research addressed the full process of nuclear power, from obtaining the uranium ore to energy production and finally waste disposal. Throughout this process we concentrated on its impacts on both the environment and human health. We also compared nuclear power to other energy sources, both fossil fuels and renewables, centering on the different advantages and disadvantages of each. Additionally, we compared the environmental impacts, space efficiency, and waste production of various sources. Nuclear energy is becoming increasingly prevalent around the world and is a topic of intense debate. While nuclear power is incredibly efficient and has little immediate impacts on the environment, it can have potentially disastrous effects because of nuclear waste. Nuclear energy costs less per kilowatt hour and other energy sources require much more space or fuel to produce the same amount of power. Also, nuclear power is not a significant contributor to greenhouse gases because nuclear power plants have no carbon emissions. However, most nuclear waste is dangerously radioactive and has a prodigiously long half-life. Nuclear power has the potential to be an inexpensive and efficient source of energy. However, the waste and possibility of fatal accidents also give it the potential for disaster.



The Impacts of Nuclear Energy

By Daniel Kaufmann (CE 321) and Thwin Zan (CE 321)

Mining and Milling

Fig. 1 from http://lifeincva.blogspot.com/2010/06/uranium-mining-in-canada.html

•Uranium ore is obtained through mining, either open cut or underground, or leaching.
•~95% of the radioactivity in uranium ore is from the U-238 decay series.
•Uranium mining produces radiation in the form of radon gas.
•Regulations protect workers by restricting them to insulated vehicle cabs, testing them for any abnormal radiation, and increasing dust control.
•Runoff from the mine is stored in secure retention ponds to isolate and extract any contaminants.
•During the milling, ore is processed by grinding it to a uniform particle size followed by chemical leaching to yield uranium called "yellowcake" (U_3O_8).
•Uranium milling waste, or tailings, consist of the majority of the original ore and are very radioactive as a result of high levels of radium so they are restricted by covered dams that reduce the emission of radiation to the same levels as the mining site.

Conversion, Enrichment, and Fuel Fabrication

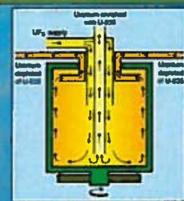


Fig 2 from http://geoinfo.nmt.edu/resources/uranium/enrichment.html

•Conversion: The uranium is converted to uranium hexafluoride gas (UF_6) and prepared for enrichment.
• Gaseous Diffusion Enrichment: The gas is pressurized and repeatedly pumped through membranes to eventually obtain the 3-5% U-235 required.
•Centrifuge Enrichment: The gas is pumped into vacuum tubes attached to rotors, which spin at about 50,000 to 70,000 rpm causing the tubes of gas to spin at about 400 to 500 meters per second, separating the U-235 and U-238.
•Fuel Fabrication: The enriched gas is converted to uranium dioxide powder and made into small pellets which are inserted into the final 12 foot long fuel rods.
•Depleted uranium, the enrichment waste, has very low levels of U-235, but remains hazardous with about 60% of radiation found in natural uranium so it is stored as UF_6 gas in steel cylinders with an estimated global stockpile of 1.3 to 1.5 million tons.

Energy Production

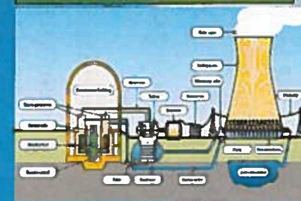


Fig. 3 from http://staff.kps.net/sgilli/content%20pages/energy_resources/nuclear_power.htm

•Normally, the energy production process does not have any serious environmental impacts.
•Emissions: There are safe standards of radiation for the environment and operators due to the containment structure and the only gaseous emissions are water vapor from the reactor cooling.
•Water vapor is used to spin the turbines and generate electricity and has no direct contact with radioactive materials.
•Chernobyl: The meltdown caused an explosion which released radiation into the atmosphere, spreading the fallout over a large area and creating significant safety risks.
•Fukushima: The reactor released radiation into the air, but was cooled in the emergency using sea water, thus releasing radiation directly into the ocean as well.

Waste Disposal

Fig. 4 from http://www.ourenergypolicy.org/court-hits-reset-button-on-nuclear-waste-disposal/

•Deep Geologic Storage: experts recommend burying high level nuclear waste and spent fuel a mile above the water table.
•Dry Cask Storage: This method uses temporary (50 year) containers to hold waste safely at the reactor sites.
•Global Estimates: 365,000 cubic meters of high-level nuclear waste, 3 million cubic meters of low- and intermediate-level long-lived waste, 2 million cubic meters of low- and intermediate-level short-lived waste.
•Recycling: Uranium and plutonium are extracted from spent fuel to create a mixed oxide fuel while the remaining nuclear waste is stored as glass logs and will be placed in a future repository.
•Reprocessing decreases the volume of high-level nuclear waste by 4-10 times, but does not reduce the heat production and radionuclide composition of the waste so it requires the same geologic storage capacity and also produces lower level waste.

Comparison between Advantages and Disadvantages of Different Types of Energy Sources

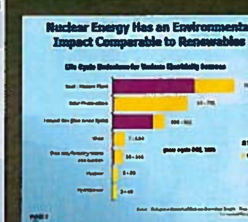
Source	Advantages	Disadvantages
Coal	-Inexpensive -Easy to recover (in U.S. and Russia)	- Requires expensive air pollution controls (e.g. mercury, sulfur dioxide) - Significant contributor to acid rain and global warming - Requires extensive transportation system
Nuclear	- Fuel is inexpensive - Waste is more compact than any source - Extensive scientific basis for the cycle - No greenhouse or acid rain effects - The energy produced per amount of material consumed is the highest available - Costs are competitive with coal, the major source used in the world - Uranium, the source material, is abundant - Plutonium, a by-product of commercial nuclear plant operation, can also be used as a fuel - The amount of waste produced is the least of any major energy production process	- Requires larger capital cost because of emergency, containment, radioactive waste and storage systems - Requires resolution of the long-term high level waste storage issue in most countries - Potential nuclear proliferation issue - Requires some serious security measures to protect and defense - Reduces the labor and job employments because the plant can be operated with only a handful of people compared with a lot of other energy source plants.
Hydroelectric	- Very inexpensive once dam is built - Government has invested heavily in building dams, particularly in the Western U.S.	- Very limited source since depends on water elevation - Dam collapse usually leads to loss of life - Environmental damage for areas flooded (backed up) and downstream

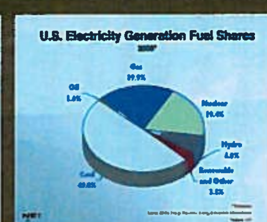
Source	Advantages	Disadvantages
Gas/Oil	- Good distribution system for current use levels - Easy to obtain (sometimes) - Better as space heating energy source	- Very limited availability as shown by shortages during winters several years ago - Could be major contributor to global warming - Very expensive for energy generation - Large price swings with supply and demand
Wind	- Wind is free if available. - Good source for periodic water pumping demands of farms as used earlier in 1900's - Generation and maintenance costs have decreased significantly. Wind is proving to be a reasonable cost renewable source.	- Need 3x the amount of installed generation to meet demand - Limited to windy areas. - Limited to small generator size; need many towers. - Highly climate dependent - wind can damage equipment during windstorms or not turn during still summer days
Solar	- Sunlight is free when available - Costs are dropping.	- Does require special materials for mirrors/panels that can affect environment - Current technology requires large amounts of land for small amounts of energy generation
Biomass	- Industry in its infancy - Could create jobs because smaller plants would be used	- Inefficient if small plants are used - Could be significant contributor to global warming because fuel has low heat content

Nuclear Power Compared to Other Sources

•One Nuclear Power Plant produces 1000 megawatts per hour.
•You would need 60,000 acres and 2400 to 2800 wind turbines to equal 1,000 megawatts.
•You need 5,000 acres of solar panels to equal 1,000 megawatts of electricity.
•Those solar panels only work at peak power levels during the sunny times, so, on average, they only put out about 25% of their rated capacity. That means you really need 20,000 acres of solar panels to generate 1,000 megawatts of electricity per hour, on average. 20,000 acres is 31.25 square miles.

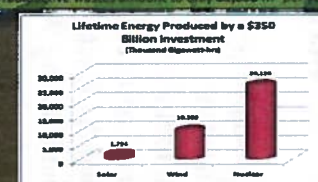
This is how many windmills and solar panels are needed to equal one nuclear plant.





How much waste are produced?

The volume of nuclear waste produced by the nuclear industry is very small compared with other wastes generated. Each year, nuclear power generation facilities worldwide produce about 200,000 m^3 of low- and intermediate-level radioactive waste, and about 10,000 m^3 of high-level waste including used fuel designated as waste. In the OECD countries, some 300 million tons of toxic wastes are produced each year, but conditioned radioactive wastes amount to only 81,000 m^3 per year.



Primary References:

MacFarlane, A. (2010, March). Nuclear power: A Panacea for energy needs? *Environment Magazine, 52*(2). Retrieved from http://www.environmentmagazine.org

World Nuclear Association. (2011, February). Environmental aspects of uranium mining. Retrieved from http://www.world-nuclear.org/info/inf25.html

(2009, April 12). Comparisons of various energy sources. *The Virtual Nuclear Tourist*. Retrieved from http://www.nucleartourist.com/basics/why.htm

Poster #3

"Coal to Clean Oil"

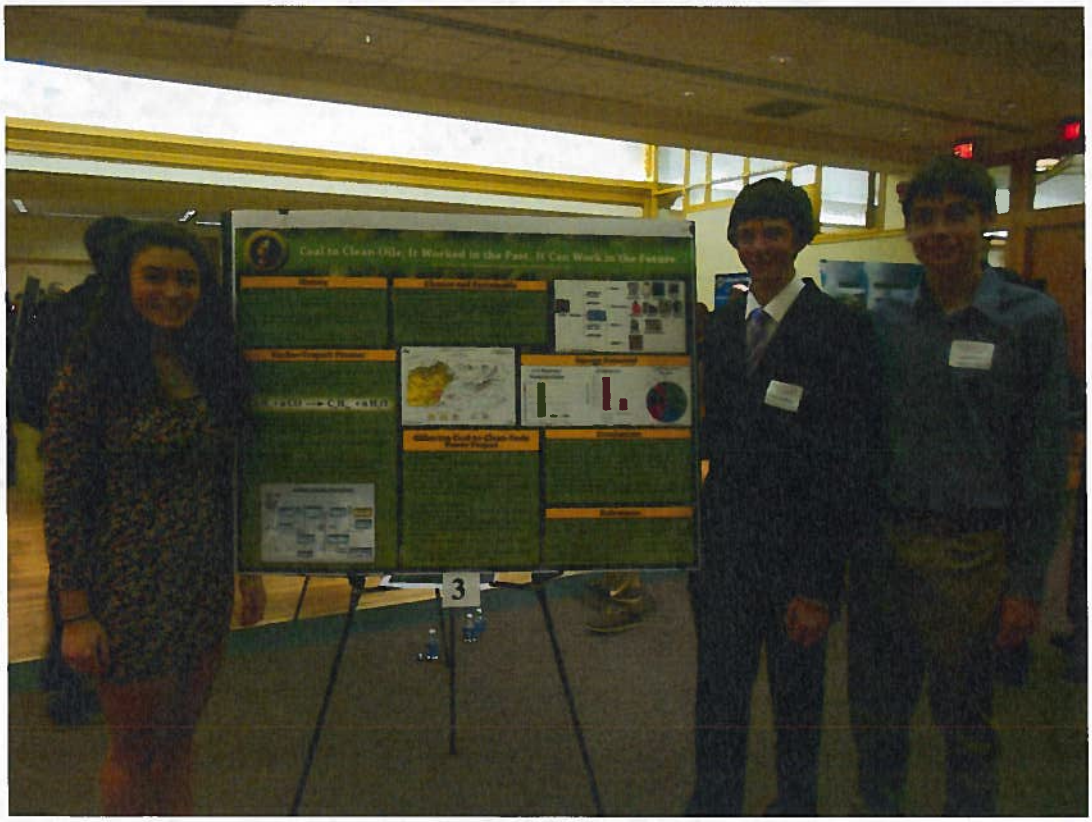
Michael Ryan, Jacob Dietz, Catherine Senopoulos

Coal as an energy source is unrivaled in its ability to draw criticism. Despite the label affixed to it by the coal miners of the 19th century, the truth is that today there are many technologies capable of reducing its ecological footprint.

Our project focused on one such technology, the conversion of coal into diesel fuel through a chemical reaction called the Fischer-Tropsch process. While not a new idea (the technology was first implemented in Germany during WWII), the process has been improved since then to meet the demands of a much more environmentally-conscious 21st century America.

We used a variety of sources to make the point that coal-to-clean-fuels technology is a practical energy source. We utilized data from Department of Energy-sponsored experiments to show that diesel created from the Fischer-Tropsch process performs nearly identical to other types of diesel we more commonly use today. Maps and graphs helped illustrate the vast amounts of coal located in the U.S., and more specifically Pennsylvania. Our project also included a case study of the Gilberton Coal-to-Clean Fuels and Power Project, the potential construction of a plant in nearby Schuylkill County to convert leftover waste coal into oil through the Fischer-Tropsch process. Plants such as these are common in other parts of the world such as South Africa.

While not an end-all solution to the energy crisis, conversion of coal to diesel provides many benefits that set it apart from other alternative fuel sources, such as: low start-up costs compared to renewables, quick payoffs, the creation of jobs in the U.S, cheaper oil for consumers, and reduced dependence on oil-bearing countries.



Coal to Clean Oils; It Worked in the Past, It Can Work in the Future

Jacob Dietz '16, Catherine Senopoulos '16, Michael Ryan '15

History

Coal to Diesel Fuel

- It's not a new concept, but recently improved
- First utilized in 1925 by German Scientists Franz Fischer and Hans Tropsch
- Used for powering military vehicles during World War II
- In 1944, coal-to-liquid-fuels produced 90% of Germany's energy needs
- Sasol, a South African energy business, followed suit in 1950 and is today the largest producer of synthetic gas in the world

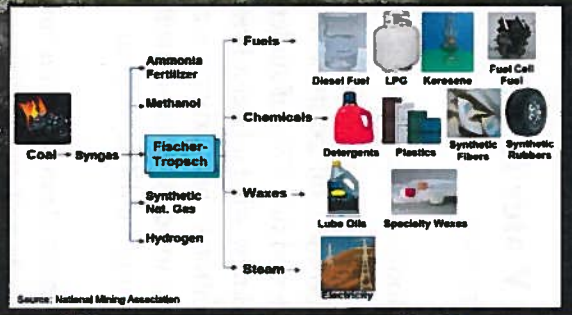
Cleaner and Sustainable

Burns Cleaner

- In a two-cylinder engine, combustion of oil created from coal through the Fischer-Tropsch process emits less nitrous gases and similar amounts of carbon dioxide compared to typical diesel fuel

Nothing Goes to Waste

- Fuels, chemicals, waxes, steam, and other organic goods are created from the hydrocarbon byproducts
- Carbon dioxide given off in the process can be captured and used



Source: National Mining Association

Fischer-Tropsch Process

How It Works

- Requires heating coal to create carbon monoxide, then reacting it with hydrogen to create an array of hydrocarbons
- Hydrocarbons are then refined into transportation fuels, lubricants, and waxes

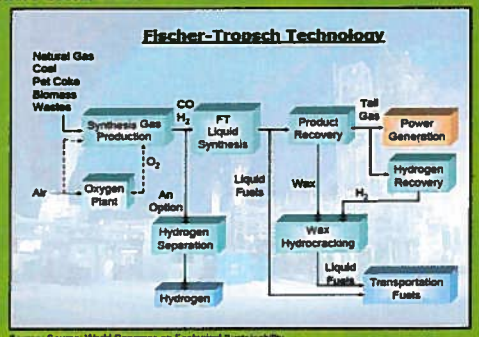
$$2n\,H_2 + n\,CO \longrightarrow C_nH_{2n} + n\,H_2O$$

Original Problems

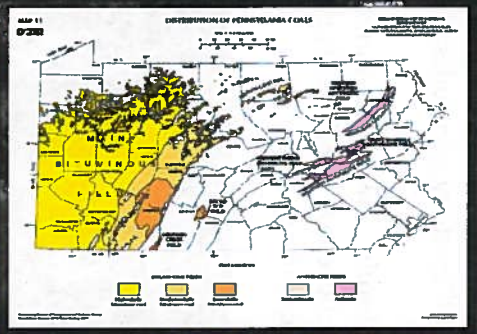
- Original process was crude and inefficient
- The process created a mixture of hydrocarbons, many of which were not useful
- No method to control the size or number of hydrocarbons the reaction yielded

New Developments

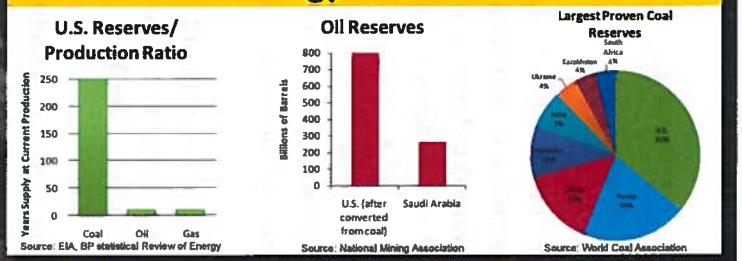
- In 2006, Professor Alan Goldman with researchers at UNC won the Nobel Prize in Chemistry for making the process more efficient
- Developed catalysts to rearrange the useless hydrocarbon molecules into more useful ones.



Source: Source: World Congress on Ecological Sustainability



Energy Potential



Gilberton Coal-to-Clean-Fuels Power Project

Plans For Project

-John W. Rich Jr. aspired to build a plant in Gilberton, PA, to convert coal into fuel
-U.S. Department of Energy needed to loan $100 million to start up this $1 billion plant
-The plant was to be built above the rich source of anthracite coal in Eastern Pennsylvania

Arguments For Project

-The plant is in an economically challenged area and would create 1000 high paying jobs
-Sulfur and carcinogenic aromatics, such as benzene, are cut from process therefore preventing their escape into the atmosphere
-The plant alone would produce 60 million gallons of fuel per year
-Carbon dioxide emissions could be reduced by utilizing wood and animal waste in conjunction with coal

Conclusions

- Coal as a fuel source will continue to remain popular well into the future
- Unlike other fuel sources, coal is well-researched- veins of coal in the U.S. are well documented, and mining practices and the Fischer-Tropsch process have been improved over the past 60 years
- While not an end-all solution to the energy crisis, coal-to-clean-oil offers an intermediate step in the right direction with instant payoffs and comparatively low start-up costs
- The only obstacles affecting coal-to-clean-oils plants from becoming a reality are politics and environmentalist groups such as the Sierra Club

References

Bullis, K. (2006, April 19). Clean diesel from coal (Massachusetts Institute of Technology, Ed.). Retrieved September 19, 2012, from Technology Review website: http://www.technologyreview.com/news/405076/clean-diesel-from-coal/

Fossil Energy Office of Communications. (2012, April 24). Coal: Our most abundant fuel. Retrieved September 19, 2012, from U.S. Department of Energy website: http://www.fossil.energy.gov/education/energyresources/coal/gen_coal.html

National Mining Association (Ed.). (n.d.). Liquid fuels from U.S. coal [Fact sheet]. Retrieved September 19, 2012, from National Mining Association website: http://www.nma.org/pdf/liquid_coal_fuels_100505.pdf

U.S. Department of Energy. (2007, July). Clean Coal Diesel Demonstration Project (Research Report) (U.S. Department of Energy, Office of Fossil Energy, & National Energy Technology Laboratory, Eds.).

U.S. Energy Information Administration. (2012). Reserves & Supply [Data file]. Retrieved September 19, 2012 from http://www.eia.gov/state/state-energy-profiles-data.cfm?sid=PA#Reserves.

Additional references available upon request

Poster #4

"Analysis of Green Roof Benefits: Rain Water Runoff"

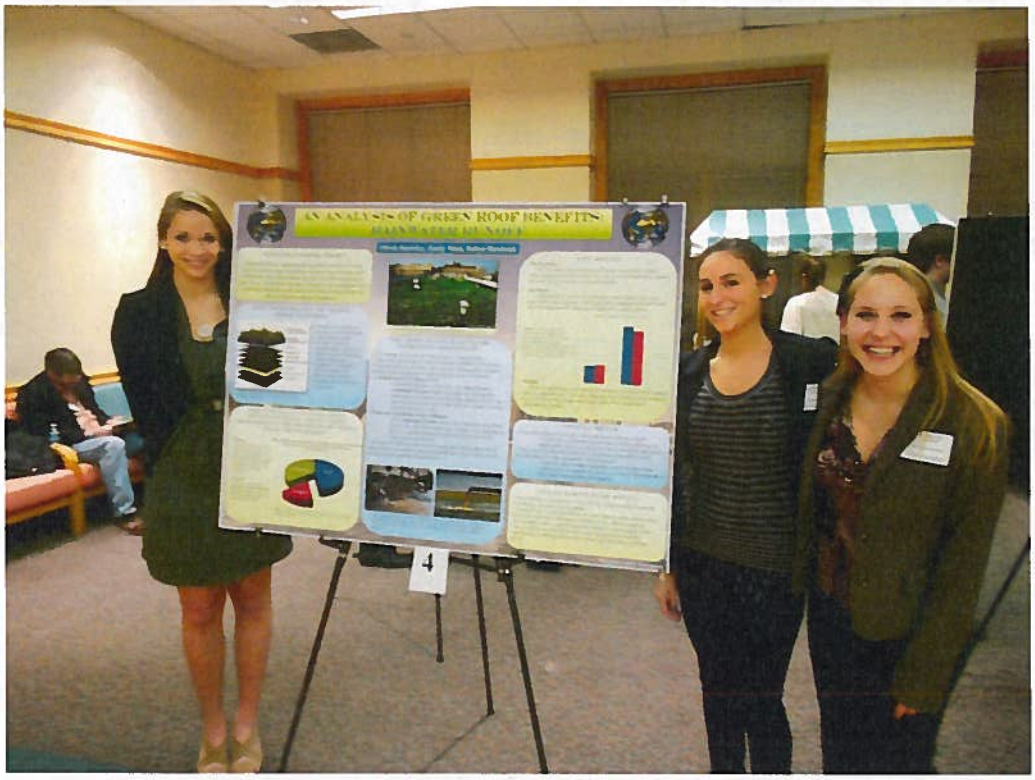
Robyn Henderek, Emily Wool, Olivia Jurewicz

Our group studied Green Roofs and focused on the impact Green Roofs have on rainwater retention. We began by explaining what a Green Roof actually is: an expansion of an existing rooftop that is either fully or partially covered in vegetation. We wanted to know what Lafayette College students knew about Green Roof technology so we surveyed 106 students and discovered that 37% of students surveyed did not know what a Green Roof was. Of the students who knew what a Green Roof was (63% of the total surveyed students), most considered energy conservation to be a driving incentive of Green Roof technology. Therefore, through this presentation, we aimed to educate the students on the importance of rainwater retention in both urban and suburban communities and Green Roof technology's impact on that figure.

A reduction in rainwater runoff is important to our communities because clean water resources are vital to our health and safety. Runoff that comes from impervious surfaces pollute our waterways and enter water infrastructure, leading to combined sewer overflow and point and non-point source pollution.

A number of studies have been conducted on rainwater retention and all have concluded that Green Roofs absorb much more rainwater that traditional roofs, leading to reduced rainwater runoff. One study highlighted in the presentation, the New York City study, concludes that 57% more rainwater is retained on a Green Roof than on a standard rooftop.

We concluded that Green Roofs not only absorb rainwater but further decrease runoff and reduce pollution in our major water resources. We believe that Green Roofs provide benefits to communities in the long run by reducing pollution in the local water system.



AN ANALYSIS OF GREEN ROOF BENEFITS:
RAINWATER RUNOFF

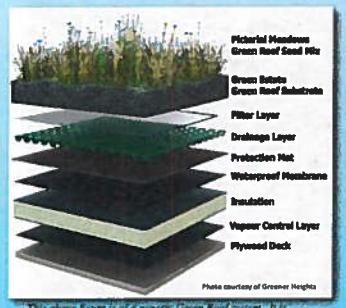
Olivia Jurewicz, Emily Wool, Robyn Henderek

WHAT IS A GREEN ROOF?

Green Roofs are vegetated rooftops that consist of several layers of technology including waterproofing, drainage, and insulation with soil substrate and actively growing plants on top. Every Green Roof system is unique in its installation and vegetation, therefore each Green Roof has varying effects on the environment and its community.

Green Roof on top of the Robertson Building in Toronto.

THE TECHNOLOGY OF GREEN ROOF SYSTEMS



This above figure is of a generic Green Roof system. It is important to understand that every Green Roof is unique in its technology and materials.

Green Roofs comprise of several layers of technology which help to absorb rainwater, which the vegetation then uses for its natural processes including photosynthesis and respiration. Traditional roofs are impervious surfaces which absorb a fractional amount of storm water runoff.

WHAT DO LAFAYETTE COLLEGE STUDENTS THINK ABOUT WHEN CONSIDERING THE BENEFITS OF GREEN ROOF TECHNOLOGY?

Findings:

- Many students (37%) don't even know what a Green Roof is.
- Most of those students who have an understanding of Green Roof benefits consider **energy conservation** to be a driving incentive of Green Roof technology.

Our Aim:

- We aim to argue that the **reduction in rainwater runoff** through absorption of water is one of the largest incentives for installing Green Roofs.

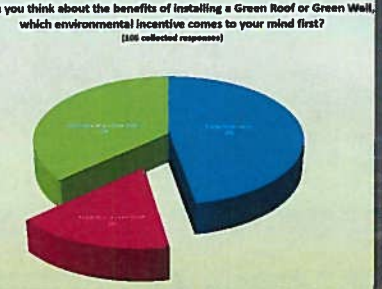


Figure 1: We found that of the 63% of students who knew what a Green Roof is, 75% of those students considered energy conservation to be the a main incentive to install a Green Roof.

WHY IS STUDYING RAINWATER RETENTION IMPORTANT?

- The average American uses 100 gallons of water per day.
- Clean water resources are vital to the heath and safety of residents.
- Pipelines carry out rainwater, however, the infrastructure is largely outdated and ill-equipped to handle large amounts of rainwater
- **Combine Sewer Overflow (CSO)**
  - Outdated pipelines which carry rainwater through a **Combined System** (where rainwater runs through the same pipe as sewage) do not have the capacity to filter all the water so a portion of it is diverted into a body of water, such as a stream or river.
- **Point and Non-Point Source Pollution**
  - In a **Separated System**, pipes carry rainwater away from the city in a different system than sewage. However, along the way captured chemicals and trash lead right to the water source, unfiltered.
- Green Roofs absorb much more rainwater than traditional roofs or other impervious surfaces, and reduce rainwater runoff which would then go into the pipeline infrastructure.

Above are photos of storm water runoff from impervious surfaces, such as sidewalks and standard roofs in Baltimore, MD. This water then runs directly into the Chesapeake Bay, causing many problems for the local wildlife populations. (Photos courtesy of usgs.gov)

NYC STUDY

The Problem:

NYC has many heath problems as a result of pollution in major water systems. About 80% of the city runs on a combined sewer system and only 61% of rainwater is treated annually.

The Study:

A simulation of rainfall on LaGuardia Airport during both a wet year (1984) and a dry year (1988) used both a Standard roof and Green Roof and measured the retention of rainwater in both systems.

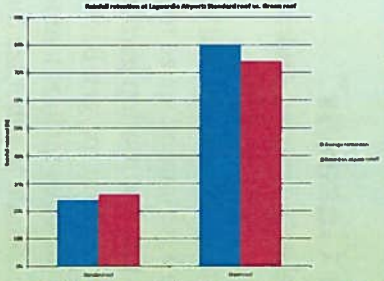


Figure 2: To the right is data collected by the Pennsylvania State University study on Green Roof systems at LaGuardia Airport. Data found that Green Roofs retained about 57% more rainwater than standard roofs.

Results:

There is significantly more rainwater retention in a Green Roof system than in a standard roof. The study projected that runoff could be reduced by up to 10% at the sewage-shed scale with a 50% Green Roof infrastructure scenario.

CONCLUSIONS

- Green Roofs absorb rainwater, which decreases rainwater runoff.
  - A decrease in rainwater runoff helps to reduce pollution in major water resources, which are vital to our health and safety.
- This is an environmental incentive of installing a Green Roof which provides benefits to the community in the long term.
  - Studying ways to reduce rainwater runoff on impervious surfaces helps to educate the public on issues of development in both urban and suburban communities.

PLANS FOR FUTURE STUDY

- We would like to analyze how Green Roofs conserve energy to provide an economic incentive for installation.
- We would like to study the effects of Green Walls in urban environments. One major incentive is the natural filtration of air, adding oxygen to environments where a lack of vegetation results in a poor quality of air.
- We would like to study the social, economic and environmental implications of drafting policies that enforce the installation of Green Roofs.

*References available upon request

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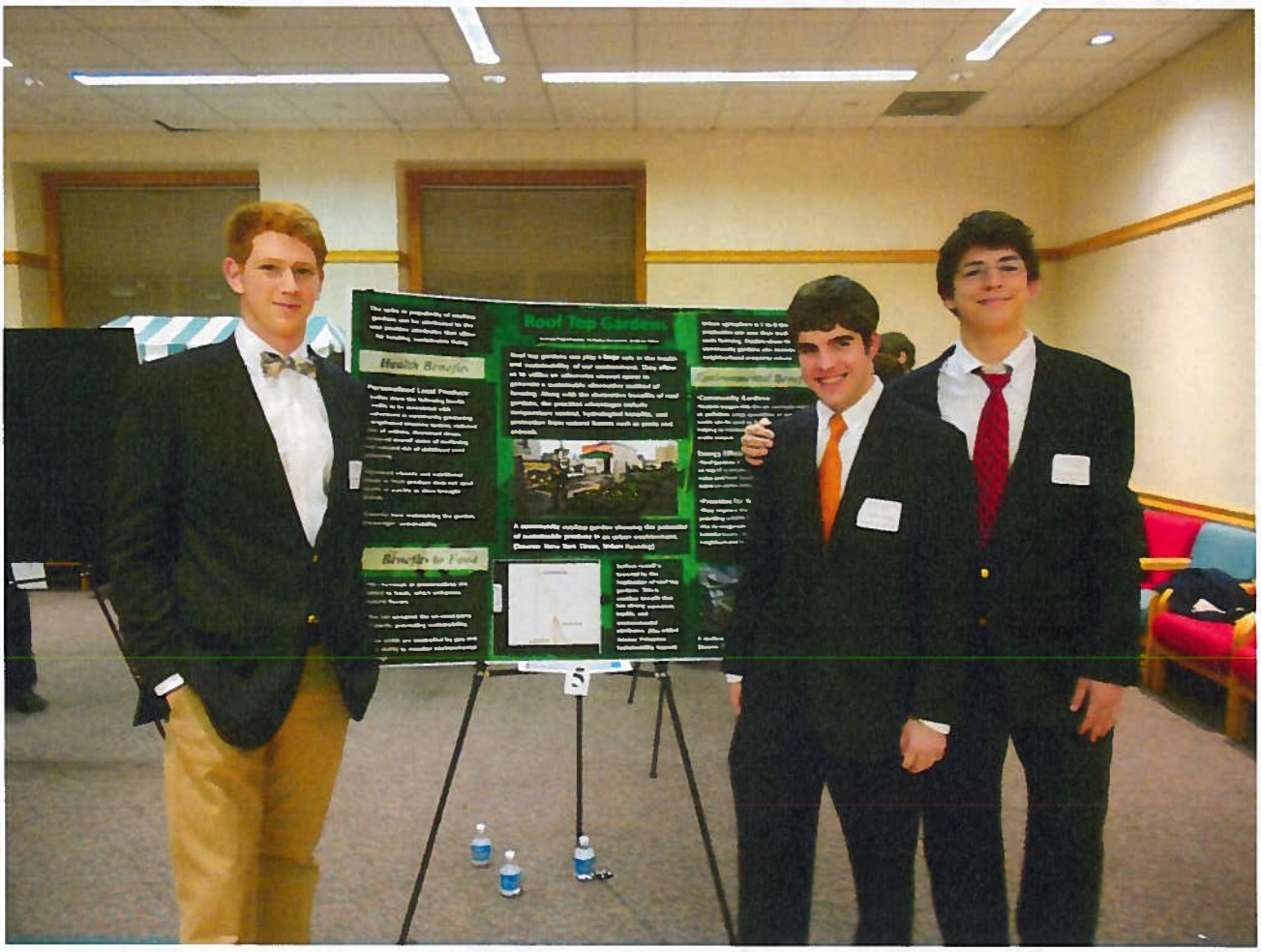
Poster #5

"Rooftop Gardens"

Nathan Papermaster, Nicholas Gurzynski, Andrew Winn

Rooftop gardens are a sustainable solution to help solve our world's continuing environmental problems. These gardens allow us to utilize an otherwise unused space to generate a sustainable alternative method of farming. Our research showed us that rooftop gardens are vital to reforming urban environments by cutting down on air pollution and releasing oxygen back in to the air. Along with the decorative benefits of roof gardens, the practical advantages include temperature control, storm water runoff absorption, and habitats for animals. As we continue to urbanize our natural environment we neglect the effect we have upon the areas we inhabit. Rooftop gardens are a way we can turn a negative into a positive by transforming our urban environment. Additionally, there are many economic benefits associated with rooftop gardens including, increasing property value, saving money on organic foods and lowering utility costs. The blossoming of rooftop gardens in the modern ages strives for excellence by farming crops high above the ground, in a safe, controlled environment. The spike in popularity of rooftop gardens can be attributed to the vast positive attributes that have been universally recognized. Rooftop gardens help construct a stronger sense of community in highly populated urban areas. Rooftop gardens display the versatility of farming produce and crops while displaying the reward yielded by our sustainable actions in urban environments. Rooftop gardens play an important role in a collective global solution for reshaping the un-utilized urban ecosystem.



