Lafayette College

Environmental Poster Presentation: Fall 2014

Biodiversity Loss: Causes, Consequences, & Choices
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The 2014 Environmental Poster Presentation was the culmination of a semester long assignment in which students researched topics related to biodiversity loss. Teams of two or three students from Dr. Waters’ Advanced Aquatic Ecology (BIOL 332), Dr. Kney’s Environmental Science and Engineering (CE 321), Dr. Tavakoli’s Alternative Energy Sources (CHE 370), Dr. Galloway’s Environmental Chemistry (Chem 252), Dr. DeVault’s Environmental Economics (ECON 202), and Dr. Hejny’s Introduction to the Environment (EVST 100) courses collaborated on topics that reflected this year’s theme: “Biodiversity Loss: Causes, Consequences, and Choices”. Reflecting the choice of Elizabeth Kolbert’s award-winning book *The Sixth Extinction*, the theme dovetails with Lafayette’s First Year Orientation 2018 Program. Orientation 2018 welcomes new students to the Lafayette College community, familiarizes them with our shared intellectual values, and establishes our rigorous academic expectations. *The Sixth Extinction* blends natural history and field reporting with intellectual conjecture into a powerful account of the mass extinction unfolding before our eyes. Choosing *The Sixth Extinction* also marked the 100-year anniversary of “Martha’s” death. Prominently pictured on this booklet, Martha was the last passenger pigeon who died at 1 p.m. on September 1, 1914. Collectively, this year’s theme, “Biodiversity Loss: Causes, Consequences, and Choices” made perfect sense.

Participants gained valuable knowledge through literature-based investigation as well as direct experimental research where feasible. At the outset, students assembled into teams, organized topics, delved into background information, designed investigations, defended draft versions, critiqued one another, self-assessed their efforts and ultimately crafted their final poster. The opportunity to present their findings in a public, adjudicated forum occurred on Thursday, December 4, 2014 at the Farinon Student Center. From 7:00 to 9:00 pm, 47 posters dominated the atrium and the Marlo room to showcase the efforts of more than 140 students judged by 87 professionals and community members. Each poster was subjected to extensive evaluation by multiple judges assessing criteria that included presentation, organization, professionalism, aesthetics, authoritative command of the subject matter and rigor. As in previous years, prizes were awarded to the five top-scoring posters. In addition, students enrolled in multiple participating courses assumed responsibility for the mechanics of hosting the conference, working with College staff to mobilize volunteers, design publicity materials, manage the session set-up and coordinate the array of judges. These student leaders deserve recognition for helping to pull off all of the details for this public event.

This event would not have been possible without our judges, who hailed not only from the Lehigh Valley, but from New York, New Jersey, Philadelphia, and Harrisburg. By participating, our judges raised expectations and enhanced the caliber of the Poster session, thereby strengthening the educational experience. Students were motivated to develop life-long independent and collaborative skills—in critical thinking, in multidisciplinary approaches, in professional conduct and in communication skills. Students and judges alike conveyed how much they learned from one another at the event. To our judges—thank you from the entire Leadership Team.

If you would like more information about the Environmental Poster Presentation or these courses, please contact Dr. Arthur Kney at kneya@lafayette.edu, or Jolene Cardassi at cardassj@lafayette.edu.
Ten Year Judge Service Awards

Award Recipients

Dr. Joe Colosi
Carmen Marinelli, Esq.
Dr. Dave Taschler
Dr. Dave Veshosky
Mr. George Xiques
Awards

1st Place
The Role of Wetland Characteristics in Shaping Plant Biodiversity: A Comparative Study of Wetlands at Merrill Creek Reservoir and Sullivan Park
Virginia Hoyt, Andrew Goldberg, and Julianna Vuotto

2nd Place
The Ecological and Economic Impacts of Invasive Myriophyllum spicatum in Merrill Creek Reservoir
Sarah Woodruff, Shannon Lenahan, and Brittany Flynn

3rd Place
The Florida Everglades: The Effect of Burmese Pythons on Biodiversity
Ingrid Yovo, Andras Doolittle, and Nicholas Gates

4th Place
Construction Erosion Control and its Effect on Biodiversity
Sarah Walko, Phillip Manna, and Julia Kripas

5th Place
Recycling and the Earth’s Oceans
Austin Bashline and Kieran Proper
Poster
Summaries
and
Pictures
The Ecological and Economic Impacts of Invasive *Myriophyllum spicatum* in Merrill Creek Reservoir

Sarah Woodruff, Shannon Lenahan, and Brittany Flynn

Aquatic macrophyte *Myriophyllum spicatum* has recently established an invasive population in Merrill Creek Reservoir (MCR), NJ. This invasive population has the potential to exert significant ecological and economic effects on MCR, as *Myriophyllum spicatum* is an extremely dense macrophyte. This characteristic causes interference with recreational activities, a high potential for invasive dispersal, and negative impacts on native populations.

Most significantly, the high density of *Myriophyllum spicatum* leads to increased plant sloughing, which increases decomposition and drops dissolved oxygen (DO) concentrations in the littoral zone. Decreased littoral DO can affect biodiversity and abundance of native macrophyte, macroinvertebrate, and fish populations. If left untreated, *Myriophyllum spicatum* could decimate the warm-water species of the “two-story fishery” that exists in MCR. Beyond ecological consequences, *Myriophyllum spicatum* has the potential to affect MCR economically by affecting donations and the fishery that MCR stocks annually.

Through in-person interviews with Merrill Creek staff and analysis of sediment and macrophyte data collected during BIOL 332 lab trips to MCR, our team has compiled a risk/management assessment of this *Myriophyllum spicatum* population. We will examine this problem from a biological standpoint by comparing organic matter content (OMC) of sediment taken from native macrophyte beds, *Myriophyllum spicatum* beds, and bare sediment at two locations within MCR, as well as OMC of native macrophytes and *Myriophyllum spicatum*. Higher OMC denotes more decomposition and lower DO in the surrounding water. From an economic standpoint, we will assess how much MCR is willing to spend on the invasion, whether eradication is necessary/feasible for this system, and what management strategies might be most effective.
The Ecological and Economic Impacts of Invasive *Myriophyllum spicatum* in Merrill Creek Reservoir

Shannon Lenahan (Bio 322), Sarah Woodruff (Bio 332) and Brittany Flynn (Econ 202)

**INTRODUCTION:**

*Myriophyllum spicatum*, commonly known as Eurasian watermilfoil, has recently established a population in Merrill Creek Reservoir (MCR). This invasive water-dwelling plant, or aquatic macrophyte, forms colonial beds through vegetative propagation. This macrophyte is very dense and mass plant-slopping can cause increased decomposition and decreased dissolved oxygen (DO). This is of major ecological concern because DO affects abundance and diversity of native macrophyte, macroinvertebrates, and fish populations.

**OBJECTIVES:**

1. Determine organic matter content of *M. spicatum* vs native macrophytes.
2. Use this to extrapolate relative macrophyte impact on [DO].
3. Determine possible economic and ecological impacts of this invasion in this system.
4. Determine if management is needed in this system and what management strategy would be most effective.

**SCIENTIFIC METHODS:**

- 3 samples (native macrophyte, invasive macrophyte, and bare sediment) taken at two sites (cove and dock).
- Secchi disk and macrophyte and plant material collected.
- Sediment and plant material collected.
- Sediment samples and plant samples dried and composted. Then organic content measured and analyzed.

**ECONOMIC THREATS:**

- Loss of revenue from recreational activities like boating, kayaking, fishing.
- Cost of spraying *M. spicatum* beds.
- Loss of the warm-water species that comprise part of the "recreational" fishery of MCR.
- Cost to recovery lost fish populations.
- Potential losses from clogged/damaged electric plant turbines.

**ECOLOGICAL THREATS:**

- High density leads to more plant slopping, more decomposition, and depleted dissolved oxygen (DO).
- Decreased native macrophyte biodiversity and abundance leaves populations and food web vulnerable.
- Chemicals used to spray invasives may harm natives.
- Clogged propellers may spread invasives to other systems.

**CONCLUSIONS:**

- *M. spicatum* has a higher organic matter content than most macrophytes, causing increased decomposition and decreased DO levels due to plant slopping.
- Although characteristics of MCR naturally constrain the effects of the *M. spicatum* invasion, the threat to surrounding systems cannot be ignored.
- Continued spraying will likely cause further harm to already vulnerable native populations.
- Draining the reservoir to below the littoral zone and leaving it that way for 3-4 months is the only hope for permanent eradication.
- Until then, threat to other systems MUST be addressed.

**PROPOSED SOLUTION:**

Create and enforce a propeller-sanitizing station and policy for boats after removal from MCR to prevent spread of *M. spicatum* to surrounding systems until a time when MCR can be drained beyond the littoral zone.

**MERRILL CREEK RESERVOIR**

**ECONOMIC & SOCIOLOGY METHODS:**

- Conducted several phone and in-person interviews with Merrill Creek staff.
- Gathered economic data on MCR invasion and invasions in other systems.

**THE MCR INVASION:**

- Deep, rocky reservoir with limited littoral zone.
- Very restricted budget.
- Spraying costs $865 per treatment.
- Reservoir can be drained.
- Threat of spread to other systems.
This poster explores the need for and use of erosion and sediment (E&S) control on construction sites. As construction sites disturb large amounts of soil, remove the protective layer of vegetation, and then compact and pave it, they increase runoff from sites and make the soil more susceptible to erosion. Accelerated erosion on construction sites is detrimental to the environment if not properly controlled.

Best management practices (BMP’s) are the acceptable methods in the industry to control erosion and reduce sediment from runoff. The most common BMP’s are compostable filter socks, hydroseeding, matting/netting, and silt fences. Compostable filter socks are the most cost effective type of these BMPs, due to its low replacement costs and essentially nonexistent removal costs.

Lafayette’s new Theater downtown serves as a case study to understand local E&S control. The construction site E&S plan utilizes a variety of BMPs and specifies proper implementation and maintenance of them. However, interviews with site professionals revealed the need for better maintenance and attention to sediment control on this site and in the construction industry in general.

Mismanagement of E&S on construction sites has many implications on the surrounding environment and decreases biodiversity. On site, it results in loss of topsoil, which reduces soil health and plant growth. Off site, runoff contains excess sediment and nutrients, which cause eutrophication, reduction of light and oxygen for aquatic organisms, clogging of fish gills, and destruction of aquatic species’ habitats.
Construction Erosion Control and its Effect on Biodiversity
Julia Kripas ’15 (CE 321), Phillip Manna ’15 (ECON 202), Sarah Walko ’15 (CE 321)

Objective: To explore the best practices for erosion and sediment control on construction sites, analyze the associated economics, and determine the impacts of mismanagement on biodiversity in surrounding ecosystems.

What is Erosion?
- Natural process of wearing away rocks and soil by water, ice, or wind, which can be accelerated by society through urbanization and agriculture.

What Causes Erosion on Construction Sites?
- Paved and Compacted Soil
- Vegetation Removed
- Soil Excavated and Disturbed

The potential for erosion on highly disturbed land is 100 times greater than on agricultural land!

Case Study: FAMS Black Box Theater
- Site Details
  - New Theater Building at the base of College Hill
  - 1 acre of disturbance; very small site
  - Adjacent High Quality Creek required special design
- BMPs Utilized:
  - Compost Filter Socks
  - Rock Construction Entrance
  - Inlet Protection
  - Erosion Blanket

Site E&S Cost

<table>
<thead>
<tr>
<th>BMP Type</th>
<th>Amount</th>
<th>Cost</th>
<th>BMP Total</th>
</tr>
</thead>
<tbody>
<tr>
<td>Compostable Filter Sock</td>
<td>1640 linear feet</td>
<td>$3/linear foot</td>
<td>$4,920</td>
</tr>
<tr>
<td>Rock Construction Entrance</td>
<td>111 square yards</td>
<td>$7/square yard</td>
<td>$780</td>
</tr>
<tr>
<td>Inlet Protection</td>
<td>4 inlets</td>
<td>$75/inlet</td>
<td>$300</td>
</tr>
<tr>
<td>Erosion Blanket</td>
<td>500 square yards</td>
<td>$2/square yard</td>
<td>$1,000</td>
</tr>
<tr>
<td>Total Material Cost</td>
<td></td>
<td>$7,000</td>
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<tr>
<td>E&amp;S Plan Preparation</td>
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<tr>
<td>Total E&amp;S Cost</td>
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<td>$10,000</td>
<td></td>
</tr>
</tbody>
</table>

- Professional Perspectives on E&S Control
  - Disconnect between E&S Design and Implementation
  - Biggest problem is improper installation of BMPs
  - Little enforcement of E&S regulations
  - Strictness of regulations vary by state

Biodiversity Effects from Mismanagement of Erosion Control

Conclusion
- Polluted runoff from construction sites poses a serious threat to biodiversity if E&S is not controlled properly
- Problems exist within implementation, maintenance, regulations and enforcement of controls
- Recommendations: Invest more money, time and effort
  - Invest more in proper management, as E&S control represents a small portion of the total project cost
  - Create standardized regulations across states
  - Increase education of E&S issues to workers onsite
  - Enforce regular inspections

Costs of Runoff Damages
Case Study: Puget Sound Area
- Polluted Water Source Cleanup: up to $1.5 million for decontamination of a single watershed
- Habitat Restoration: $26.8 million cost in 2005 for wildlife habitat restoration for a single jurisdiction
- Lost Revenue: loss of over $3 million in shellfish sales for one harvest area due to closures
- Lost Recreation Opportunities: beach closures led to lost opportunities for large amount of recreational fishers

References
References available upon request.
Harnessing Wind Energy in Relation to Migratory Patterns of the California Condor

Michael Goldman, Peter Levine, and Wiley Houldin

As the United States continues its commitment in shifting its energy production away from traditional methods toward more sustainable and renewable sources, the market for green energy will only continue to expand. Wind power, one of the leading sources of renewable energy can yield high production levels if utilized efficiently. However, the expansion of wind farms can pose potential risks if it is not implemented properly. One example of these negative impacts is on biodiversity loss in avian species. In our poster, we analyze the impact of wind turbine expansion on migratory patterns of the California condor.

Our poster begins with a brief overview, explaining the problem structure of renewable energy development and the risks it poses to the California condor. As a group, we consider the benefits of wind energy versus the effects on local ecosystems, specifically the migratory patterns of the California condor. This bird is an endangered species concentrated in the American southwest, with about 250 birds remaining in the wild. The bird is important to California’s ecosystems as “nature’s cleaning crew”, particularly removing dead plant and animal matter from the natural world.

After a full analysis of how to effectively implement wind energy farms without affecting the California condor. It’s vital to consider the potential for migratory patterns to change. Therefore, solutions include tracking the few remaining condors’ migratory patterns, installing safer blades, and “siting” the wind farms so they are in an ecologically safe location.
Harnessing Wind Energy In Relation To Migratory Patterns Of The California Condor
An analysis of wind turbine expansion and the ensuing effects on biodiversity loss, with a focus on migratory patterns of the California Condor species in southern California.
By: Wiley Houldin ’15, Peter Levine ’16, Michael Goldman ’16

Problem Structure: The development of renewable energy is one of the Department of Interior’s utmost priorities. However, wind energy has the capability of conflicting with the recovery of the California Condor. Therefore, wind energy projects should be established in a way of minimizing risks to the California Condor.

The California Condor:
- Largest bird in North America
- It has long been symbolic of avian conservation in the United States
- Vital to the ecosystem as “nature’s cleaning crew”
- Located in rocky, forested geographic areas (mountains, canyons), SW United States
- Only 437 remaining
- Travel up to 150 miles per day in search of next meal
- Few offspring, extensive parental care

California Condor Wind Energy Work Group:
- The mission of this group is to evaluate wind energy development within the range of the California condor in California.
- With the main goal of providing the U.S. Fish and Wildlife Service Regional Director, science-based recommendations that will reduce the risk correlated with wind energy activities on the conservation and recovery of the condor.
- Analytical research will provide the Work Group with essential tools to develop evaluative criteria for further wind resource development within the scope of the California Condor.

Wind Energy Overview:
- Green: No pollution and minimal environmental impact
- Sustainable: Potential for 20x present human need
- Space-efficient: Large turbines can generate power for 600 American homes
- Cost-efficient: Prices have decreased 80% in past decade
- Long-term potential
- Growth in well-paying jobs
- Only cost-effective in certain locations; to what extent should we limit wind farms in efficient regions?

Wind-Farm Monitoring:
- Goal is to assess the risks of wind energy development and provide the Service’s Regional Director, science-based recommendations of actions that can be taken to minimize those risks.
- Geological Survey analysis of condor locations, movement and wind usage designed to evaluate potential areas of conflict.
- Traditional Monitoring: daily, high cost, low range of observation.

Renewable Energy Efforts:
- A number of proposed wind energy projects overlap with or are in close proximity to the occupied and historical range of the California condor
- Problem with bird migration and wind:
- Service anticipated that if a single (or several) condor(s) enters the risk zone within a wind energy facility; the same wind currents would promote similar movements by other individuals, which would result in ongoing fatalities.
- The increase in energy production will also increase the need for additional transmission lines, which could pose a threat to condors due to collision or electrocution.

Policy Solutions:
The solution, once determined, will take into consideration the Endangered Species Act and the national need to discontinue our dependence on foreign oil.
- Tracking migratory patterns, siting in safe locations
- Radar
- Efficiency: only utilizing turbines when speeds high enough
- Sounds, ultrasonic waves
- Changing the shape of the blades: kites and vertical-axis turbines
- Stilt detection
- Incentive-based market solutions—limit presence of wind farms in critical natural habitats

California Condor GPS Locations 2011

California Wind Resource Potential
As concerns about global climate change grow, serious attention is being drawn to the development of alternative, low-carbon energy sources. One such solution is nuclear power; however, waste produced by these plants poses a serious risk to the environment if improperly managed. To evaluate this risk, we researched past nuclear disasters, such as Chernobyl and the Hanford Site, to determine exactly how radiation affects biodiversity.

In particular, we focused on the morphological impacts on birds, the bio-concentration of radioactive isotopes in plants and the cancer rates in humans as a result of the Chernobyl disaster. For the Hanford Site, we studied the effects of radioactivity in the Columbia River, the effects of radioactive material spreading via the air and current issues with leaking tanks. It is assumed that similar outcomes would occur if another disaster transpired. Additionally, we also provided a generalized overview of how radiation affects biological organisms at a molecular scale.

Given the risk of nuclear waste to biodiversity, we researched past and present ways nuclear waste has been stored and disposed. Currently, this is one of the main issues with the implementation of nuclear power. Through our research, we evaluated the safety of current storage methods and potential ways waste can be handled in the future. We tried devising a plan to store the nuclear waste so that it would reduce the risk of negative effects on biodiversity. The research for this plan was conducted by exploring different storage options that provide resistance to radiation.
NUCLEAR WASTE AND ITS IMPACT ON BIODIVERSITY

Michael Meshberg – Chemical Engineering (CHE 370), Rebecca Miller – Chemical Engineering (CHE 370)
Matthew Morris – Geology and Geoscience (CHEM 252)

OBJECTIVE
To explore the effects of nuclear waste disasters on people, plants, animals and their surrounding environment.

PRODUCTS OF FISSION
The initial fission products of \( ^{235}U \) are typically \(^{119m}Ag\) and \(^{119m}Cd\), however, as these products undergo fission and decay, a wide range of radioactive nuclei accumulate in the fuel rods.

\[
\begin{align*}
{n} & \quad ^{235}U \quad ^{144}Ce \quad ^{144}Pr \quad ^{144}Nd \quad \text{+ HEAT} \\
235 & \quad 92 \quad 96 \quad 92 \quad 92
\end{align*}
\]

BIOLICAL EFFECTS
If cells are exposed to radiation, the water contained in them is ionized, forming the hydroxyl free radical (\( \cdot OH \)). This molecule is highly reactive and damages DNA and proteins in the cell.

\[
\text{H}_2\text{O} + \text{Radiation (a, b, or } \gamma) \rightarrow \text{e}^- + \text{H}_2\text{O}^* \\
\text{H}_2\text{O}^* \rightarrow \text{H}^+ + \cdot \text{OH}
\]

Exposure effects on humans:
- 0.3 rem – yearly exposure of avg. person
- 25 rem – decrease in white blood cells
- 100 rem – nausea and hair loss
- 500 rem – 50% chance of death

HANFORD SITE
- Most contaminated nuclear site in U.S.
- 59 of 177 tanks have leaked
- 300 miles of Columbia River affected
- $110 billion cleanup cost
- 400% increase in birth defects

CHERNOBYL
- 1986: Worlds worst nuclear disaster
- Reactor explosion due to operator error
- 237 cases of Acute Radiation Sickness
- 30 deaths
- Over 116,000 people evacuated

ENVIRONMENTAL IMPACTS
Red Forest:
- 1000 acres of Scots Pine died soon after the accident
- Area contaminated by a plume of radioactive nuclei
- Birch and Aspen trees are more resistant to radioactivity and are slowly repopulating the area
- In general, slower rates of growth and decay are observed

HUMAN IMPACTS
- Pregnant women were advised to have abortions due to radiation exposure
- Children drank contaminated milk
- 5000 cases of thyroid cancer for people 18- in 1986
- Increased incidence of cataracts and cardiovascular disease
- Increased risk of leukemia for cleanup workers

BIOLICAL IMPACTS
- Decrease in the number of insects and arachnids
- Morphological, physiological, and genetic changes in species
- Effects on Barn Swallows:
  - Radiation caused albinos spots
  - Decreased brain size
  - Increased frequency of cataracts
  - Increased egg size

WASTE
- Short-Term Storage:
  - Wet: pools for reactor fuel rods
  - Dry: above ground in casks
- Long-Term Storage:
  - Waste Isolation Pilot Plant
  - Yucca Mountain

Components of Spent Fuel

<table>
<thead>
<tr>
<th>Component</th>
<th>Half-Life</th>
</tr>
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<tbody>
<tr>
<td>Strontium-90</td>
<td>29 yrs</td>
</tr>
<tr>
<td>Cesium-137</td>
<td>30 yrs</td>
</tr>
<tr>
<td>Americium-241</td>
<td>433 yrs</td>
</tr>
<tr>
<td>Neptunium-237</td>
<td>2,000,000 yrs</td>
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</tbody>
</table>

REFERENCES
Available upon request
Consequences of Oil Dispersants: Is the Cure Better Than the Disease

Luke Timber, Dylan Hahn, and Joanie Haling

We are using cost benefit analysis to determine whether the environmental effects from oil dispersants are worth all the expenses or if we are better using either different cleaning methods, or not cleaning leaving the spilled oil as it is after the spill. We are going to look at the deep horizon oil spill as an example of a spill as it provoked the largest injection of oil dispersants to date.

We are studying the environmental effects of oil spills. How the dispersed oil affects the food chains and major dangers that the dispersing process causes. We are going to compare the after effects caused by older oil spills that used little to no oil dispersants versus the British Petroleum spill.
Consequences of Oil Dispersants: Is the Cure Better Than the Disease?
By: Luke Timber (CE321), Dylan Hahn (CE321), Joan Haling (ECON 202)

Objective:
- To study whether dispersants are the best method to minimizing damage to biodiversity in a marine ecosystem

What is an oil dispersant?
- "Dispersants are chemicals that are sprayed on a surface oil slick to break down the oil into smaller droplets that more readily mix with the water".
- Dispersants release toxic breakdown products that do not remove oil, but only further spread the problem

Cost Benefit analysis of Oil Dispersants

COSTS
- Biodiversity loss of animals, plants and coral species
- Health issues, hurts industries, expensive and impractical

BENEFITS
- Removes oil from the surface, protecting shoreline habitats and surface animals
- Clean up efforts lead to higher GDP

Chemicals break up spill
Dispersants, a mixture of solvents, surfactants and other additives, are being sprayed on the Gulf of Mexico oil spill. How they break up oil over time:

- Break up surface tension of oil slick, make oil more soluble in water
- One end of dispersant attaches to oil
- Wave action helps pull oil apart into smaller and smaller droplets
- Other end attaches to water
- Bottom line
- Dispersants make oil less likely to stick to animals on water surface, shoreline, but may harm animals living underwater

Conclusion:
- We have found that oil dispersants are used for aesthetic appeal not for practical use
- Just because the oil is no longer visible does not mean the problem is solved
- A new, more environmentally conscious, way must be found and utilized to cure ecosystems of traumatic spills

Effects on the ecosystem:
- Marine ecosystems are complex interconnected parts of the world that can be decimated by one small change
- Dispersants have been banned from use near coral reefs due to their effects on the growth cycles of corals
- All animals will be affected by either direct contact or bioaccumulation

Please ask for a complete list of references
Our poster focuses on the “Garbage Patch” located in the Pacific Ocean. We discuss why the Garbage Patch has accumulated, and the effects it has on biodiversity loss and more specifically on marine life, the food chain and the overall chemistry of the ocean. The plastic debris has countless harmful physical effects by way of entanglement, ingestion and changing the chemistry of the oceans. Plastics in the ocean have also been connected to the addition of endocrine disrupting chemicals.

Furthermore we discuss the breakdown of the garbage in the ocean, specifically the process of plastic breaking down, and why it breaks down, as well as the consequences of it breaking down. The plastic can absorb organic pollutants very easily and because plastic floats on the surface can in turn be easily ingested by animals causes disruption throughout the food chain. However, we also learned that the plastics sinks, causing biodiversity loss at the ocean bottom too.

We also touch on some possible solutions to the garbage accumulation and their feasibility. We discuss how to go about implementing these methods and how most fail to be an efficient and cost-effective method due low capture rates and large costs. We further looked into one of the most efficient and cost-effective methods, the barrier and vacuum system. This method works with the ocean current to collect the debris in the ocean. We conducted an economic analysis on this method to prove that it appears to be the best method to clean up our oceans, and reduce biodiversity loss.
The Pacific Ocean Garbage Patch: The Eighth Continent
Matthew Goldsworthy, Eli Karp, and Robert Pollastro

Objectives
- Discuss the Pacific Ocean Garbage Patch, its effect on biodiversity loss and whether or not it is economically feasible to implement a barrier and vacuum system.

What is the Garbage Patch?
- The Garbage Patch is an accumulation of plastic debris due to ocean gyres.
- Plastic bottles are broken down into small particles which occupy the majority of the patch.
- Roughly 500,000 metric tons of plastic litter and debris are estimated to be floating in the ocean gyres.
- 0.9 million pieces of plastic per square mile.
- 15% floats on surface, 15% collects near shore or on beaches, 70% sinks below surface, damaging precious life on the ocean floor.

Possible Solutions
- Conventional Method:
  - The use of vessels and nets to capture and fish for debris.
  - Not a safe, efficient, or cost-effective method.
- Pollution Prevention Policies:
  - Safer and more efficient landfills, subsidies for recycling, and nets and barriers to capture debris from rivers.
  - In addition, awareness, land clean up, and education programs.
- Bans, Taxes, or Regulations:
  - On nurdles (California law) and plastic bags (San Francisco).

Barrier and Vacuum Method
- Method:
  - Barrier and vacuums allow the ocean's currents to do the work of debris collection.
- Efficiency:
  - 85% of the debris encountered by the barrier will be captured.
- Costs:
  - Total costs of cleanup of 42% of garbage (155 million pounds) in 10 years, are predicted to be $3.99 million.
  - Research and Simulations:
  - 80% of debris encountering barrier will be captured.
  - Ocean plastics is usable to be turned into oil and recycled into new materials.