Roof Top Gardens

Nathan Papermaster, Nicholas Gurzynski, Andrew Winn

The spike in popularity of rooftop gardens can be attributed to the vast positive attributes that allow for healthy, sustainable living.

Roof top gardens can play a large role in the health and sustainability of our environment. They allow us to utilize an otherwise unused space to generate a sustainable alternative method of farming. Along with the decorative benefits of roof gardens, the practical advantages include temperature control, hydrological benefits, and protection from natural factors such as pests and animals.

Urban agriculture is 3 to 5 times more productive per acre than traditional large scale farming. Studies show that community gardens can increase neighborhood property values.

Health Benefits

•Personalized Local Produce:

•Studies show the following health benefits to be associated with involvement in community gardening: strengthened immune system, reduced rates of asthma, decreased stress, increased overall sense of wellbeing and reduced risk of childhood lead poisoning.

•Increased vitamin and nutritional intake as fresh produce does not spoil nearly as quickly as store brought brands.

•Exercise from maintaining the garden, encourages sustainability.

A community rooftop garden showing the potential of sustainable produce in an urban environment. (Source: New York Times, Urban Farming)

Environmental Benefits

•Community Gardens:

•Restore oxygen into the air and help reduce air pollution. Large quantities of organic waste can be used to fertilize gardens, thus helping to minimize a community's overall waste output.

Energy Efficiency:

•Roof gardens absorb a lot of energy by being on top of a structure. They naturally provide noise and heat insulation, thereby cutting down on utility bills.

•Provides for Nature:

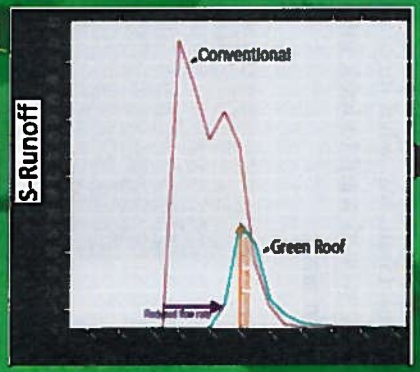
•They improve the natural environment by providing wildlife habitats. These gardens also re-oxygenate the air and sequester harmful toxins, allowing your home and neighborhood to reap the natural benefits.

Benefits to Food

•No chemicals or preservatives are added to foods, which enhances natural flavors.

•You can compost the un-used parts of plants, promoting sustainability.

•Crop yields are controlled by you and your ability to monitor environmental settings



Surface runoff is lowered by the implication of roof top gardens. This is another benefit that has strong economic, health, and environmental attributes. (The added Source: Princeton Sustainability Report)

A rooftop garden on top of Chicago City Hall (Source: Chicago City Green Program)

Poster #6

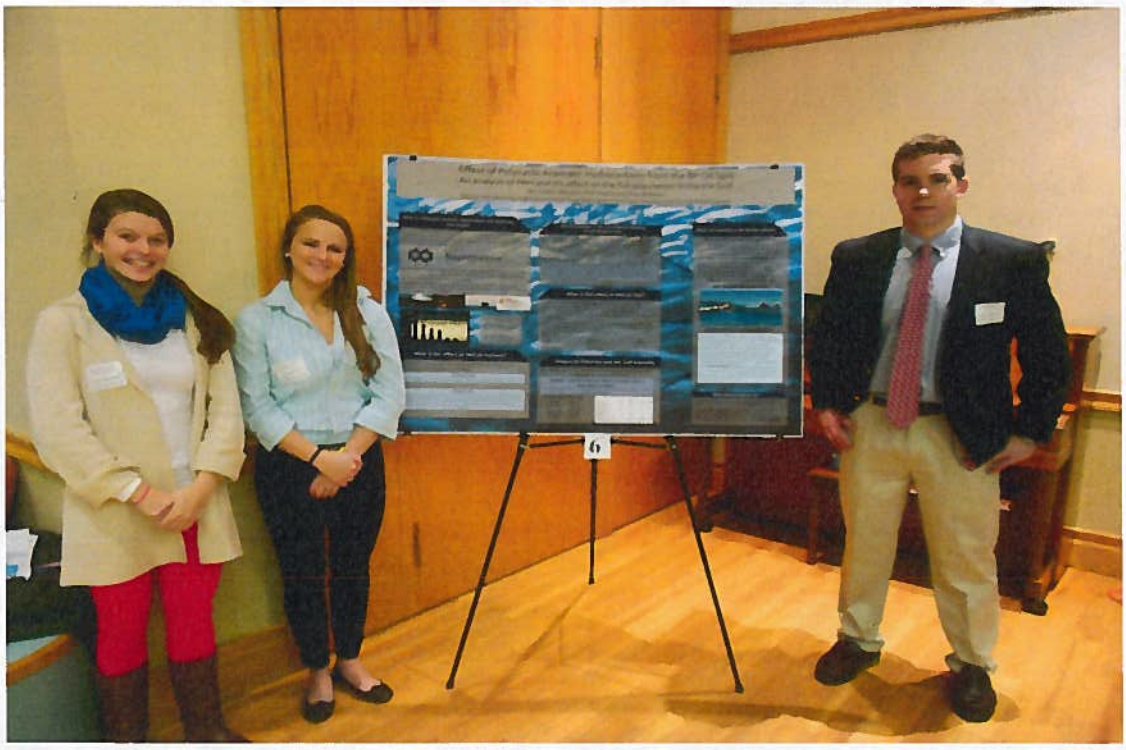
"Effect of Polycyclic Aromatic Hydrocarbons from the BP Oil Spill"

Caitlin Mitchell, Troy Williams and Arin Stasco

For our semester poster project, our group decided to look into environmental effects that occurred after the BP Oil Spill in 2010. After some research we came across the subject of PAH, Polycyclic Aromatic Hydrocarbons. To get a solid understanding of the effect of PAH's from the Oil Spill, we focused on the effect involving humans, fish and the economy in states that touch the Gulf of Mexico. We also researched methods on how the spill was cleaned up, and newly developed engineering solutions to oil spills.

Some important information that we gathered during our research was, PAH's and their effect on humans are not widely known. However, we do know that they have detrimental effects on human development. Women that are pregnant or looking to become pregnant should not consume foods containing PAH's or avoid contact with materials that contain them. Because PAH's are lipid soluble fish and other marine life that came into contact with the oil or were near the spill now contain concentrated levels of these PAH's. Economically, once the Oil Spilled the FDA placed a ban on "tainted" fish, fish that had been touched by the oil during the oil spill. This ban on "tainted" fish took a major hit on the profits of fisheries and companies selling fish. Many clean up efforts were made after the spill but an engineering solution developed was, a new technique, specifically including nanotechnology.

Once we completed the project and presented our projects to judges, we were able take the time to reflect on our project. PAH's obviously a dangerous compound that can have a major health effect on the unborn generation if mothers consume the compound. It made our group want to understand if there is a way to remove the PAH from fish, how we can keep humans from consuming them and understanding what large scale engineering projects will be tested next. If we were to future our project we would want to look into the testing of large-scale nanotechnology and what results this technology can have.



Effect of Polycyclic Aromatic Hydrocarbons from the BP Oil Spill

An analysis of PAH and it's affect on the fish population in the the Gulf

By: Caitlin Mitchell, Arin Stasco and Troy Williams

CE321 Introduction to Environmental Engineering and EVST100 Introduction to the Environment

What is a Polycyclic Aromatic Hydrocarbon and where are they found?

Polycyclic Aromatic Hydrocarbons (PAH) "are a group of over 100 different chemicals that are formed during the incomplete burning of coal, oil and gas, garbage or other organic substances like tobacco or charbroiled meat." (Agency for Toxic Substances and Disease Registry)

Naphthalene

Naphthalene is the simplest PAH, with a structure that consists of fused benzene rings. Along with naphthalene there are twelve different forms of PAHs, including Coronene and Pyrene.

According to the Registry, some PAH's are manufactured while others occur naturally in the environment. "Manufactured PAH's appear as colorless, white or yellow-green solids." (ATSDR)

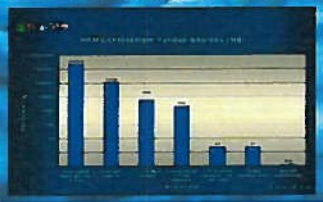


Figure 1 displays the various levels of concentrations in which PAH's are found in our own environment.

What is the effect of PAH on humans?

A PAH can have several effects on human health. Each type of PAH can be identified as either carcinogenic or mutagenic.

Carcinogenic PAH

Long term exposure to carcinogenic PAH's can lead to increased risks of developing various forms of cancer. Lung, stomach, and skin cancer have all been linked to exposure of PAH's through breathing, ingesting, or physical contact.

Mutagenic PAH

Women that are pregnant or looking to become pregnant are advised to limit the amount of PAH's in their environment. PAH's have been proven to be detrimental toward human development. Mutagenic PAH's are proven to affect the development of a fetus. Lower IQ, asthma, low birth weight, premature delivery, heart malformations, and behavioral problems are all proven side effects of parental exposure to mutagenic PAH's. Studies done on umbilical cord blood of infants where PAH was found, indicated higher levels of sociological problems later on in development.

PAH Concentration in the Gulf of Mexico Following the BP Oil Spill of 2010

The British Petroleum (BP) oil spill of 2010 resulted in over 200 million gallons of crude oil in one of the largest fisheries in the United States, the Gulf of Mexico. The gulf is responsible for over 60% of shrimp and 70% of oyster production for the United States. Upon the gulfs contamination, carcinogenic PAH's that were present in the spilled oil accumulated in the seafood present in the gulf.

PAH Contamination Quota:

"PAHs are detectable in shellfish for up to 13 years after oil contamination, and there is evidence of ongoing DNA damage from PAHs in marine life after that time (Bejarano and Michel 2010; Thomas et al. 2007). There is considerable variation in the half-life of PAHs, depending on the structure of the compound and environmental conditions. However, using an average value recommended by the California EPA for PAHs in soil (570 days), approximately 10% of the contamination would be expected to remain after 5 years, and < 2% would remain after 10 years (OEHHA 2000)"

What is the effect of PAH on fish?

The effect on each fish in the gulf depends on several factors, which include length of exposure, concentration of PAH in the oil and how far the oil has traveled. While the full effect has to be determined specifically for each fish any exposure can lead to infertility, development problems and similar issues in their children.

If fish are exposed to PAH but do not have any noticeable effects often the effects of the exposure will pass to the embryos. The fish unaffected by PAH but still contain PAH can pass the chemical compound on to humans that ingest them.

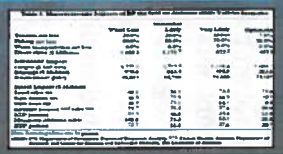
Scenario	Naphthalene	Total
Woman	0.008 (0.006, 0.012)	0.5 (0.1, 0.8)
Child	2.1 (1.5, 3.0)	1.9 (0.5, 3.3)
Pregnant Women	4.2 (3.7, 6.2)	3.9 (1.1, 6.7)

Impact on Fisheries and the Gulf Economy

After the oil spill occurred the Food and Drug Administration (FDA) placed a ban on fish "tainted" during the gulf oil spill.

Tainted -- any fish that has been in contact with a petroleum product.

Once a fish comes in contact with a petroleum product is can accumulate PAH in its tissues. It can also acquire a oily smell and taste.



What are solutions to BP Oil PAH effects?

First Completed Engineering Solution:

Shoreline protection and clean up was done by many local commercial fisherman and vessel owners. In order to keep the oil from reaching the shore, BP used **LARGE-SCALE OFFSHORE SKIMMERS** and other water equipment to skim oil from the surface. Areas where weather, sea distance and other conditions allowed it to be appropriate, Unifies Command conducted controlled bringing of oil.

This destroyed between 220,000 and 310,000 barrels of oil.

Proposed Engineering Solution:

As a result of the BP oil spill, researchers have been doing extensive research to find innovative new techniques to save companies money through clean up bills. One specific technique involving nanotechnology and magnets was found by researchers from Massachusetts institute of Technology (MIT). Oil, when mixed with **NANOPARTICLES** that contains iron, it can be magnetically separated from water and later on these nanoparticles can be removed so that the oil can be re-used.

What resources did we use?

Rotkin-Ellman, M., Wong, K. K., & Solomon, G. M. (2012). Seafood contamination after the BP gulf oil spill and risks to vulnerable populations: a critique of the FDA risk assessment. *Environmental Health Perspectives*, *120*(2), 157 – 161. Doi: 10.1289/ehp.1103695

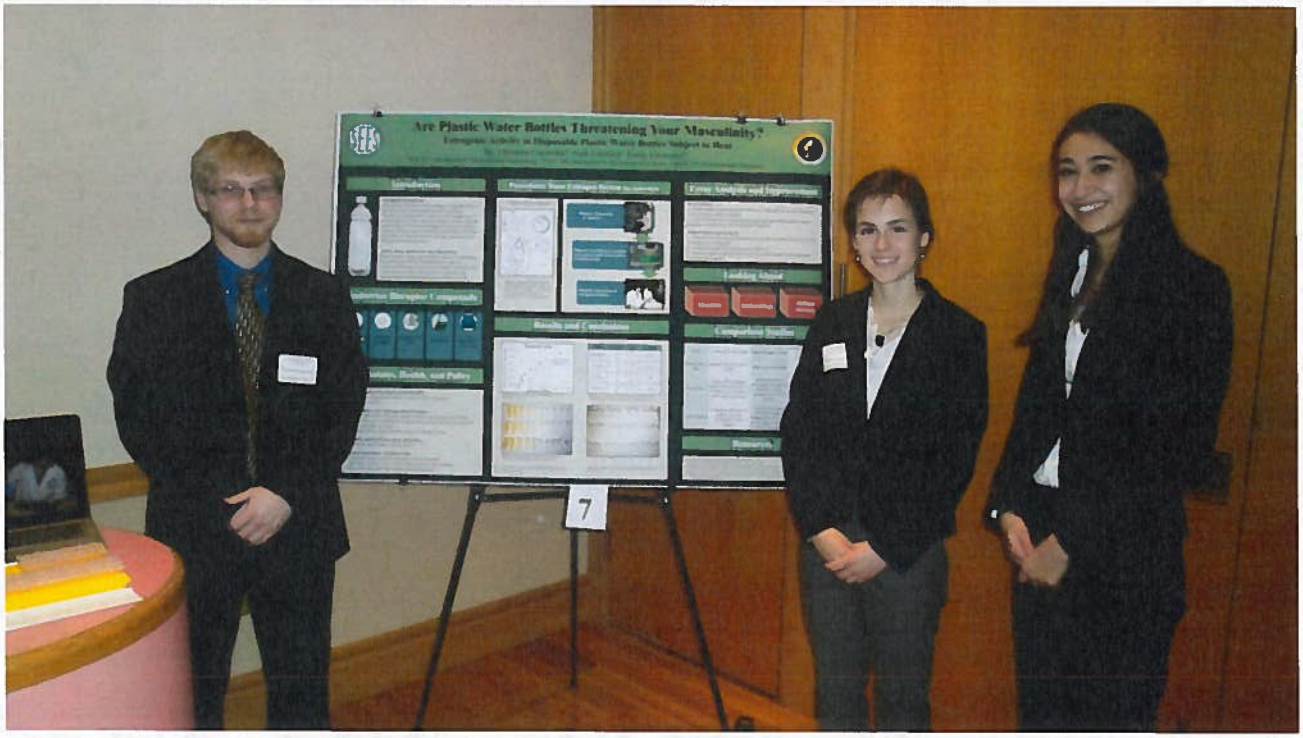
Poster #7

"Are Plastic Water Bottles Threatening Your Masculinity?"

Emily Crossette, Christina Cucinotta, Nicholas Limburg

Estrogenic compounds are a subset of endocrine disrupting compounds (EDC) that mimic natural estrogen. Bisphenol A, pesticides, fire retardant chemicals and phthalates are types of estrogenic compounds. Our research focused on phthalates, a type of plasticizer found in many common household products, including plastic water bottles. Over time, phthalates leach out of the plastic into the surrounding environment. Research indicates that there is a correlation between male reproductive disorders and blood phthalate levels, particularly when exposed to these compounds during prenatal and postnatal development.

Using a Yeast Estrogen Screen (YES), we measured the estrogenic activity in the plastic water bottles to determine the extent to which plastic water bottles leach estrogenic compounds when exposed to heat. The YES involved growing yeast in the samples of water. When estrogenic compounds were present in the sample, the yeast produced a compound that was measured with a spectrometer. The more estrogenic activity in the water, the more chemical was produced. Samples evaluated for their estrogenic activity included water from a bottle at ambient temperature, a bottle incubated at 40°C for 12 hours, a bottle incubated at 40°C for 24 hours, and a sample of tap water. Our experiment found estrogenic compounds in all water samples in the range of 0.8-2.3 ppt with no correlation between increased time in the incubator and increased estrogenic activity. However, upon further research, we found studies that proved there is an increase in estrogenic activity with greater time and temperature exposure. If we were to run this experiment again, we would make several improvements including incubating the bottles at elevated temperatures for longer amounts of time.



Are Plastic Water Bottles Threatening Your Masculinity?

Estrogenic Activity in Disposable Plastic Water Bottles Subject to Heat

By: Christina Cucinotta*, Nick Limburg§, Emily Crossette*°

*CE 321: Introduction to Environmental Engineering; §EVST 100: Introduction to Environmental Science, °CHEM 252: Environmental Chemistry

Introduction

Estrogenic Compounds

One group of Endocrine disrupting compounds (EDC) in particular has recently gained public attention. Estrogenic compounds include natural estrogens and chemicals that mimic natural estrogen. Various sources contribute to the overall estrogenic activity in surface waters. Plastics, flame retardants, pesticides, and other chemicals can bind to human estrogen receptors and disrupt hormone activities.

Plastic Water Bottles and Your Masculinity

Plastic water bottles are typically made of Polyethylene terephthalate (PETE). Phthalates are a type of endocrine disruptor that mimic estrogen and affect the reproductive system, particularly in males during prenatal and postnatal reproductive development.

Endocrine Disruptor Compounds

Phthalates, Health, and Policy

Phthalate exposure has been connected with:

- Decreased anogenital distance, cryptorchidism, and sperm count and motility

Current Policies in the USA regarding Phthalates:

- Section 108 of the Consumer Product Safety Improvement Act (CPSIA) restricts the use of phthalates in the production of child (12 years old and under) care and toy items.
- No other federal laws currently restrict phthalates in USA.

States with additional laws about phthalates:

- California, Washington, and Vermont

Phthalate Restrictions Outside of USA:

- European Union, Sweden, Norway, Finland, Denmark, Germany, Austria, France, Spain, Japan, Greece, Italy, Canada
- PVC, Child Care and Toy Products, Medical devices

Procedure: Yeast Estrogen Screen *(no extraction)*

Yeast Strain for YES(ne)

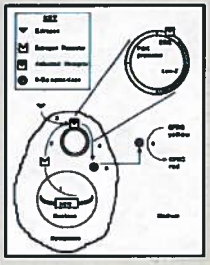
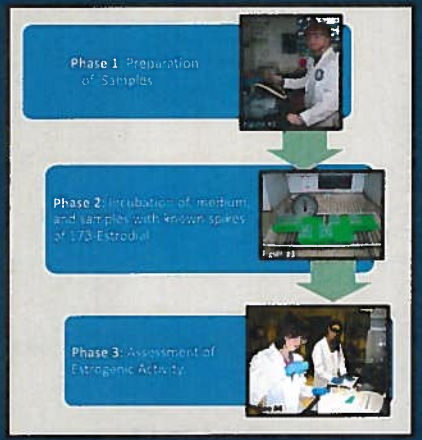


Figure 1. Transgenic yeast developed by Routledge and Sumpter (1996). The yeast contains the gene for the human estrogen receptor and the lac-Z operon from *E. coli*. B-galactosidase.



Results and Conclusions

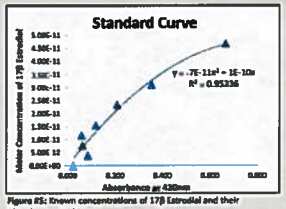


Figure #5: Known concentrations of 17β Estradiol and their Absorbance at 430 nm

Sample	Dilution	ppt	Average
Tap Water	.5	1.3	1.75
	.25	2.2	
Control	.5	0.8	1.45
	.25	2.1	
12-Hour	.5	1.5	1.90
	.25	2.3	
24-Hour	.5	1.0	1.65
	.25	2.3	

Figure #6: Concentrations of Estradiol equivalents based on absorbance of sample at 420 nm and the standard curve.

Figure #7: Standard curve set with known concentrations of Estradiol after phase 3 of Yeast Estrogen Screen.

*Our results do not prove that bottled water threatens one's masculinity.

Figure #8: Samples after phase three of Yeast Estrogen Screen (no extraction)

Error Analysis and Improvement

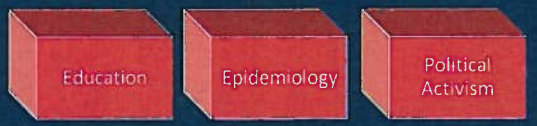
Error Analysis

- Challenging to quantify results because of deviations across triplicate runs and poor return of spikes
- 17B-estradiol concentrations may have already existed within water samples, instead of as result of plastic leaching

Experimental Improvements

- Extend time and elevate temperatures to increase the recovery of 17B-estradiol concentrations
- Increase sample size and decrease dilutions
- Replace water in bottles before test to avoid impact of prepackaged contaminated water

Looking Ahead



Comparison Studies

Study	In Vivo Snail Bioassay	Yeast Estrogen Screen	Effect of Incubation on Phthalate Concentration
Researchers, Year	Wagner and Oehlmann, 2009	Pinto and Reali, 2009	Casajuana and Lacorte, 2003
Procedure	Empty PETE and glass bottles filled with culture medium and incubated with snails for 56 days	Yeast bioassay to investigate estrogenic activity in water samples from PETE bottles	Phthalates measured in incubated PETE and glass bottles over extended time
Conclusions	Production of embryos greater in snails incubated in PETE bottles	Variations among brands of water, ranging from 0.9 ng/L to 23.1ng/L in ethinyl estradiol equivalents	After 10 weeks of incubation, samples showed measurable levels of DEHP and DEP

Resources

Colosi, J.C., & Kney, A.D. (2011). "A Yeast Estrogen Screen Without Extraction Provides Fast, Reliable Measures of Estrogenic Activity." *Environmental Toxicology and Chemistry*, 30(10), 2261-2269.

Routledge, E.J., and Sumpter, J.P (1996). "Estrogenic Activity of Surfactants and Some of Their Degradation Products Assessed Using a Recombinant Yeast Screen." *Environmental Toxicology and Chemistry*, 15(3), 241-248.

Swan, S.H., Main, K.M., Liu, F., Stewart, S.L., Kruse, R.L., Calafat, A.M., Mao, C.S., Study for Future Families Research Team (2005). "Decrease in Anogenital Distance among Male Infants with Prenatal Phthalate Exposure." Environmental Health Perspectives, 113(8), 1056-1061.

*More Resources available by request

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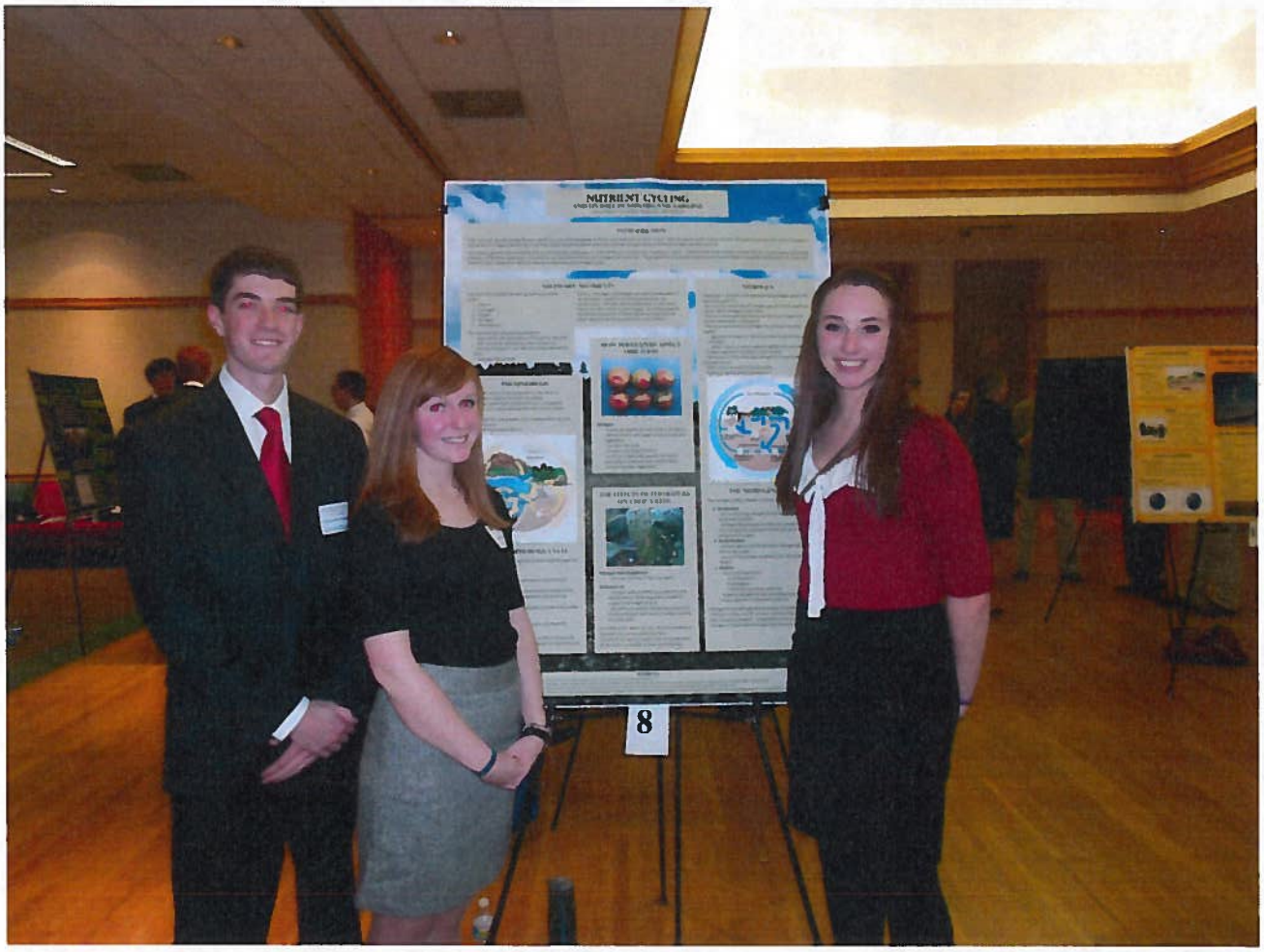
Poster #8

"Nutrient Cycling"

Allison Scoular, Christopher Radomski, Sage Hartlaub

For our poster we looked into nutrient cycling and non-organic gardens from the scale of a small home garden to high yielding farms. We wanted to see if the addition of nitrogen and phosphorous fertilizers had any affects on crop yields and overall crop quality. By looking at the processes that make up the nitrogen cycle as well as the phosphorous cycle, we gained insight into the roles these elements play in the plants' lifecycle. Phosphorous is necessary for root growth and stress tolerance in plants, while nitrogen is a vital ingredient in proteins and enzymes within the plant, and also increases seed and fruit production. When gardeners or farmers over-fertilize their crops, other problems tend to arise that can ultimately lead to health issues. Excess nitrogen can lead to discoloration in tomatoes, alter the taste of food, and change the nutritional content of the crop. On the other hand, when no fertilizers are used, a deficiency of nitrogen and phosphorous cause thin and spindly stems rendering plants unable to support the weight of fruit. From our research we found that nitrogen and phosphorous are very important elements for crop quality and yields, but too much or not enough of these nutrients in the soil can have negative effects.



NUTRIENT CYCLING
AND ITS ROLE IN NON-ORGANIC GARDENS

Allison Scoular, Christopher Radomski, Sage Hartlaub

INTRODUCTION

Have you ever wondered why farmers spend so much time spreading fertilizers and chemicals on their crops? What do plants really need to thrive? We took a look into the topics of nutrient cycling and non-organic gardening to see how plants acquire essential elements and how the application of fertilizers impact our food sources.

Non-organic gardens are defined by the use of chemicals, pesticides, or other fertilizers to create the "healthiest" plants. Traditional farming practices involve the use of non-organic gardening strategies of fertilizer application to fortify the soil with phosphorous and nitrogen rich materials. These additions of essential elements can have positive or negative ramifications on food crops based on their interactions with the natural phosphorous and nitrogen cycles.

NECESSARY NUTRIENTS

Five elements essential to plant growth and overall health:

1. Carbon
2. Hydrogen
3. Oxygen
4. Nitrogen
5. Phosphorous

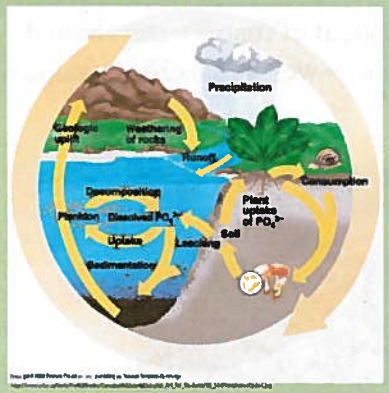
Carbon, Hydrogen, and Oxygen are naturally abundant in air and water; supplements of these elements are unnecessary. Nitrogen and Phosphorous, on the other hand, are often times in short supply. To compensate for insufficient quantities of these elements, they are both often added to fertilizers and other crop fortifiers.

The characteristics of essential elements:

- required for the completion of the plants' lifecycle
- role cannot be replaced by other substances
- directly involved in reproduction and growth of the plant
- necessary for survival

PHOSPHOROUS

- Naturally occurs in the ecosystem in the form of phosphate as organic, mineral, or sorbed
- The only usable form of phosphorous is phosphate
- Plays a role in early plant growth and hastens plant maturity
- Important for root growth, encouraging blooming, and stress tolerance
- Essential for photosynthesis



THE PHOSPHOROUS CYCLE

Phosphorous is cycled through the environment through the processes of:

1. **Sorption**
   - process by which phosphorous is bound to soil particles
   - opposite of this process (desorption) breaks these bonds and leads to more available phosphorous
2. **Mineralization**
   - process where organic phosphorous becomes usable phosphate
3. **Dissolution**
   - refers to minerals dissolving and subsequently releasing phosphorous

Phosphorous is lost through leaching, sorption, erosion by wind and runoff, and immobilization where the element gets tied up in microorganism cells.

HOW FERTILIZERS AFFECT OUR FOOD

Nitrogen:

- excess can lead to discoloration in tomatoes
- affects vitamin and sugar levels in fruits and vegetables
- can alter the taste
- changes nutritional content
- build up in dark leafy greens can lead to poisoning in livestock and small children consuming these vegetables

THE EFFECTS OF FERTILIZERS ON CROP YIELDS

Nitrogen and phosphorus:

- increase the size of the crop plant

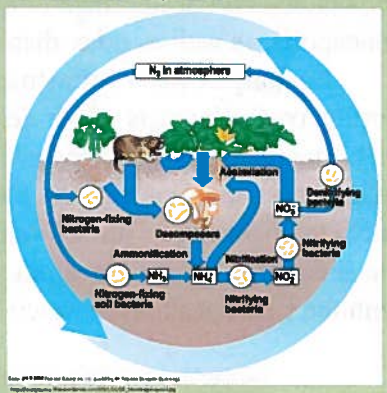
Deficiency of:

- nitrogen and phosphorus causes thin and spindly stems rendering plants unable to support the weight of fruit
- phosphorus reduces the ability of plants to produce flowers and seeds, thereby lowering the crop yield

It is difficult for plants to over-absorb phosphorus because it is quickly eroded by rain.
Too much nitrogen in a plant can cause the plant to become susceptible to bugs and diseases.