Organic Pollutants
- Plastic debris accumulates (adsorbs) Persistent Organic Pollutants (POCs) on surface of plastic.
- Plastic debris behaves like sediments, these floating “sediments” are mistaken as food.
- Plastic particles concentration of POC’s > than the water.
- Ingested by marine life entering the food chain.
- Plastic debris is close to surface so they can also accumulate Polycyclic Aromatic Hydrocarbons (Carcinogens at high concentrations) and other airborne pollutants. Main source: incomplete combustion of organics.

Biodiversity Loss
- Wildlife (ingestion, entanglement, poisonous materials, destruction of ocean flooring, prevention of lighting)
- More than 180 different species have been documented consuming plastics.
- Over 100,000 marine animals die each year from ingestion of plastics and wash up on shore.
- 1,000,000 Sea Birds die each year from consumed plastics.
- Plastic in the ocean floor are consumed by organisms low in the food chain. Enter the food chain.
- Biomagnification occurs

Sources & Effects
- Polychlorinated Biphenyl’s (PCB’s) (Polychlorinated biphenyls) are used as additives in plastic used to increase flexibility, decrease brittleness, resist degradation.
- Endocrine disrupting chemicals
- Interferes and affects hormones: Lipid soluble
- Effects of EDC’s are damage include disrupting sexual orientation, resistance of brain development. Sources: Chemical discharge, Landfill runoff.
- DDT (dichlorodiphenyltrichloroethane): A pesticide, is generated from agricultural runoff. Thinning of eggshells. Toxic to humans, can cause death if concentration is above 2.36 mg DDT per kg of body weight.

Conclusion
- Due to small operational expenditures, high capture efficiency, and the ability to reuse the captured plastic, the vacuum method will be about 33% less expensive than conventional methods.

Figure 3. Garbage Patch: Categorizing Zones & Locations
Figure 4. Forms of 
PCBs
Figure 5. Structures of Pollutants
An Economic and Chemical Analysis of Deforestation’s Effect on Biodiversity in the Amazon Rainforest

Jacqueline Cirincione, Allie Nagurney, and Chris Radomski

Brazil is home to one third of the Amazon Rainforest, which is one of the most biologically diverse areas of the world. Scientists estimate that they have studied just over 1% of all the species there. Over the last 40 years, 20% of the Amazon Rainforest has been lost to deforestation. The cattle and soybean industries are the two main causes of deforestation in the Amazon. The Brazilian government promotes deforestation by providing economic incentives and economic policies such as road and expansion projects, agricultural subsidies, tax breaks, and the encouragement of exporting goods.

When deforestation occurs, plants cannot uptake carbon dioxide. Thus, there is a net gain of carbon dioxide in the atmosphere, which increases global warming. In 1990, deforestation in Brazil led to $340 \times 10^6$ tons CO$_2$-eq being released into the atmosphere, which was 5% of the worldwide CO$_2$ impact from deforestation. Global warming reduces biodiversity. Ecologically, deforestation alters the water flow patterns of an area, causes increased erosion because the topsoil is loosened, and reduces the availability of food and medicine. Each of these consequences of deforestation can result in a loss in biodiversity in the Amazon. It is estimated that over 50,000 species are lost every year due to Amazon Rainforest deforestation. While the rate of deforestation has decreased in recent years, it still continues to negatively impact the Amazon’s
Fertilizing the Infertile or De-fertilizing the Fertile?

Lisa Goulding, Tyler Pircio, and Kanako Shibano

The human population is rapidly increasing and hence achieving efficient and productive agricultural land use is important. But how do we maximize yield of crop while also conserving biodiversity? Agriculture intensification over the years has had many negative effects on biodiversity. It has caused many wild plant and animal species to go extinct regionally or nationally. Agriculture intensification happens in various ways, but in this study we focus on the increased use of fertilizers and the benefits/consequences of organic farming.

Use and overuse of chemical fertilizers cause soil to become arid overtime at a more rapid rate than farming methods using homemade organic fertilizers that are safe for not only plants, but the soil and soil inhabitants as well. A small scale experiment was conducted to demonstrate the effects of fertilizers on biodiversity and soil health. Using three groups, a control group using only tap water, a group using a store bought, concentrated chemical fertilizer, and lastly a homemade organic fertilizer comprised of rice milk, seaweed, unspent coffee grounds, and barley tea leaves. An organic and conventional farm were contacted to answer some questions about their fertilizing methods and production. Through contact with the farms, we hope to gather information on economic efficiency of organic and inorganic methods of farming, in addition to extra costs that may or may not incur by making our own fertilizer. The cost of organic farming versus conventional farming was analyzed as well to determine the long term economic/production effects. The intensity of conventional fertilizer use in agriculture may increase productivity in the short run; however, in the long run, the risk to biodiversity and the well-being of future generations significantly rises.
Acid deposition, commonly referred to as acid rain, is a problem which has come to light at different times in different countries. As a result, the way in which it has been studied and the policies enacted differ in each country. This project looks at two of the countries: the United States of America, which has known about acid deposition effects on environmental degradation and biodiversity loss since the early 1960s, and China, which has only been looking into the problem since the early 1980s. Specific studies in the US will look into the effects of acid deposition on sugar maple trees in the Lake Michigan region and fish species such as, brook trout (Salvelinus fontinalis), lake trout, white sucker, and brown bullhead (Ictalurus nebulosus), while the analysis of China will look into the effects on trees, such as Pinus massoniana (Masson’s Pine) and Cinnamomum bur-mannii (Indonesian Cinnamon).

The US has been able to implement an effective strategy called the Acid Rain Program whose main tenants include innovative, traditional, and market-based strategies for controlling air pollution without having a high-cost on society through encouraging energy efficiency, alternative energy, and pollution prevention. China has implemented few policies regarding SO$_2$ emission controls, but their policies are not as advanced as the Acid Rain Program. This project will also include lessons the Chinese could learn from the US successful acid deposition policy.
Acid Deposition Effects on Biodiversity and Environmental Policy in the United States and China

Alessandro Sindoni (CHEM 252), Cassandra Uthgenannt (CHEM 252), John H. Jarboe (CHE 370)

Problem Statement

- This project studies the effects of acid deposition on policy and biodiversity in two countries who realize their problem over a decade apart and have vastly different forms of government.

Context

- Acid deposition is caused by sulfates and nitrates released from coal plants and oil refineries.

Environmental Effects

- Kills off fish eggs and causes adult fish to be underweight and uncompetitive for resources.
- Leeches toxins, like aluminum, out of soils into water bodies.
- Erodes nutrients in soil before trees can utilize them.

Environmental Effects

- Excess nitrogen released causes maple leaf decay to decrease and layer of leaf litter builds up, which prevents leaf seedlings from sprouting in nutrient-rich soil.
- Decreased recruitment of young fish.
- Lower acidity interferes with female reproductive physiology and metabolism.

Policy Response

Acid Rain Program (Clean Air Act Amendments of 1990)

- Uses market-based strategies for controlling air pollution without having a high cost on society through encouraging energy efficiency, alternative energy, and pollution prevention.
- Cap and trade program: Cap emissions, auction of allowances, market for trading allowances, and a tracking system.
  - Install scrubbers.
  - Switch to low-sulfur coal.

Conclusions

- The policies enacted by the US were very effective with reducing overall emissions.
- Results of current air pollution policy in China have yet to be evaluated.
- Government differences have resulted in very different strategies for mitigating acid deposition effects in the USA and China.

United States

- Study 1: Sugar Maple Tree Decay near Lake Michigan
- Study 2: Fish Population Extinction in the Adirondacks

China

- Study 1: pH Study in the Fmei Mountain
  - average pH of 4.64, minimum of 3.7.
- Study 2: Pine Forest Death in Nanshan Mountain
  - more than 50% of 1800-ha Masson pine (Pinus massoniana) died in 1996.
  - Trees experienced decreased needle length, premature abscission, branch die-back, and decreased radial growth.

Policy Response

Twelfth Five Year Plan

- National plan to reduce air pollution, including SO2 and NOx.
- Zoning control on 47 cities that fail to reach national air quality levels.
- Adjusts industrial sector by eliminating high pollution enterprises, promoting clean energy, and increasing coal-free zones.

Figure 3: Graphic showing sulfate deposition over three years.

Figure 4: pH levels in China.
Effects of Aquaculture and Commercial Fisheries on the Biodiversity of Pacific Salmon

Rachel Elias, Danielle Ricciardi, and Sarah White

The fishing industry is a vital component of the global food industry, providing food security for millions of individuals. The ability to ensure the abundance of healthy fish for consumption is crucial to the economies of many countries, including the United States. However, the fishing industry is threatened by a loss of biodiversity with respect to many species. According to a study completed by the Food and Agriculture Organization, over 70% of the world’s fish populations are severely exploited or completely depleted. This exploitation has serious consequences on the environment and its biodiversity.

The objective of our research project is to analyze and compare the benefits and drawbacks of aquaculture, or farm raised fishing practices, and fisheries on the biodiversity of fish populations. Specifically, we plan to investigate how chemistry and the economy are connected to the biodiversity of several species of salmon from the Pacific Northwest. Salmon is one species that has exhibited susceptibility to exploitation. Contributions to biodiversity loss with respect to salmon populations include overfishing and high-pollutant concentrations in fish. Studying these factors is crucial to understanding how to approach the issue of biodiversity to ensure a sustainable fishing industry.
Effects of Aquaculture and Commercial Fisheries on the Biodiversity of Pacific Salmon

Rachel Elias; Danielle Ricciardi; Sarah White
Lafayette College

Objective
Analyze and compare the benefits and drawbacks of aquaculture and commercial fisheries on the biodiversity of Pacific salmon populations using chemical analysis and economic analysis.

Abstract
The fishing industry is a vital component of the global food industry, providing food security for millions of individuals. The ability to ensure the abundance of healthy fish for consumption is crucial to the economies of many countries, including the United States. However, the fishing industry is threatened by loss of biodiversity with respect to many species. According to a study completed by the Food and Agriculture Organization, over 70% of the world's fish populations are either depleted or completely depleted. Specifically, salmon is one species that has exhibited susceptibility to this exploitation. Contributions to this biodiversity loss with respect to salmon populations include overfishing, pollution, and changing economic and political responses. Studying these factors is crucial to understanding how to approach the issue of biodiversity in the fishing industry.

How Is Biodiversity Impacted by Fishing?
At the Breaking Point
The condition of the world's fisheries has declined drastically because of overfishing.

In 1950:
15% of fish stocks were harvested at their maximum sustainable levels.
85% were sustainably fished.

In 2013:
32% of stocks had collapsed.
30% were overfished.
The remaining 20% were at the limit of sustainability.

- Overfishing
- Changing and varying aquaculture and harvesting techniques
- Genetic diversity as a result of selective breeding and introbreeding
- Observable impact of fish escaping from fish cages into the ocean
- Farm-wild breeding can spread effects to wildlife and farm ecosystems
- Good news – damage is potentially reversible, but it is still a slow process

9 of 20+ populations of salmon in the Pacific Northwest are endangered or threatened.

Economics of Aquaculture versus Commercial Fisheries
Aquaculture:
- Supply advantage
- Product advantage
- Industry owned by four companies
- Cheaper production

Commercial Fisheries:
- Production is variable and uncertain
- Limited catching season
- Limited number of permits given to fishers
- Production is costly
- More natural and healthy fish produced
- Subsidized by government

Economic Perspective of Biodiversity Loss
Economically Sustainable
Profitable in the long run without subsidies

- Aquaculture

Politically Sustainable
Extent of dependency on political intervention

- Aquaculture

Ecologically Sustainable
Maintains the ability of the resource to provide services

- Aquaculture

Discussion of Results
- Distinct threat to salmon biodiversity caused by salmon overfishing
- Severe salmon population depletion is occurring in the Pacific Northwest region
- Salmon aquaculture alleviates the depletion of wild stocks but increases the chance of genetic contamination through crossbreeding, and can result in waste products that are generated and released into the environment

Recommendations:
- Biodiversity: aquaculture
- Chemistry: commercial fisheries
- Economics: aquaculture

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Monoculturism: Corn Crops of America

Jesse Greenfield, Morgan Nobles, and Lisa Salomon

One of the main consequences of monocultures is the loss of biodiversity. The definition of biodiversity is “the variety of life in the world or habitat.” Monocultures do not allow variety of life to exist in their particular habitat. Our goal is to understand what the environmental and economic impacts of monoculture are and how they create biodiversity loss.

The loss of biodiversity within corn monocultures causes the depletion of soil. With only one crop growing the soil suffers. Corn monocultures cause the most soil erosion out of all the different crop monocultures. Another environmental problem is pathogens. One pathogen that affects one corn crop can spread to all the other corn crops in the same area because all of the corn crops are genetically similar. If one corn crop can’t resist the pathogen, then the rest probably aren’t going to either. We will explore how these consequences of monocultures lead to the loss of biodiversity.

Economically our project hopes to explore the reasons why monoculturism in corn crops has become an increasing problem. We will primarily focus on ethanol and its role on the increased demand for corn. Policies such as subsidies and tariffs lead to increased incentives for farmers to grow corn. The percentage of
Monoculturalism: Corn Crops of America
Jesse Greenfield (ECON 202), Lisa Salomon (EVST 100), Morgan Nobles (EVST 100)

Problem Statement:
Even though monocultures might be efficient for corn crops, they lower biodiversity and therefore have environmental and economical impacts.

Economics of Increased Demand for Corn
- Ethanol production increases the demand for corn as a fuel source instead of as a food product leading to exhausted soil and decreased biodiversity due to non-sustainable farming methods.
- Tariffs on imported corn products for ethanol production increase price for imported corn. This leads to more corn being grown in the continental United States where other more efficient corn production methods from other countries are ignored.
- Corn subsidies incentivize farmers to produce as much corn as possible in order to maximize their benefit. This leads to destructive methods of farming such as single crop farming.