NITROGEN

- Naturally is present in the atmosphere and deep within the soil in clay particles.
- Air is mostly comprised of nitrogen gas, but most organisms cannot utilize nitrogen in this form.
- The most accessible and functional forms are 'fixed' and incorporated within compounds.
- The required amount of nitrogen for survival varies by species.
  - agricultural crops (i.e. corn) use massive quantities of nitrogen
  - other crops (i.e. wheat) absorb significantly less nitrogen
- Is a key ingredient in proteins and enzymes
- Significant in chlorophyll pigment which is responsible for photosynthesis
- Vital in plant growth and crop quality
- Increases seed and fruit production



THE NITROGEN CYCLE

The nitrogen cycles is based on three main processes:

1. **Nitrification**
   - key in returning nitrogen to the soil where it is accessible to plants
   - Nitrogen fixing bacteria in the soil convert ammonium into nitrite and subsequently into nitrate in the presence of oxygen
2. **Denitrification**
   - process where nitrate becomes nitrogen gas by removing oxygen
   - occurs in anaerobic conditions (i.e. poorly drained fields)
3. **Fixation**
   - occurs in three forms
     a) atmospheric
     b) biological
     c) fixation caused by lightning
   - supplies nitrogen to the microorganisms that are responsible for nitrification in the soil

Nitrogen is lost through the processes of volatization, crop removal, surface runoff, erosion, and leaching where nitrate runs into ground water. Volatization is the process by which nitrogen is lost as ammonia gas from manure and fertilizers.

SOURCES

An introduction to soil fertility. (2012, October 23). Retrieved from http://soil.gsfc.nasa.gov/index.php?section=77
Jones, C., & Jacobsen, J. (2005). Nitrogen cycling, testing and fertilizer recommendations. *Nutrient Management*, Retrieved from http://landresources.montana.edu/nm/Modules/NM 3 mt44493.pdf
Jones, C., & Jacobsen, J. (2005). Plant nutrition and soil fertility. *Nutrient Management*, Retrieved from http://landresources.montana.edu/NM/Modules/NM 2 mt44492.pdf
Jones, C., & Jacobsen, J. (2005). Phosphorus cycling, testing and fertilizer recommendations. *Nutrient Management*, Retrieved from http://msuextension.org/publications/AgandNaturalResources/4449/4449_4.pdf

Poster #9

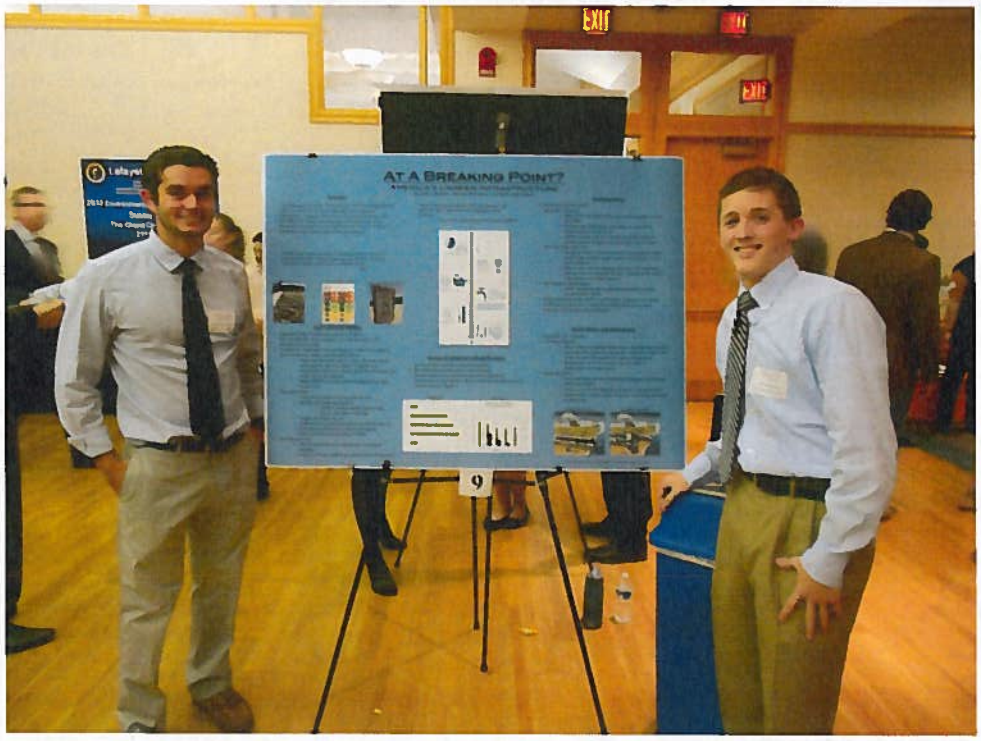
"At a Breaking Point?"

Nicholas Villani, Brandon McKim, Dennis O'Heney

For our poster project we will be covering two main subject areas with respect to America's water infrastructure; water systems, and the environmental impact of our degrading infrastructure. America's water infrastructure has been steadily decaying over the past 40 years. The vast majority of our water infrastructure was implemented between 1920 and 1980, after which time funding was cut and development/maintenance could not keep up with the growing population. In the 2009 ASCE Report Card on Infrastructure, our country received a D- in both drinking water and wastewater; with and overall grade of a D averaged across all areas of Infrastructure. This shows that water infrastructure is a current, very prominent subject with regards to our sustainability for the future.

We will be analyzing the physical water infrastructure, with respect to three specific areas: drinking water, wastewater, and storm water. Within these three categories we will report on the overall condition of the infrastructure, typical age and useful lifespan, as well as ways in which they are degrading and some of the different costs or obstacles associated with repairing or replacing components. We will thoroughly research each of these categories of water infrastructure so as to be well informed on the current status and any current events associated with them. Examples of such events include the water main failure in Baltimore this July, the collapse of the I-35 Bridge in Minneapolis, as well as other disruptions to communities as a result of a water infrastructure failure.

Looking at water infrastructure from more of an environmental angle, we will be analyzing and reporting on the impacts of our degrading water infrastructure on the particular environments that they affect. Examples of such areas of focus include combined system overflows (CSO's – storm water management), non-point source pollution with respect to the affect of pervious an impervious pavements relative to quantities of runoff water, as well as efforts to "buffer" the amount of runoff water through various methods. We will examine general effects of infrastructure failure as well as specific examples within the Chesapeake Bay watershed and Santa Monica Bay.



At a Breaking Point?

America's Unseen Infrastructure

Brandon Mckim, Dennis O'Heney, and Nicholas Villani

Summary

Drinking water is being contaminated, rivers are being polluted, entire ecosystems are being affected by infrastructure degradation. America's infrastructure boomed between 1920 and 1980 in all areas, including water infrastructure. This investment has been largely neglected over the past 30 years, resulting in large-scale deterioration and failures.

"Global water usage continues to increase at twice the rate of population growth. Clearly something must be done to better manage our water supply for a sustainable future"

-IBM

Pervious Pavement

State of the Chesapeake

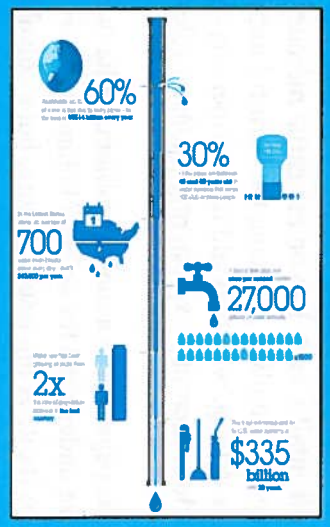
Santa Monica Bay Warning Sign

Environmental Impacts

- Degrading water infrastructure leads to failures. Environmentally, those of largest concern are CSO's and untreated storm water.
- Outdated or improperly maintained sewer systems can lead to flow deficiencies, leaks, and complete failures.
  - Repairing and replacing our sewer networks would add capacity, allow for further integration of wastewater treatment plants (WWTP) and further the useful life of the systems.
  - More WWTPs or more advanced WWTPs can help avoid CSO's
- Chesapeake Bay:
  - Trace levels of dissolved pharmaceuticals
  - Quickly declining water quality
    - 48 hour swimming/fishing warnings
    - Fish consumption warnings
  - Largest estuary in the US
  - Large amounts of sediment build up behind dams in Susquehanna threaten to flood Chesapeake.
  - Dams received a D from ASCE in 2009.
- Santa Monica Bay
  - Heavily polluted due to wastewater and runoff drainage
  - Closes for 72 hours after rain events of more than 0.2"

"We've known for a long time that pipe networks are aging. We didn't appreciate the magnitude of the challenge."

Tom Curtis, Deputy Executive Director AWWA

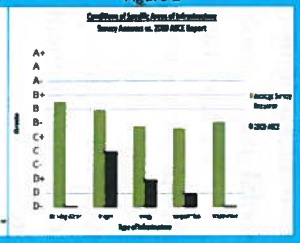


Survey of Lafayette College Students

- Survey of 494 randomly selected students
- 80 completed surveys used in data analysis
- Results show a clear overestimate of the health of infrastructure as a whole in figure 1 and in individual areas of infrastructure in figure 2.

Figure 1

Figure 2



Drinking Water

- Received a D- from ASCE
- Aging pipe networks
  - Major boom of water infrastructure was between 1920 and 1980.
  - Average age of drinking water pipes in America is approximately 70 years old.
  - AWWA reports cost of $1 trillion to repair/expand drinking water infrastructure over the next 25 years.
- New York City, New York
  - Installing a third, 24 foot diameter, underground water distribution pipe to supplement the current 96 and 77 year old pipes.
  - New "water tunnel" will help maintain required flow, reduce strain on current "tunnels" and allow for repair/ maintenance on other tunnels
- Port Angeles, Washington
  - 2008 - Replaced entire pipe network that had been constructed in 1914.
- Many cities and areas need to repair and/or upgrade their water distribution systems to meet current flow requirements and maintain fire capacity (fire hydrants)

Storm Water and Wastewater

- Received a D- from ASCE
- Combined System
  - More common sewage/storm water management system
  - Uses one main pipe for wastewater and storm water with a weir to allow for overflow in heavy rain events.
  - Wastewater and storm water are both sent to wastewater treatment plant.
- Separate System
  - Uses two separate pipe networks to manage wastewater and storm water
  - Storm water drains directly, untreated, into waterways
  - Wastewater is sent to treatment plant and then released to waterway

Combined System

Separate System

*A complete list of references is available upon request.

Poster #10

"Mercury in Aquatic Ecosystems Summary"

Olivia Lewis, Andrew Rowland, and Leo Spear

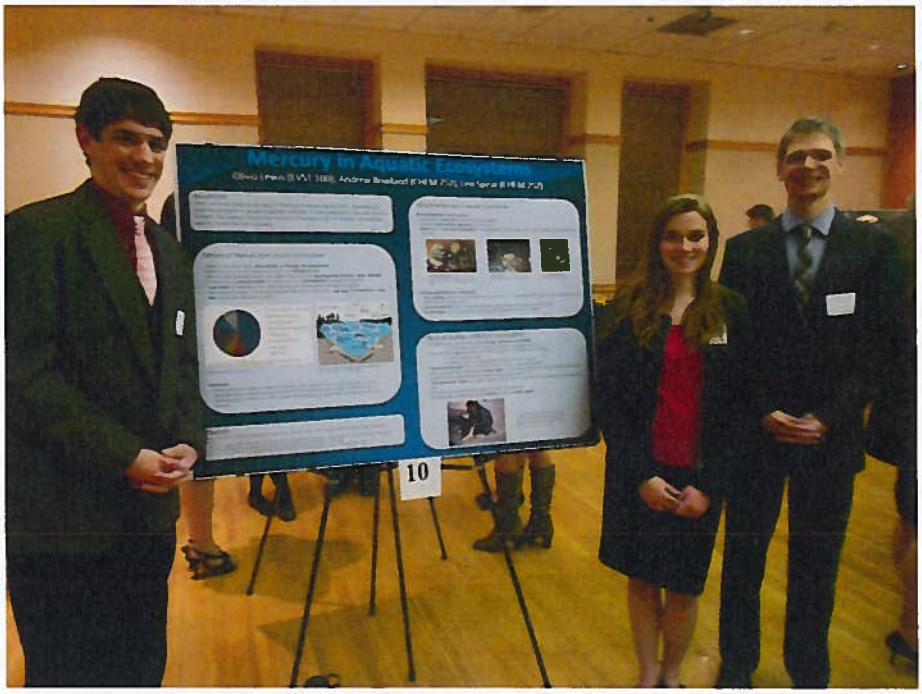
Our poster focused on mercury in aquatic ecosystems, which has become a global issue. We performed extensive research about the problem, gathering information from a plethora of scientific sources. Our research was then divided into three basic sections: how mercury enters aquatic ecosystems, the social impacts of this mercury, and possible methods of alleviation.

Humans account for approximately half of the mercury in the atmosphere. The major sources of mercury include fossil fuel combustion, gold production, and cement production. Volatilized mercury in the atmosphere can enter bodies of water, where it is converted to harmful methylmercury. Methylmercury bioaccumulates in small aquatic life and biomagnifies up the food chain to harmful levels.

Consumption of fish contaminated with methylmercury can have severe health impacts, such as heart disease and neurological impairment of unborn babies. Unfortunately, many people in the world rely on fish as a source of protein and nutrients in their everyday diets. This creates an unequal impact due to the amounts of fish consumed by different peoples. Thus, this environmental issue also becomes a social justice issue.

We have two basic methods of alleviating the mercury issue. The first is to reduce the anthropogenic mercury output. This could entail a trade ban on industrial mercury or an international agreement between nations. The other method involves reducing the harmful impact of mercury directly. The most promising idea is fish stocking, which would release mercury-free bred game fish into the environment. Other solutions include mercury sequestering plants or selenium input into waters.

In conclusion, mercury in aquatic ecosystems is a major problem. What's worse, the impact is unequal around the world. Fortunately, we understand the science behind mercury and how it enters the environment. This allows us the chance to fix it. A big issue for sure, but a solvable one.



Mercury in Aquatic Ecosystems

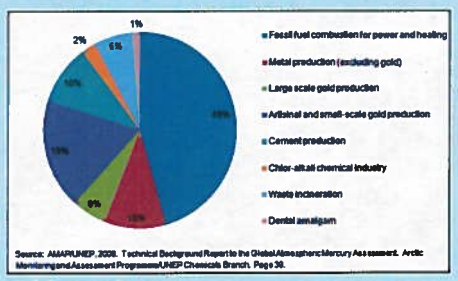
Olivia Lewis (EVST 100), Andrew Rowland (CHEM 252), Leo Spear (CHEM 252)

Background

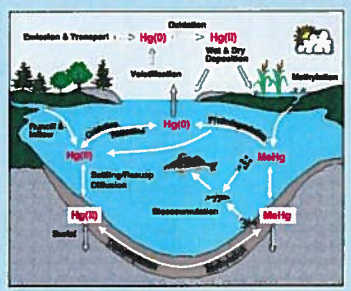
There are three facets to the topic of "Mercury in Aquatic Ecosystems": how mercury becomes prevalent in aquatic ecosystems and how it bioaccumulates in fish and hence in humans, the unequal impacts that mercury consumption has on humans, and possible ways to reduce mercury's impacts.

Pathway of Mercury from Source to Ecosystem

- Mercury can either enter **water directly or through the atmosphere**
- Bacteria in the soil turn inorganic mercury into **methylmercury**
- Mercury may photodecompose into organic mercury or be **absorbed into plankton, algae, and fish**
- Methylmercury **bioaccumulates** in aquatic life and is **biomagnified** through the food web
- **Food intake** by organisms is the major pathway of methylmercury through aquatic life
- Methylmercury binds to amino and sulfhydryl proteins in the muscle, **and stays in the body for a long time** due to high affinity for sulfides



Global sources of mercury



Mercury cycling in a lake and its watershed

Definitions

- Bioaccumulation: when an organism absorbs a toxic substance at a rate greater than it's lost
- Biomagnification: the increasing concentration of a substance as it moves up the food chain
- Methylmercury: mercury ion with a single methyl group, the more toxic and persistent form of mercury

Citations

Bender, M. (2009, December). *Seeking Environmental Justice: The Global Mercury Crisis Threatens Those Least Able to Protect Themselves* (Report).

Lepak, J. M., Hooten, M. B., & Johnson, B. M. (2012). The influence of external subsidies on diet, growth, and Hg concentrations of freshwater sport fish: implications for management and fish consumption advisories. Ecotoxicology, 21, 1878-1888.

Spiro, T. G., Purvis-Roberts, K. L., & Stigliani, W. M. (2012). Chemistry of the Environment (3rd ed.). University Science Books.

Mitigating Mercury in Aquatic Ecosystems

Minimizing Mercury at its Sources

- Implement a **trade ban** on industrial mercury sales
- Create an **international agreement** on mercury
- **Reduce** use of **oxidizing disinfectants** in dental waste (oxidized mercury is more hazardous than elemental mercury)

Dental amalgam

Stocking fish

Water hyacinth

Dealing with Mercury in Ecosystems

- **Fish stocking:** add stock fish to freshwater ecosystems → increased growth of game fish →diluted mercury concentration in game fish
- **Increase selenium** past a threshold to protect against mercury bioaccumulation in fish
- **Certain plants** can remove mercury from aquatic ecosystems via root uptake

Effects on Humans of Mercury Consumption

- FAO/WHO report states fish provides **energy, nutrients, and protein**
  - In most cases benefits of fish consumption outweigh the risks
- There are often risks associated with consumption of methylmercury, including:
  - Coronary heart disease
  - Impact on the neurological development of unborn babies
- **Environmental justice** issue: "net benefit" for many but a hazard for others
- Mercury-tainted fish compromises **human rights** to "uncontaminated food, work in safe environments, health, and the rights of peoples to preserve traditional ways of life"
- **Disproportionate impact** on unborn babies, young children, indigenous communities, and the world's poor
- Unrealistic for some groups to reduce their fish consumption
- Not being able to consume fish has **cultural as well as health impacts**

An Inuit man fishing. The Inuit are one cultural group that relies heavily on fish and marine mammals as a part of their diet.

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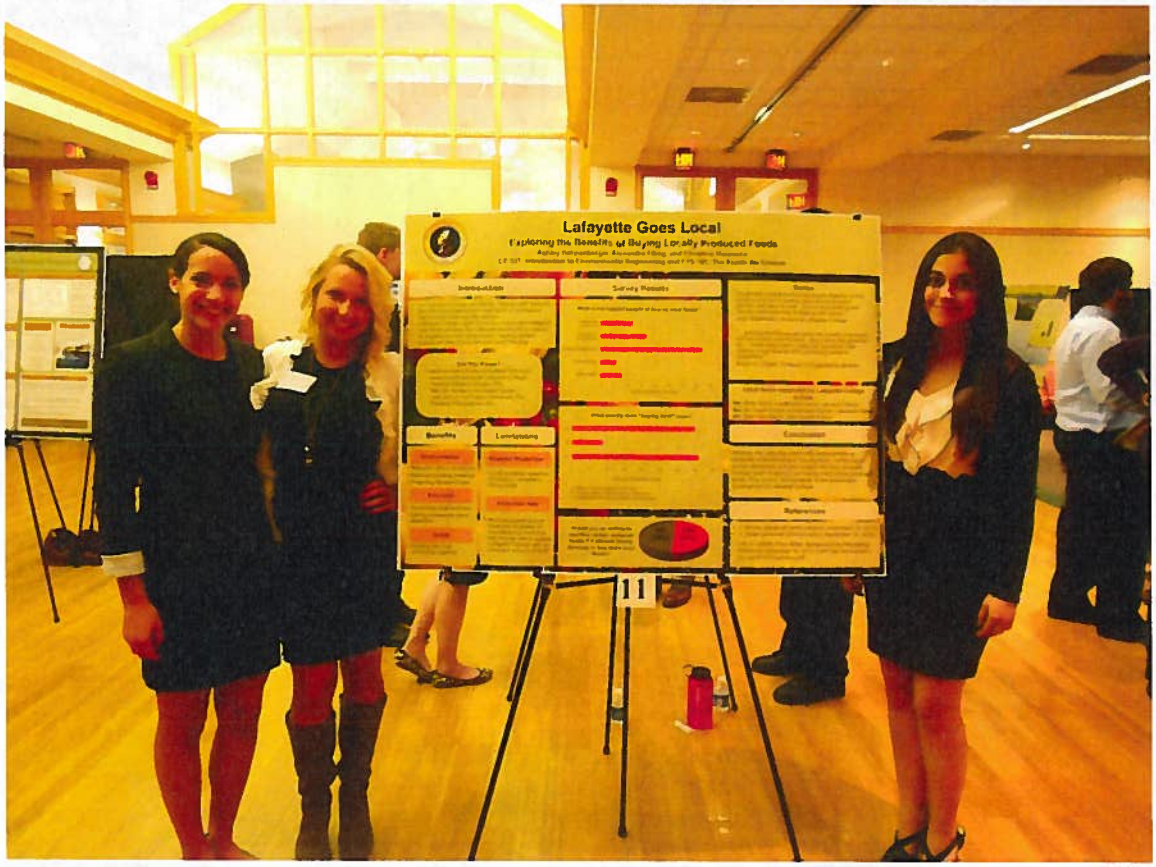
Poster #11

"Lafayette Goes Local"

Ashley Bohnenberger, Alexandra Elling, and Christina Marzocca

Lafayette College continually strives to become more sustainable. Dining Services has taken the initiative to purchase more locally produced foods in order to help the school reach this goal. However, obstacles, such as little student support, seasonal restrictions on food variety, limited production rates, and a lack of awareness regarding the environmental, social, and economic benefits of buying local, get in the way of reaching this goal. Our project objective was to educate the student body on these benefits. In turn, we hoped this awareness would increase student support for Lafayette College's goal of buying more locally produced foods. Through extensive research and numerous interviews with members of the Lafayette College community, we compiled a list of benefits tied directly to buying locally produced foods. After gathering the facts, we surveyed the students to test both their knowledge of and support for buying local foods. We concluded that, although the students were somewhat aware the definition of "buying local," they were oftentimes unaware of the diversity of its benefits. Almost fifty percent of the students surveyed revealed that they were not willing to support buying an increased amount of local foods if it meant sacrificing some seasonal foods. This may be closely linked to the students' belief that the biggest benefit of buying local foods is solely economic, a benefit students may be less inclined to support. We hope that through this project, we were able to increase student awareness of the benefits of buying local. Furthermore, we strived to increase student support, as this will allow Lafayette's dining halls to implement their plan of becoming more sustainable through local food purchases.



Lafayette Goes Local

Exploring the Benefits of Buying Locally Produced Foods

Ashley Bohnenberger, Alexandra Elling, and Christina Marzocca

CE 321: Introduction to Environmental Engineering and FYS 185: The Foods We Choose

Introduction

- For Lafayette College specifically, "buying local" refers to the school purchasing from local farms or businesses that produce food near the campus.
- Lafayette College's goal of buying a higher percentage of local foods will allow the Lafayette community to reduce its negative environmental impact. Gaining student support will help Dining Services reach this goal.

Did You Know?

Listed are some foods purchased from local vendors and served at Lafayette College:

- Salsa at Gilbert's (Easton, PA)
- Milk (90 dairies in the Easton area)
- Jack and Jill Ice Cream (Allentown, PA)
- Pretzels (Philadelphia, PA)

Benefits

Environmental

- Reduced carbon emissions
- Reduced packing materials
- Protecting farmland area

Economic

- Supporting local business
- Saving companies travel expenses

Social

- Bringing the local community together

Limitations

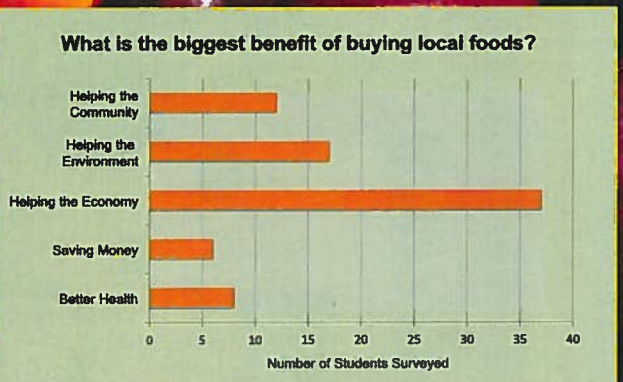
Seasonal Production

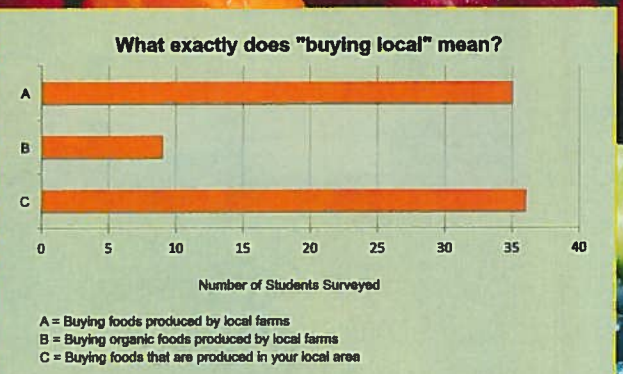
- Limits available selection of foods in Lafayette's Dining Halls

Production Rate

- Most producers of local foods are incapable of manufacturing food at a fast enough rate to supply Lafayette College with an adequate amount of food

Survey Results





Quotes

"Emphasizing local food brings people together to buy [food] at a farmer's market, grow at a community garden, and learn to cook…it is an empowering and literally grassroots way of dealing with issues."

Julia Seidenstein, student at Lafayette College

"…growing local foods can foster the health of the body, the community, and the land…[they] allow the potential for… health outcomes in ways that industrial, high-volume, long-distance food production tends to undermine."

Benjamin Cohen, Professor of Engineering Studies

Local farms supported by Lafayette College include:

PA: Wick Farms, Kauffmans Farms, Johnson Farms
NJ: Hill Creek Farms, Homestead Farms, Lakeview Farms
NY: New York Farms, Saul Paugh Farms

Conclusion

Although the Lafayette community demonstrates an adequate understanding of "buying local," continuing to spread awareness and gain support will help Lafayette College reach its goal of purchasing more locally produced foods. This, in turn, will contribute to the sustainable development of Lafayette College.

References

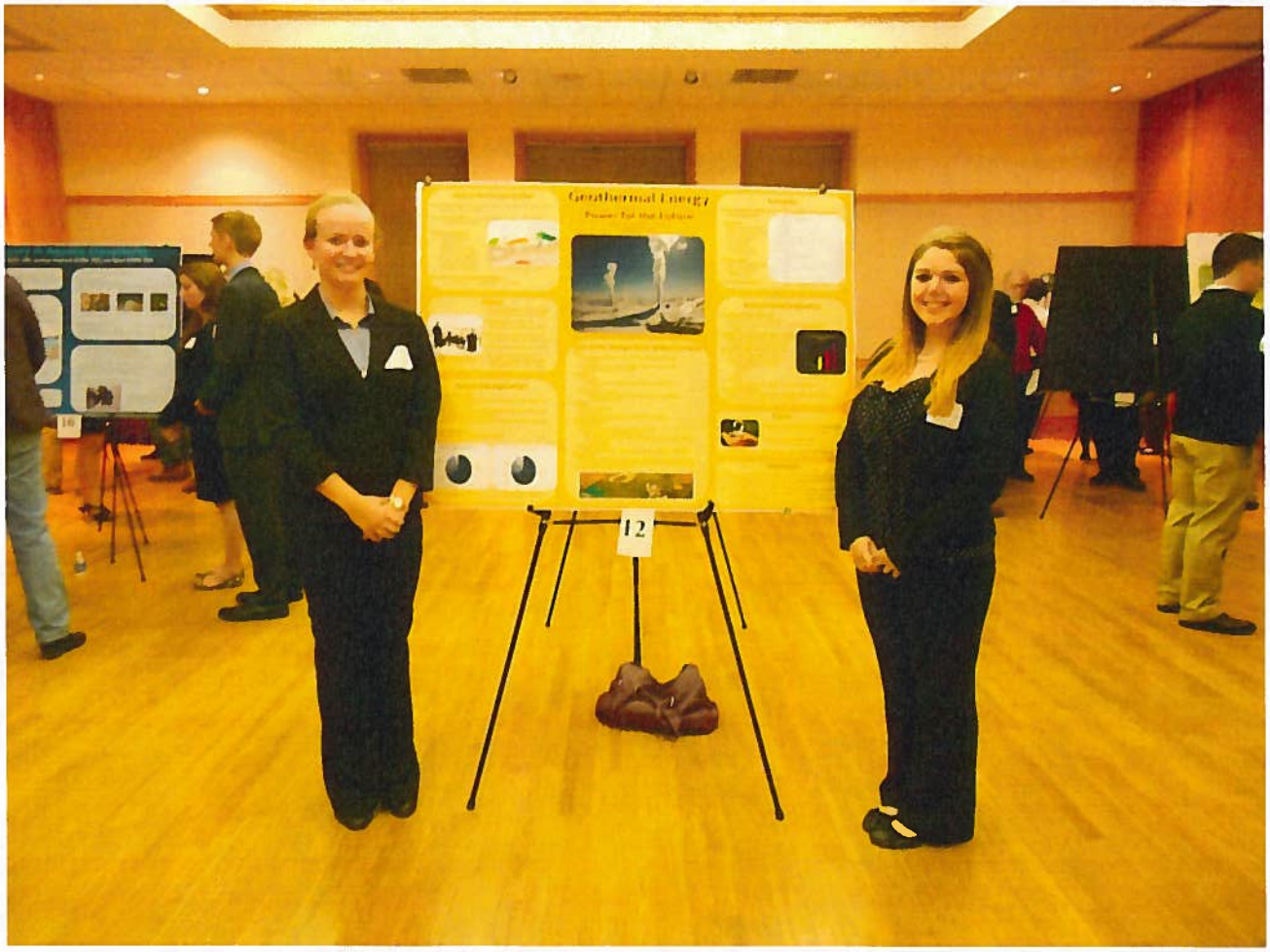
- J. Binotto (personal communication, September 14, 2012)
- J. Soder (personal communication, September 14, 2012)
- Hill, H. (2008). Food Miles: Background and Marketing. Retrieved September 18, 2012, from http://www.struan-oll.com/PDF/Foodmiles.pdf

Poster #12

"Geothermal Energy: Power for the Future"

Lucy Bass and Kathleen Jordan

We researched Geothermal Energy and its relevance today as a potential major world power source. With depletion of fossil fuels looming, there is a rising demand for alternative energy sources, one such source being geothermal energy. We looked at the past, present and future of geothermal energy, along with economics and environmental impacts, both scientific and social. We compared geothermal energy to numerous other resources, both fossil fuel and renewable resources, to determine the potential of geothermal in competition with other sources. After this in-depth analysis, we looked to determine whether or not this up and coming power source was a feasible option for Lafayette College. While geothermal energy is naturally more available in other parts of the world, this energy source could be harnessed in Pennsylvania for smaller energy uses such as heating instead of electricity. Researching geothermal energy was eye-opening, and instilled a solid belief in both of us that there are great renewable resources to be utilized when society commits to "go green."



Geothermal Energy

Power for the Future

Lucy Bass '14 and Kathleen Jordan '13
Lafayette College

What is Geothermal Energy?

- **Renewable Energy:** energy which comes from natural resources, which are naturally replenished
- **Geothermal Energy:** heat contained within the Earth that could be recovered and exploited
- **Geothermal Gradient**
  - Drives a continuous conduction of thermal energy from the core to the surface
  - Useful in the assessment of geothermal resource potentials of an area

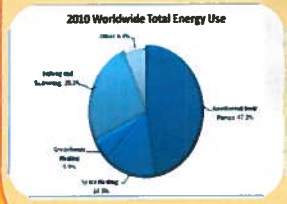
- **Three Necessities for a Geothermal System**
  1.) Heat Source 2.) Reservoir 3.) Fluid

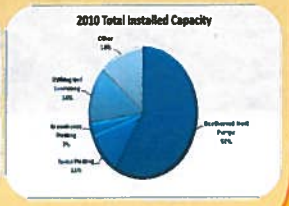
History

- Ancient civilizations have been using hot springs for thousands of years
- Mining provided insight into temperature changes in the Earth
- 20th century – study of radiogenic heat to determine core temperature
- 1904: first geothermal power plant
- The installed geothermoelectric capacity is now approximately 88 times greater than it was in 1942

Current Day Applications

- **Indirect Use – Electricity**
  - In 2010, IGA reported that 10,715 MW of geothermal power in 24 countries was online
  - in 2010, the U.S. led the world in geothermal electricity production
  - Enhanced Geothermal Systems (EGS)
    - instead of relying on naturally occurring hydrothermal resources
- **Direct-use Applications**
  - More efficient than electricity generation



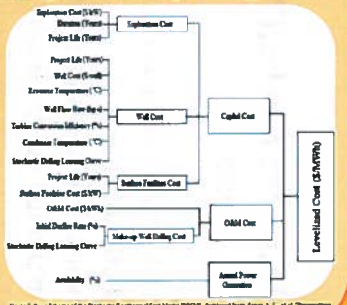


Case Study: Metzgar Fields Athletic Complex

- **GOAL**
  - Assess Metzgar Fields as a possible candidate for geothermal energy renovations
  - Use generated power to sustain Metzgar athletic buildings as well as buildings on Lafayette's main campus
- **LOGISTICS**
  - Enough space
    - Large fields around Metzgar would be suitable for geothermal systems
  - Enough financial funding
    - Lafayette College is willing to spending money on environmentally sustainable renovations
- **BENEFITS**
  - Environmentally friendly
  - Low Maintenance
  - Social Aspect – Promotes environmentally conscious changes
- **ISSUES AND OBSTACLES**
  - High initial cost
  - Process of constructing system would take a long time
  - Transporting energy to Lafayette main campus
    - Need permission from state, town, or private land owners to pass utility lines over property
  - Building Construction
    - Geothermal system would have to replace existing systems in buildings
- **CONCLUSIONS**
  - More analysis needs to be done by Lafayette College regarding costs and benefits
  - Lafayette College is currently exploring this option, but the process is slow and big decisions will likely be far in the future

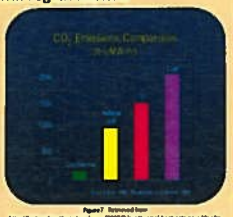
Economics

- **Many variables present in each system so hard to present a general cost-benefit analysis**
- **Advantages**
  - Higher capacity factor
  - Lower production costs
  - Immune to fuel cost fluctuations
  - Extra revenue if produce excess
- **Disadvantages**
  - Significant capital costs
  - Not economical in certain areas
- **Tax incentives offered**



Environmental Implications

- **Renewable? Sustainable? *Yes!***
  - Globally infinite BUT locally finite
  - After heat extraction, geothermal sites will regain normal temperatures
- **Negative environmental impacts minimal**
  - Significantly lower CO_2 emissions than other energy sources (see figure)
- **Any Environmental Down Sides? Sure.**
  - Small green house gas emissions
  - Negative Impacts of Construction
    - Transportation and on-site machinery
    - Waste
  - Industry
    - Power plants often placed in sensitive ecosystems
- **Controversial Aspects**
  - People naturally do not want to live next to large power plants
  - Risk of chemical leakage into watersheds



Future

- **Focus on Enhanced Geothermal Systems (EGS)**
  - Long-term alternative for electricity
- **Moderate Temperature Fluids**
  - Geopressured resources
- **Naturally occurring geothermal reservoirs**

References

Dickson, M. H. and Fanelli, M. (2004). *What is Geothermal Energy?* Istituto di Geoscienze e Georisorse. Retrieved from http://www.geothermal-energy.org/314,what_is_geothermal_energy.html.

Lund, J. W., Freeston, D. H., Boyd, T. L. (2011). Direct utilization of geothermal energy 2010 worldwide review. *Geothermics*, 40(3), 159-180.

Rybár, P. (2007). Geothermal energy sources and possibilities of their exploitation. *Acta Montanistica Slovaca*, 12(1), 31-41.

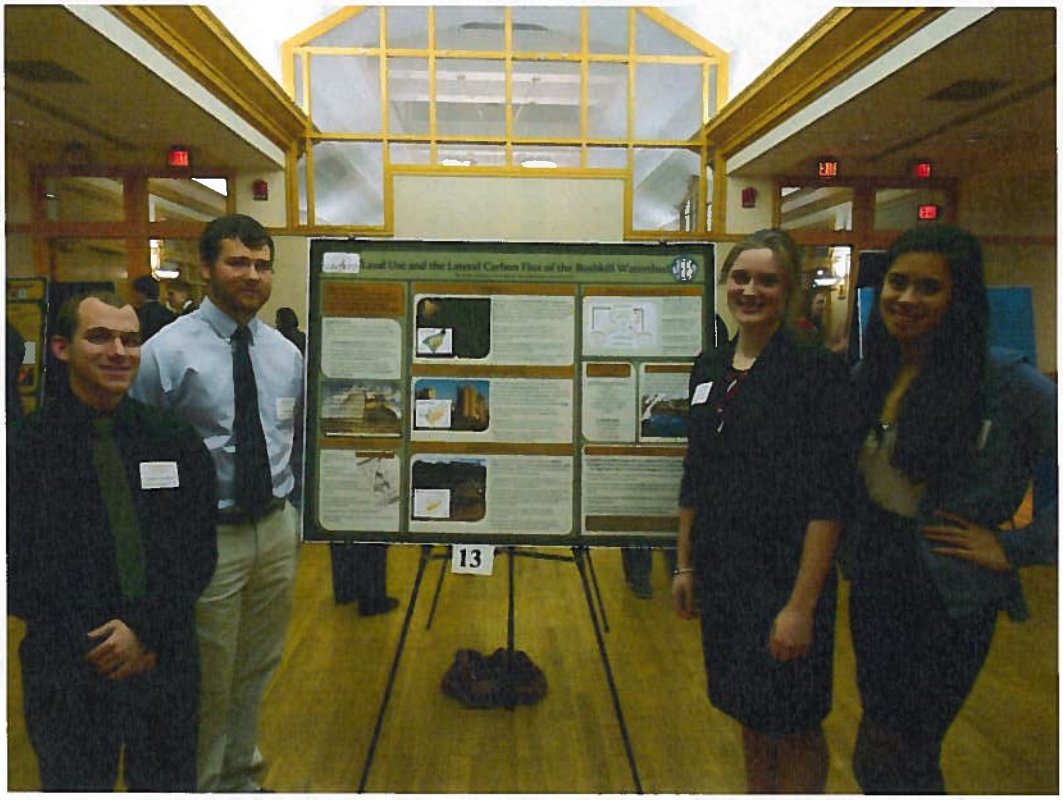
FALL 2012 LAFAYETTE COLLEGE

Poster #13

"Land Use and the Lateral Carbon Flux of the Bushkill Watershed"

Josh Koerber, Annie Mikol, Alexa Maramba, Charles Timko

Rivers serve as a major conduit for the lateral transfer of carbon from continents to the oceans serving as major link in the global carbon cycle. Anthropogenic land use and urbanization can drastically increase carbon loading into local watersheds, and reduce the amount of carbon stored within the watershed. Our research focus was on that of the lateral transfer of carbon throughout the Bushkill Watershed serving as a preliminary investigation for future research. We looked at the primary factors associated with carbon loading into the watershed including urbanization, mining and the cement industry, wastewater treatment practices, and agriculture; and analyzed how each of these factors would influence the global carbon cycle, specifically how it affects carbon cycling within the hydrosphere. We also looked at past research which analyzed how different types of carbon inputs could be metabolized differently by microorganisms within the aquatic ecosystem, determining the fate of that carbon. We then considered the broader implications of this issue, namely the fate of that carbon, and how an increased flux of carbon from the continents to the oceans may significantly increase carbon loading to the atmosphere. Overall, we found that anthropogenic land use has significantly increased carbon loading into the Bushkill Watershed, and increased levels of organic and inorganic carbon into the watershed may have significant global implications.



Land Use and the Lateral Carbon Flux of the Bushkill Watershed

By : Joshua Koerber, Annie Mikol, Alexa Maramba, Charles Timko

Research Question:

To investigate land use changes and local factors that may effect the lateral transport of organic and inorganic carbon through the Bushkill Watershed

Significance:

Rivers serve as a major conduit for the lateral transfer of carbon from continents to the oceans serving as major link in the global carbon cycle.

- Anthropogenic land use can drastically alter the lateral carbon flux affecting the carbon cycle.
- The Bushkill Watershed is rapidly becoming a "peri-urban" environment and has historically been a significant agricultural area.
- An increase in the net flux of carbon to the oceans may significantly add to atmospheric carbon and thus contribute to anthropogenic climate change.

Land Use and Effects:

- Development- soil disturbance and erosion increases carbon transport to rivers
- Mining Activities-increased ... and transport of soil $CaCO_3$
- Agriculture-application of lime, organic fertilizer and pesticides
- Wastewater Treatment- addition of $CaCO_3$ during treatment process and organic carbon in effluent. Raw sewage leaks due to ageing infrastructure

Local Factors

- Historically an agriculturally significant area
- Rapid development, evolving into a "peri-urban" environment
- Since 1975, conversion from agricultural to urban areas is occurring at a rate of 3.5 square miles per year
- In the Lehigh Valley, only 6 municipalities have zoning regulations to protect agriculture
- Carbonate geology, mined for cement industry
- Shift in sewage treatment, from septic to municipal with urbanization

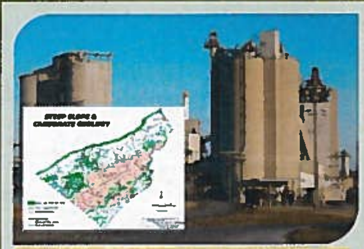
Urbanization

Retrieved from: Google Earth

Urban areas are hot spots that dive environmental change at multiple scales, and currently our global urban population exceeds that of rural populations. Because urban centers are disproportionately located along rivers and coastlines urban development has significantly effected the hydrosphere.

- Wastes generated in cities, significantly affect various biogeochemical cycles from local to global scales
- Increased impervious surfaces, decrease infiltration and increase runoff
- Decreased riparian buffers and trees along stream banks can reduce natural allochthonous carbon inputs and increase light and temperature of streams
- An increase in sewage derived particulate organic carbon and organic carbon through autochthonous production

Carbonate Geology and Mining



A significant proportion of the Lehigh Valley is comprised of carbonate geology, and therefore activities such as farming and cement production have been important to the Valley's economy. While this is a valuable resource, industries surrounding its extraction have significantly altered the local ecology.

- Mining can increase sedimentation and erosion by uncovering limestone material and creating subsurface water channels
- Limestone is easily eroded by acidic waters, such as rainwater and increased exposure can result in an increase in carbonate loading into the aquatic environment
- Wash-out water, a product of the concrete industry, typically has a high pH (basic), and effluent from this industry can alter stream chemistry

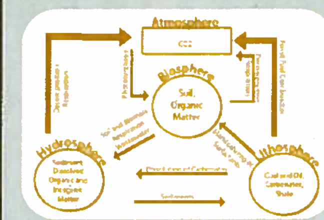
Waste Water Treatment

Retrieved from: Nathan Winter

Rapid urbanization is causing a shift from diffuse septic systems to concentrated municipal waste water treatment plants (WWTPs) which has had a significant effect on the urban stream ecology.

- During primary and secondary treatment, biosolids are separated from the water through a series of steps that include both physical and biological treatment.
- Waste water treatment plants filter about 90% of organic carbon through primary and secondary processes. The remaining percentage, is released into water supplies. Septic systems filter this remaining carbon through the soil before reaching groundwater supplies.
- Significant amounts of inorganic carbon are added to the WWT process to buffer pH during microbial decomposition
- The increase in wastewater carbon and the decrease in natural carbon inputs may have an effect on decay rates and carbon sequestration within the watershed

The Carbon Cycle And Key Terms



Organic Carbon: Fraction of carbon containing compounds that are organic in nature typically formed with at least one covalent bond

Inorganic Carbon: Carbon containing compounds not classified as organic, and usually ionic in nature

Dissolved Carbon: Fraction which passes through a filter

Particulate Carbon: Fraction which does not pass through a filter

Urban Ecology and Carbon

Δ Conditions and Inputs

↑ light
↑ temperature
↑ nutrients
↑ scouring flows
↓ natural carbon inputs
↑ anthropogenic carbon inputs

Δ Responses

↑ photosynthesis
↑ respiration
Δ decay rates
↓ carbon storage

Future Research

A study of carbon trends along the Shoeneck Creek in Lower Nazareth is currently underway, and plans exist to expand this study to streams of the entire watershed.

Conclusions

Using the watershed approach to understand how carbon moves throughout the hydrosphere can increase our understanding of the aggregate effects of land use change on the global scale.

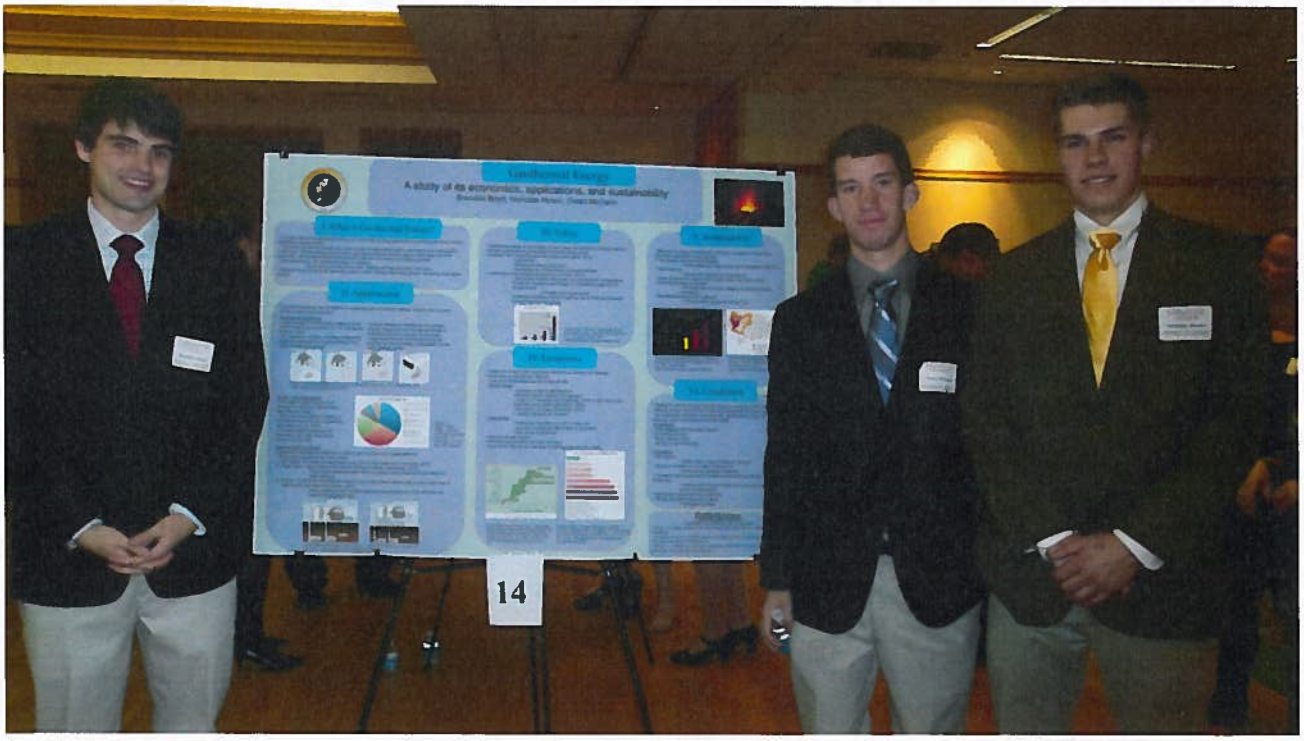
- Anthropogenic factors are significantly accelerating the transport of inorganic carbon from land to sea
- Increased bioavailability of carbon in the watershed may lead to an increase in CO_2 emissions through bacterial respiration and other factors
- Increased urbanization, municipal wastewater, and mining may be significant factors
- Overall, the alteration of the carbon biogeochemical cycle can potentially lead to global effects such as climate change

Poster #14

"Geothermal Energy"

Brendan Boyd, Nick Hyson, Owen McCann

Our group focused on analyzing the interconnected relationships of geothermal energy. We thought that not only looking at the uses of geothermal energy, but also studying the potential economic and political benefits of this energy source. We researched various sources in order to view the numerous relationships from different perspectives. Geothermal energy is a renewable energy source that is small, but is an increasing segment of the world's energy sources. Geothermal energy can be applied to residential and commerical settings, as well as used to generate electricity for power plants. Its main uses break down into direct use applications where heat is pumped directly to a needed source, heat pumps which provide heat for homes and office buildings, and power plants to produce electricity. Geothermal energy is further developed through the use of public policy; both tax incentives and grants increase the geothermal energy business. It benefits local economies and creates local jobs. Geothermal energy systems are relatively inexpensive to maintain, they only require a large initial investment to implement the systems. As compared to fossil fuels, it costs less to maintain and upkeep geothermal energy. Geothermal energy has very little environmental impact and is a reliable and efficient renewable energy source. It has several significant drawbacks. It is site specific, meaning that the source of energy is often distant from where people live. Geothermal energy also causes significant and expensive engineering design difficulties, and its parts are expensive. As technology develops, the costs will fall and the it will become a much more economical and viable energy source.



Geothermal Energy

A study of its economics, applications, and sustainability

Brendan Boyd, Nicholas Hyson, Owen McCann

I. What is Geothermal Energy?

- Purpose: Show that geothermal energy is a renewable energy source that is a growing part of the world's diversified energy options
- This poster studies its benefits and costs through its applications, policy, economics, and sustainability
- Definition: Thermal energy acquired from geological sources such as magma, subsurface hot water reservoirs, hot rock and temperature gradients between the surface and shallow ground
- Heat produced by the radioactive decay of minerals
  - Crust acts as a thermal insulator, holding the heat produced in the core
- Obtained by pumping fluids, generally water or vapor, through deep wells to carry the energy back to the surface

II. Applications

- Geothermal energy can be applied in residential and commercial settings, industry, and in power plants for electricity production

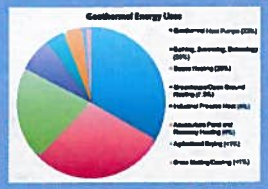
Geothermal Heat Pump

- Uses energy in the first three meters of crust which remains at a constant 10°-16° Centigrade (Fanchi, 2005)
- For heating or cooling, a building is fitted with ductwork connected to a heat exchanger and pipes buried in the ground
- A liquid medium is warmed as it is pumped through the ground and the thermal energy is extracted and blown through the ductwork.
- Heat pump process is reversed during the summer as thermal energy is deposited into the Earth (Fanchi, 2005)

"World Geothermal Energy Policy Council." Untitled Document. N.p., n.d. Web 18 Nov. 2012. <http://wgeopc.org/typesofsystems.html>.

Direct – Use Applications

- Hot water is piped directly to an application without an intermediate step (Renner, 2008)
- Most commonly used for heating or for melting snow and ice on sidewalks and roads (Fanchi, 2005)
- A disadvantage is scaling from minerals in the water that comes directly from the soil



Renner, J. L. (2008). *Future energy: Improved, sustainable and clean options for our planet* (pp. 211-223). New York: Elsevier.

Geothermal Power Plants

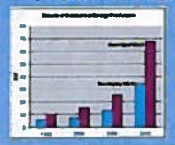
- Steam from geothermal reservoirs is used to spin turbines and create electricity
- Three types of geothermal power plants:

1) Dry Steam: Dry steam is used directly from hot dry rock reservoirs (Gevorkian, 2010)
2) Flash Steam: High pressure hot water is "flashed to steam" (Gevorkian, 2010)
   - This process separates water from the steam which protects the turbines from water damage
3) Binary – Cycle: A geothermal well is used to turn a secondary medium with a lower latent heat of vaporization into steam (Gevorkian, 2010)
   - Binary plants are very versatile because the temperature of the well does not have to be extremely high

"World Geothermal Energy Policy Council." Untitled Document. N.p., n.d. Web.18 Nov. 2012. <http://wgeopc.org/typesofsystems.html>

III. Policy

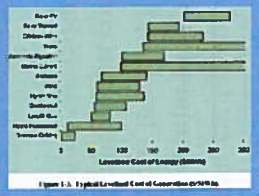
- Geothermal energy is encouraged on both state and federal level through grants, incentive programs and percentage renewable energy goals
- Available Tax Credits (Geothermal Energy Association, 2012)
  - Residential
  - Renewable energy production
  - Businesses for implementing renewable facilities
- Federal grants for geothermal development (GEA, 2012)
  - Renewable Portfolio Standards requires electricity companies to include an increasing percentage of renewable energy into the energy supply
    - 43 states have implemented
  - American Recovery and Reinvestment Act of 2009 appropriated money to geothermal energy



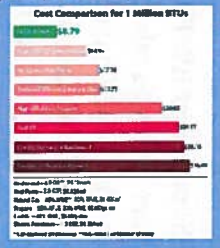
"GreenJobs - Industry - Geothermal Power." Renewable Energy Jobs from Greenjobs.com. N.p., n.d. Web. 18 Nov. 2012. <http://greenjobs.com/resources/industry/>

IV. Economics

- Aside from a high initial investment, geothermal systems are relatively inexpensive to operate and maintain
- Less price fluctuations than Oil or Natural Gas
- Power Plants
  - Requires no fuel to operate plant
  - Minimal cost for pollution management
  - Costs 4.5-7 cents per kWh produced, which is 50% lower than fossil fuel power plants (Gevorkian, 2010)
  - Pay back in 15 years (Gevorkian, 2010)
  - Lifespan generally 35-45 years
- Heat Pumps
  - Drilling and loop fields are 50% of total cost
  - Ductwork in buildings often needs to be redone
  - Heat pump is expensive
- Reduces energy imports
- Benefits local economy with jobs and taxes
- Economics improve with decrease in drilling costs (Renner, 2008)



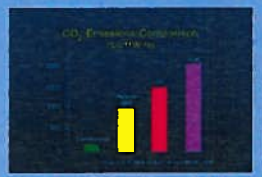
"What Does Clean Energy Cost? | Alternative Energy Stocks." Alternative Energy Stocks: The Investor Resource for Investing in Alternative Energy Stocks. N.p., n.d. Web. 18 Nov. 2012. <http://www.altenergystocks.com/archive>



"Gelinas HVAC | Geothermal Energy Efficient Comfort." Gelinas HVAC | A Heating, Air Conditioning, and Plumbing Services Company. N.p., n.d. Web. 18 Nov. 2012. <http://gelinashvac.com/geothermal-energy-solutions.php>

V. Sustainability

- Geothermal energy is sustainable and clean compared to fossil fuels and other renewable energy sources
- Few negative environmental impacts
  - Power plants and heat pumps have negligible emissions
- Small land use
  - Coexist with agriculture and business
- Power production is reliable and uninterrupted (Gevorkian, 2010)
- Geothermal energy is flexible
  - Produces electric power, heating, or industrial drying processes
- Geothermal energy is 97% efficient
  - Turbine friction causes the energy loss



"Introduction to Geothermal Energy - Emissions Comparison." Geothermal Education Office. N.p., n.d. Web. 18 Nov. 2012. <http://geothermal.marin.org/geopresent>.

"World Geothermal Energy Policy Council." Untitled Document. N.p., n.d. Web 18 Nov. 2012. <http://wgeopc.org/typesofsystems.html>

VI. Conclusion

- Research proves that geothermal energy is a practical and cost-effective energy solution that could be implemented in many sectors
- As technology develops and prices fall, geothermal energy will become much more economical and viable

Advantages

- Little negative environmental impact
- Extremely efficient
- Many different uses
- Benefits local economies

Drawbacks

- Site specific
  - Distant from areas of consumer demand
- Depletion of steam or hot water in the ground
  - Centuries to recharge a reservoir
- Installation requires significant studies and engineering design challenges
  - Displacement of groundwater can cause serious environmental issues
- Mechanical components are expensive
- Mineral deposits building up in pipes
  - Expensive to clean

References

- Complete List of References on Handout

- Fanchi, J. R. (2005). *Energy in the 21st Century* (pp. 108-118). N.p.: World Scientific Publishing.
- Gevorkian, Ph.D, P.E., P. (2010). *Alternative Energy Systems in Building Design* (pp. 333-344). New York, NY: McGraw Hill.
- Renner, J. L. (2008). *Future energy: Improved, sustainable and clean options for our planet* (pp. 211-223). New York: Elsevier.

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Poster #15

"Applying Aquaponics to Wastewater Treatment"

Sarah Hardy, Alexa Gatti, Sally Trout

In response to the growing pressure for clean water, Living MachinesTM, designed by Dr. John Todd, offer a wastewater treatment alternative to expensive, high-energy, conventional systems. Living MachinesTM treat sewage effluent with a series of components containing plants, bacteria, fish, and fungus in symbiotic ecosystems. By utilizing nature's technology, Living MachinesTM make an essential societal function more sustainable and aesthetically pleasing. Living MachinesTM are being used for wastewater treatment by corporations such as Coca-Cola® and Tyson® as well as for national and international municipal wastewater. The technology is not yet being utilized in the local wastewater treatment plant.

This study is analyzing the feasibility of incorporating Living MachineTM technology into the local Easton Wastewater Treatment Plant (EWTP) to demonstrate the benefits of sustainable systems to the community. Phosphorus removal will be tested, as it is often the limiting nutrient in eutrophication. Phosphorus levels are currently not limited by the National Pollutant Discharge Elimination System (NPDES) permit at EWTP; however, phosphorus will likely be included in future permits. The EWTP wastewater used was taken from the effluent of the secondary clarifier, before the chlorination process, as this is where the final design will likely be implemented. Baseline tests indicated approximately 3.3 mg/L of total liquid phosphorus in the wastewater. Previous research indicates water hyacinths, a floating macrophyte species, are effective at removing phosphorus from water. Water hyacinths will be tested for phosphorus removal by growing plants in a tank with wastewater continuously circulated for better nutrient uptake. Water and plant samples will be collected throughout the testing period, and both liquid and solid total phosphorus will be measured. Predicted results will demonstrate decreasing phosphorus levels in the wastewater over time. Future tests will study nitrogen removal, the second most limiting nutrient in eutrophication, and other plant species. The final results of the study will be presented as a proposal to the Easton Wastewater Treatment Plant.

Applying Aquaponics to Wastewater Treatment

Sarah Hardy, Alexa Gatti, and Sally Trout

Objective

Design laboratory test for phosphorus uptake in water hyacinths and implement Eco-Machine technology into the Easton Wastewater Treatment Plant

Overview

What is Aquaponics?

Eco-machines use aquaponics to treat wastewater

- Mimics nature's efficiency in removing nutrients from water
- Uses organisms (plants, bacteria, fish, and fungi)
- Low energy, odorless, aesthetic value, cost-effective
- Used by The Pennsylvania State University, Vermont, China, and large companies
- Prior research conducted but system is not widely implemented
- Dr. John Todd designed complete system, called a Living Machine™

Conventional Treatment Methods

- Trouble removing nutrients completely (in some systems)
- Foul odor
- Large amount of land required
- Requires more energy

Importance of Wastewater Treatment

- Limited clean, liquid water
- Promote robust ecosystems and human health
- Reduce water pollution

Figure 1: Picture of an Eco-Machine

How It Works

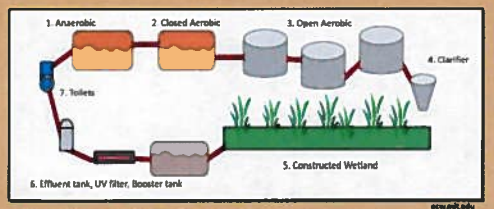


Figure 2: Diagram of example Eco-Machine

Components

- Fish, plants, bacteria, fungus, and invertebrates
- Complex symbiotic relationships

Variety of Systems

- Depend on climate, wastewater composition, amount of influent flow
- The Pennsylvania State University
  - duckweed in open aerobic tanks
  - fungus

Output

- Not potable
- Can be used for:
  - Irrigation
  - Toilet water

Steps

1. Anaerobic septic tank
   - Solids separate from liquids
   - Microbes feed on organic matter
2. Closed aerobic reactor
   - Microorganisms convert nitrates to nitrogen gas
3. Open aerobic tank
   - Pumps bubbles of fresh oxygen into bottom of tank
4. Clarifier
   - Separates solids from liquids
5. Constructed wetland
   - Water flow under plant beds, through gravel
   - Plants take up remaining excess nutrients
6. Additional components (found in some systems)
   - Booster tank
   - Ultraviolet filter
   - Effluent tank

Methodology

1. Determine nutrient in excess at Easton Wastewater Treatment Plant
   - Work with Charles Wilson, Asst. Superintendent
2. Collect water from Easton Wastewater Treatment Plant
   - 10 gallons
   - From effluent of secondary clarifier
3. Obtain live water hyacinth plants (order online)
4. Run wastewater sample through tank growing water hyacinths
   - Tank dimensions: 4' x 2'7.5" x 7.75"
   - Continuous water recirculation (mixing of influent and effluent) using submersible pump
   - 1 week test
   - Collect water samples twice a day
5. Test effluent for phosphorus concentration

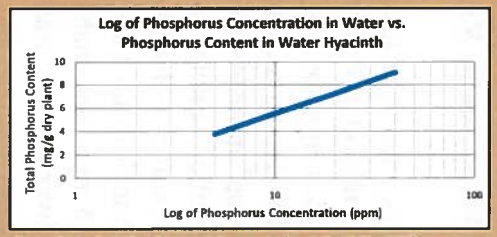


Figure 3: Graph of phosphorus uptake in water hyacinths (Haller 1973)

Figure 4: Picture of water hyacinths

Figure 5: Picture of tank setup with continuous recirculation

Key References

Haller, W.T., & Sutton, D.L. (1973). Effect of pH and high phosphorus concentrations on growth of water hyacinth. *Journal of aquatic plant management, 11*, 59-61.

Todd, J., & Josephson, B. (1996). The design of living technologies for waste treatment. *Ecological Engineering, 6*, 109-136.

Wolovitz, J. (2000). The living machine. *Penn State Research and Policy, 21* (3). Retrieved from http://www.rps.psu.edu/0009/machine.html

Yeoman, S., Stephenson, T., Lester, J.N., & Perry, R. (1988). The removal of phosphorus during wastewater treatment: A review. *Environmental Pollution, 49*(3), 183-233.

Future Work

- Conduct tests during interim session according to methodology described
- Present findings to Easton Wastewater Treatment Plant

Acknowledgements

Dr. Arthur Kney, Dr. Rachel Brennan, Dr. Rachel Brummel, Dr. Edward Gamber, Mr. Charles Wilson, Chris Ramirez, and Zachary Benedetto

Poster #16

"It's Food, Not Waste"

Andrew Goldberg, Spring You, Daniel Friedwald

The amount of food that is discarded as waste is unsustainable. Food is discarded at every step of the process before and after it arrives at our table. Our research focused on several aspects of the current food waste crisis including: identifying the major sources of food waste, identifying several solutions or strategies for reducing food waste, and developing recommendations for Lafayette College which fit within the existing "Sustainable Food Loop" infrastructure. As food waste comes from many sources and in various states, there is no "silver bullet" solution to the crises; however, we identified four food waste recovery methods. These methods: source reduction, feeding hungry people, composting, and sustainable agriculture practices all have their distinct advantages with various types of food waste, but if implemented all together, will lead to a more sustainable future. It is in the best interest of the college to improve upon the current model for diverting food waste by using the already existing infrastructure in order to make positive impacts on the environment and to become a national model for sustainability.

It's Food, Not Waste:

Food Waste Prevention and Solutions

Andrew Goldberg (CE 321), Spring You (FYS 185), Daniel Friedwald (FYS 185)

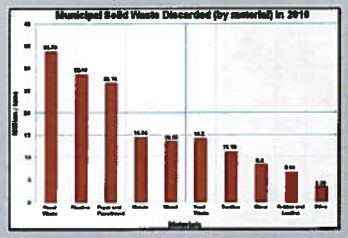
Introduction:

- Food waste: any food substance, raw or cooked, which is discarded, usually generated by the handling, storage, sale, preparation, cooking, and serving of foods
- Roughly 1.3 billion tons of food, one-third of the food produced for human consumption, gets thrown away and disposed of in landfills each year in the US
- Opposition to landfills in the Easton community
- Connection to sustainability

Recommendations for Lafayette

- Develop an education and marketing campaign to reduce post-consumer waste
- Increase support for the "Sustainable Food Loop"
- Develop relationships with local food pantries and homeless shelters in need of food donations: Safe Harbor, ProJeCt of Easton, Salvation Army
- Establish an education center for members of the surrounding community to learn about Environmental Initiatives at Lafayette

The Problem: Food Waste



- Food waste accounts for more than 13% of the 250 million tons of MSW generated in the United States.
- Including yard trimmings in this total, nutrients from more than 30% of MSW could be used as compost rather than discarded and lost in landfills.

One of Lafayette College's MSW Collection Vehicles

Food Waste in the Chrin Brothers Landfill in Easton, PA

Solutions: Food Waste Recovery

Source Reduction

Grocery stores, Restaurants, and other institutions are some of the major producers of food waste

More than 300 pounds: the amount of pre-consumer food waste and unused food generated on a typical day at Lafayette College's Marquis and Farinon Student Restaurants

Feed Hungry People

According to the US Census, in 2011, more than 46 million Americans were living below the poverty line

Gleaning Corn at America's Grow-a-Row (above, Peaceful Valley Orchard in New Jersey). Food goes to local and regional Food Kitchens and Pantries, such as the Salvation Army (below)

Composting

Composting converts food into a nutrient source for plants. Food waste can be high in nitrogen, which is a macronutrient required for plant growth

Industrial Food Composting Technique using a Windrow (above) and two Earth Tubs (below) at Lafayette College's Composting Facilities

Sustainable Agriculture Practices

Converting excess food into animal feed.
Collecting animal waste as food for worm compost and biofuel production

California Red Worms (above) and Pigs (below) converting food waste into resources at a Sustainable Farm, La Gran Vista, in Costa Rica

Objectives of Research:

- Identify the sources of and effects of food waste
- Identify solutions to reduce food waste
- Create recommendations for Lafayette College on becoming a more sustainable institution and a national model for food waste solutions

References:

- US Environmental Protection Agency. (2012, November 20). *Resource conservation - food waste*. Retrieved from http://www.epa.gov/wastes/conserve/foodwaste/index.htm
- Stuart, T. (2012). *The food waste scandal* [Web]. Retrieved from http://www.ted.com/talks/tristram_stuart_the_global_food_waste_scandal.html
- Gustavsson, J. (2011). *Global food losses and food waste: extent, causes, and prevention*. Dusseldorf, Germany: Interpack2011.