Consequence: Spread of Pests
In a monoculture, pathogens have less trouble spreading to all of the corn crops because the crops are all the same; they are genetically similar. Consequently, this can cause major disturbance in the corn system. Entire population of crops can be destroyed.

Because pathogens spread very easily, farmers use a lot of pesticides to save the crops infected to be able to use them after. But those pesticides have consequences on species. For example, bees are starting to disappear because of the intense use of chemical pesticides and bees and other insects pollinators are very important for a third of the food that we eat.

A loss of biodiversity causes soil erosion. Biodiversity loss causes the soil to be less healthy because the soil doesn’t receive all the nutrients that it would receive from the multiple plants in a diverse habitat. Monocultures are especially bad in terms of biodiversity loss because there is specifically one crop being grown in the soil. This causes the soil to lose most to all of its nutrients because the one crop can’t provide the soil with all that it needs.

Solution to Monoculturalism
One of the main issues with corn monocultures is the economic incentive to grow it. If we are able to move away from demanding corn for our economy we would be able to reintroduce biodiversity into agriculture. We could do this by forming polycultures instead of monocultures. By forming polycultures we would also address the issues with pests and soil erosion and depletion. With polycultures there is less risk of an entire crop being wiped out. The soil is also much healthier because all of the different plants provide different nutrients for the soil.

Consequence: Soil Erosion and Depletion

References
References are provided on a different sheet.
Predicting Changes in Plankton Biodiversity: How Useful are Estimates of Chlorophyll a, Phosphorous, and Silica at Merrill Creek Reservoir?

Elizabeth Osborn, Jaimie Bandur, and Caitlin Young

The purpose of our project is to compare concentrations of chlorophyll a, phosphorous, and silica to phytoplankton abundance at epilimnetic depths at Merrill Creek Reservoir in Washington, NJ. Chlorophyll a (chlor a) concentration is commonly used to estimate phytoplankton biomass in lakes. Though levels of chlor a naturally fluctuate, long-term elevated levels of chlor a often indicate poor water quality. Nutrient load increase coincides with a rise in chlor a concentration and can indicate eutrophication of lakes and other aquatic ecosystems. Conversely, low levels of chlor a often suggest good conditions.

Knowledge of phytoplankton abundance is useful for understanding larger trends of biodiversity in lakes. High levels of phytoplankton can shade the floor of lakes so that the less sunlight reaches the animals and plants below, possibly affecting the diversity of the species found at that depth. This study seeks to determine whether or not chlor a, phosphorous, and silica are accurate indicators of phytoplankton biomass in Merrill Creek Reservoir. We collected data at the reservoir throughout the semester and compared it to historical data from the reservoir.

Constructed in 1988, Merrill Creek Reservoir was the first constructed lake built for the purpose of refilling a river (in this case, the Delaware). The reservoir is 650 acres of water within an environmental preserve.
Predicting Changes in Phytoplankton Biodiversity: How Useful are Estimates of Chlorophyll a, Phosphorous and Silica in Merrill Creek Reservoir?

Jaimie Bandur ’15 (BIOL 332), Elizabeth Osborn ’15 (BIOL 332), Caitlin E. Young ’15 (CHEM 252)

Objective

To determine whether or not chlorophyll a (chlor a), phosphorus (PO4) and silica (Si) estimates are useful in prediciting phytoplankton abundance in Merrill Creek Reservoir (MCR).

Introduction

The purpose of our project is to compare concentrations of chlor a, PO4, and Si with the phytoplankton populations of three major groups (Diatoms, Greens, and Dinoflagellates) at epilimnic depths of Merrill Creek Reservoir in Washington, NJ. Chlor a concentration is commonly used to estimate phytoplankton biomass in lakes, but the correlation between phytoplankton abundance, PO4 and Si tends to be less clear (Boyce et al. 2010).

Considerations

- The global decline in phytoplankton populations over the last century, possibly due to human impacts on water systems (Boyce).
- Phytoplankton serve as an important food source for many freshwater organisms, generating nearly half of the world’s primary productivity (Boyce).
- Phytoplankton abundance is an indicator of eutrophication, which is a response to excess nutrients that causes a spike in algae and plant growth that depletes dissolved oxygen within bodies of water. Diagnosis is crucial as it is a serious danger to marine biodiversity.

Methods

We collected two replicates of epilimnetic water samples through fall turnover (September 3 through November 12) at MCR to determine the chlor a, P, and Si levels, as well as phytoplankton content with a Schindler-Patalas trap. We averaged the results of the replicates to obtain our data.

Measurement techniques:
- Chlorophyll a: filtration and spectrophotometry
- Dissolved phosphorous: Ascorbic acid spectrophotometry (Hach® Reagen’s kits)
- Silica: Silicicosylate method (Hach® Reagen’s kits)

Results

Figure 1. Chlor a and Total Phytoplankton for Fall 2012 and 2014

Figure 2. Dissolved Phosphorus and Silica for Fall 2012 and 2014

Conclusions

- A correlation between chlorophyll a levels and phytoplankton population levels was observed. Therefore, chlorophyll a can be used to estimate phytoplankton population levels in Merrill Creek Reservoir (See Figure 1).
- Phosphorus and Silica levels are inversely related. Phytoplankton populations respond to eutrophication levels of phosphorus in the water (Schneid et al. 2006) Phosphorus increases phosphate phytoplankton population growth, which in turn causes depletion in silica levels, as the phytoplankton (predominately diatoms) take up silica (Wetzel 2001) (See Figures 1 and 2).
- The increase in both silica and phosphorus after day 27 was likely due to fall turnover, which increases the levels of nutrients in the lake as deeper, nutrient-rich waters are pushed up to the epilimnion (Wetzel 2001). While phosphorus levels are high early in the sampling period, silica levels are low to support the large population boom that occurs later.
- Depletion of both nutrients at the end of fall turnover when phytoplankton populations increase most dramatically after day 36, and use up the available Si and P. (See Figures 1 and 2).

References Available Upon Request
Troubled Waters: The Causes and Consequences of the 2010 Deepwater Horizon Blowout

Michael Bennett, Yuxiang Shen, and Fletcher Horowitz

On April 20th, 2010, the Deepwater Horizon oil well exploded and sank in the Gulf of Mexico. Before the well was sealed four months later, over 200 million gallons of oil gushed into the Gulf. Almost five years later, the spill’s terrible toll on biodiversity in the Gulf remains all too apparent. Severely damaged populations of a wide variety of species still have not returned to their pre-blowout health levels, and may not recover for many years.

Troubled Waters is a multidisciplinary literature review of the Deepwater Horizon explosion from both engineering and biological perspectives. It begins by reviewing the slipshod engineering decisions made by BP and its subcontractors, such as their choices to use under-tested concrete and to loosely interpret safety test results, which ultimately caused the destruction of the Deepwater Horizon. The poster then discusses the blowout’s consequences for Gulf wildlife, examining the impacts of oil on the region’s various bacterial, coral, vertebrate, and plant communities.

Troubled Waters draws upon a multitude of reliable sources in telling the Deepwater Horizon’s story. The descriptions of management and engineering tests of Deepwater Horizon drill are summarized from the government report created by the National Commission on the BP Deepwater Horizon Oil Spill and Offshore Drilling. Results from various post-explosion field studies of the Gulf of Mexico and lab experiments simulating these natural conditions have been referred to in introducing the spill’s effects on biodiversity.
Consequences of Lafayette College Hill Runoff

Aliza Furneaux, Trevor Houck, and Ellen Colbourne

Storm water runoff affects the health of water bodies in the quality of the water and the quantity. Storm water runoff can carry any number of pollutants and in large volumes can cause serious erosion. These problems can harm the water’s ecosystem and effectively lower the biodiversity.

Our question was how runoff from Lafayette College affected the Bushkill Creek running below the campus. We hypothesized that excessive runoff from Lafayette College campus contributes negatively to the Bushkill creek ecosystem health. We also concluded that practices throughout the campus could be improved to reduce the volume of runoff coming from campus.

We tested three sites on the Bushkill where runoff from the campus would generally flow into the creek. The sites turbidity and conductivity were tested to give a gauge of the stream’s water quality. The sites were tested for four weeks. The data was compared to itself on days with and without precipitation. The data was also compared to a control from Jacobsburg State Park.

After assessing the water quality of the Bushkill, we researched Environmental Protection’s Best Management Practices, to find solutions to the problem area on campus of the Sullivan Trail Hill. The Sullivan Hill Trail has a concrete ditch that funnels runoff down the hill leading into the Bushkill. The solutions suggested by EPA’s Best Management practices include rain gardens, rain barrels, and green parking...
Consequences of Lafayette College Hill Runoff
Aliza Furneaux CE 321, Trevor Houck CE 321, Ellen Colbourne EVST 100

Hypothesis
Lafayette College hill’s runoff contributes negatively to the Bushkill Creek in water quality and quantity of runoff.

Objective
- Monitor Conductivity and Turbidity
- Address problem area
- Provide solutions
  - EPA Best Management Practices

Experiment Design
- Pick three sites to depict Lafayette’s runoff based on location
- Test turbidity with a nephelometer, conductivity with a conductivity meter
- Collect samples for three weeks
- Compare to standard of Jacobsburg Park

Turbidity
- Measures the cloudiness of water
- Indicates water quality and filtration effectiveness

Conductivity
- Measures the ability of water to pass through an electrical current
- High conductivity = high levels of inorganic dissolved solids

Lafayette College Campus

Site 1
Site 2
Site 3

Data Results

Conclusions
- Health of stream could be improved compared to standard
- No significant change in turbidity or conductivity after rainfall
  - Turbidity average slightly higher
- Water quality cannot be directly tied to runoff of Lafayette College hill

Key Nutrient Averages

<table>
<thead>
<tr>
<th>Nutrient</th>
<th>Site 1</th>
<th>Site 2</th>
<th>Site 3</th>
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<tr>
<td>After Rainfall</td>
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</table>

Best Management Practices
- Manage the quantity of stormwater
- Improve the quality of stormwater runoff

1) Green Parking Design
- Permeable pavement
- Green parking infrastructure
  - Duke University

2) Rain Garden
- Natural drainage
- Vegetation and soils remove contaminants

3) Grassy Swale
- Broad shallow channel with dense vegetation on side slopes
- Traps pollutants
- Reduces runoff volume
- Large stones in steepest slopes

Sullivan Hill Trail

Problems
- Concrete ditch turns water into storm drains
- Storm drains dig with street ditches
- Volume of runoff

Sources upon request.
Bird Window Collisions: A Clear Killer

Daniel Vincent, Andrew Faett, and Chris Bouquet

Our poster details the occurrence of bird window collisions across the United States each year, and uses Lafayette College as a case study. Bird window collisions occur in large numbers across the country, and are the source of millions and millions of bird deaths annually. While exact figures are unknown, an estimated 10 percent of the bird population is killed by these collisions every year. While human development continues to occur, glass remains an effective way to work with natural light in and a sure way to design a structure that is aesthetically pleasing. However, the effects this use of glass could have on the surrounding environment are almost never given any thought are by the architects. Our poster outlines possible effects on biodiversity that could stem from this problem, as well as presenting exactly what types of birds are most affected here on campus. The data set that we have gathered this fall is just part of understanding the whole scope of the problem. The poster also begins a discussion on the existing policies that are in effect regarding these collisions and the safety of the birds. This issue has begun to draw some attention from environmental groups, and continues to gain attention as the number of kills continues to grow. As a conclusion to our presentation, our poster examines possible solutions to eliminate, or at least reduce, the vast number of bird fatalities caused by collisions with windows. While a number of solutions are
Bird Window Collisions: A Clear Killer

Andrew Faett (CE321), Chris Bouquet (EVST100), and Daniel Vincent (CE321)

The Problem

Bird Window Collisions occur in great numbers in the United States each year, resulting in the deaths of various species of birds across the country. These collisions also occur at Lafayette College.

Introduction

- An estimated 365 to 988 million birds are killed annually across the United States due to collisions with glass on various types of buildings.
- Roughly 56 percent of these collisions occur at low rise buildings one to three stories tall, 44 percent occur at medium rise buildings four to eleven stories tall, less than one percent occur at buildings taller than eleven stories (Loss, et al., 2014).

Existing Policies

- Government policy includes several acts that apply to bird-window collisions, although many violations of these acts go unenforced.
- Over 90% of the kills found at Lafayette have been birds specifically listed as protected in the Migratory Bird Treaty Act as of December 2, 2013.
- A Toronto Court ruled in February 2013 that both the Environmental Protection Act and the Species at Risk Act should be interpreted to prohibit the reflection of light from windows where it endangers birds.

A Look at the Future

- Strategies to reduce collisions include: ultraviolet coated glass, fritted glass, angled glass, and window nets.
- Window nets seem to be the most likely solution at Lafayette College due to their cost, placement, and effectiveness.

Effects on Biodiversity

- Bird window collisions are becoming an increasingly more common issue with human-bird interactions.
- Ecosystem effects can include an imbalance in the food web, loss of high quality individuals, and an increase in scavenger activity.

Resources

- [Add resources here, such as studies or reports on bird window collisions and solutions.]
Linking the Impact of Bombing on Soil Environment and Groundwater to Biodiversity Loss

Aleksey Zebrowski, Kristen Pogozelski, and Casey McCusker

In order to preserve the environment and protect biodiversity, governments have created laws that regulate individuals and businesses. However, those laws are not always enforced. In addition, the United States Congress has created laws that exempt the military from environmental regulations.

Due to the modernization of warfare, the US military has focused most of its attention to airborne attacks. Although airstrikes are meant to reduce negative externalities to humans, it does not take into account environmental impacts. The research included in this project will focus on the impact of projectiles on land degradation, groundwater, and ensuing biological consequences. The project will be subgrouped into physical and chemical effects on soil and groundwater.

After impact, projectiles tend to leave long-lasting environmental effects. The first and most immediate effect is the geographical scarring caused by the force of impact. This may cause soil destruction, liquefaction, and turbation. Visible effects also include a loss of topsoil or landslides. These occurrences are very harmful when considering how the soil and plants are permanently uprooted or killed.

Another issue to consider is the chemical effects caused by explosive residues. The most common chemical residues include nitroaromatic explosives and ammonium nitrate. These chemicals tend to be more toxic to plant life and more susceptible to groundwater transportation. Also, because the contaminants are rarely—if ever—cleaned, these results can have a long lasting damage to soil and to its ecosystems.
Linking the Impact of Bombing on Soil Environment and Groundwater to Biodiversity Loss

By Casey McCusker, Kristen Pogoelski, and Aleksey Zebrowski

**Objective**
To investigate the physical and chemical effects of military bombing on soil topography and chemistry, and how these directly cause biodiversity loss.

**Physical Effects**

**Main Topographical Effects of Bombing:**
- *Bombardment*: A term given exclusively when bombs or other explosive munitions cause soil to mix and excavate out of the impact site.
- *Commonly known as cratering*
- *Soil liquefaction*: When the strength and stiffness of soil is reduced by earthquakes or other high-load blasts such as bombing.
- *Liquefaction may lead to landslides*

**Effects on Biodiversity Loss:**
- Penetration of the water table affects groundwater sources and vegetation.
- *Craters become either permanently barren or flooded with water.*
- *Agriculture is affected by soil erosion, damaged hydrology and workability of soil, and buried unexploded munitions.*
- * Destruction, infection, and weakening of trees with wood-rotting fungi.*
- *Overall pedogenic pathways are impacted.*

**Introduction**
Bombing is a tactic used by militaries throughout the world. When a bomb first reaches the earth’s surface it has immediate physical and chemical effects on the soil environment. Instantaneously, the force of the bomb displaces soil and changes its topography. Meanwhile, chemicals, especially TNT, are released and begin to affect the soil chemistry. Bombing also has serious long-term effects on soil, which cause biodiversity loss. Physically, cratering affects how diverse the land will be in the future. Military use of bombing releases many chemicals into the soil which have a severe immediate effect, but the damage will endure for many years as a result of smaller effects that may not be as noticeable.

**Massachusetts Military Reservation**

**Soil Contamination**
- Concentrations of TNT, RDX, and HMX are inversely proportional to the soil distance from detonation sites.
- Low TNT detection following quick, aerobic degradation.
- *Groundwater Contamination*: RDX and HMX dissolve and are transported to groundwater.

- *US Environmental Protection Agency Method 8330 – Use of High Performance Liquid Chromatography to determine contaminants (TNT, RDX, HMX) and their products.*
- *Soils*: Top layers of sand (Fine and Course), Silt and Clay at bottom of saturated zone are all highly permeable.

**Chemical Effects**

**Main Chemical Compounds Contained in Explosives and Released into Soil:**

<table>
<thead>
<tr>
<th>Compound</th>
<th>Properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>2,4,6-Trinitrotoluene (TNT)</td>
<td>Sorbed Less than TNT by Soils, Recalcitrant to Mineralization</td>
</tr>
<tr>
<td>Hexahydro-1,3,5-trinitro-1,3,5-triazine (RDX)</td>
<td>More Volatile and Sorbed Less than TNT, Waves Beyond TNT in Groundwater, Plumes</td>
</tr>
<tr>
<td>Octahydro-1,3,5,7-tetranito-1,3,5,7-tetrazocine (HMX)</td>
<td>Sorbed Less than TNT by Soils, Recalcitrant to Mineralization</td>
</tr>
</tbody>
</table>

**Ammelcan Nitrile**
- *Acidic Solvent*
- *Solvability Dissolved in Water (87%)*
- Density: 3.725 g/cm³
- Solubility in Water: 150g/liter/ml

**Visual Effects on Biodiversity Loss:**

- *TNT extracted from soil using methanol and determined using HPLC*
- *Concentrations of TNT significantly related to concentrations of RDX and HMX* in worm mass of earthworms with soil-TNT concentrations.
- *Root/Leaf growth show significant decreases in growth (Loannus perenne, Medicago sativa)*
- *Soil polluted affected differently but 5.4 mg/kg or greater killed plants.*
- *Molecular sorption affects surrounding area (dangerous if constantly exposed to contaminated water or soil).*

**Case Study: Camp Edwards, Massachusetts**

**Chemical Transport for Camp Edwards (Closed):**

- Model of Contaminant Transport for Camp Edwards (Closed).

**Notes:**
- Water-Saturated Sediment
- Liquification
- Water fills the pore space between grains. Friction between grains holds sediment together.
- Water completely surrounds all grains and eliminates all grain to grain contact. Sediment flows like a fluid.
Biodiversity Loss of Birds Due to Climate Change and Urbanization

Alexander Gordon-Sandweiss and Vincent DeMarco

Our focus of the project is researching the biodiversity loss of birds due to climate change and urbanization. One of the primary sources that we used was the 2014 State of the Birds published by the Audubon Society. We learned through this report about the catastrophic changes that are happening to the bird population due to climate change. We addressed one of the causes of climate change by looking closely at urbanization and how this issue specifically harms birds. One of the issues that we looked at in relation to urbanization is how bird population is increasing but species richness is decreasing. We looked at a report published by King County in Washington, which discussed the effects of urbanization on the biodiversity of birds around the Puget Sound area. Through this report, we learned a great deal about how species richness is suffering due to the urbanization of watersheds. Overall, the state of the birds should be a major concern among everyone because the loss of birds due to these two factors are significant and these aren’t the only two factors affecting bird population in a negative fashion.
Biodiversity Loss of Birds Due to Climate Change and Urbanization
Alexander Gordon-Sandweiss and Vincent DeMarco
Lafayette College

Introduction
With the Audubon’s recent release of the 2014 State of the Birds, the issue of bird biodiversity loss caught our attention as an issue that needs to be addressed. We decide to look into how climate change and urbanization affect bird biodiversity. By examining the Audubon reports, as well as other articles discussing these issues we were able to come up with several conclusions as to what is causing bird biodiversity loss in relation to climate change and urbanization. These include how birds return to their habitats that no longer can sustain them and how climate change and urbanization affect species richness and biodiversity. Countless species of birds have been eradicated because of humans and this is how it will continue unless we stop it.

Urbanization Pictures
Above: Urban development pressure over climate prioritization (percent increase) (A)
Below: Agricultural development over climate prioritization (percent increase) (A)

Climate Change
- Global warming will dry up wetlands
- Sea level rise from climate change also threatens coastal habitats
- Feeder birds have migrated hundreds of miles since 1966
- Vulnerable to stormy conditions
- Disrupt ecosystems by moving less adaptable species out
- Permafrost will melt as temperatures rise allowing tundra to have woody plants (C)

Urbanization
- Avoider species populations decreased near urban wetlands and in areas with decreased watershed habitat (F)
- Moderate levels of development increases overall species diversity and decreases native species diversity while increasing development lowers diversity as a whole (F)
- Wetlands in urban areas have higher numbers of non-native species (F)

Conclusion
- Migratory birds often return to their habitats that have been destroyed. They have been ravaged by urbanization and no longer provide what the birds require to survive.
- In addition to the destruction of habitat, urbanization and development are two of the leading causes of climate change. This climate change further limits the ranges of the birds, as seen above.
- If we don’t see reduction in increasing development, we will continue to observe the overall trend of reduced species richness; i.e., biodiversity. We will also see an increase of the population of invasive and harmful birds, such as the European Starling and the Common Pigeon.
The Effects of Chemical Pollution on the Fishing Industry in Lake Tanganyika

Munyaradzi Chifetete, Flavia Umulisa, and Feevan Megersa

Lake Tanganyika contains 17% of the world’s surface freshwater and is known for its globally significant freshwater biodiversity. However, chemical pollution brought about by urban and industrial sources has altered the nutrient balance in the lake leading to eutrophication and creating a competition for valuable resources between the already inhabiting freshwater fish species and other non-native species as well as bacteria. This poses a serious threat to the survival of the fish living in Lake Tanganyika because many of them are endemic. The new algae and bacteria that chemical pollution introduces into the lake depletes the amount of available oxygen for the current fish, reducing the lake’s rich biodiversity and fish catches. This in turn would impact the millions of people and species inhabiting the area in or near the lake. In order to curb the effects of chemical pollution on the biodiversity in Lake Tanganyika, different stakeholders such as local and global policy makers as well as industry need to work together. Chemical pollution is derived from urban and industrial sources, thus new pollution prevention policies need to be put in place to ensure that Research & Development is fully financed to support innovation in alternative energy systems and infrastructure.
The Effects of Chemical Pollution on the Fishing Industry in Lake Tanganyika
By Flavia Umulisa, Feevan Megersa, Munyaradzi Chifete

1. Background of Lake Tanganyika
- Considered one of the African great lakes, Tanganyika is the world’s second largest lake (by volume).
- It ranks in the top tier of some 250 lakes found to have globally significant freshwater biodiversity.

2. Main Sources of Chemical Pollution in the lake
- Settlements near the lake
- Mining exploration
- Recreation activities in the lake

3. Impact

4. Case Study
- Given the lake’s nearly-closed system, pollution is catastrophic to the lake’s water quality and biodiversity.
- Research has shown that the rising number of industries such as paint, soap and battery factories combined with industrialized fishing and the chemicals used in small scale mining create pollutants.
- These untreated wastes will ultimately be discharged into the lake and deplete the available oxygen for the current endemic fish species.
- This consequently leads to a decrease in the amount of fish species found in the water.

5. Considerations in Mitigating Chemical Pollution Effects
- Pollution control policies: Regulatory and Incentive Based.
- Pollution prevention policies: Source Reduction and Sectoral Shifts.

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**a) Ecological** - Alterations in the nutrient balance of the lake have lead to competition of resources between native fish species and evasive species/bacteria.

**b) Socio-Economic** - Reduced fish catches would impact millions of people dependent on the lake for the protein from fish and clean water to drink.
Colony Collapse Disorder: The Effect of Agricultural Pesticides

Jessica Rupp, Bryn Gornick, and Jordan Roses

A lethal combination of toxic agricultural pesticides and exposure to these pesticides is causing a decline in the honey bee population. Contact with plant dust, pollen, plant parts, soil and oral consumption during pollination result in pesticide contamination within the hive. The bees transport the pesticides back to the hive contaminating their honey, wax, and all other bee by products.

Clothiandin and thiamethoxam are the two main forms of neonicotinoids responsible for contamination. These chemicals are used in a majority of agricultural settings around the United States. The long half-lives and ability to be transposed by plants allow bees to have long time exposure to these pesticides. Studies have shown the dosages currently being used on crops is toxic enough to be lethal to the bee population. This combination of toxicity and exposure provided by the typical agricultural setting is proving to have a detrimental effect on the honey bee population.

Honey bees are the world’s most important pollinators. Thirty-five percent of the world’s food relies on pollinators for a variety of crops including, watermelon, almonds, pumpkins, blueberries, and apples. Without bees to pollinate these plants, a parallel decline in plant species is expected.

To start prevention of colony collapse disorder, farmers must be aware of their pesticide spray patterns, bee research could be increased by the USDA and EPA, farmers could implement the use of biofertilizers, or possibly get rewarded for not using the strongest pesticides.
Colony Collapse Disorder: The Effect of Agricultural Pesticides

Jessica Rupp (CHEM 252), Bryn Gornick (CHEM 252), Jordan Roses (EVST 100)

**Problem Statement**
The honey bee population is disappearing due to the use of toxic pesticides in agriculture.

**Background**
The decline of the honey bee population, colony collapse disorder (CCD), is due to:
- Harsh winters
- Parasites
- Pesticides/insecticides
- Reduction in available forage
- Beekeeping management

**Exposure**
- Routes of Exposure
  - Planter Dust
  - Soil
  - Wild Plants
  - Hive/Colony

**Toxicity**
- The LD50contact toxicity for clothianidin is 22-44 ng/bee
- The LD50 for thiamethoxam is 2.8-3.7 ng/bee
- Maize compounds range 0.25-1.25 mg/kernel
- A single kernel of maize contains more of active ingredient than published LD50 values

**Neonicotinoids**
- 2 major used: clothianidin and thiamethoxam
- Used in the application of maize seed, production of maize for food, and largest single use of arable land in North America
- Acts as nicotinic receptor antagonists in insects, causing persistent excitation of these receptors leading to death
- Acts to be translocated by plants
- Persistent (long half-life, usually measured in months)

**Significance**
- Honey bees are one of the world’s most important pollinators
- 35% of the world’s food depends on pollinators
- Decline of bees may result in the parallel decline of plant species

**Steps for Prevention**
- Beware of spray patterns for agricultural farming
- Reward farmers for not using the strongest pesticides
- Bee research strengthened by the USDA and EPA
- Biofertilizers

**What we can do to help?**
- Plant flowers in clumps of at least four feet in diameter
- Plant succession of flowering plants that lasts from spring–fall
- Flowers of different shapes will attract different types of pollinators
- Do not spray with pesticides and try a more natural approach to farming or gardening
- Avoid usage of pesticides during midday hours when bee are foraging nectar
Shark-finning is a worldwide environmental issue that leads to dramatic biodiversity loss through unsustainable harvesting practices. Overhunting apex predators, like sharks, causes chain reactions on multiple scales that hinder or even halt marine ecosystems from existing healthily. These destructive fishing trends could be limited or eliminated with increased education and international implementation of sustainable fishing laws and practices that address sharks.