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Poster #17

"The Food, Energy and Environment Trilemma"

Jacob Parrish, Dan Dymecki, Kelly Chickering

As the use of technology has progressed, so has the need for ways to power such innovations. The competition for energy sources is continuously increasing and driving the search for a balance between three delicate factors: food, energy and the environment. We decided to research the alternative energy source of biofuels, which use materials like corn or sugar cane to break down into usable fuels. There are various types of biofuels, among them use of scraps from foresting and harvesting of rice or wheat, growth of mass crops on soil degraded from agriculture and decomposition of municipal wastes. Although these options seem beneficial to the environment, they may actually have negative consequences in the future. Use of land for biofuels could eventually lead to a competition with use of land for food production as the population increases. Certain biofuels may also end up giving off more greenhouse gases into the atmosphere depending on the processes used to produce the fuel. Based on our research on biofuels, they don't appear to be sustainable sources of energy that are beneficial for the environment as well as a good balance for our need for food in the long-term. Alternative methods of harvesting energy need to be developed, possibly using the wind, sun, tidal motion or chemical energy. Wind farms have become more common in suitable regions, as have solar panels. However, these ways of mechanically harvesting energy can be further developed to be more cost-efficient and convenient for the general public in order to have a greater impact. It became clear from our research that although certain biofuels may last into the future, they won't be able to satisfy the food, energy and environment trilemma without the help of alternative forms of cleaner energy.

The Food, Energy, and Environment Trilemma

Jacob Parrish, Dan Dymecki and Kelly Chickering

Introduction

-The food, energy, and environmental trilemma is a major issue when talking about fuel
- **Depletion** of important resources like **gas, oil, corn, and land.**
- **Corn** is no longer used to just fuel our ever growing population but will have to **fuel** our cars, machines, and energy needs.
-The **answer** to our problems is found in **alternative fuels**, like hydrogen.

Benefits?

Biofuels are perceived as beneficial because:
- renewable
- no fossil fuels
- excess
- greenhouse gases

Event Timeline

Demand for energy goes up

Farmers use land to grow corn for biofuel

Greenhouse gases are released during land conversion (1)

Price of food goes up

Exports decline, causing farmers to lose money (1)

Farmers convert more land to farmland

More greenhouse gases are released during land conversion (1)

Conclusion: Farmers that use land for food instead of converting into land for biofuels are helping to lower greenhouse gases from land conversion. (1)

Food or Fuel? (2)

- Population **1 billion** in 1800, **6 billion** in 2000, projected **9 billion** in 2050
- Faced with the choice between **food or fuel**
- Studies show in the UK **15-20%** of agriculture land will need to be used **for fuel** demands, instead of food.

Looking to the Future: (3)

-energy may be collected mechanically using windmills, waves, the sun
-More stable sources
-Hydrogen
-High cost
-Not efficient

Hydrogen (4)

- Most abundant element in the universe
- By-products are oxygen and water
- Most hydrogen is made from natural gas
- 1kg of hydrogen= 1gal gasoline
- Production of hydrogen is cleaner than fossil fuels

1)Searchinger, T., Heimlich, R., Houghton, R.A., Dong, F., Elobeid, A., Fabiosa, J., Tokgoz, S., Hayes, D., & Yu, T. (2008, February 7). Use of U.S. Croplands for Biofuels Increases Greenhouse Gases Through Emissions from Land-Use Change. Science, 319, 1238-1240. Retrieved October 16, 2012, from "Science"/AAAS database.
2)Tilman, D., Socolow, R., Foley, J. A., Hill, J., Larson, E., Lynd, L., Pacala, S., Reilly, J., Searchinger, T., Somerville, C., & Williams, R. (2009, July 17). Beneficial Biofuels- The Food, Energy and Environment Trilemma. Science, 325, 270-271. Retrieved October 5, 2012 from "Science"/AAAS database.
4) Air Products and Chemicals, Inc (2010). Get the Facts on Hydrogen. retrieved 11/19/2012, from Hydrogen The fuel of the future-today Web Site: http://www.hydrogenfuturetoday.com/facts.html

Poster #18

"Food Waste in America"

Victoria Moscato, Nicole Catino, Jen Ruocco

Our poster, Food Waste in America, discussed the inefficiencies along the process that follows food from its production to its disposal. We spoke about the history of food, how society has interacted with food and waste in the past and how we got to where we are today as major contributors of food waste. Each year, Americans waste 33 million tons of food, which is equivalent to throwing away $165 billion. That waste generates negative impacts on the environment, which was also examined in our poster. We discussed food production as a huge actor in negative environmental impacts due to improper care and feeding of livestock and the overuse of synthetic fertilizers on our crops. In order to maintain some positive outlooks we ended our discussion of food waste in America by presenting recommendations that we felt could adequately address this pressing matter, including a re-structuring of consumer expectations, rotational grazing and vertical farming.

Nicole Catino
Victoria Moscato
Jen Ruocco

Food Waste in America

Lafayette College
2012

Production → Processing → Distribution → Acquisition → Preparation → Consumption → Digestion

1) Background

Food waste occurs at all levels of the food system, but very few studies have been done to quantify data. EPA established a Food Recovery Hierarchy as guidelines to reducing food waste (Figure 1).

A Social History of Waste

- 1900s: A shifting social status
- Frugality commended during Great Depression
- 1950s: Veneration of newness
- Since the 1960s the municipal solid waste (MSW) has continued to grow (Figure 2)
- The second largest portion of MSW is food scraps (Figure 3)
- Today's consumers are far-removed from the production process

Supermarkets

- Overstock to give the appearance of abundance
- Cosmetic standards necessitate the perfect produce
- Limited shelf life for produce

Figure 1 EPAs guidelines to reduce the amount of food waste

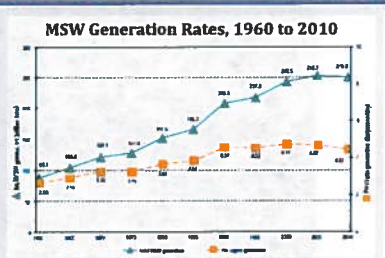

Figure 2 Municipal Solid Waste generation rates from 1960 to 2010

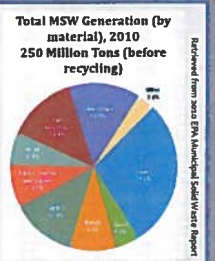

Figure 3 Composition of Municipal Solid Waste before recycling

2) Impact on the Environment

Livestock

- **Concentrated Animal Feeding Operations** (CAFO)
  - Anaerobic lagoons from concentrated animal waste emit toxic gases (such as methane) and toxic runoff contributes to mutations in the genes of animals downstream
  - Diet of cows (corn) contributes to a higher level of methane emissions from them

Agriculture

- Nitrogen and phosphorous from fertilizers leads to eutrophication and dead zones in waterways (Figure 4)
- Loss of biodiversity through GMO's and massive commodity crops
- Reduction of pastured lands leads to less CO_2 and nutrients in soil, and more erosion runoff (Figure 5)

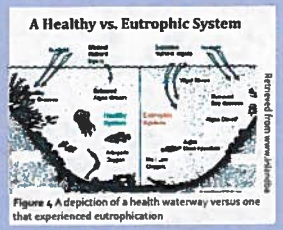

Figure 4 A depiction of a health waterway versus one that experienced eutrophication

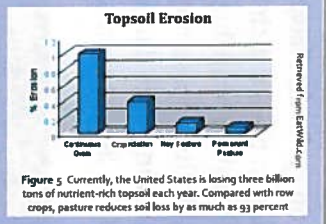

Figure 5 Currently, the United States is losing three billion tons of nutrient-rich topsoil each year. Compared with row crops, pasture reduces soil loss by as much as 93 percent

Landfills

- Food waste in landfills produces methane gas (CH_4), a green house gas that is 21 times more potent than CO_2
- Leachate can contaminate groundwater

3) Recommendations

For the Consumer

- Follow the Food Recovery Hierarchy
- Plan meals for the week and only buy food you will eat (Figure 6)
- Eat lower on the food chain
- Lower aesthetic standards, raise nutritional ones
- Eat or freeze your leftovers
- Buy local
- Create a personal garden
- Compost leftovers

Figure 6 An ad from the Committee of Public Safety; Pennsylvania; 1917

Innovative Industry Ideas

- **Rotational Grazing**
  - Perennial grasses provide natural habitat and reduce soil erosion
  - Reduces toxic runoff
- **Vertical Farming**
  - A man-made ecosystem that recycles energy, water and nutrients between floors to grow plants indoors (Figure 7)
  - Uses up to 90% less water to grow food compared to traditional agricultural practices because of the use of hydroponics and aeroponics
  - Allows people living in urban environments to always buy local so that less food and energy is wasted

Figure 7 An example of a vertical farm

Quick Facts:

- Each year, Americans waste 33 million tons of food, which is equivalent to throwing out $165 billion annually
- America has four times as much food than is actually required to feed the population
- Over half of the land use and over 80% of water consumed in the US is dedicated to food production
- It takes 50 gallons of oil to produce 1 acre of industrial corn
- In multiple US States it is illegal to research where the food you eat comes from

References:

Bloom, J. (2010). *American Wasteland. How America Throws Away Nearly Half of Its Food (and What We Can Do About It).* Cambridge, MA. Da Capo Press.

Flatow, I. (2012, September 21). *The ugly truth about food waste in America* [Audio file]. Retrieved from http://www.npr.org/2012/09/21/161551772/the-ugly-truth-about-food-waste-in-america

McCorkell, D., Power, K., & Nelms, R. (2009). *A river of waste [video recording] : the hazardous truth about factory farms /Tumbleweed Arts presents ; a Dan McCorkell film , produced and directed by Dan McCorkell.* [Los Angeles] : Cinema Libre Studio, c2009.

Stuart, T. (2009). *Waste: Uncovering the Global Food Scandal.* New York, NY: W. W. Norton & Company.

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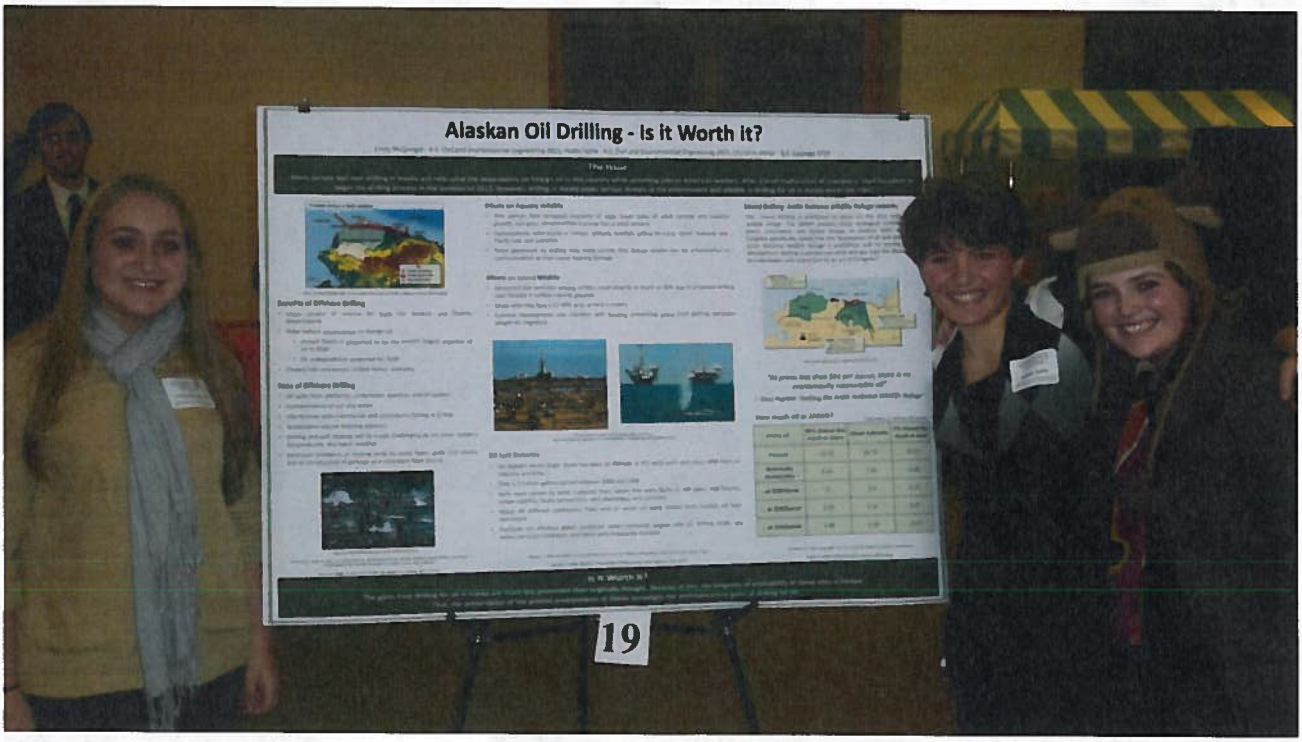
Poster #19

"Alaskan Oil Drilling: Is it Worth it?"

Emily McGonigle, Hailey Votta, Christine Almer

We studied if drilling for oil in Alaska is worth the costs to the environment. Currently there are plans to drill offshore and inland in Alaska. Shell Alaska to drill in the offshore Arctic. Though, these plans have been cancelled for this year because a series of glitches on the company's oil barge resulting in damage in the containment dome created to hold oil in the event of an underwater leak, plans have been set to start drilling in this location in the summer of 2013. The ANWR, or Arctic National Wildlife Rescue, is a 19.6 acre national wildlife refuge in Alaska that is the nesting site to thousands of birds and the calving ground of caribou. Because of oil located on about 8% of the ANWR there are plans to try to drill on the area despite it being protected by the federal government. It is believed that if this oil was recovered, it would significantly increase domestic oil production. The problem with drilling in Alaska, both onshore and offshore, is that there will be irreversible damage to the environment and ecosystems there. Although drilling in Alaska would help the United States reduce dependence on foreign sources subject to disruption for oil, the environmental risks of drilling for oil in Alaska are too large. Looking back on the oil spills that have occurred, one can see that the destruction left in their wake is enormous. Unlike drilling in places such as the Gulf of Mexico where the primary challenge is depth, the Arctic poses other threats. These threats include ice cover, subzero temperatures, and harsh weather. It is also a concern that drilling operations could threaten animals, onshore and offshore, such as bowhead whales and caribou. Doing such damage to the beauty of Alaska and its inhabitants is wrong and environmentally and economically unsafe for Alaska.

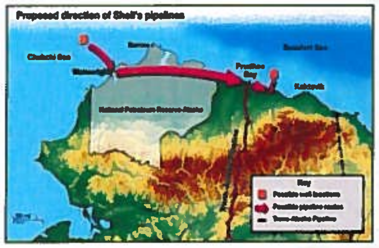


Alaskan Oil Drilling - Is it Worth it?

Emily McGonigle - B.S. Civil and Environmental Engineering 2015, Hailey Votta - B.S. Civil and Environmental Engineering 2015, Christine Almer - B.S. Geology 2016

The Issue

Many people feel that drilling in Alaska will help solve the dependency on foreign oil in this country while providing jobs to American workers. After a brief malfunction of machinery, Shell has plans to begin the drilling process in the summer of 2013. However, drilling in Alaska poses serious threats to the environment and wildlife. Is drilling for oil in Alaska worth the risks?



http://www.alaskadispatch.com/content/what-shell-oils-arctic-drilling-ambitions-mean-alaska

Benefits of Offshore Drilling

- Major source of income for both the Alaskan and Federal Governments
- Helps reduce dependence on foreign oil
  - United States is projected to be the world's largest exporter of oil in 2020
  - Oil independence projected for 2030
- Creates jobs and boosts United States' economy

Risks of Offshore Drilling

- Oil spills from platforms, underwater pipelines and/or tankers
- Contamination of soil and water
- Interference with commercial and subsistence fishing activities
- Accelerated natural draining patterns
- Drilling and spill cleanup will be made challenging by ice cover, subzero temperatures, and harsh-weather
- Increased predation of nesting birds by arctic foxes, gulls, and ravens due to introduction of garbage as a consistent food source

http://faculty.buffalostate.edu/smithrd/PR/Exxon.htm

Effects on Aquatic Wildlife

- Pink salmon face increased mortality of eggs, lower rates of adult survival and juvenile growth, and gross abnormalities in young fish in oiled streams
- Hydrocarbons were found in halibut, pollack, rockfish, yellow-fin tuna, dover, flathead sole, Pacific cod, and sablefish
- Noise generated by drilling may mask sounds that beluga whales use for echolocation or communication or even cause hearing damage

Effects on Inland Wildlife

- Estimated that birthrate among caribou could drop by as much as 40% due to proposed drilling sites located in caribou calving grounds
- Musk oxen may face a 25-50% drop in herd numbers
- Summer development may interfere with feeding, preventing geese from gaining adequate weight for migration

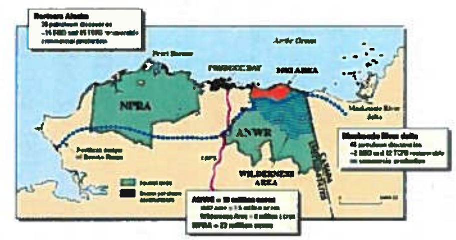
http://www.unc.edu/~mooney/geography/anwr2.html
http://devnazworld.typepad.com/.a/6a00d8341c7c7d53ef0133ed2825d5970b-450wi

Oil Spill Statistics

- On Alaska's North Slope, there has been an average of 427 spills each year since 1996 from oil industry activities
- Over 1.2 million gallons spilled between 1996 and 1998
- Spills were caused by leaks, ruptured lines, valves that were faulty or left open, seal failures, tanker overfills, faulty connections, vent discharges, and corrosion
- About 40 different substances from acid to waste oil were spilled from routine oil field operations
- Hydraulic oil, ethylene glycol, produced water, methanol, engine lube oil, drilling muds, sea water, corrosion inhibitors, and halon were frequently dumped.

Inland Drilling: Arctic National Wildlife Refuge (ANWR)

The inland drilling is scheduled to occur on the 19.6 acre national wildlife refuge. The ANWR protects three ecological systems: coastal plains, mountains, and boreal forests. In Section 1003 of ANILCA, Congress specifically stated that the "production of oil and gas from the Arctic National Wildlife Refuge is prohibited and no leasing or other development leading to production of oil and gas from the [Refuge] shall be undertaken until authorized by an act of Congress."



http://pubs.usgs.gov/fs/fs-0028-01/fs-0028-01.htm

"At prices less than $16 per barrel, there is no economically recoverable oil"

– Chris Ingram "Drilling the Arctic National Wildlife Refuge"

How much oil in ANWR?

**Numbers in billions of barrels*

Crude oil	95% chance this much or more	Mean Estimate	5% chance this much or more
Present	11.59	20.73	31.52
Technically recoverable	4.25	7.69	11.80
...at $18/barrel	0	2.4	6.15
... at $24/barrel	2.03	5.24	9.37
... at $30/barrel	2.98	6.30	10.47

Cameron, R., Reed, D., Dau, J., & Smith, W. (n.d). REDISTRIBUTION OF CALVING CARIBOU IN RESPONSE TO OIL-FIELD DEVELOPMENT ON THE ARCTIC SLOPE OF ALASKA. *Arctic*, 45(4), 338-342.

Lee, D. R. (2000). To drill or not to drill. *The Independent Review*, VI(2), 217-226.

Murphy, K. (2012, September 17). Arctic drilling: Shell scales back offshore drilling efforts until next year. *Los Angeles Times*.

Gemmill, F. (1999). PEOPLE OF THE CARIBOU REBORN. Native Peoples Magazine, 13(1), 50-54.

Thompson, M. (2012, November 12). U.S. to become biggest oil producer. *CNN Money*.

Ingram, C. (2001). Drilling the arctic national wildlife refuge.

Is It Worth It?

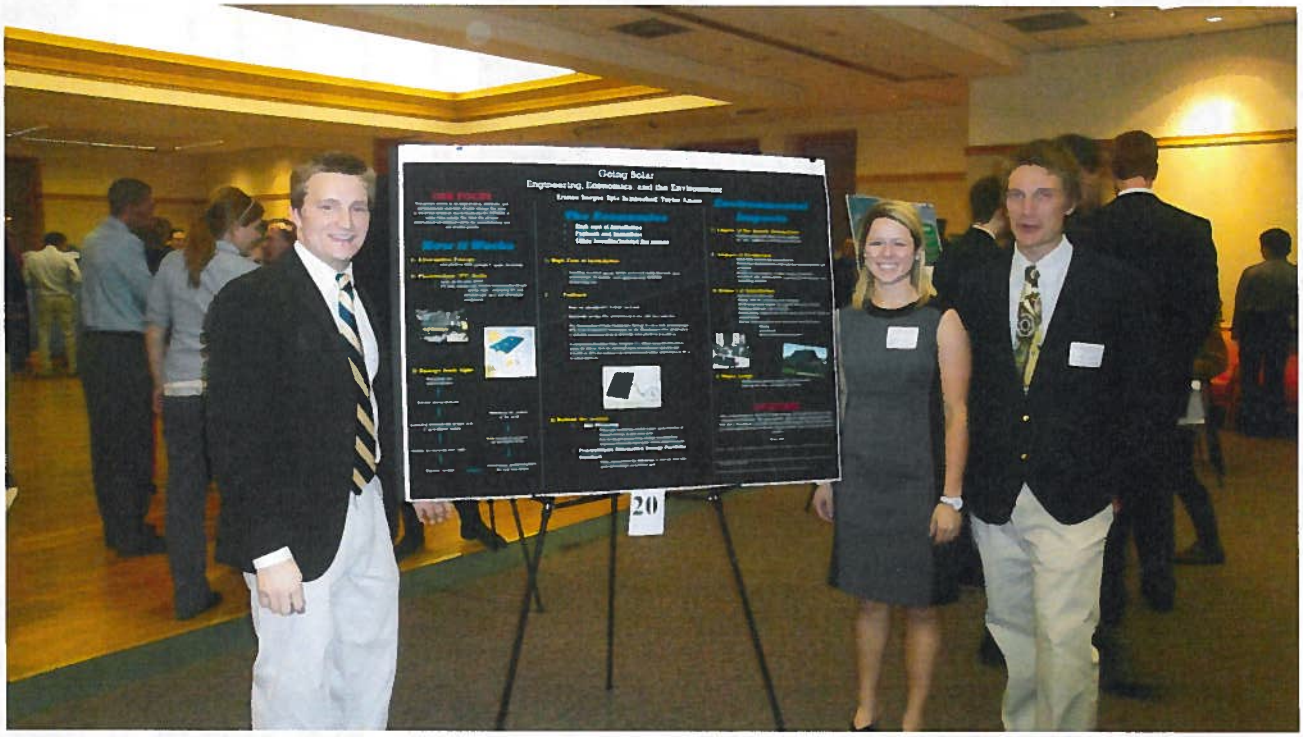
The gains from drilling for oil in Alaska are much less prominent than originally thought. Because of this, the longevity of profitability of these sites is limited. Thus, the preservation of the pristine environments of Alaska outweighs the anthropocentric gains of drilling for oil.

Poster #20

"Going Solar"

Kyle Brinkerhoff, Kristen Berger, Taylor Amato

The focus of our research was on how solar panels work, the economics behind using solar panels, and the environmental impacts of using solar panels. The basic principle behind how solar panels work is that they capture the suns energy and convert it into electricity. Solar panels are a large initial investment, but a good one over the long-term because you will have virtually no energy bill and they will end up paying for themselves. There are many federal grants and loans available that the small businessperson or the homeowner can apply for to get help to pay for solar panels. Solar panels are currently cost-effective in the long run, but they are still a work-in-progress. Currently the majority of solar panels operate at about 10-15% efficiency and there is no great way to store the energy from these panels. There is a lot of potential with solar panels. If scientists can find a way to better store the energy captured by solar panels and increase the efficiency from what they are today, they could produce a lot of energy, at virtually no cost. Solar panels are a clean source of energy that do not create water or air pollution. While solar panels do require fossil fuels to make the panels themselves, they are still an environmentally friendly source of energy that should be taken seriously and invested in more in the future to reduce our ecological footprints.



Going Solar

Engineering, Economics, and the Environment

Kristen Berger, Kyle Brinkerhoff, Taylor Amato

OUR FOCUS

This poster serves as an engineering, economic, and environmental overview of solar energy. The main focus of our research was to figure out the IMPACTS of using solar energy. The three E's, all have interconnected relations within the manufacturing and use of solar panels.

How it Works

1) Alternative Energy

- uses photons from sunlight to create electricity

2) Photovoltaic (PV) Cells

- make up the solar panel
- PV cells absorb only certain wavelengths of light
  - – visible light – reflecting UV and infrared rays (over half of sunlight combined)

3) Energy from light:

Absorbed into semiconductor

Knocks electrons loose

Instability between the n-type and p-type silicon layers

Supplies in electrons and "holes"

Current created

Determines potential power the cell can create

Metal contacts are placed at top and bottom of cell

Withdraws the current to be used

The Economics

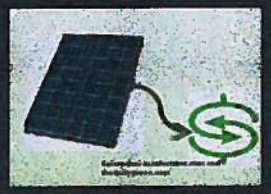
- High cost of installation
- Payback and Incentives
- Other benefits/behind the scenes

1) High Cost of Installation

- Installing the panel system can be extremely costly. Example: 1 kw system (appx. 87 panels) costs approximately $ 150,000.
- Reinforcing roof

2) Payback

- Short-run includes 30 % Federal tax break
- Essentially leaving 70 % of burden on owner and state subsidies
- The Metropolitan Edison Sustainable Energy Fund as well as the PanelSec SEC of the Community Foundation for the Alleghenies offer grants of up to $25,000 and loans of up to $500,000 depending on the project.
- Pennsylvania Sunshine Solar Program is a rebate program that offers either $7,500 or 35 % for installed costs of residential systems and $52,500 or 35 % for commercial installations of either photovoltaic or solar thermal systems



3) Behind the scenes

- Net Metering
  - When sun is shining, electric meter spins backwards. Unused energy is sent onto grid
  - Sun no longer generating energy, household or business then pulls from grid, meter spins forwards
- Pennsylvania Alternative Energy Portfolio Standard
  - Make money from the difference of energy sent onto grid and energy pulled from grid

Environmental Impacts

1) Impcts of the panels themselves

- During energy production, no air pollution
- No water pollution or environmental hazards

2) Impact of Production

- Fossil fuels emitted during production
- Production of photovoltaic cells involves use of arsenic and cadmium
- Arsenic is a carcinogen. Causes cancer in workers.
- Cadmium also causes cancer, targeting cardiovascular and respiratory systems

3) Impact of Installation

- Land use is a main issue
- Mainly with the comercial solar business
- 20-50 megawatts require one square kilometer of land
- Building roofs are a great solution
- Residentially, using houses as the main area is ideal. Roofs are unused space.
- Energy generated from coal uses more land than solar.
  - Mining
  - Converting
  - Major environmental impacts

4) Water usage

- Electricity production uses 40 % of freshwater
- Solar power does not require any water

OUTCOME

After researching the three E's of solar energy, we found that this is a very interconnected situations. Not only does the type of engineering impact the cost, but it also plays a role with environmental impacts. These factors make it a challenging decision to decide if solar energy is the way to go for most people.

Resources

FALL 2012

Poster #21

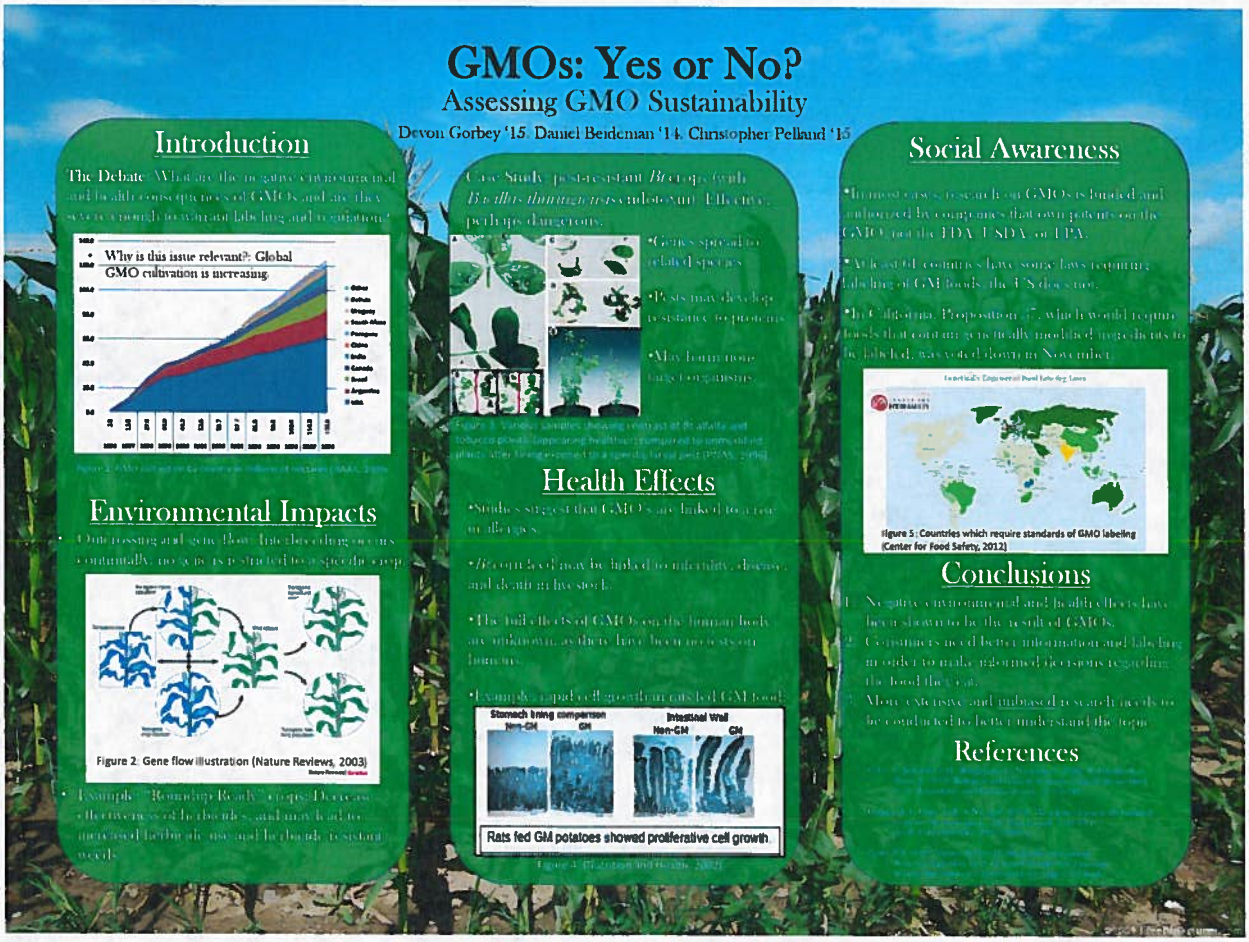
"GMOs"

Dan Beideman, Chris Pelland, Devon Gorbey

Over the past two decades, GMO use has increased dramatically while consumer awareness on the subject has remained low. Furthermore, extensive and comprehensive research has not been conducted on GMOs. What research has been published is primarily funded and carried out by the industries that produce GMOs, and is typically short-term and likely bias. Recently, more long-term, independently funded research has been published, with some contradictory results. The goal of our poster was to review the published literature and draw conclusions on the environmental and health effects of GMOs with regard to selected issues.

Specifically, we examined the environmental and health effects of "Roundup Ready" and *Bt* modified crops, which are widely used and are associated with many potential environmental and health issues. We also examined the issue of product labeling, and noted that the United States has no legal requirements for the labeling of genetically modified food, despite being the leading global producer of GMOs.

We developed three conclusions based on our research: (1) Specific and general negative environmental and health effects have been linked to GMOs; (2) More extensive and unbiased research needs to be performed in order to accurately assess the safety of environmental impact of GMOs; (3) United States citizens need to be more informed on the food they eat and the possible deleterious effects of GMOs.



GMOs: Yes or No?

Assessing GMO Sustainability

Devon Gorbey '15, Daniel Beideman '14, Christopher Pelland '15

Introduction

The Debate: What are the negative environmental and health consequences of GMOs and are they severe enough to warrant labeling and regulation?

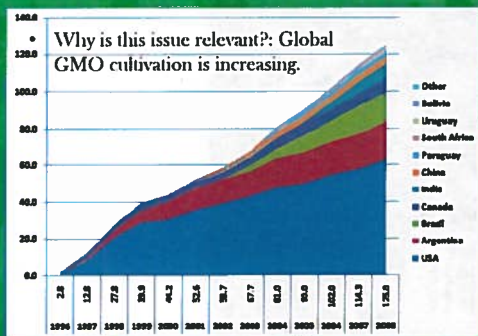


Figure 1: GMO cultivation by country in millions of hectares (ISAAA, 2009)

Environmental Impacts

- Outcrossing and gene flow: Interbreeding occurs continually; no gene is restricted to a specific crop.

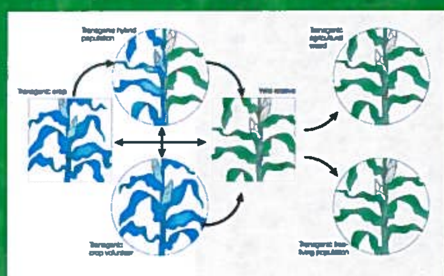


Figure 2: Gene flow illustration (Nature Reviews, 2003)

- Example: "Roundup Ready" crops: Decrease effectiveness of herbicides, and may lead to increased herbicide use and herbicide resistant weeds.

Case Study: pest-resistant *Bt* crops (with *Bacillus thuringiensis* endotoxin): Effective, perhaps dangerous.

- •Genes spread to related species
- •Pests may develop resistance to proteins
- •May harm non-target organisms.

Figure 3: Various samples showing contrast of *Bt* alfalfa and tobacco plants (appearing healthier) compared to unmodified plants after being exposed to a specific larval pest (PNAS, 1996)

Health Effects

•Studies suggest that GMO's are linked to a rise in allergies.

•*Bt* corn feed may be linked to infertility, disease, and death in livestock.

•The full effects of GMOs on the human body are unknown, as there have been no tests on humans.

•Example: rapid cell growth in rats fed GM food.

Figure 4: (Nutrition and Health, 2002)

Social Awareness

•In most cases, research on GMOs is funded and authorized by companies that own patents on the GMO, not the FDA, USDA, or EPA.

•At least 61 countries have some laws requiring labeling of GM foods, the US does not.

•In California, Proposition 37, which would require foods that contain genetically modified ingredients to be labeled, was voted down in November.

Figure 5: Countries which require standards of GMO labeling (Center for Food Safety, 2012)

Conclusions

1. Negative environmental and health effects have been shown to be the result of GMOs.
2. Consumers need better information and labeling in order to make informed decisions regarding the food they eat.
3. More extensive and unbiased research needs to be conducted to better understand the topic.

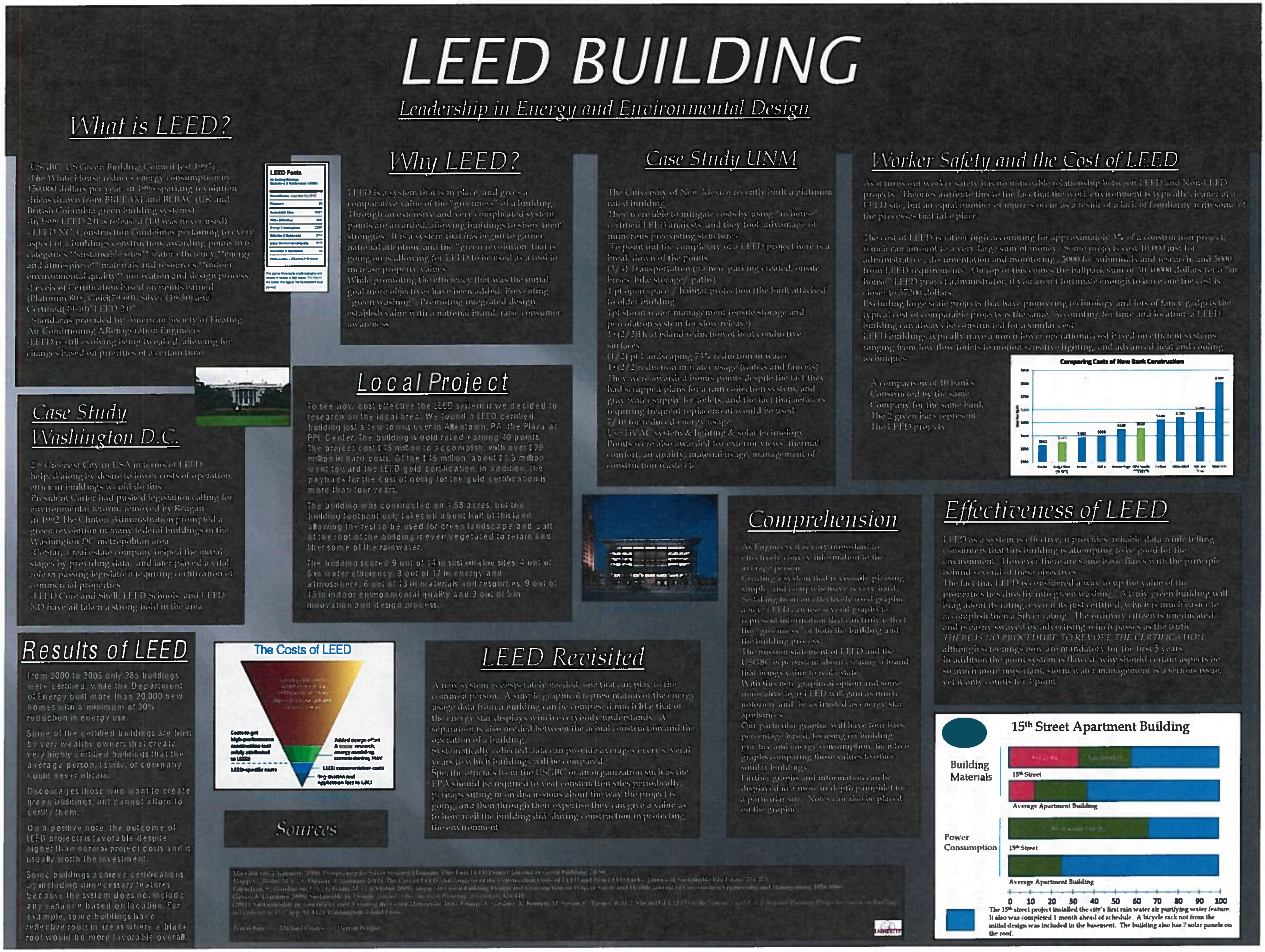
References

Poster #22

"LEED Building"

Travis Barr, Michael Coates, and Darren Wright

For our poster we investigated the LEED certification of buildings. We spent our time researching several areas; the current organization and certification process, its historical context, the cost and safety of a LEED versus a non-LEED construction, and what was being planned for the future. During the process we came to the realization that the system was lacking transparency and also was extremely difficult to comprehend. We decided to investigate a method in which "green-washing" could be minimized, while the common consumer could easily understand the given information. We discovered that the costs and safety of LEED projects are the same as non-LEED projects. We acknowledge that the USGBC is still working and adjusting LEED, and hope they take steps similar to those that we suggest which would help increase transparency, allowing for the true goal of the system to be achieved, the preservation of the environment and resources, while rewarding those for taking actions to support such an idea. It is important to note that the system is continually improving and every year the number of LEED projects is increasing, which suggests that at a point in the near future LEED will be in a position with enough influence where the system on the table will control the way construction projects are approached, and it is important that the proper system is in place by such a time.

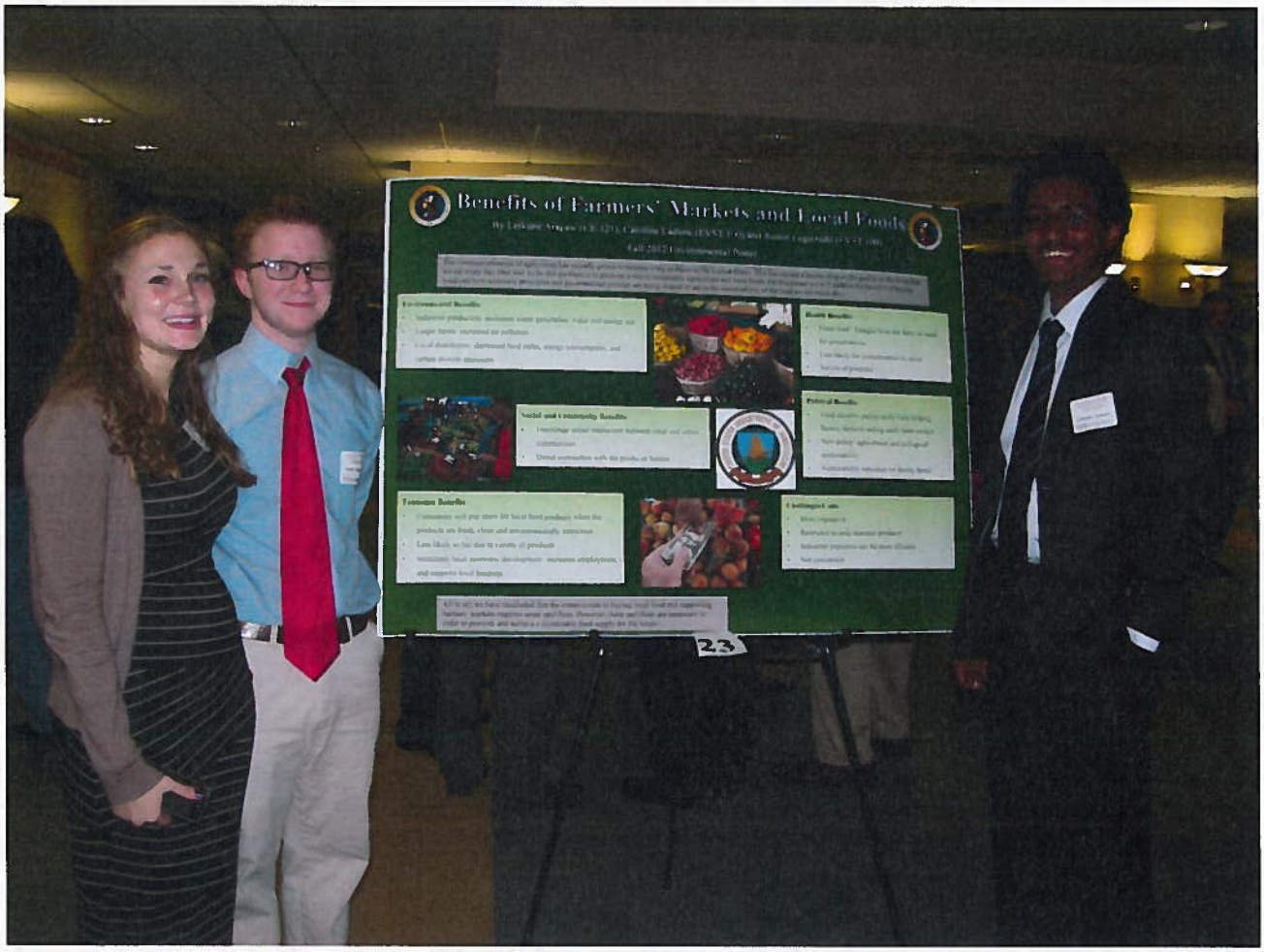

LEED BUILDING
Leadership in Energy and Environmental Design
What is LEED?
LEED Facts
Why LEED?
Case Study UNM
Worker Safety and the Cost of LEED
Comparing Costs of New Bank Construction
Case Study Washington D.C.
Local Project
To see how cost effective the LEED system is we decided to research on the local area. We found a LEED certified building just a few towns over in Allentown, PA: the Plaza at PPL Center. The building is gold rated earning 40 points.
The building was constructed on 1.58 acres, but the building footprint only takes up about half of this land allowing the rest to be used for green landscape and part of the roof of the building is even vegetated to retain and filter some of the rainwater.
Results of LEED
From 2000 to 2005 only 285 buildings were certified, while the Department of Energy built more than 20,000 new homes with a minimum of 30% reduction in energy use.
Some of the certified buildings are built by very wealthy owners that create very highly certified buildings that the average person, family, or company could never obtain.
Discourages those who want to create green buildings, but cannot afford to certify them.
On a positive note, the outcome of LEED projects is favorable despite higher than normal project costs and is usually worth the investment.
Some buildings achieve certifications by including unnecessary features because the system does not include any variance based on location. For example, some buildings have reflective roofs in areas where a black roof would be more favorable overall.
The Costs of LEED
LEED-specific costs
LEED documentation costs
Sources
LEED Revisited
Comprehension
Effectiveness of LEED
THERE IS NO PROCEDURE TO REVOKE THE CERTIFICATION
15th Street Apartment Building
Building Materials
15th Street
Average Apartment Building
Power Consumption
15th Street
Average Apartment Building
0 10 20 30 40 50 60 70 80 90 100
The 15th street project installed the city's first rain water air purifying water feature. It also was completed 1 month ahead of schedule. A bicycle rack not from the initial design was included in the basement. The building also has 7 solar panels on the roof.

Poster #23

"Benefits of Farmers' Markets and Local Foods"

Leikune Aragaw, Austin Luginbuhl, Caroline Ladlow

In recent years, the commercialization of food production has led to problems leading to an overall reduction of food quality. In our poster, we looked at farmers' markets and local foods as an alternative. Due to the interdisciplinary nature of the topic and the classes we are taking, we took a broad approach. We accomplished this by investigating the different benefits of farmers' markets and local foods from environmental, health, social/community, economic, and political perspectives. We also looked at the possible cons/challenges with farmers' markets and local foods. Through the process of doing this poster and research, our team believes that farmers' markets and local foods are better alternatives to commercialized foods. Although they come with challenges, we believe sacrifices are necessary to move forward to a more sustainable and environmentally friendly world.



Benefits of Farmers' Markets and Local Foods

By Leikune Aragaw (CE 321), Caroline Ladlow (EVST 100) and Austin Luginbuhl (EVST 100)

Fall 2012 Environmental Poster

The commercialization of agriculture has recently grown to become a big problem in the United States. This has caused a drastic drop in the quality in the foods that we eat every day. One way to fix this problem is to promote a rise in sustainable agriculture and local foods. On this poster we will address the benefits of buying local and how economic principles and governmental policies are being shaped to aid in the sustainability of the food we eat every day.

Environmental Benefits:

- Industrial production: increased waste generation, water and energy use
- Larger farms: increased air pollution
- Local distributors: decreased food miles, energy consumption, and carbon dioxide emissions

Health Benefits:

- Fresh food: Straight from the farm, no need for preservatives
- Less likely for contamination to occur
- Variety of products

Social and Community Benefits:

- Encourage social interaction between rural and urban communities
- Direct connection with the producer/farmer

Political Benefits:

- Food security: policy shifts from helping factory farms to aiding small farm owners
- New policy: agricultural and ecological sustainability
- Sustainability subsidies for family farms

Economic Benefits:

- Consumers will pay more for local food products when the products are fresh, clean and environmentally conscious
- Less likely to fail due to variety of products
- Stimulates local economic development: increases employment, and supports local business

Challenges/Cons:

- More expensive
- Restricted to only seasonal products
- Industrial processes can be more efficient
- Not convenient

All in all, we have concluded that the commitment to buying local food and supporting farmers' markets requires some sacrifices. However, these sacrifices are necessary in order to promote and achieve a sustainable food supply for the future.

References

- Baldwin, C. (2009). *Sustainability in the food industry*. Ames, Iowa: Wiley-Blackwell/IFT Press.
- Stark, J. E. (2008). *Crisis & Opportunity: Sustainability in American Agriculture*. Lincoln: University of Nebraska Press.
- Feiner, R. (2012, March 6). Benefits of farmers' markets - LocalFoods.org.uk. *Home - LocalFoods.org.uk*. Retrieved October 29, 2012, from http://www.localfoods.org.uk/info/10-farmers-markets-faq/40-benefits-of-farmers-markets/

Poster #24

"Algae as a source of Biofuel and its Sustainability"

Abél Kidané, Brian Bock, Ryan Callanan

Our poster is about algae and how it can be used as a source of fuel. We discuss the state of the technology and how it is currently being used. We also discuss the methods of growing algae that are being used, their efficiency and construction costs. We touch upon methods of extracting lipids from the algae which then can be processed into oil. We also mention the various possible paths of research that can lead to the increase in yield of lipids to turn to biofuel.

Algae grow in all types of waters like lakes, ponds and oceans. They have a very high reproduction and growth rate and do not require much material, making them easily cultivatable for use. The two main ways algae can be grown on a large scale is through the photobioreactor method and the open pond method. The photobioreactor is much more efficient and is more common because it is a closed system, meaning no outside contaminants can enter the system and interfere with the growth of the algae. In addition, it allows for ideal conditions to be set, making it very easy for algae to grow rapidly. This differs from the open pond system in that open ponds are vulnerable to contamination and even invasive algae species.

The main part of the algae that in needed for the production of biofuel is the lipids. These lipids contain triglycerides which are then converted to biodiesel through the process of trans-esterification. The resulting compound is an ester which is very similar to diesel and is fully usable in diesel engines. To extract these lipids we first need to dry out the water which consists of about 50% by mass. After this step there are two ways to extract the lipids. One is by increasing pressure to as to squeeze the lipids out of the dried algae. The other is by using special solvents that dissolve the triglycerides but not the other material and then extracting the lipids from the solution usually by boiling and making it precipitate. Both methods consume a large amount of energy and depending on the design, one can be more efficient that the other.

More research needs to be done on how to increase the efficiency of systems and also increase the productivity of algae. For mass production, initial costs of construction are very high and profits are not guaranteed due to the presence of cheaper (but less clean) sources of diesel which constitutes to the lack of widespread use of this technology. However as oil deposits run dry and the world looks to a new source of fuel, algae biodiesel can be a very viable option.

LAFAYETTE

Algae as a source of Biofuel and its Sustainability

By Ryan Callanan, Brian Bock and Abél Kidané

Methods of Growing

3 ways algae can be produced on a large scale:

1. Photo-bioreactors
   - Machines that pump nutrient-rich water through glass tubes that are exposed to sunlight, facilitating the growth of algae
   - Most commonly-used method in the United States
2. Closed-loop system
   - A type of bioreactor that ensures that no foreign substances enter into and contaminate the system
3. Open ponds
   - Least efficient, not often used anymore because it requires a very hardy strand of algae resistant to temperature and pH fluctuations

Mass Production

- There are various methods to increase the yield of algae lipids for fuel production, such as:
  - Co-culturing: Typically algae is grown with Cyanobacteria (blue-green algae) or other species of algae to help increase the growth and reproduction rate. The co-culturing organisms are chosen by use of experimentation since there is currently no other reasoning method to indicate the effectiveness
  - Genetic engineering: increased resistance to harsh conditions as well as higher reproductive rates and lipid contents can be achieved through this method. So far, this is the least researched but most promising path of mass production of algae fuel.
- With the current level of research, the mass production of algae takes too much energy, water, and fertilizer to be economically sensible
- However, it would dramatically decrease the United States' reliance of foreign oil

Abstract

This poster explicates the usage of algae, specifically lipid molecules that can be extracted from algae, in the production of biofuel. It touches upon ways to increase lipid yield. It explains the state of mass production in the world, techniques used to grow and convert the substances to fuel, and limitations to using this technology

Algae culture for commercial use

Source http://newenergyandfuel.com

Dried Algae this is the intermediate product from which triglyceride is extracted for the synthesis of fuel

Source: Lafayette College Chem Lab

Factors Affecting Production

Growth Rate

- Growth rate is affected among other things by nutrient content of cultivation, weather and climate of area, natural tendency of the specific type of algae to reproduce, duration of exposure to sunlight etc...

Lipid Content

- Lipids are the part of algae that is converted to burning fuels. The amount of lipids per cell governs how much biofuel can be synthesized.
- The type and quality of lipids, meaning their triglycerides content, determines how much fuel can be produced from the culture. Triglyceride is the main ingredient that is to be converted to fuel.

Limiting Nutrients

- Using wastewater to produce algae cultures is most efficient because algae uses the main pollutants from the wastewater as a source of nutrients.
- Macronutrients- phosphate, nitrate, and silicate. In order to make any culture of algae , these nutrients are essential in larger quantities.
- Micronutrients- Growing algae requires potassium, calcium, iron, magnesium. These chemicals are present in trace amounts but could potentially affect the yeild of algae

References

- Hu, Q., Sommerfeld, M., Jarvis, E., Ghirardi, M., Posewitz, M., Seibert, M., Darzins, A. (2008). Microalgal triacylglycerols as feedstocks for biofuel production: perspectives and advances. *The Plant Journal*
- Tate, J., Gutiérrez Wing, M.T., Rusch, K., Benton, M. (2012). Gene expression analysis for Louisianna native *Chlorella vulgaris* (Chlorophyta)/*Leptolyngbya* sp. (Cyanobacteria) co-culture using suppression subtractive hybridization. *Engineering in life sciences*.
- Perrinez, D C (2010) Lipid analysis of micro-algae used in biodiesel production. Presentation. http://www.unh.edu/erc/sites/unh.edu.erc/files/media/pdfs2011/award_pdfs/2010/Perrinez_.pdf

Poster #25

"Environmental Impacts of Perflourinated Compounds"

Matthew McMurray, Alec Eidelman, Chris Parker

Perfluorinated Compounds (PFCs) were introduced to the consumer market 50 years ago. The compound has been widely adopted by industries to create a non-binding surfactant seal for many domestic products. Compounds are not found naturally in the environment, and because of this anthropogenic nature, quantity of information pertaining to the environmental, and biological impacts are still under investigation.

PFCs cause Bioaccumulation in membranes of living organisms. Some of their properties are that they; do not hydrolyze, photolyse, or biodegrade in any environmental condition currently tested. They are found in: cooking appliances, food packaging, upholstery, Teflon products, fire retardants. Highest levels of PFCs are found in bodies of water, and remediated within soil near industries and plants where fluoropolymers and PFCs are produced. Mass flow for Perfluorinated Compounds are unidirectional in nature, it flows from the point or diffusional source to where it bio-accumulates.

Toxicity studies show PFCs accumulating in adipose and muscle tissue. Animal studies have linked high exposure level of PFCs to bladder cancer, liver cancer, and developmental and reproductive toxicity in neonatal mortality. PFCs are a likely carcinogen for humans, with largest concern for pregnant women, where PFCs can cross the placenta to the developing child.

Regulations for Perfluorinated Compounds have led to it becoming a Persistent Organic Pollutant in 2005 by the Stockholm Convention for it's bio-accumulative properties. In order to help PFC levels in the environment we need to make a sustainable solution for removing PFCs from water resources and regulate waste from production plants. This can be done by using other, less toxic, chemicals for similar uses, or by treating waste water to remove PFCs.

Environmental Impacts of Perfluorinated Compounds

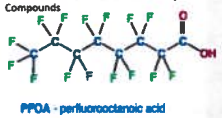
Alec Eidelman, Matthew McMurray, Chris Parker
Lafayette College, *Sustainability, The Grand Challenge of the 21st Century*

Introduction

Perfluorinated Compounds (PFCs) were introduced to the consumer market 50 years ago. The compound has been widely adopted by industries to create a non-binding surfactant seal for many domestic products. Common practice for synthesizing PFCs is to take carbon rich compounds such as oil and coal and manipulate them into long carbon chain compounds.[1] Subsequently, carbon chains are exposed to electric currents where hydrogen's are substituted by fluorine. The resulting compound is highly stable.

PFCs can be subcategorized by the length of their carbon chain backbone, which are saturated by single binding fluorine atoms. The head of the PFC can be functionalize, most often by sulfates or carboxyl groups. Compounds are not found naturally in the environment, and because of this anthropogenic nature, quantity of information pertaining to the environmental, and biological impacts are still under investigation.

Figure 1. Functionalized Fluorinated[2] Compounds



Chemical Properties

- Bioaccumulation in membranes and fatty tissue of living organisms
- Do not hydrolyze, photolyse, or biodegrade in any environmental condition currently tested.[3]
- High chemical and thermal stability, both hydrophobic and oleophobic
- Half-lives in human body for 3.5—9.0 years[3]
- Water insoluble—Non-polar intermolecular forces

Common Domestic Uses

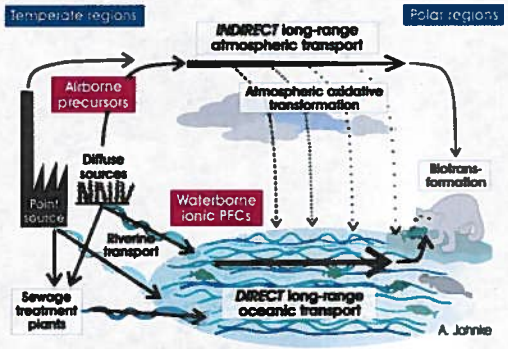
- The carbon-fluorine bonds are very strong and stable, which leads to its durable nature as a non-stick surface
- Found in: cooking appliances, rain coats, carpets, leather, paper, food packaging, fabric, upholstery, alkaline cleaners, floor polishes, photographic film, shampoo, denture cleaners, insecticide, Teflon, microwave popcorn, fire retardants.

Figure 2. Common Household Foods with Perfluorinated Compounds[3]

Perfluorinated Compounds in the Environment

- Perfluorinated Compounds are strictly anthropogenic.[1]
- PFCs do not degrade in the environment. Where are the sinks?
- Highest levels of PFCs are found in bodies of water, and remediated within soil near industries and plants where fluoropolymers and PFCs are produced.[6]
  - Transported through water resources as well as migrant animals such as humans, fish, birds, and marine mammals.[7]
  - Found downstream of plants, sometimes in drinking water resources.
- Levels of PFCs found within the United States and China, were significantly higher than those found in other countries.[6]
  - Rain contributes to PFCs being found in ground samples. Once in the soil the compounds can be taken up by plants
- *Unidirectional mass flow: NOT Sustainable.*

Figure 3. PFC Mass Flow[8]



International Regulations for PFCs

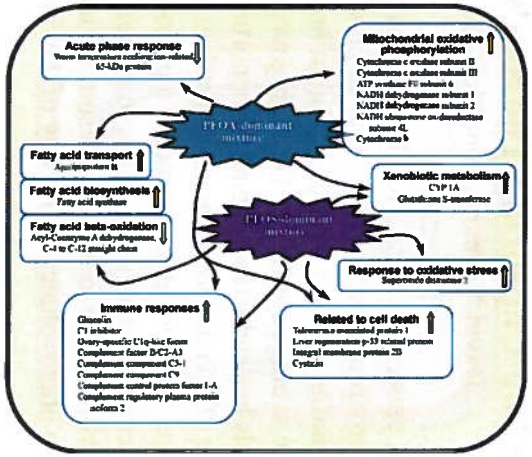
- ✓ Efforts are being made to remove PFCs from the bodies of water in close proximity to plants.
- ✓ PFCs have recently been added to the Persistent Organic pollutants category (2005) which are compounds that remain in the environment for long periods with extreme resistance to degradation.[12]
- ✓ PFCs are a Substance on the Very High Concern list, as a Persistent, Bioaccumulative, and Toxic substance (PBT), as reviewed by the Registration, Evaluation, Authorisation and Restriction of Chemicals (REACH) European Union.[13]
  - ✓ One common POP are CFCs, very similar in nature to PFCs.

Figure 5. Stockholm Convention for Review of Persistent Organic Pollutants[12]

Toxicity Studies

- Accumulates in liver and blood, attaching to proteins, and within membranes, Non-polar tail is hydrophobic, likely association with affinity to phospholipids within adipose and muscle tissue.[9]
- In animal studies PFCs are linked to bladder cancer, liver cancer, and developmental and reproductive toxicity in neonatal mortality
  - A likely carcinogen for humans[10]
- PFCs can cross the placenta in humans[9] leading to:
  - Lower growth measurements in newborns
  - May be associated with infertility in woman[10]
  - Possible ineffectiveness for infant vaccines

Figure 4. Combined effects of PFC mixtures on hepatocytes of rare minnow. Novel effects of PFOA- or PFOS-dominant mixtures were not detected in single PFCs exposure groups.[11]



References

References:

1. Environmental Working Group. (April 2003). PFCs Global Contaminant. In PFCs A Global Contaminant. Retrieved Sep 20, 2012, from http://www.ewg.org/reports/pfcworld.

2. Picture: http://cook.chem.ndsu.nodak.edu/chem341/wp-content/uploads/2012/01/PFOA-PFOS-285x300.png

3. Suja, Fatihah, Biplob Kumar Pramanik, and Shahrom Md Zain. "Contamination, bioaccumulation and toxic effects of perfluorinated chemicals (PFCs) in the water environment: a review paper." Water Science and Technology 60.6 (2009): 1533.

4. Domingo, J. (n.d). Health risks of dietary exposure to perfluorinated compounds. Environment International, 40187-195

Complete list of references available upon request

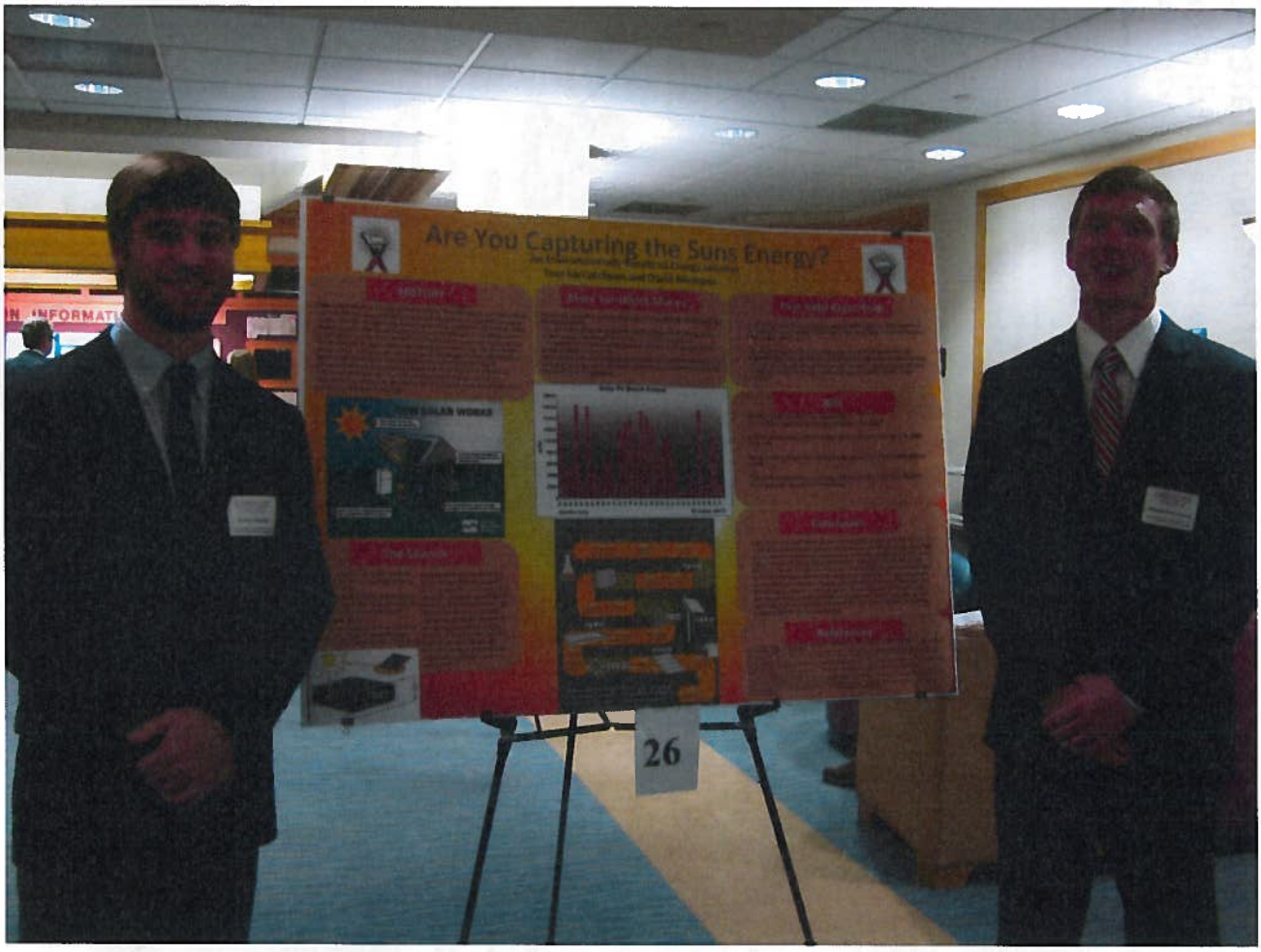
Attributions: Dr. Steve Mylon, Chem 252. Dr. Edward Gamber, FYS 185

Poster #26

"Are You Capturing The Sun's Energy?"

David Niemann, Tom McCutcheon

The sun is a vital part of our existence as a species. It brings us light, heat and the ability to produce clean sustainable energy. The environmental benefits of solar power have long been recognized but only recently have the economic benefits come to light. It is a smart business option and, as of recently, even holds a place in the heart of the average consumer. Through government programs and other recent innovations owning solar panels has suddenly become an opportunity to make a profit. Our project details the science and practice of owning solar panels and strives to identify with a general audience through its content and message. We were able to conduct a personal interview and get statements as well as data regarding consumer solar panel usage. This, to us, really made the practicality and feasibility of a solar powered world come to life. As a result, we have presented our information in such a way that people might look to photovoltaics as the way of the future and something to consider in their own lives.



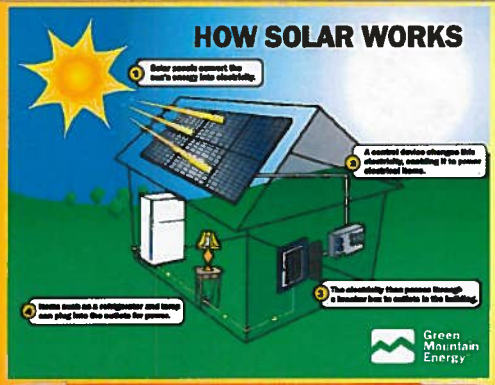
Are You Capturing the Suns Energy?