Sustainability is a major concern with shark finning as international shark populations are and have been rapidly decreasing. When sharks are removed from their habitats in large quantities, there are far-reaching consequences throughout the ecosystem. The means by which they are removed is also inherently harmful, as it is through pain-inducing, devious, or otherwise careless capturing techniques. It is however, difficult to appeal to the ethics of sustaining shark populations, as sharks are a universally feared species. Additionally, the species left in the wake of shark loss are vulnerable to poorer water quality and dramatic food web changes, shifting population sizes and overall ecosystem well-being. Legislation implemented to stop shark finning has been largely ineffective due in part to cultural misconceptions. The response to this has been a shift to a more education-based approach, intended to instill the importance of maintaining these predators despite fears or misinformation.
Consequences of Shark Finning
Katherine Buckley, Margaret Noonan, Alexandra Beyer

Problem
Shark finning is the slicing removal of a living shark’s fins. If the shark survives this removal, the finless shark is tossed back into the ocean where it dies slowly or is eaten alive. The loss of shark populations through indiscriminate finning and capturing practices represents one of the most significant attacks on the Earth’s biodiversity. Shark finning is founded in legally evasive practices and unfounded ancient legends, neither of which account for the gravity of eliminating these prehistoric-age apex predators from their ocean habitats, instead acting solely for economic or social purposes.

Objective
To illuminate the destructive nature of this wholly unnecessary practice. As such, we wish to demonstrate through a multidisciplinary lens why the human race must set aside its fears and ignorance regarding the impending doom of this crucial marine predatory species, and begin changing to ensure the sustainable, ethical, and politically conscious future of our interactions with the world’s ocean ecosystems.

Key Players

Ecosystem Sustainability
- Decrease in sharks
  - Increase in their prey (e.g., small sharks, rays, and skates)
  - Decrease in their prey (e.g., shellfish)
- Poorer water quality because shellfish filter water
- Negative impact on recreational activities
- Fewer healthy coral reefs

Ethics
Shark finning is unethical primarily for two reasons:
1. Removing sharks from their oceanic habitats is an attack on their right to live in addition to being a degradation of the ecosystem’s diverse biological value.
2. The way the shark fins are harvested inflicts suffering on the sharks.

Policy
US Policy:
- Shark Finning Prohibition Act of 2000:
  - Loophole allowed for trading of shark fins
- Shark Conservation Act of 2010:
  - Ineffective: Atlantic Ocean commercial shark landings increased between 2010-2011 by 22 metric tons

International Policy:
- Focus on education
  - Kobe II Bycatch Workshop
  - West Africa Observer Training Workshops
  - Eastern Pacific Ocean Regional Workshops

*References available upon request.
Is Fracking All It’s Cracked Up To Be?

Doug Hank, Grace Todesco, and Charlie Chrin

Our group decided to research hydraulic fracturing for our poster project. More specifically we want to look at the effects on the neighboring communities. We all have an interest on the topic and have a bit of background experience on it as well.

Hydraulic Fracturing or what is colloquially referred to, as “fracking” is a process used by drilling companies to extract methane gases from rock formations thousands of feet below ground. It was developed by the Halliburton Corporation in the 1940s to rejuvenate old wells near the end of their productivity cycle. It is done by drilling into the earth about 8,000 feet and then horizontally into the sedimentary rock. Then by pumping two to nine million gallons of water, sand, and toxic chemicals at high pressures into the well, hairline fractures are created in the rock freeing up the gas deposit.

Our group looked at how it effects the environment and the surrounding communities. According to the research we have done, we have realized some of the effects such as contamination of the ground water is really ruining the neighboring communities. We looked more in depth at the chemicals that are contaminating the ground water and the ways that these chemicals infect the local water system.
IS FRACKING ALL IT’S CRACKED UP TO BE?
Doug Hank, Grace Todesco & Charlie Chrin

Mission Statement: Our mission is to develop an understanding of hydraulic fracturing and investigate local groundwater contamination in order to expose the effects it has on biodiversity in Pennsylvania communities.

Breakdown:

What is hydraulic fracturing?
- “Hydro-fracking,” procedure used to withdraw natural gas from beneath the Earth’s surface.
- First used in the 1940s and has grown in popularity since the discovery of shale.

How does it work? (a brief overview)
- High pressures cause water, sand, and chemicals fracture the rock.
- Fluids return the surface containing mostly water mixed with a cocktail of chemicals.
- Fluids stored in ponds or tanks temporarily until later transported away from fracking sites.
- Various incidents of failure of containment strategies concerning pond liners, leading to contamination of surface water and shallow groundwater.

Significance: Why do we care?
- Rising serious health concerns as a result of toxic chemical usage in drilling environments.
- Land clearing required to establish well drilling sites have negative effects on biodiversity.
- Preventative measures being taken are not effective. Plastic liners used to keep the toxic chemicals out of surface water and soil are not effective.
- Causes problems for humans, livestock and vegetation.

The Basics Behind the Fracturing Process:
- Well drilled into a shale deposit containing pockets of natural gas up to 8,000 feet underground.
- 2-9 million gallons of water, sand, and toxic chemicals are pumped into the well to fracture rock.
- High pressures cause water, sand, and chemicals fracture the rock.
- Fluids released in the natural gas.
- Natural gas + water and chemicals flow back up the well.
- Each well can be “fracked”.

The Issue of Focus: Flowback Liners & Chemicals
A “Chemical” Prosecution:
- Fracturing fluids used for fracturing gas shale include variety of additive components each with engineered purpose to facilitate the production of gas.
- Fluids currently used for fracture treatments in Marcellus Shale are water-based or “mixed stick” fracturing fluids.
- Addition of friction reducers allow fluids to be pumped to target zones at higher rates and reduced pressures than by using water alone.
- Additives of biocides prevent micro-organisms growth and reduce bio-fouling of fractures.
- Oxygen scavenger stabilizers prevent corrosion of metal pipes. Acids used to remove drilling mud damage the area near wellbore are common in fracturing fluids or as part of fracture treatment.

Flowback & Holding Pond Liner Containment:
- Flowback definition: the fluids which return to the surface containing mostly water mixed with a cocktail of chemicals.
- Flowback stored in ponds or tanks temporarily until later transported away from fracking sites.
- Ponds constructed of “compacted clay” or high density polyethylene to prevent leakage of fluids.
- Various incidents of failure of containment strategies concerning pond liners, leading to contamination of surface water and shallow groundwater.
- Location of the containment ponds or tanks.
- Poor design of liners and ponds leaves possibility of accidental discharge and leakage.

Hitting Close to Home:
- 46% of 366,000 local wells tested have evidence of leaks that are contaminating drinking water with methane.
- Water contamination effect farm animals and wild animals.
- Negative health effects found in humans as well as domestic animals.

Parting Thoughts & Comments:
- Hydraulic fracturing kills, and its prevalence will only continue to increase exponentially.
- In order to protect the citizens and habitats of Pennsylvania more regulations need to be set into motion.
- Use of safe chemicals.
- More monitoring of waste water and flow-back.
- Less storage of harmful chemicals in lined containment ponds.
- Full disclosure of chemicals and strict standards of disposable toxic products.

Reference List will be provided upon request.
As population increases, our demand for resources increases as well. Those resources come from the natural world, putting greater stress on its ability to continue supplying them. In particular, rainforests are disappearing at an incredible rate. As the forests’ delicately balanced ecosystems are destroyed, many of the resources that they supply are lost, sometimes beyond recovery. It has been estimated that more than 50,000 species of plants, animals, and fungi become extinct annually due to rainforest deforestation; drastically inhibiting the forests’ ability to survive and continue supplying humans with the resources they depend on it for.

Food, timber, oxygen, and medicine are just a few of the things that humankind obtains from rainforests. Roughly 25% of active pharmaceutical ingredients are obtained from species native to the rainforest, but less than 1% of them have been tested for medicinal properties. Deforestation is also one of the leading contributors to greenhouse gases, and as more of the rainforest is cut down, there are fewer plants and trees to sequester carbon dioxide and produce oxygen.

The struggle to slow the rampant destruction of our rainforests has been difficult thus far. Some national governments have placed restrictions on logging activities as well as the trade of timber.
Consequences of Rainforest Deforestation

By: Jillian Fahy, Kim Evans and Rick Cerretani

Objective
To address the global environmental impact of biodiversity loss due to rainforest deforestation, evaluate the reasons why it is occurring and how it can be prevented from worsening.

Obstacles to Prevention
- Enforcing regulations involves such operations as monitoring logging activities and disciplining violators, which need funding.
- Excessive constraints on legal forest clearing may incentivize illegal practices.
- Paying landowners to protect forests only works if they are offered more than what they would earn from clearing the forests.
- Lack of public awareness regarding these issues limits the ability to draw support and funding from citizens in developed nations.

Preventative Actions
- Payment for Ecosystem Services (PES) pays land owners to avoid deforestation and practice conservation.
- Governments have been placing tighter restrictions on logging practices and the distribution of permits to loggers.

Cost
- Roughly 25% of the active ingredients used in pharmaceuticals today are derived from plants and fungi native to the rainforest, but less than 1% of existing rainforest species have been tested for potential medicinal properties.
- Almost 50% of the developing world’s diet consists of food sources obtained from rainforests.

Did you know?
- The Forest Trends Data report states that nearly five football fields of forest have been cleared out of the tropical rainforest every minute between the years of 2000 and 2012.
- Between 2002 and 2004 the highest forest clearing rate occurred out of any other three year time period.
- Synthetic clothing fibers such as rayon are made from wood pulp.
- Half of the world’s rainforests have disappeared.

Illegal Deforestation for Commercial Agriculture in Major Countries

Scope of Problems
- Rainforest used to cover 14% of the Earth’s surface, today it only covers a mere 6%. About 85% of the world’s species are found in the rainforest. More than 50,000 of these species are lost annually due to deforestation.
- Rainforest soil is held together by the roots of trees and vegetation. Removing the trees causes the soil to rapidly erode, resulting in poor, infertile soils. Damage to these soils may take hundreds of years to repair.
- Rainforests are responsible for 10% of the world’s biomass and terrestrial productivity by storing greenhouse gases in soils and preventing them from accumulating in our atmosphere.

Causes
- Logging, agriculture and livestock ranching are the largest incentives for the rampant destruction of rainforests occurring today.
- High demand for timber motivates excessive logging, some of which occurs illegally.
- Clearing forests for farmland often makes use of haphazard methods, such as slash-and-burn, damaging the forest’s ability to recover and the land’s agricultural productivity.
- Cattle ranchers remove forested area to create pastures for their livestock to graze.

Environmental Impact
- Human needs, such as agriculture, timber, roads, housing, and livestock ranching, are overpowering and pushing animals out of their habitat.
- Cutting down one tree prevents the potential storage of 1.5 tons of carbon dioxide and emits stored carbon into atmosphere, accounting for 20% of anthropogenic carbon emissions.
- Preventing deforestation is the most cost effective means of cutting emissions of carbon dioxide in developing countries.
Analyzing Phosphorous Concentrations in the Sullivan Park Wetlands

Livy Waxler, Sarah Bray, and Billy Schaeffer

The Sullivan Park wetland is a constructed wetland located on College Hill. It plays a role in reducing storm water flow, filtering nutrients, and providing aesthetic appeal. This wetland in particular was built in response to major floods in the area; however it has undergone an algal bloom in recent years. This bloom is likely connected to the phosphorous content in the wetland. The poster discusses both a scientific and an economic analysis on phosphorous concentrations in the wetland. In particular, the wetland’s health is related to biodiversity, and the multitude of services it provides for society is explained.

Specifically, concentrations of phosphorous were determined and compared to values found by previous studies. Various soil samples were collected, analyzed in a research lab, and related to the wetland’s overall health. High levels of phosphorus eventually lead to eutrophication, which in turn contributes to biodiversity loss. The poster also examines the ecosystem services the wetland provides to society and discusses the difficulties in determining how individuals value this type of environmental resource. Various economic valuation methods such as revealed preferences, hedonic pricing and replacement value that help estimate the value of the wetland and its significance to society are included. Lastly, the poster assesses the effects of high phosphorous content on things such as indirect use and option value, a reduction in ecosystem resilience, and the biological productivity of the ecosystem.
Analyzing Phosphorus Concentrations in the Sullivan Park Wetland

Sarah Bray - Environmental Economics (ECON 202)  Olivia Waxler - Environmental Economics (ECON 202)  Billy Schaeffer - Environmental Engineering (CE 321)

Objective
To perform scientific and economic analysis on phosphorus concentrations in the constructed Sullivan Park Wetlands to identify the effects on biodiversity.

Impacts of Phosphorus
- Usually scarce under natural conditions
- A micro nutrient that in excessive amounts causes eutrophication
- Phosphorus from external sources overloads wetlands' phosphorus capacity fueling excessive algal growth leading to biodiversity loss

Methods
- Collect soil samples
- Remove water from soil
- Convert all phosphorus present into orthophosphate
- Orthophosphate reacts with a reagent and turns blue
- “Shade” of blue is measured in a spectrophotometer
- Value is plotted against a standard curve to find Phosphorous concentration

Valuation of Wetlands

What are we losing?
Biodiversity: High levels of phosphorus → anaerobic environment that can only support few species of bacteria → kills or displaces fish and other aquatic life → disrupts food chain → creates unsustainable environment for wildlife

What are the values we are losing?

Use-value
Recreational value: using the wetlands for recreational activity (e.g. bird watching, fishing)
Replacement value: the dollar amount needed to replicate services provided by a resource (e.g. flood control, nutrient filtration)
Non-use value
Existence value: valuing a resource simply because it exists, and if destroyed, society would feel a loss.

Estimating the value of what we are losing
Revealed preferences: inferring use-value from how people and markets use a resource
  - Hedonic pricing: use market prices to infer the value of a resource
Stated preferences: rely on the value that people assign to a resource
  - Contingent valuation: capturing non-use value through public surveys

High concentrations of phosphorus causes excessive growth of algae. Algae die and decompose, depleting the dissolved oxygen levels.