An Environmentally Beneficial Energy Solution

Tom McCutcheon and David Niemann

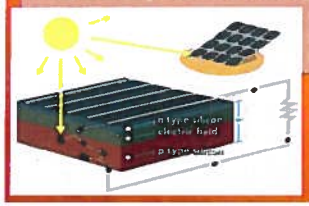
HISTORY

Solar power has come a long way from its origins. The first humans used solar energy as a radiant heat source allowing life to persist though the ages. Tens of thousands of years later we are harnessing the sun's power in a completely different way. Solar energy has come into its own in the past several decades but the invention of the photovoltaic cell is far older. The advent of modern solar panels was made possible thanks to Einstein's explanation of the photoelectric effect. From this concept the design using p-n silicon wafers was developed. This design has been the dominant form of solar power production in the last decade and the technological advancements have been centered around it. This development has led to an increase in efficiency from 1% of the very first solar cell design to 27% for commercially available cells. However, there are also more recent developments concerning solar panel technology



The Science

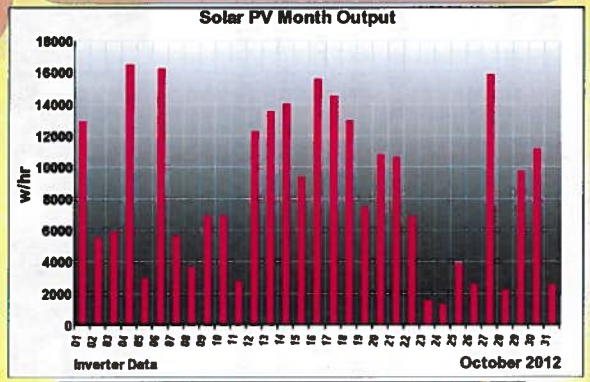
- The suns energy reaches earth as heat and light amid a wide range of wavelengths
- Some of these wavelengths bounce off of the photovoltaic cell, some pass right through it and others are absorbed by it
- The wavelengths that are absorbed by the cell are the ones that are utilized in the production of electricity
- By a phenomenon known as the photoelectric effect the incident photons cause the semiconducting silicon to eject electrons utilized in the production of electrical energy
- These electrons are channeled through the conductor and out of the system as usable electricity
- Individual cells are small and do not produce much electricity, therefore, many of these cells are connected in parallel to create a solar panel

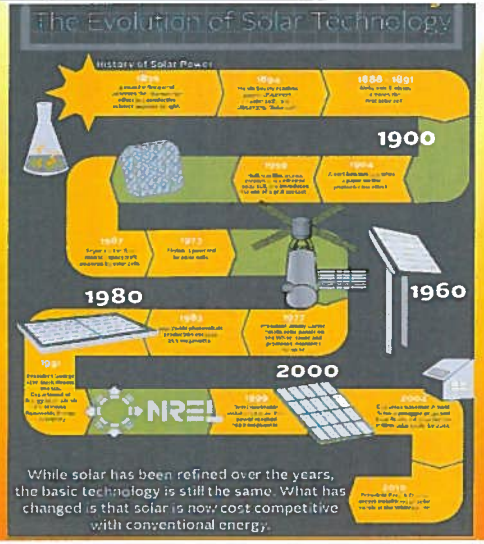


More Sun=More Money

The primary draw of solar technology is that it is **eco-friendly** but there are also **Economic Benefits**:

- There is a state policy which declares electric companies will buy back the unused energy from the solar panels that the owner does not use.
- On average, farms who use solar panels to power their farms save about **$1,800 annually** on utility bills.
- There is also a tax credit for buying solar panels up to 30% of your income tax.
- Depreciation is also an income tax break but for business owners only which targets the cost of equipment.





First-hand Experience

Joe Stratton, a small business owner, has presented our team with a statement regarding his recent installation of a solar panel array and the economic benefits he has found come with it.

"Installing solar panels has a very high initial cost; $90,000 for the 84 solar panels installed. However, every month since their installation they have yielded more energy than my home requires producing not only power, but profit. Solar panels, in my book, are an option every home and business owner should consider."

Bills

How do solar panels affect your monthly bill?
On average Mr. Startton's energy was bill per month is $950

With the annual savings of $1,800, the Stratton's bill has been lowered to $800 per month.

Energy bill, oil and electric, for residential homes is in the range of $450-650 per month

With the help of solar panels the energy bill per monthly plummets. Which in the long benefits you and the environment.

Conclusion

Solar panels and solar technology have come a long way from the first solar cell in 1894. The science behind them is not always an easy thing to wrap your head around but the results of this revolutionary technology are plain to see. They are a green way of producing energy and have the potential to truly change the path of our future. The advent of new solar technologies such as solar paint and thin films are being studied heavily and getting more efficient every day. Soon the world will see a dramatic change, one that allows individual consumers to both change the way they live and receive electrical power. It will come with environmental and economic benefit and is already in its primary throws. We had the agricultural revolution, the industrial revolution and now the world is preparing itself for the solar revolution.

References

Borenstein, S. (2012). The Private and Public Economics of Renewable Electricity Generation. *The Journal of Economic Perspectives, 26*(1), 67-92. Retrieved from http://0-www.jstor.org.library.lafayette.edu/stable/41348027

Boyd, R. (2012, March 30). Light on Landfills: Solar energy covers turn mined-out landfills into solar farms | Plugged In, Scientific American Blog Network. *Scientific American Blog Network*. Retrieved September 19, 2012, from http://blogs.scientificamerican.com/plugged-in/2012/03/30/light-on-landfills-solar-energy-covers-turn-mined-out-landfills-into-solar-farms/

Gary, S. (2011, January 31). Sun rises on next solar generation ? News in Science (ABC Science). *ABC.net.au*. Retrieved September 20, 2012, from http://www.abc.net.au/science/articles/2011/01/31/3123761.htm

Goldemberg, J., Johansson, T. B., Reddy, A., & Williams, R. H. (2001). Energy for the New Millennium. *Ambio, 30*(8), 330-337. Retrieved from http://0-www.jstor.org.library.lafayette.edu/stable/4315181

Grätzel, M. (2007). Photovoltaic and Photoelectrochemical Conversion of Solar Energy. *Philosophical Transactions: Mathematical, Physical and Engineering Sciences, 365*(1853), 993-1005. Retrieved from http://0-www.jstor.org.library.lafayette.edu/stable/25150494

Hadman, M. C., & Solomon, B. D. (2004). Power to the People: Electric Utility Restructuring and the Commitment to Renewable Energy. *Annals of the Association of American Geographers, 94*(1), 94-116. Retrieved from http://0-www.jstor.org.library.lafayette.edu/stable/3694070.

Joe Stratton 610-868-3332

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Poster #27

"Bushkill Creek Watershed Nutrient Analysis"

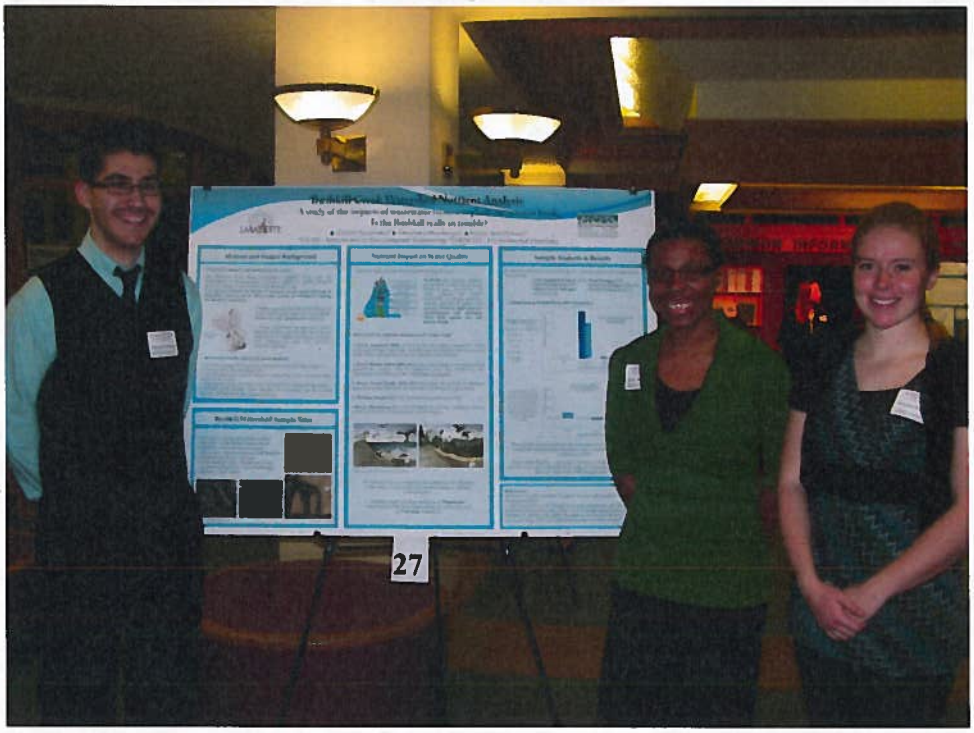
Gabriel Hernandez, Alexandra Hunsberger, Stacey-Ann Pearson

The primary purpose of this project is to compare the levels of nutrients in the Bushkill Creek Watershed to the state regulated limits for a healthy body of water. As we delved into the project subsequent objectives were developed: observe, predict and document how nutrients levels affect water quality in the Bushkill watershed; and formulate a plan defining how the community can work with government agencies to remediate this environmental problem.

In order to understand the depth of this issue, we must discuss the impacts of nutrients on water quality. Nutrients are essential to life and growth; however, high concentrations of certain nutrients in a stream (nitrogen and phosphorus) can have significantly negative impacts on human and aquatic life.

We found that several points of the Bushkill Creek have very high levels (higher than regulations allow) of Nitrate-Nitrite and fecal coliform. Excess Nitrate-Nitrite leads to eutrophication (an unsustainable stimulation of plant growth, which results in the death of stream). Also, if Nitrate-Nitrite infiltrates the groundwater supply it will be fatal to toddlers younger than six months. High Levels of fecal coliform provide a warning that there are possible disease carrying pathogens floating around in the water. The Department of Environmental Protection has accounted for these effects and has restricted several miles of the Bushkill Creek to impaired status – no swimming, no fishing, no entering the stream.

There are several factors affecting the nutrient levels in the Bushkill Creek: fertilizer runoff from residential properties, ruptured septic tanks along the bank of the creek and non-buffered (storm runoff drains straight into creek) farms. In order to begin the process of correcting this problem, students, scientists and conservancy groups need to work in tandem to educate the public about the effects of their everyday actions, and recruit residents' resources to protect a critical part of the community life – the Bushkill Creek.



Bushkill Creek Watershed Nutrient Analysis

A comparative study of the historical impacts of wastewater treatment plants on nutrient levels.

▪ Gabriel Hernandez ▪ Alexandra Hunsberger ▪ Stacey-Ann Pearson

LAFAYETTE

DRBC Delaware River Basin Commission — DELAWARE · NEW JERSEY · PENNSYLVANIA · NEW YORK · UNITED STATES OF AMERICA

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Abstract and Project Background

The Delaware River Basin Commission (DRBC) charged Nazareth Borough Municipal Wastewater Authority (NBMA) with gathering in-stream water quality data to help refine the Lower Delaware River–Water Quality Management (LDR-WQM) program. Our project will contrast the levels of nutrients in the water, from five years ago compared to the present; and how these nutrient levels affect water quality in tributaries feeding the Bushkill watershed.

Delaware River Basin

The Delaware River Basin has reported that there are tributaries in the Bushkill Creek Watershed that are impaired due to wastewater and quarry discharges. Bushkill Creek Conservancy has periodically documented high levels of nitrates, sediments and conductivity and low diversity macroinvertebrate near Easton. In fact *"Bushkill Creek has the dubious distinction of having the worst water quality at its mouth of all lower Delaware tributaries."* DRBC.

In compliance with the LDR Management Plan municipalities releasing effluent into the Bushkill Creek – a tributary of Delaware River – had to implement external monitoring schedules in order to achieve Goal 1: Water Quality, which states *"Maintain existing water quality in the Delaware River and its tributaries from measurably degrading and improve it where practical."* Section IV, LDR Management Plan.

Bushkill Watershed Sample Sites

Water samples were collected in a manner consistent with DRBC sampling protocol. The samples are collected from various sites stemming from two main points: Schoeneck Creek and Bushkill Creek at Main Street. In order to accurately analyze effects of municipal effluent, we collected samples from the following locations:

Map of sample locations

- Schoeneck - bridge along Hollow Road
- Bushkill – above Uhler Bridge, Tatamy Road
- Bushkill – above Schoeneck mouth
- Schoeneck – above its confluence with Bushkill
- Bushkill-Schoeneck confluence
- Little Bushkill Creek – Stockertown D. Park
- Jacobsburg State Park – above footbridge
- Bushkill – at 4th Street

For accuracy and precision we collect two or four samples at each location. We also collect various samples for the Academy of Natural Sciences to perform nutrient analyses concurrently.

Nutrient Impact on Water Quality

For every body of water there is a basic ecological cycle:

- Aquatic plants, like algae, require nutrients and sunlight in order to grow and flourish.
- Algae is eaten by herbivorous sea creatures, like zooplankton.
- Herbivores are eaten by small aquatic animals, like crustaceans.
- The small fish are eaten by larger fish; then humans fish the waters or use it for recreation.

A healthy body of water upholds this ecological pyramid by having a proper balance of nutrients.

Nutrients are essential mineral compounds needed by all living things to grow and thrive. In water systems, the limited availability of certain nutrients reduces growth of plants and animals; however, high concentrations can adversely affect both aquatic life and human health.

The nutrients monitored in this project were Nitrogen and Phosphorus (in high concentrations, these nutrients are contaminants).

Nitrogen and Phosphorus are present in different forms in a water body: Ammonia (excessive ammonia leads to ionized water, which is toxic to fish); Nitrate (easily transferred to groundwater supply); & Phosphates (the only significant forms of dissolved phosphorus).

Effects:

Excess nutrients in treatment-plant effluent causes toxicity in water and removes the oxygen from the water during chemical transformation. Contamination produces unsightly scums of algae on the water surface and occasionally result in fishkill.

Image courtesy of: LTB – Hamilton Lakes Program

Human activities in a watershed add sediments and nutrients to the water, which results in accelerated aging or "cultural eutrophication"

Bodies of water are classified by the amount of nutrients or food present in it. Bushkill Creek watershed started as an **Oligotrophic** shed but it has been deteriorating, at a rapid pace, into an **Eutrophic** watershed.

Having a eutrophic status would mean the creek had high levels of nutrients and a high population of algae and aquatic animals. This is not optimal because algae is an eyesore and emits an offensive odor, impeding tourism and recreation; and over population of plants greatly decreases fish population.

Sample Analysis & Results

In order to analyze the nutrient levels at various locations, all samples were analyzed for:

- **Total Suspended Solids (TSS)**
- **Total Phosphorous (TP)**
- **Nitrite-Nitrate Nitrogen (NO2-NO3-N)**
- **Total Nitrogen (TN)**
- **Ammonia Nitrogen (NH3-N)**
- **Dissolved Oxygen (D.O.)**

Comparison of Results:

	pH	TKN (ug/L)	Total Nitrogen (ug/L)	Nitrite-Nitrate Nitrogen (ug/L)	Ammonia-Nitrogen (ug/L)	Total Phosphorus (ug/L)
Confluence	5.60	19.2	2022	2233	80.2	9
Tatamy Rd	6.70	14.6	1496	1481	48	14.2

The results above represent nutrient concentrations in Dresser Lake. This lake is comparable to the tributaries of the Bushkill Creek watershed with respect to nutrient levels.

National standard for water quality is: Ammonia<0.1 mg/L; Nitrate<0.6 mg/L; Total Phosphorus<0.1 mg/L.

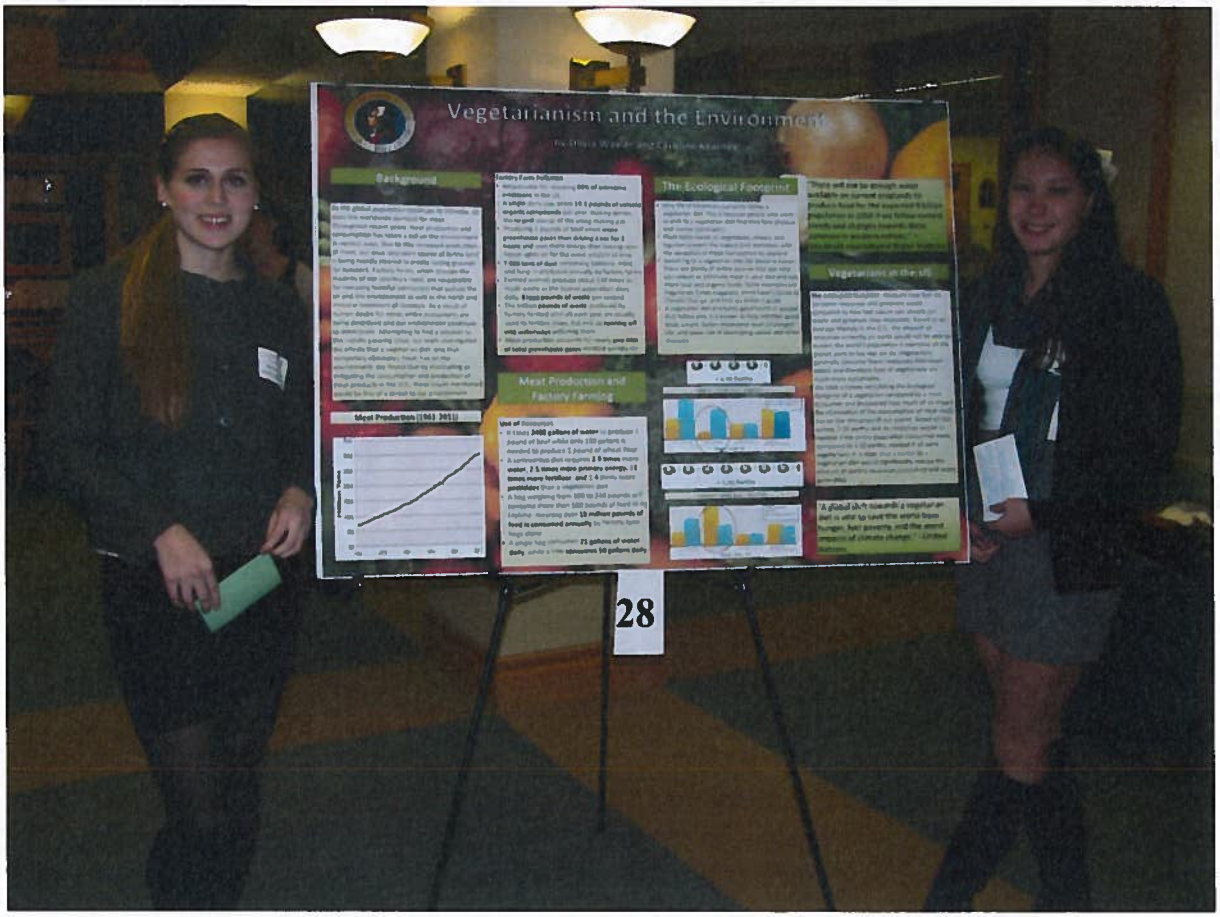
References:
- Browne, F.X. (2011, October). Dresser Lake and Lake Carobeth Watershed Management Plan.
- Lake Classification. Lake George is a young, oligotrophic lake. Retrieved from Lake George Association http://www.lakegeorgeassociation.org
- Mueller, D., Helsel, D.R. (2009). Nutrients in the Nation's Waters – Too Much of a Good Thing. *USGS-National Water Quality Assessment Program.*

Poster #28

"Vegetarianism and the Environment"

Olivia Waxler, Caroline Kearney

For this poster project presentation, we decided to investigate the effects that a vegetarian diet has on the environment. We researched the many side effects that meat production and consumption have on the environment, such as, the depletion of once abundant resources, the pollution of air and water, as well as the cruel treatment to animals. With the production of meat, we are losing more than we are gaining. As the global population continues to increase, so does the worldwide demand for meat. Throughout recent years, meat production and consumption has taken a toll on the environment in various ways. Due to this increased production of meat, our once abundant source of fertile land is being rapidly cleared to create raising grounds for livestock. Factory farms, which provide the majority of our country's meat, are responsible for releasing harmful admissions that pollute the air and the environment as well as the harsh and immoral treatment of livestock. As a result of human desire for meat, entire ecosystems are being destroyed and our environment continues to deteriorate. Attempting to find a solution to this rapidly growing issue, our team investigated the effects that a vegetarian diet, one that completely eliminates meat, has on the environment. Our group also focused on the ecological footprints that each diet, vegetarian and carnivorous, leave behind, and compared their impacts on the environment. We concluded that a vegetarian diet leaves behind a significantly smaller footprint and therefore reduces the amount of greenhouse gases that are released into the atmosphere. We found that by eliminating or mitigating the consumption and production of meat products in the U.S., these issues mentioned would be less of a threat to our environment.



Vegetarianism and the Environment

By Olivia Waxler and Caroline Kearney

"There will not be enough water available on current croplands to produce food for the expected 9 billion population in 2050 if we follow current trends and changes towards diets common in western nations." –Stockhold International Water Institute

Background

As the global population continues to increase, so does the worldwide demand for meat. Throughout recent years, meat production and consumption has taken a toll on the environment in various ways. Due to this increased production of meat, our once abundant source of fertile land is being rapidly cleared to create raising grounds for livestock. Factory farms, which provide the majority of our country's meat, are responsible for releasing harmful admissions that pollute the air and the environment as well as the harsh and immoral treatment of livestock. As a result of human desire for meat, entire ecosystems are being destroyed and our environment continues to deteriorate. Attempting to find a solution to this rapidly growing issue, our team investigated the effects that a vegetarian diet, one that completely eliminates meat, has on the environment. We found that by eliminating or mitigating the consumption and production of meat products in the U.S., these issues mentioned would be less of a threat to our environment.

Vegetarians in the US

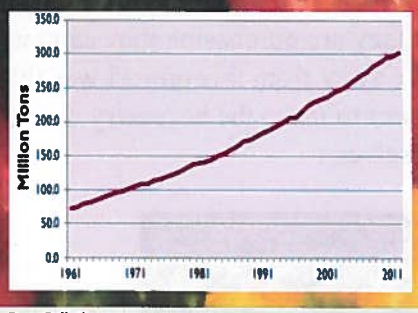
- Only 3% of Americans currently follow a vegetarian diet. This is because people who want to shift to a vegetarian diet find they face physical and mental constraints.
- Plant foods based on vegetables, cereals, and legumes present the lowest GHG emissions with the exception of those transported by airplane
- Switching to a vegetarian diet has become easier: there are plenty of online sources that can help you reduce or eliminate meat in your diet and eat more local and organic foods. Some examples are Vegetarian Times magazine, Meat Eater's Guide to Climate Change, and Ecology Action's guide.
- A vegetarian diet promotes good health in people that follow one. It is known to help maintain good body weight, better cholesterol level, prolonged life, and lower risk of developing cancer and other diseases

Meat Production and Factory Farming

Use of Resources

- It takes **2400 gallons of water** to produce 1 pound of beef while only 180 gallons is needed to produce 1 pound of wheat flour
- A carnivorous diet requires **2.9 times more water, 2.5 times more primary energy, 13 times more fertilizer, and 1.4 times more pesticides** than a vegetarian diet
- A hog weighing from 100 to 240 pounds will consume more than 500 pounds of feed in its lifetime, meaning over **10 million pounds of feed is consumed annually** by factory farm hogs alone
- A single hog consumes **21 gallons of water daily**, while a cow **consumes 50 gallons daily**

Meat Production (1961-2011)



Factory Farm Pollution

- Responsible for releasing **80% of ammonia emissions** in the US
- A single dairy cow emits **19.3 pounds of volatile organic compounds** per year, making dairies the largest source of the smog-making gas
- Producing 2 pounds of beef emits **more greenhouse gases than driving a car for 3 hours** and uses more energy than leaving your house lights on for the same amount of time
- **7,000 tons of dust** containing bacteria, mold, and fungi is produced annually by factory farms
- Farmed animals produce about 130 times as much waste as the human population does daily, **87000 pounds of waste per second**
- The **trillion pounds of waste** produced by factory-farmed animals each year are usually used to fertilize crops, but end up **running-off into waterways** polluting them
- Meat production accounts for nearly **one-fifth of total greenhouse gases** emitted worldwide

"A global shift towards a vegetarian diet is vital to save the world from hunger, fuel poverty, and the worst impacts of climate change." –United Nations

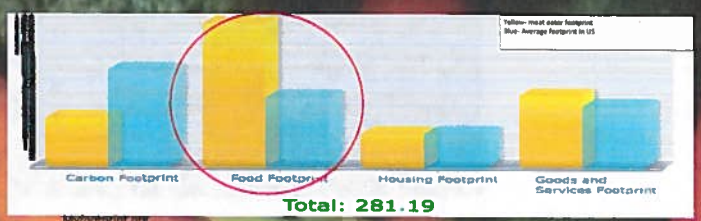
The Ecological Footprint

The ecological footprint- measure how fast we consume resources and generate waste, compared to how fast nature can absorb our waste and generate new resources. Based on an average lifestyle in the U.S., the amount of resources currently on earth would not be able to sustain the world's population if everyone on the planet were to live like we do. Vegetarians generally consume fewer resources than meat eaters and therefore lives of vegetarians are much more sustainable.

We took a survey calculating the ecological footprint of a vegetarian compared to a meat consumer and discovered how much of an impact the elimination of the consumption of meat really has on the resources of our planet. Based on this survey, 7.25 earths and its resources would be needed if the entire population consumed meat, compared to 4.10 earths, needed if all were vegetarians. It is clear that a switch to a vegetarian diet would significantly reduce the amount of earth's resources consumed and waste generated.

Footprint in Global Acres – Vegetarian

Footprint in Global Acres – Meat Eater



Myfootprint.org

Poster #29

"Factory Farming"

Daria Donato, Leah Salamone, and Bridgit Reeve

Our poster project focused on factory farming's negative relationship with human health, animal health, and environment health. We chose to investigate a topic that we felt the need to learn more about especially to improve our individual eating habits at college. This topic to us was factory farming because it plays a very large role in the food industry and in many areas, is the sole provider of meat for many families.

We began our presentation by defining factory farming with its universal, straightforward definition. As Bridgit carefully explained, she pointed out elements of the few pictures we displayed on our poster to help move her point across. Upon finishing, Daria then described the role factory farming plays in human health, and then followed with the role factory farming plays in animal health. Leah then spoke, focusing on factory farming's impact on the environment. This was followed by her conclusion of our presentation and at that point she opened up a period of time for the judges to ask their questions.

In many cases, the remainder of the poster discussion period with particular judges revolved around the discussion or replies from their previously asked questions. If this was not the case, Bridgit moved forward to talk about laws and policies regarding factory farming. Leah and Daria closed the presentation with sharing ideas about how to overcome this problem in communities and why it is such an ongoing struggle in the food industry.

Overall, the presentation ran smoothly and was an excellent opportunity for us to share our knowledge and opinions about a truly detrimental problem. Certain members of our audience did not realize the extent of the animal mistreatment on factory farms or that the government is in fact making small steps to solve this problem. As a group we came to the conclusion that it is time for us to continue to spread awareness about this problem, because if people understand what they are purchasing they can make even the littlest effort to fix it in their own homes. Our biggest take away from this project was that if we educate our communities with the truth about their food, we can start to make the necessary changes that will provide a healthier life for animals, the environment, and ourselves.

Factory Farming: Environmental Health Impacts and Policies

By Daria Donato, Leah Salamone, and Bridgit Reeve
FYS 185: The Foods We Choose and EVST 100: Introduction to the Environment

I. Introduction

Factory Farms
- "a large-scale farming enterprise that raises livestock, poultry, and fish in small areas and uses hormones, antibiotics, and processed feed." (Pampel, 2006)

History
- Emerged during the industrial revolution in the early 1900s.
- Resulted because business and society shifter away from agriculture and toward industrialization.
- Adding hormones, antibiotics, and vitamins A and C to animal feed helps animals grow more quickly, people capitalized on this.
- Farmers quickly realized that with the new feed, animals no longer needed to graze and could be packed close together in factories to be raised for slaughter.

Overcrowding facilities cause diseases in animals.

II. Effects on People and Animals

- Because animals are housed in small areas in multitudes such as battery cages and gestation crates, they contaminate each other.
- Animals are beaten unnecessarily.
- Also are force fed antibiotics and live in restricted, polluted areas.
- Animals are fed anything from cattle blood to restaurant waste in order to keep them alive until an eventual slaughter.
- Contamination in factory farms can cause illnesses in humans (PETA)
- Ex: birth defects, miscarriage, depression, brain damage, antibiotic-resistant bacterial infections, severe respiratory problems (PETA)
- Runoff exposes people in rural communities to heavy metals and bacteria like E coli (Sustainable Table)
- Factory farms emit deadly gasses like hydrogen sulfide, methane, ammonia, and carbon dioxide, which are fatal to humans in high levels (Sustainable Table)

III. Effects on the Environment

- Unmanageable amounts of waste are created by the animals.
- On a farm containing 35,000 hogs, over four million pounds of waste are produced each week, and over 200 million pounds each year.
- The creation and disposal of such enormous quantities of waste has a devastating effect on the air, water and soil surrounding factory farms.
- Soil fertility can be damaged by heavy metals like zinc, copper, chromium, arsenic, cadmium and lead that are found in livestock excretions.
- Harmful gases are emitted, like methane and hydrogen sulfide, which contribute to global warming and harm the heath of close communities.
- Runoff from factory farms kills fish, degrades aquatic habitats and threatens drinking water supplies.
- Chemical fertilizers and pesticides have turned agriculture into a leading source of water pollution in the US.

Aquatic pollution causes fish kills.

Unethical methods of slaughter.

IV. Factory Farm vs. Organic Farm

Animals enclosed in tight spaces; no fresh air or exercise; live in their waste

Limited number of animals enclosed in one space; healthy life

V. Laws and Policies

The 28 Hour Law
- enacted in 1873; amended in 1994
- states that when animals are in transit for slaughter, they must be let out every 28 hours for exercise, food, and water
- does not apply to birds

The Humane Methods of Slaughter Act
- originally passed in 1958
- states that animals must be stunned until they are unconscious before slaughter
- does not apply to birds, rabbits, or fish

The Utilization of Manure and Other Agricultural and Industrial Byproducts
- proposed in February 2009 by the USDA
- aims to protect the environment as well as human and animal health by using manure safely and effectively

Problems
- laws not strictly enforced
- birds, who are not included in most laws, make up more than half of all animals slaughtered for food

VI. Conclusion

Factory farms may produce cheap food, but they do so at the cost of human and animal health as well as environmental safety. Though traditional farming may not be productive in the modern, industrial world, factory farming could be transformed into a safer business. If the current laws were better enforced, animal health could improve, which would also ensure better food safety for humans.

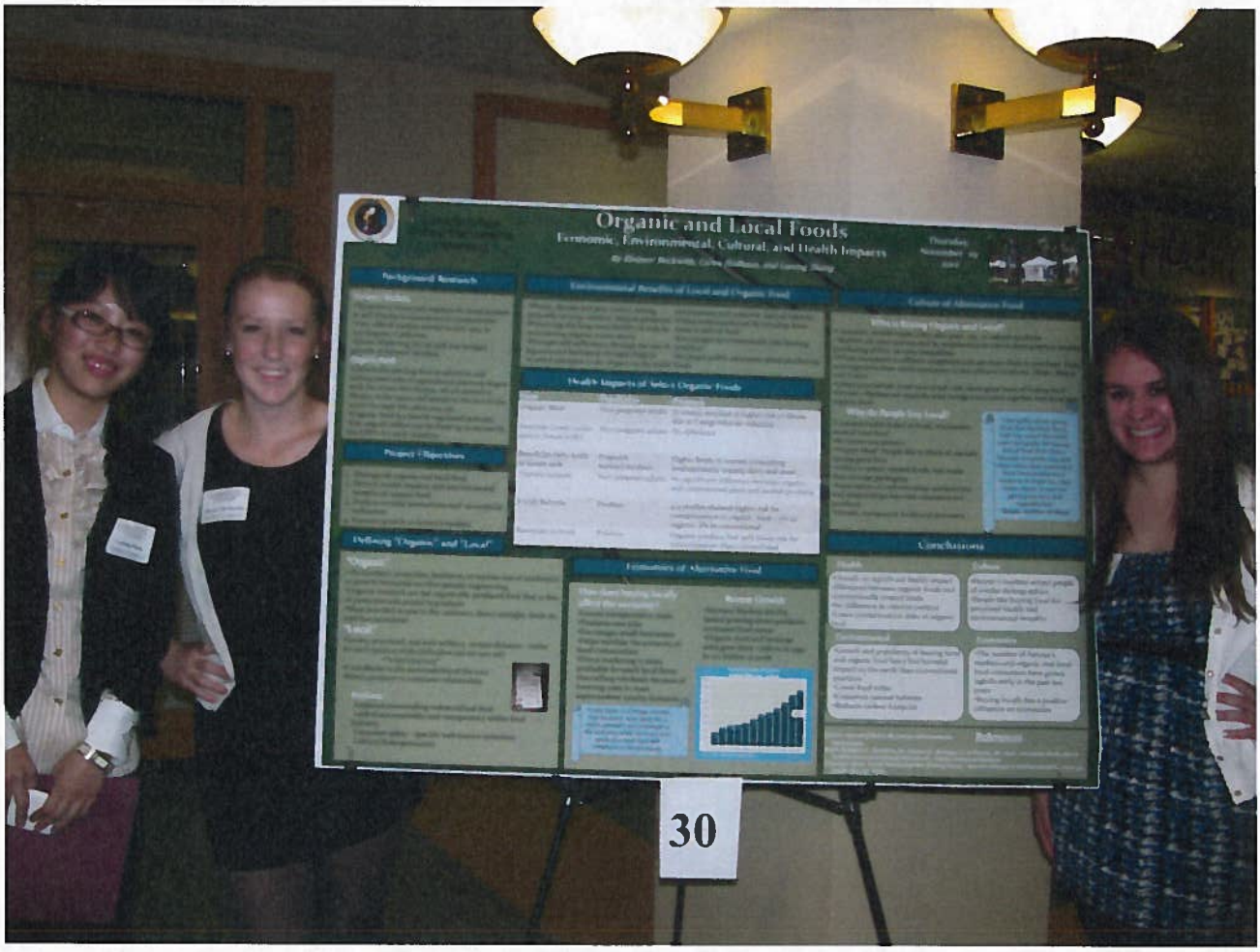
FALL 2012 LAFAYETTE COLLEGE

Poster #30

"Organic and Local Foods"

Eleanor Beckwith, Caren Hoffman, Luning Zhang

Our topic is mainly about the environmental, health, economic, and cultural impacts of organic and local food. We started our research with the background and history of farmers' market and organic food, and define the terms of local and organic food. Then we explore the environmental benefits of organic and local food through literature review and analysis, and get the conclusion that buying local and organic food has less harmful impact on the earth than conventional practice because of the protection of soil and natural habitats and energy-saving. Secondly, we compare the health impacts of organic and conventional food in the table form, and surprisingly find out that there is no significant difference between the two. Then we examine this topic through economic and cultural standpoints, indicating the mass increase on the popularity of buying locally statistically in graph, and the increase benefits the local economy by lowering transportation cost and producing new jobs. Finally, we discuss the major population of the local food's consumers and people prefer buying local and organic food due to psychological and environmental reasons. We also connect local food with Lafayette College and we get information directly from Sedexo.



Lafayette College
Civil and Environmental Engineering

Organic and Local Foods

Economic, Environmental, Cultural, and Health Impacts

By Eleanor Beckwith, Caren Hoffman, and Luning Zhang

Thursday, November 29 2012

Background Research

Farmers' Markets

- Temporary (seasonal) markets for local farmers to sell directly to consumers in communities
- First official market started in July 1934 in Los Angeles, California
- Direct Marketing Act of 1976 encouraged growth of farmers' markets

Organic Food

- Genetically altering food production and adding pesticides to agricultural practices began with the Green Revolution, which started in Mexico in the 1940s and spread to the rest of the world through the 1960s and 70s.
- Organic food is a heavily regulated industry, false organic sellers can be fined up to $11,000 by the USDA for each violation

Project Objectives

1. Distinguish organic and local food
2. Identify health impacts and environmental benefits of organic food
3. Analyze societal interactions and economical influences
4. Examine growth in farmer's markets

Defining "Organic" and "Local"

"Organic"

- No synthetic pesticides, fertilizers, or routine use of antibiotics or growth hormones or other genetic engineering
- Organic livestock are fed organically produced feed that is free of pesticides and animal byproducts
- Meat provided access to the outdoors, direct sunlight, fresh air, and free movement

"Local"

- Grown, processed, and sold within a certain distance – varies for each opinion of the definition (40 mi-200 mi)
  - "A day's journey"
- Contributes to the sustainability of the area
- Direct producer to consumer relationship

Problems

- Suspicion surrounding industrialized food
- Lack of accountability and transparency within food industry
- Consumer safety – specific well-known violations
- Cultural homogenization

Environmental Benefits of Local and Organic Food

- Weeds, disease and pest control relying primarily on crop rotation, natural predators
- Protecting the long-term fertility of soils by maintaining organic matter levels
- Nitrogen self-sufficiency through the use of legumes and biological nitrogen fixation
- Careful attention to the impact on the wider environment and conserve natural habitats
- Helps reduce pollution by traveling fewer miles to deliver food
- Encourages environmentally safe farming practices
- Increases public awareness about purchasing foods

Health Impacts of Select Organic Foods

Issue	Population	Presence
Organic Meat	Non-pregnant adults	In winter, resulted in higher risk of illness due to Campylobacter infection
Pesticide Levels (urine, serum, breast milk)	Non-pregnant adults	No difference
Beneficial Fatty Acids in breast milk	Pregnant women/mothers	Higher levels in women consuming predominantly organic dairy and meat
Vitamin content	Non-pregnant adults	No significant difference between organic and conventional plant and animal products
E-Coli Bacteria	Produce	4/5 studies showed higher risk for contamination in organic food – 7% in organic, 6% in conventional
Pesticides in Food	Produce	Organic produce had 30% lower risk for contamination than conventional

Economics of Alternative Food

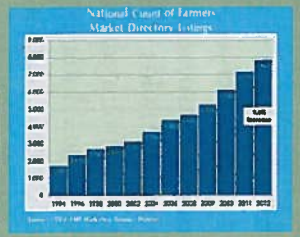
How does buying locally affect the economy?

- Lowers transportation costs
- Produces new jobs
- Encourages small businesses
- Helps stabilize the economy of local communities
- Direct marketing is more profitable for small local firms than selling wholesale because of lowering costs to meet supermarkets' quality demands.

A case study in Chicago showed that for every $100 spent on a chain company, $43 remained in the economy, while for every $100 spent on a local food $68 remained in the economy.

Recent Growth

- Farmers' Markets are the fastest growing direct producer-consumer food venue
- Organic food and beverage sales grew from 1 billion in 1990 to 21.1 billion in 2008



Culture of Alternative Food

Who is Buying Organic and Local?

- Caucasian, middle-upper class, educated, city or suburb residents
- Markets are often surrounded by neighborhoods whose demographics present purchasing ability; income inequalities
- White consumers in affluent neighborhoods are more likely to purchase fruits and vegetables than white consumers in less affluent locations. (Blake, Mellor, and Crane).
- Urban populations more concerned with ideological basis of buying local
- Farmer's Markets are typically what brings consumers together over local and organic food.

Why do People buy Local?

- Unquestionable belief in fresh, wholesome, state of local food
- No hormones present,
- "Happy Meat" People like to think of animals having good lives
- Ability to select needed foods; less waste than in large packaging
- Expectation of craftsmanship, authenticity and relationships between consumer and producer
- Honest, transparent foods and processes

"I feel guilty about eating food that has been flown half way round the world and I feel guilty for buying lots of food from Tesco, because it's quick, easy and close rather than sourcing it from local producers or whatever it might be, I feel better about it now I'm getting my fruit and vegetable box"
-Sarah, mother of three

Conclusions

Health

- Overall, no significant health impact differences between organic foods and conventionally treated foods
- No difference in vitamin content
- Lower contamination risks in organic food

Culture

- Farmer's markets attract people of similar demographics
- People like buying local for perceived health and environmental benefits

Environmental

- Growth and popularity of buying local and organic food has a less harmful impact on the earth than conventional practices
- Lower food miles
- Conserves natural habitats
- Reduces carbon footprint

Economics

- The number of Farmer's markets and organic and local food consumers have grown significantly in the past ten years
- Buying locally has a positive influence on economies

References

Farmer. *Journal of Park & Recreation Administration*. Environment.
Smith-Spangler, C., Brandeau, M., Hunter, G., Bavinger, C., & Pearson, M. (2012). Are organic foods safer or healthier than conventional alternatives? . Annals of Internal Medicine.
Getachew, Abate. "Local Food Economies: Driving Forces.." *Journal of Hunger & Environmental Nutrition* 3.4 (2008): 384-396. Print.

Poster #31

"Endocrine Disrupting Compounds"

Julia Harris, Tommy St. Vincent, Mike Makino

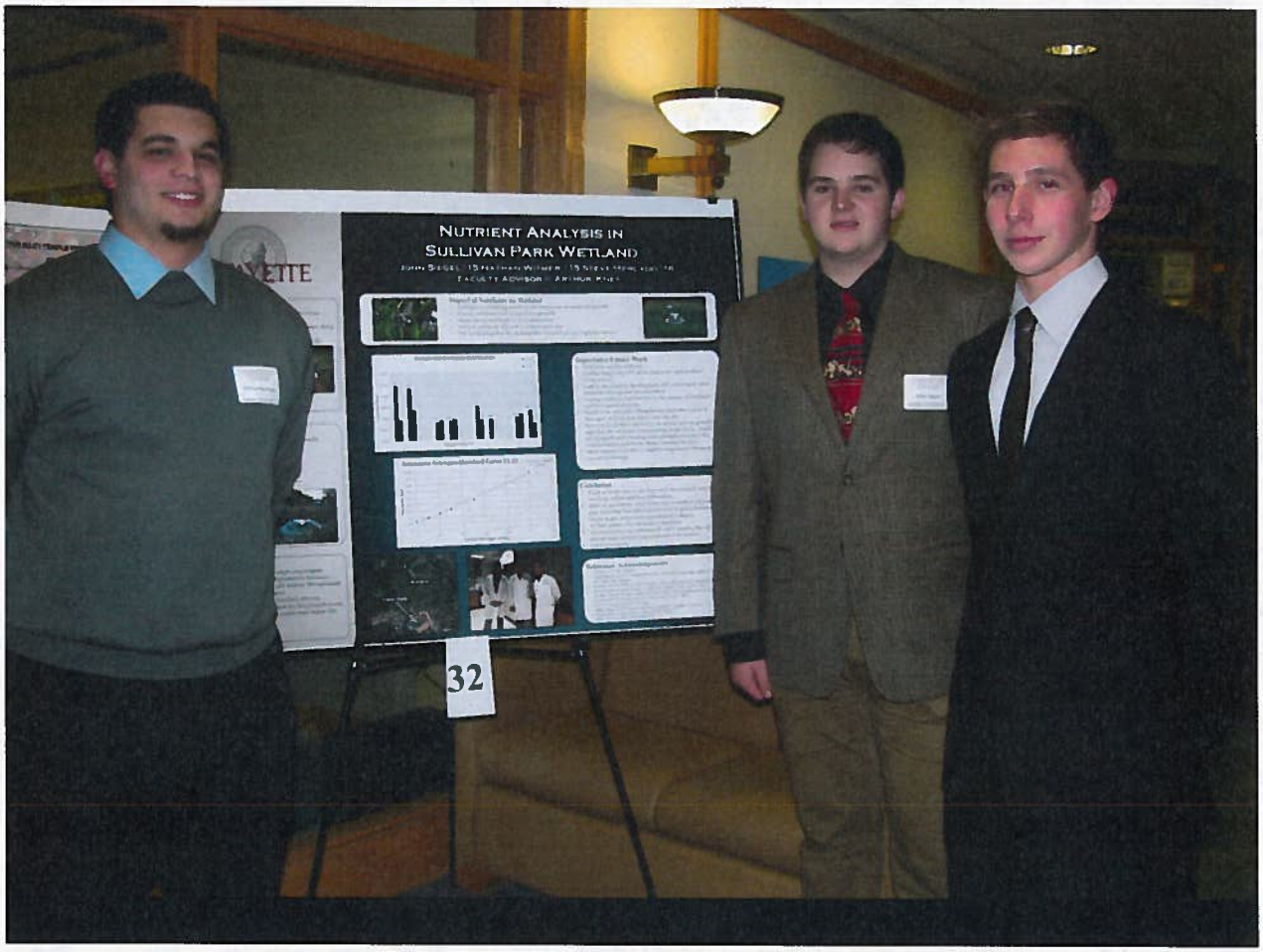
Endocrine disruptors are chemicals that interfere with the endocrine system, which controls the body's metabolic activity. Endocrine disruptors are molecules that mimic hormones in the body, such as estrogen. Chemicals can disrupt the endocrine system by binding to receptors involved in the pathways and causing disruptions in proper function. Endocrine disruptors can cause cancer, learning disabilities, and/or neurological effects. Some examples of endocrine disrupting compounds are BPA, PCB, and DDT. Bisphenol A (BPA) is used in the manufacture of epoxy resins, which are used in sealing metal food cans, and plastics, as a hardening agent. Humans are exposed to BPA through its absorption into the foods they eat and from plastics. In July 2012, the US banned the use of BPA in all plastic baby products, and water bottles can also be found to be BPA free. The FDA and CDC have released statements that levels humans are exposed to are not harmful. Polychlorinated Biphenyls (PCB) are compounds used in various electrical devices. They're now banned in most countries but can still be found in older devices. Simple contact with the skin is enough for PCBs to cause damage, and they can be leaked from old electronics when damaged or improperly disposed of. These chemicals also bioaccumulate in wildlife, such as fish, and so most human exposure today occurs in the diet. Dichloro-diphenyl-trichloroethane (DDT) is an organochlorine insecticide used to combat insect transmitted diseases, especially malaria. Between 1940 and 1970, DDT was used and sprayed everywhere, even on the battlefields in World War II. DDT was eventually banned in 1973 because of its negative impacts on the environment due to its long half-life and detrimental health effects. Endocrine disrupting compounds are found throughout nature and their effects should be monitored and removed or replaced from aspects of our everyday lives.

Poster #32

"Nutrients in Sullivan Park"

Nathan Witmer, John Siegel, Steve Mercado

For our poster project we assisted Hassaan Khan in his senior thesis based on nutrient analysis in the Sullivan Park Wetland. Sullivan Park Wetland, also referred to as the Brandes Wetland, is located on Hamilton Street, not far from Lafayette College campus. The wetland was created by Lafayette students of varying class years with the guidance of Professor David Brandes. A healthy wetland immensely improves the overall quality of a watershed due to its ability to purify water. Significant algae growth was observed in the wetland but the cause was unknown. Since the wetland was a relatively new creation no in depth testing of nutrient levels had been previously done. Algae growth can generally be associated with the presence of excess limiting nutrients. The two key limiting nutrients for plants are Nitrogen and Phosphorus; we tested for a type of Nitrogen called Ammonia Nitrogen. A major part of our project was conducting lab work and we learned to create different chemical compound and to compare standards and samples by analysis with a photo-spectrometer. Over 25 hours were spent in the lab learning and mastering these procedures. We found and concluded that the wetland indeed decreased the amount of nutrient concentrations of the inflowing water. Our trend-lines have shown a significant decrease in concentrations and our wetland functions and performs as a natural wetland does. Through the studies we hope that communities will recognize the importance of wetlands and take action to create more and preserve current ones that thrive among our environment today. Future testing will ideally be done on other limiting nutrients, nutrients in the soil, and through periodic health checks.



Nutrient Analysis in Sullivan Park Wetland

John Siegel '15 Nathan Witmer '15 Steve Mercado '16
Faculty Advisor – Arthur Kney

Purpose/Background

- Assisted Hassaan Khan with Senior Thesis on Nutrient Analysis.
- Wetland constructed by students from various classes along with Professor Brandes.
- Located on Hamilton Street in the Bushkill Watershed.
- Significant algae growth observed but no studies had been recorded.
- Growth due to excess Limiting Nutrient(s).
- Tested for Ammonia Nitrogen.
- Man-made wetlands need to be continually monitored.
- Building wetlands improves a watershed's health.

Watershed/Wetland Importance

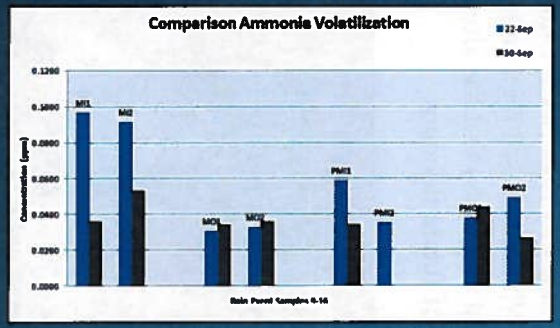
- Wetland: An area of land permanently or seasonally saturated by water.
- Flood/Silt/Runoff/Erosion control
- Plethora of Wildlife
- Important to Ground water
- Water Purification
- Reduces concentration of limiting nutrients

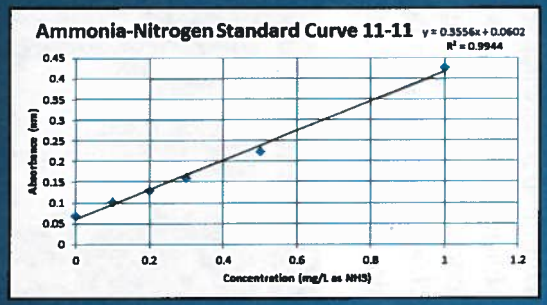
Analysis/Process

- Learned to create compounds (complexing reagent, Alkaline Phenol Solution, and Hypochlorite Solution)
- Prepare solution with each and add Sodium Nitroprusside
- Analyzed with Photo-spectrometer
- Compared values of samples to Standard solution
- *Minimum detectable concentration for this procedure was 0.1 ppm (mg/L) and most of our results were below this benchmark.*
- Over 25 hours of lab work

Impact of Nutrients on Wetland

- Nitrogen is a limiting nutrient; our focus was on ammonia growth
- Excess nutrients lead to rapid overgrowth
- Algae occurs and leads to Eutrophication
- Natural wetlands efficiently remove particles
- We are hoping that by creating this wetland we can replicate nature





Importance/Future Work

- First tests on this wetland.
- Conducting study for Easton, Lafayette, and wetland constructors.
- Lead to the possible development and restoring of other wetlands throughout the watershed.
- Testing needs to continue due to the nature of wetlands and their seasonal cycles.
- Needs to be tested for Phosphorous and other types of Nitrogen; and not just water, also the soil.
- Nutrient levels have shifted up as winter arrives, possibly a sign that the wetland is functioning properly (ie- plants are dying off and releasing more phosphorous into the wetland and nutrients are being retained on site)
- More testing is needed to support hypothesis (Hassaan currently testing)

Conclusion

- Point of study was to see how well the wetland was/is working; inflow/outflow differences.
- Most of our results were below our procedure limit of 0.1 ppm meaning that only inferences as to general amounts can be made, accuracy is uncertain to a degree
- As time passes, the Ammonia volatilizes.
- All results were an indicator of water quality, like all similar tests, no data is guaranteed to be perfect.
- Lab Experiences

References/ Acknowledgements

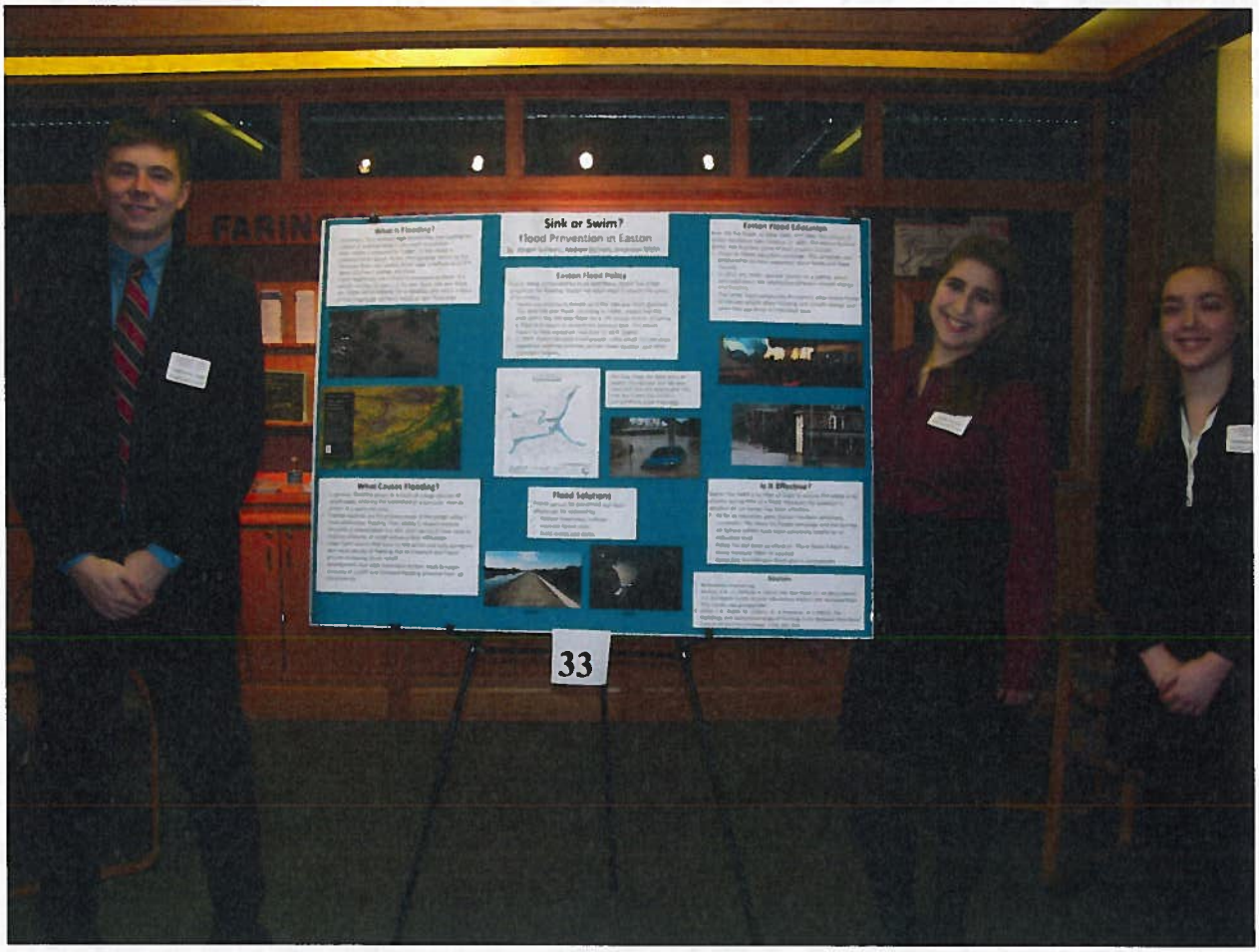
- Lafayette CE Lab Manual
- Acknowledgement to Hassaan Khan for information regarding Sullivan Wetland and collecting samples
- Brandes, David. "Sullivan Park Project." *http://sites.lafayette.edu/brandesd/courses/sullivan-park-project/*. Lafayette College, Web. 19 Nov. 2012.
- Bressler, David W., and Michael J. Paul. "Effects of Eutrophication on Wetland Ecosystems." *Tetratech-ffx.com*. Tetra Tech, 19 Nov. 2012. <http://n-steps.tetratech-ffx.com>.
- Miller, Brian K. "Wetlands and Water Quality." *Purdue University*. U.S. Department of Agriculture, Web. 19 Nov. 2012. <http://www.extension.purdue.edu>.

Poster #33

"Flood Prevention in Easton"

Abigail Schwarz, Andrew Burnett, Jenavieve Smith

Our poster analyzed flooding in the city of Easton and the steps Easton has taken in response to this flooding. Our poster first discusses what flooding is and how flooding is defined. We explain what a year flood is, and what stage is with respect to river height. Additionally, we discuss which weather systems usually cause flooding in Easton. We then discuss possible methods of flood prevention, such as the use of dams and levees. Our research concluded that these and other flood prevention techniques are not feasible for Easton to implement, so we moved on to an analysis of how Easton has reacted to lessen damage during flooding. One of the major changes in regulation that Easton has adopted is expanding its recognition of flood prone areas from the 100 year flood plain to the 500 year flood plain. This has led to increased regulation of development in these areas, while also providing those who live and work in those areas greater opportunity for assistance in the wake of a severe flood. Easton has also made significant strides in terms of flood education, primarily with the opening of the Nature Nurture Center in 2007. The center has been responsible for launching the Focus on Floods campaign, a website aimed at educating residents on flood risk, when to evacuate, and how to protect their life and property. Our poster concludes that Easton's location puts it at a very high risk for flooding, and there is no feasible way to prevent this flooding from occurring. While increased regulation will be helpful in further limiting flood related loss, the increase in flood awareness that has already been implemented will be a major factor in lessening the negative effects of future flooding.

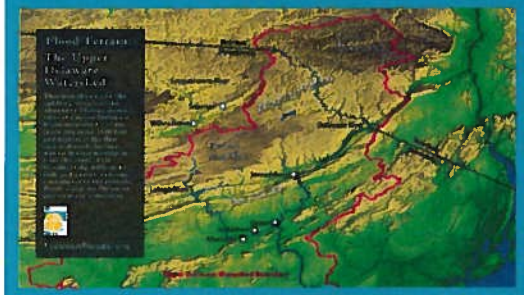


Sink or Swim?
Flood Prevention in Easton

By: Abigail Schwarz, Andrew Burnett, Jenavieve Smith

What is Flooding?

- The flooding is "any relatively high stream flow overtopping the natural or artificial banks in any reach of a stream."
- River height is measured as "stage", or feet above a predetermined datum. At the USGS gauging station on the Delaware River near Easton, flood stage is defined at 22.0 ft above the river's average low point.
- Flood magnitudes are commonly measured as floods of a specific number of years, i.e. 50 year flood, 100 year flood, etc. These names indicate the probability with which a flood of that magnitude will occur based on past flood data..



What Causes Flooding?

- In general, flooding occurs as a result of a large volume of runoff water entering the watershed of a particular river or stream at a particular time.
- Tropical cyclones are the primary cause of the Lehigh valley's most destructive flooding. Their ability to deposit massive amounts of precipitation in a very short period of time leads to massive amounts of runoff and very little infiltration.
- Large storm events that occur in late winter and early spring are also major causes of flooding due to snowmelt and frozen ground increasing storm runoff.
- Development that adds impervious surface leads to larger amounts of runoff and increased flooding potential from all storm events.

Easton Flood Policy

Due to being surrounded by three waterways, Easton has a high propensity for flooding. Easton has taken steps to ensure the safety of its citizens.

- Easton has voluntarrily moved up to the 500-year flood standard. The term 500 year-flood, according to FEMA, means that the area within the 500-year flood has a .2% annual chance of having a flood that equals or exceeds the previous year. This allows Easton to have regulation over land 15-30 ft. higher.
- In 2007, Easton adopted Smart growth codes which inclludes slope regulation, planting schemes, cellular tower location, and other important hazards,

This map shows the flood plains of Easton. The 100-year and 500-year flood zone lines are demarcated. This map also shows how Easton is surrounded by three waterways.

Flood Solutions

Floods cannot be prevented, but their effects can be reduced.

- Reduce impervious surfaces
- Increase forest cover
- Build levees and dams

Levee

Dam

Easton Flood Education

After the big floods of 2004, 2005, and 2006, the citizens of Easton decided to take initiative. In 2007, the Nature Nurture Center was founded. Some of their projects include:

- Focus on Floods education campaign. This campaign was produced to increase awareness about floods and flood hazards..
- In 2010, the center opened Science on a Sphere, wich educated about the relationshpi between climate change and flooding.
- The center hosts community discussions after severe floods to educate people about flooding and climate change and what they can do.

Is it Effective?

Easton has taken a number of steps to ensure the safety of its citizens during time of a flood; however, the question is whether or not Easton has been effective.

- As far as education goes, Easton has been extremely successful. The Focus on Floods campaign and the Science on Sphere exhibit have been extremely helpful.
- Policy has not been as effective. There hasn't been as many measure taken as needed
- Some feel the 500-year flood is unecessary

Sources

1. Nurturenaturecenter.org
2. Holmes, R.R., Jr., Dinicola, K. (2010) 100-Year flood–it's all about chance: *U.S. Geological Survey Generol Information Product 106*. Retrieved from http://pubs.usgs.gov/gip/106/
3. Smith, J. A., Baeck, M., Villarini, G., & Krajewski, W. F. (2010). The Hydrology and Hydrometeorology of Flooding in the Delaware River Basin. *Journal Of Hydrometeorology*, *11*(4), 841-859. Retrieved from http://0-

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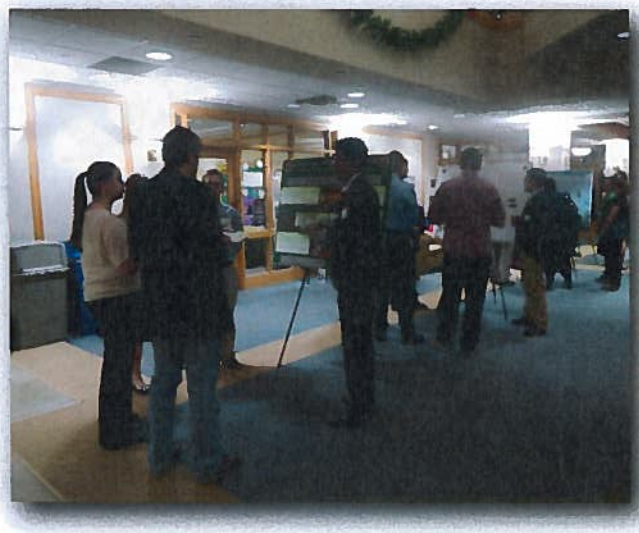
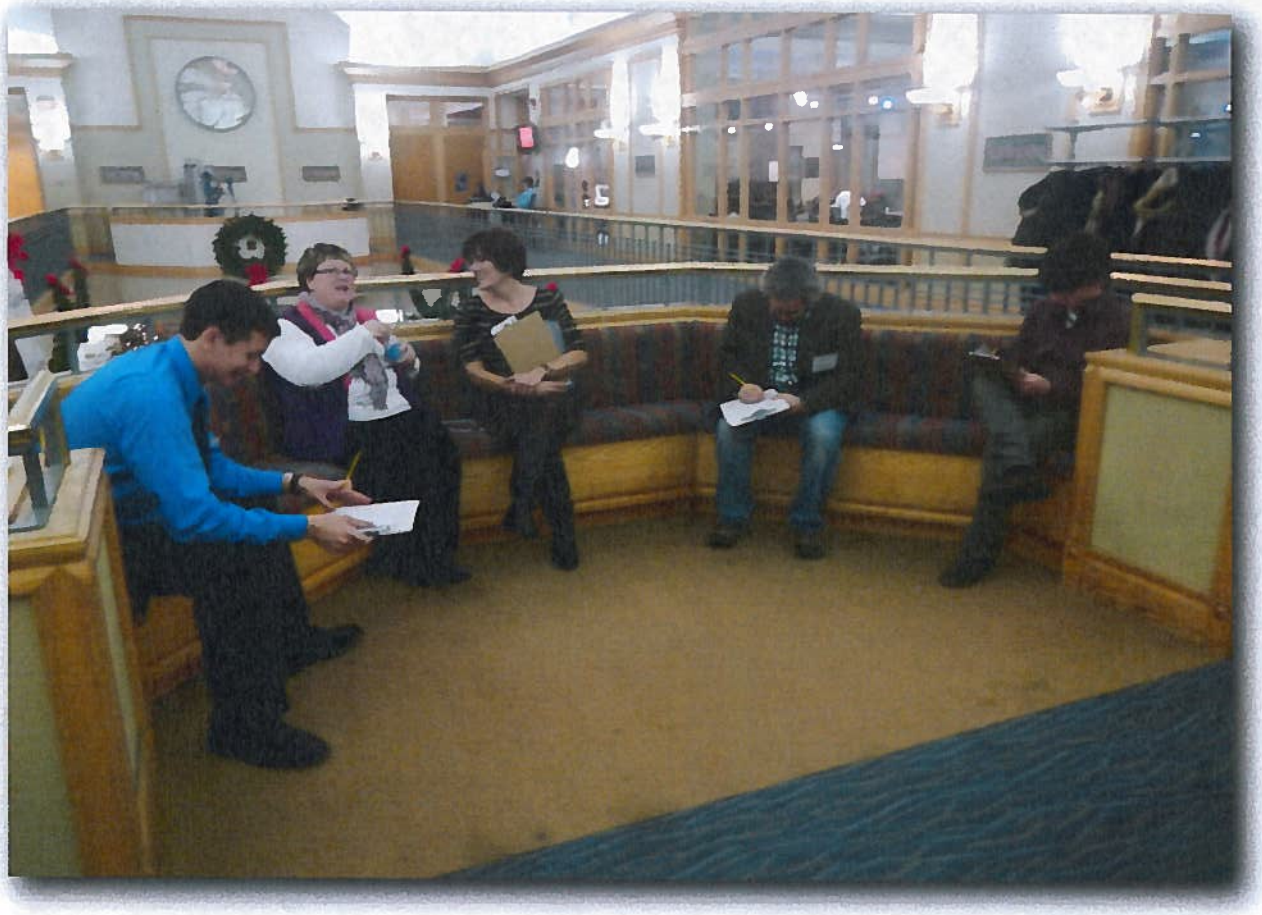
Photo Gallery





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