Eutrophication

The values of measured phosphorous found above are considered to be moderate. The Sullivan Park Wetland is experiencing issues from algal growth, and a direct cause of the growth could be attributed to poor nutrient filtration by plants. In order to prevent further growth, more nutrient processing plants like cattails could be planted.
Our group intends to explore the Brook Trout species that have been threatened by deforestation on the East Coast - specifically the New England area. We will focus on deforestation due to the large ecological impacts it creates. About seventy percent of Earth’s land animals and plants live in forests and many are prone to extinction with the destruction of their natural homes. Among the many reasons causing deforestation, one of the biggest drivers is agriculture. Farmers will cut forests to provide more room for planting crops or grazing livestock, which have many direct and indirect impacts on the health of the land. Agricultural deforestation ruins the land by failing to rotate crops, which causing the soil to become barren. Ultimately, farmers must take down more forested areas to create new usable farmland. Forest soils are moist, but without trees protecting them from the sun, they quickly dry out. We will look at the environmental effects on aquatic life due to the combination of deforestation, since aquatic life has a large presence in New England. We will be looking at certain organizations to gain a better understanding of what actions have been made in regard to the deforestation threatening Brook Trout populations. We will lastly investigate what regulatory policies have been made and what sustainable practices we, as a community, need to take.
Threat of Biodiversity Loss Caused by Deforestation and Land Development in New England

Lafayette College Poster Project 2014
Intro to the Environment: Abby Purhan
Environmental Engineering and Science: Doug Mitguy & Campbell Weyland

Abstract

- Our group intends on exploring how native brook trout health and populations have been threatened by the combination of deforestation and land development in the eastern United States, specifically in New England.
- We will focus primarily on deforestation - investigating the environmental impacts of tree harvesting (logging) operations, and land development (roads) due to the large impacts they create on the health and water quality of rivers and streams. Deforestation and land development do not only deplete fish populations - but they also pollute freshwater areas and impact ecosystems as a whole.
- We will discuss solutions in regards to deforestation and find ways to better manage forest resources so we don’t negatively impact bodies of freshwater and the aquatic life.
- We will also develop better ways of preserving buffer zones between river sided roads and decrease the amount of nutrient runoff.

Background

- Deforestation is the clearing of Earth’s forests on a massive scale, often resulting in damage to the quality of land and the surrounding ecosystems.
- About 70% of Earth’s land animals and plants live in forests and many are prone to extinction with the destruction of their natural homes.
- Deforestation and Land Development have many negative impacts on aquatic life and freshwater ecosystems.
- The deforestation decreases the buffer zone between roads and waterways, allowing pollution to seep from the surrounding land to runoff directly into the water. These forests (ex. Red Falls) now have easier access to the river basins and become embedded in the sediments lining these water systems.
- Deforestation also damages aquatic ecosystems by abruptly altering the water temperature, as forest cover is depleted, the absence of shade allows direct sunlight to warm these freshwater bodies.

Case Study: New Hampshire

In this case study, “Influences of Logging History on Brook Trout Abundance in First-Order Streams in New Hampshire”. The Department of Biological Sciences at Dartmouth College assessed the relationship between logging history on abundance of brook trout in 10 first-order streams that had been logged 6 to more than 30 years prior.

Results:
- There were significant correlations between brook trout abundance and stream characteristics.
- Logging History: The highest density of brook trout was found in streams that had been most recently logged.

Brook Trout Sustainability

- Poor land management associated with agriculture across the East ranks as one of the most widely distributed impact to brook trout’s ability to self-reproduce and is largely responsible for the decline in population.
- Stream flow populations of brook trout (where wild brook trout occupy 90-100% of their historical habitat) only exist in 5% of sub watersheds.

Brook Trout Assessment - Key Findings

- Poor land management associated with agriculture across the East ranks as one of the most widely distributed impact to brook trout’s ability to self-reproduce and is largely responsible for the decline in population.
- Stream flow populations of brook trout (where wild brook trout occupy 90-100% of their historical habitat) only exist in 5% of sub watersheds.

Threats to Brook Trout and Their Habitat

- Eastern brook trout live in some of the most heavily populated and intensely urbanized regions of the United States.
- Land use decisions made over the past several hundred years has severely impacted the quality of brook trout streams and rivers. This is largely based on the removal of streamside trees and increasing sedimentation and nutrient runoff.
- Some areas of the East have regained forests and are slowly healing from the widespread clearing of eastern forests, where other areas have been undergoing rapid change due to population growth and need for road and water networks.

Primary Threats to Brook Trout

1. Poor land management
2. High water temperature
3. Sedimentation (Runoff)
4. One or more non-native fish species
5. Urbanization
6. Riparian habitat
7. Brown Trout
8. Stream fragmentation
9. Dam installation/fragmentation
10. Forestry

Threats information based on professional opinion of regional experts. Figure data is pie in each. Each threat can exist in sub watersheds.

Conclusions & Suggestions

- Deforestation and Land Development have direct negative influences on aquatic ecosystems and needs to be more closely regulated. Not only does it affect the warming of aquatic ecosystems, but also allows for more pollution and runoff to enter the water systems ultimately depleting trout populations.
- We advocate for repainting of native tree populations alongside bodies of water whose natural ecosystem requires it to thrive, along with a more closely regulated system of logging.

References & Associations

- Eastern Brook Trout Joint Venture
Now and Then: Seasonal Changes in Macroinvertebrate Biodiversity in a Well-Designed Reservoir

Rebecca Indeck, Katie Engberg, and Trudyann Buckley

This poster details the seasonal change in composition and abundance of benthic macroinvertebrates, small bottom-dwelling organisms, in Merrill Creek Reservoir. The reservoir was created to restore stream flow in the Delaware River during dry seasons. This particular one was constructed to be as similar to a lake ecosystem as possible. Benthic organisms are important to monitor within this reservoir because they are sensitive to pollution and a high benthic macroinvertebrate biodiversity indicates a healthy water system. They also process energy by consuming algae, bacteria, and decaying plants and animals. We monitored the changes in abiotic conditions as well as benthic macroinvertebrate composition and abundance before and after fall overturn, in order to determine how they impact biodiversity.

This was done by collecting weekly samples throughout the months of September through November. To gain additional understanding of environmental characteristics that may impact the benthic macroinvertebrates, multiple environmental characteristics were monitored. Weather data on the reservoir was collected on sampling days. Dissolved oxygen content as well as water temperature at the site of macroinvertebrate collection was monitored using an O$_2$ meter. Light penetration was measured using a Secchi disk. Macroinvertebrate samples were collected using an Ekman dredge, and were sorted and identified to the lowest identifiable taxon.
Now and Then: Seasonal Changes in MI Biodiversity in a Well-Designed Reservoir

Katie Engberg EVST 100, Becca Indeck BIO 332, Trudyann Buckley BIO 332

Overall Purpose of Study:
- Does high biodiversity indicate good water quality?
- Can biodiversity be a useful measure for successful reservoir management?
- Among biota, do bottom-dwelling macroinvertebrates (MIs) provide insight into changes in biodiversity?

Specific Objectives:
- To determine how seasonal change affects composition and abundance of benthic MIs
- To relate sediment organic content to MIs biodiversity

Merrill Creek Reservoir:
- Constructed as part of a scheme to protect flows in Delaware River without building a large dam (Civil Engineering 1991)
- Bank-side reservoir constructed to store water pumped from Delaware River (Vinayagam 2014)
- Water stored in reservoir for several months, particles settle out, algae and planktonic animal removes water contaminants (Vinayagam 2014)

Comparative Case Study:
- MI biodiversity in Malilangwe Reservoir, Zimbabwe
- Water level had an important impact on MI biodiversity
- Differences in abundance and biodiversity of MIs are influenced by strong gradients, reservoirs with relatively stable conditions have a high biodiversity (Dalu 2012)

Methods:

Figure 1. Temperature (a) and oxygen (b) at 2m and 4m over sampling time

- Temperature and oxygen profiles (Fig. 1a, 1b) on 11-12-2014 demonstrate typical fall overturn
- 14 total taxa were recovered with only 3 common throughout the season (Fig. 2); 7 were exclusively found during summer stratification while 4 were restricted to overturn
- Both Simpson's and Shannon's indices (Fig. 3a, 3b) exhibit similar trends in biodiversity
- Simpson diversity is unimodally related to organic matter but only at shallow depths (Fig. 4)

Figure 2. MI composition at 2m (outer circle) and 4m (inner circle) during summer stratification and after fall overturn

Figure 3. Simpson (a) and Shannon (b) indices of MI populations over sampling period

Conclusions:
- In September, reservoir epilimnion cooled and temperature zonation broke down
- Reservoir reached uniform temperature and completely mixed in early November
- Seasonal change has a clear correlation to biodiversity both at shallow and deep sites
- Results from biodiversity indices relate well to those of the case study, indicating that we demonstrate an important difference in high and low biodiversity in our figures.
- Further research could look into MI biodiversity in the summer, when water is diverted to the Delaware River.
Fall 2014

Honeybees: A Measure of Biodiversity Loss

Rachel Barron, Colton Mitchell, and Chad Peterson

Honeybees account for the proliferation of one-third of all U.S. crops and some, such as almonds, rely completely on honeybee pollination to grow. It has been estimated that pollination by honeybees contributes $15 billion to the economy. Recently there has been a decline in honeybee populations, resulting in biodiversity loss, crop loss, and a major economic cost. Our poster focuses on the chemistry behind honeybee pollination, the factors that may contribute to decline in population and recommendations for how to remedy the problem.

We approached our problem by separating the research into three areas. First we focus on the scent chemistry behind pollination: what attracts bees to flowers, and what may disrupt that connection. Second, we researched a new phenomenon called Colony Collapse Disorder (CCD), which has recently surfaced as the major cause of honeybee disappearance. CCD first appeared in the United States in 2004 and contributes to approximately 30% of hive loss a year. The main factors that cause CCD are pesticides, pathogens and poor nutrition. Finally we researched the economic contribution of honeybees to evaluate how much economic burden results from CCD.
The Role of Wetland Characteristics in Shaping Plant Biodiversity: A Comparative Study of Wetlands at Merrill Creek Reservoir and Sullivan Park

Andrew Goldberg, Ginny Hoyt, and Julie Vuotto

Wetlands provide many ecosystem services including reducing peak stormwater flow, providing a habitat to a variety of flora and fauna, and improving the water quality. However, increased development over the last century has negatively impacted the total land area covered by wetlands and therefore reduced benefits and has disrupted surrounding areas.

Our research focused on a comparison of wetland characteristics and biodiversity at Merrill Creek Reservoir in Washington, NJ and at the Sullivan Park in Easton, PA. For the study, we collected samples at both sites for water; sediment; and emergent aquatic macrophytes, plants growing with roots submerged in shallow water. We completed a plant biodiversity inventory and conducted laboratory analysis for plant organic content, concentrations of nitrate and phosphorous in water, and sediment texture and composition. Using these data, we were able to compare how varying wetland characteristics at the two sites correlate to plant biodiversity.
The Role of Wetland Characteristics in Shaping Biodiversity: A Comparative Study of Merrill Creek Reservoir Wetland and Sullivan Park Wetland

Andrew Goldberg – Environmental Science, 2015 (BIOL 332)
Ginny Hoyt – Environmental Science, 2016 (CHEM 252, BIOL 332)
Julie Vuotto – Civil & Environmental Engineering, 2017 (CE 321)

Objective:
Conduct a comparative study between two wetlands to determine how wetland characteristics impact biodiversity. The two wetlands in this study were a natural wetland adjacent to Merrill Creek Reservoir in Washington, MI and a constructed wetland at the Sullivan Park in Easton, PA.

Wetland Characteristics:
- Wetland: land area in which water saturates plant root zones
- Ecosystem services: flood control, nutrient exchange in groundwater, natural habitat for plant and animal species, and overall water quality improvements
- Trends: wetlands are a hotspot for biodiversity; however, the land area for wetlands, particularly in the US, has decreased substantially over the last century.

Wetland Comparison:
- Wetland at Merrill Creek Reservoir
- Wetland at Sullivan Park

Water Quality:

Site Characteristics:
The wetland at Merrill Creek Reservoir (MCR) is classified as a mesotrophic bog due to its high elevation. The wetland retains groundwater and has a natural clay lining.

Sullivan Park Wetland was designed to reduce stormwater flow and flooding after Hurricane Irene (2011). The wetland removes contaminants from the surrounding watershed through photoremediation.

Plant Biodiversity and Composition:
Emergent Macrophytes present at Merrill Creek:
- Nymphaea odorata (water lily), Sparganium eurycarpum (bog-root), Juncus effusus (common rush), Alisma subcordatum (water plantain)

Emergent Macrophytes present at Sullivan:
- Botrychium virginianum (bog-beauty), Carex stricta (sedge family), Lactarius (mushroom family), Liriope spicata (lily family), Asarum canadense (twayblade family), Asclepias syriaca (butterfly weed)

Organic Matter and Moisture Content:

Conclusions:
- The wetland at Sullivan Park had significantly more nutrient availability throughout the system and greater biodiversity due to higher day content in sediment, which increases its ability to store water and nutrients.
- Higher organic matter in sediment, which allows for greater availability of nutrients to plants.
- The constructed wetland at Sullivan Park is effective at capturing contaminants (nutrients). High concentration of nutrients correlates to greater emergent macrophyte growth and biodiversity.
- Long-term monitoring could indicate seasonal variations in nutrient availability impacts biodiversity.

Sediment Properties:

References:
[Provide a list of references related to wetland characteristics and biodiversity.]
Oil Spills in the Arctic Circle: Untapped Risks

Jonathan Maschio, Andie Mitchell, and Steve Berube

Our poster project is focused on how oil spills in the Arctic affect biodiversity. We are comparing oil spills in this region of the world to spills in warmer climates, such as the BP oil spill in the Gulf of Mexico. This is pertinent because the Arctic has massive reserves of shale formations and natural gas, making it very valuable as we need more fossil fuels. Also, the Arctic is controlled by eight countries, so it is a highly contested area. So, drilling and natural gas extraction will become more commonplace in this region, which will increase the likelihood and risks for spills. We know that oil spills have been catastrophic in the past, so we can surmise that it would negatively affect the ecosystems and biodiversity of the Arctic. We are going to discuss the risks of oil exploration, the impacts on the biodiversity if there was an oil spill, the policy controversy between the eight nations, and possible solutions if an oil spill occurred.
Oil Spills in The Arctic Circle: Untapped Risks
Andie Mitchell 2018 (EVST 100)
Steven Berube, Jonathan Maschio 2017 (CE 321)

Objective
As humanity’s demand for energy increases, fossil fuels in the Arctic Circle are becoming more sought after commodities. Extraction of Arctic resources will become more commonplace, and a lack of infrastructure and technology equipped for the Arctic environment increases the risk of oil spills. Past oil spills have been catastrophic, so our objective is to analyze how a potential spill could affect biodiversity in the Arctic. We will also examine why it is difficult to create and enforce international policy aimed at protecting an ecosystem in a region controlled by nations with conflicting interests.

Comparative Analysis
- Analysis of the Exxon Valdez Oil Spill reveals that Arctic conditions hinder relief efforts to a much greater extent than conditions in warmer climates.
- The Arctic Circle is remote and undeveloped. (Ruedl)
- Compared to oil spills in warmer regions, the Arctic Circle lacks any substantial infrastructure, making cleanup procedures difficult. (Amos)
- Most Arctic oil resides far offshore, complicating relief logistics. (Oost)
- In cold water regions, approximately 10% of past spills have been recovered due to the remoteness of incidents. (Stuzik)

Policy
- There is difficulty reaching agreements concerning biodiversity, protection policy in the Arctic because eight countries have territorial jurisdiction and economic investments in this region. (Kisilov)
- The US, in its National Strategy for the Arctic Region, has goals for the safe extraction of non-renewable energy, with goals to also protect the Arctic environment and its biodiversity. (US White House)
- Biodiversity loss from oil spills is most acute in coastal and marine ecosystems, thus primary research into relief efforts should focus on these regions. (Arctic Biodiversity Assessment)
- Ocean ecosystems are difficult to police with international law because they are common areas.

Possible Solutions
- Invest in remote oil sensing and detection technologies to complement pipeline development in Arctic regions. (Preparing for Oil Spills)
- Research chemical treating agents and dispersants to minimize their effects and decrease degradation time in cold water environments. (Schmidt)
- Devise international agreements specifically directed toward protecting the Arctic Circle environment.

Impacts on Biodiversity
- Food Web Degradation: After the Exxon Valdez oil spill, “19 out of the 32 monitored wildlife populations are now, 25 years later, ‘not recovering’” (Exxon). Keystone species like the Pacific Herring in Alaska show that oil spills impact entire food webs. If one species cannot recover, several more will follow.
- Loss of Habitat: Oil spills make miles of water and coastline uninhabitable for fish and animals. Slow oil decay rate leads to prolonged habitat contamination. (Aarhus)
- Reduced Reproductive Rates: Toxins in oil and chemical dispersants used to clean oil tamper with the biological reproductive organs of wildlife. Areas in a pod affected by Exxon Valdez have not reproduced since the spill. (Exxon)

References
(See back)
Our purpose is to demonstrate the potential for New York City to adapt to solar-thermal energy and what the affect would be on biodiversity. We looked into case studies involving the engineering design, management, and installation costs of solar panels on rooftops of buildings. We further researched how the installation of solar panels will affect biodiversity, specifically migrating birds. We also have looked at the present solar-thermal technologies and the future of these technologies and how it will affect biodiversity. There have been case studies on this as well further examining the benefits of the new energy.

From an economic standpoint, New York City has the highest demand for and cost of energy in the United States. Our goal is to create and environmentally sustainable city while simultaneously ensuring economic stability. We’re focusing on solar-thermal technology to improve clean energy in the city. Solar-thermal energy has increased tremendously in NYC and in the past seven years the city has added 116 million dollars to the local economy.
The Potential for Solar-Thermal Energy in New York City

Laura Oh - Civil and Environmental Engineering (CE 321)
Charlotte Weseley-Civil and Environmental Engineering (CE 321)
Kirsten Wilhelmsen - Neuroscience (ECON 202)

Hypothesis
The adoption of solar thermal energy will increase energy efficiency and will both positively and negatively affect biodiversity.

Solar Thermal Pilot Program
New York, NY 2010-2011

Economic Drawbacks:
- High initial cost

Economic Assistance:
- Federal, state, and city incentives are offered and will reduce payback periods by 10.25 years on average.

Economic Benefits:
- Cost-efficient alternative to fossil fuels

Impact of Solar Energy on Biodiversity
Negative
- Risk of water pollution through leaks of heat transfer fluid and coolant
- Disruption of breeding and non-breeding birds
- Unsymmetry of breeding and non-breeding birds
- Collision mortality of breeding and non-breeding birds

Positive
- Significantly displaces CO₂ emissions by replacing heavy oil with solar thermal energy
- Protects biodiversity by maintaining greenspaces
- Protects and enhances environment for current and future generations

Potential Environmental Effect
- CO₂ and other greenhouse gas emissions
- Changes in albedo
- Changes in microclimate
- Changes in precipitation regime
- Dust production
- Water pollution

Purpose: To test the potential for solar-thermal energy in NYC

<table>
<thead>
<tr>
<th>Case</th>
<th>Building Size</th>
<th>Installation</th>
<th>Annual Savings</th>
<th>Savings During the Summer</th>
<th>Displacement of CO₂ Emissions</th>
<th>Cost Covered by Incentives</th>
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<td>2 stories</td>
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<td>6.5 years</td>
<td>16.75 years</td>
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</table>

Percentage of buildings suitable for Solar-Thermal energy in NYC

References available upon request
Is Coastal Development and Ecotourism Threatening the Biodiversity of Coral Reefs?:
A Case Study of Costa Rica
Emma Sosa, Dolcie Degrandcham, and Linnel Macklin

Economically speaking, tourism contributes significantly to the wealth of many Central American countries. With many of these countries being vacation destinations, tourism draws in a significant amount of the region’s economic revenue. While being the driving force behind tropical economies, tourism has a significant impact on the health and biodiversity of ecosystems.

As a habitat for a manifold number of plants and animals, tropical coastlines hold a good deal of environmental wealth. As complex, interconnected systems, a disturbance to one component can have cascading effects on the overall coastal health of the region. Unfortunately the beauty and allure of these areas bring tourism, and with it, environmental distress. For example, the removal of a mangrove forest, cleared to make way for a beach resort, can result in loss of habitat and massive soil erosion, dumping sediment into the ocean, smothering coral reefs, and creating murky waters not suited for recreational purposes. In this case, poorly managed construction resulted in the destruction of the habitat that had served as the primary attraction to the resort.

Costa Rica is no exception to this phenomenon. As a country with great ecological diversity, Costa Rica has expanded its tourism industry and, as a result, has degraded the environment and put its biodiversity in danger. However, Costa Rica is unique in its approach to combatting this ecological damage and is seen today as a leader in ecological conservation. This study looks at the problems Costa Rica has faced regarding its coral reefs and the measures taken to reverse the damage of ecotourism and coastal development.
Are Coastal Development and Ecotourism Threatening the Biodiversity of Coral Reefs? 
A Case Study of Costa Rica

Emma Sosa, Linnel Macklin, Dolcie DeGrandchamp

As areas with great ecological diversity and beauty, tropical regions are developing to accommodate the growing tourism industry, resulting in environmental degradation and loss of biodiversity, particularly in shallow marine environments such as coral reefs. However, some regions have developed legislation to combat this ecological damage and restore their environments to their former health. This study examines the health of coral reefs as regions develop, using Costa Rica as a case study.

Coral Bleaching

Coral 24 hours after exposure to no sunscreen [A], 300 μL of sunscreen at 28°C [B], and 100 μL of sunscreen at 30°C [C]

Affects of Development

- Agriculture
- Soil no longer able to grow
- Deforestation
- Soil erosion
- Tourism
- Foreign investment
- Sediment blocks sunlight
- Declining coral health
- More pollution created
- Coral death from sediments and pollution

What Coral Reefs do for the Environment

- Habitat and reproductive area
- CO2 absorption
- Calcium input
- Ecotourism

Progress Already Made

- Permits required for logging
- Mandatory environmental education in schools
- Amendments to constitution, a "healthy ecological environment" is now a natural right of every citizen

Coral Fragmentation

Coral reef before (left) and after (right) damage from siltation

Where Does the Money from Tourism Go?

Despite these improvements in ecological health and conservation, biodiversity in Costa Rica remains low. Some experts believe this is just because there is a lag time between the recovery of the land and the recovery of species. ECO-tourism in Costa Rica contributes to environmental degradation and generates coastal pollution that may hinder biological recovery. By outsourcing its tourism industry to external investors, Costa Rica is losing revenue that could be reinvested into environmental conservation. An initial attempt to rectify this is to increase the amount of internal contribution, emphasizing Costa Rica’s role in its own tourism industry. By doing this, funds from tourism would no longer be lost to countries outside of Costa Rica, and the income could now be spent on the infrastructure of the country itself.
Desertification and Biodiversity Loss due to Unsustainable Agriculture

Jackie Jacobson, Dionne May and Rebecca Miller

Desertification is defined as “the permanent decrease in biological productivity of dryland areas (World Information Transfer 2009). It occurs primarily in arid and semi-arid lands, which comprise about 41% of the land on earth. The number one cause of desertification is overgrazing, followed closely by a host of unsustainable agricultural practices. These practices include water mismanagement, over-frequent slash-and-burn farming, and exploitation of marginal lands for agriculture. These issues are all tied to food production for an exponentially growing human population.

Across the world, farmland represents a significant portion of land use, and as such a large portion of diverse species establish a habitat in farmland areas. When these lands get degraded and desertification occurs, one of the major repercussions is habitat loss, which affects the many species living on farm land. This eventually brings about widespread loss of biodiversity. In our poster project, we intend to highlight the causes and effects leading from unsustainable agriculture to desertification, and ultimately to biodiversity loss throughout the world. We will illustrate this issue through case studies, hopefully shedding light on this prevalent environmental issue.
Desertification and Biodiversity Loss Due to Unsustainable Agriculture

Jackie Jacobson, Dionne May, and Rebecca Miller

Introduction
- Desertification: "a permanent decrease in biological productivity of dryland areas"¹
- Premise:
  - exponential population growth → food production → unsustainable agricultural practices → habitat degradation → Biodiversity Loss!

Global Depiction

Causes and Effects
Unsustainable Agriculture
- Overfarming
- Overgrazing
- Unsustainable technologies
- Pesticide overuse
- Runoff
- Drainage
- Greenhouse gas emissions
- Agrochemical contamination
- Tillage

Desertification
- Erosion
- Water quality decline
- Economic losses
- Flooding
- Increased sediment deposits
- Dust storms
- Reduced Soil Fertility

Biodiversity Loss
- Habitat loss and fragmentation
- Decreased species abundance
- Decreased species richness
- Decreased genetic diversity
- Increased population mortalities

Organic Farming

Examples
- A study measuring bat passes in 47 hours showed a total of 11,123 bats on organic farms and 624 bats on conventional farms²
- A study measuring earthworm abundance in organic and conventional farms found that there were nearly twice as many earthworms in organic farms²
- A study by The Soil Association found 57% more plant species on organic farms versus conventional farms³

References
References are available upon request.
Economic, Environmental, and Social Implications of the Introduction of Nile Perch to Lake Victoria

Jackie Drago, Scarlett Jimenez, and Rebecca McIver

Illegally introduced into Lake Victoria during the 1950s and 1960s, the Nile Perch has had adverse effects on the lake and surrounding communities in Tanzania, Uganda, and Kenya. Previously home to over 500 endemic species, Lake Victoria has undergone drastic changes and the question that remains is, does the overall economic benefits outweigh the costs that the lake and community are incurring?

The Nile Perch (*Lates niloticus*) is a freshwater fish that can grow to be more than 6 feet long and weigh over 400 pounds. As an invasive species with no common predator, the initial introduction of the Perch resulted in the demise of the lake’s native tilapiine and haplochromine fish. The value of such a large fish caused the development of new a market in Lake Victoria that was promptly overpowered by large fishing companies.

In our project we examined the impact the Nile Perch has had in the Lake Victoria and weighed the environmental, economic, and social cost incurred against the brief but powerful economic benefits. By looking at the tradeoffs between the initial positive economic market and succeeding biodiversity losses well as social disruption, we look to provide a clear analysis on the state of the lake and alternative solutions.
Economic, Environmental, and Social Implications of the Introduction of Nile Perch to Lake Victoria
Jackie Drago (EVST 100), Scarlett Jimenez (Econ 202), Rebecca McIver (Econ 202)

**RESEARCH QUESTION**
Does the overall economic benefit outweigh the costs that the lake and community are incurring?

**INTRODUCTION**
Illegal引进 into Lake Victoria during the 1950s and 1960s, the Nile Perch has had irreversible effects on the surrounding areas of Kenya, Uganda, and Tanzania. It’s initial introduction brought about brief prosperity for the local fishermen but environmental, effects, and larger players have overshadowed these benefits.

**PRIOR SITUATION**
Lake Victoria previously, consisted of a diverse community of aquatic life.
- Contained over 500 endemic fish species.
- Most prominent fish included the tilapia and the haplochoeris.
- Loss of fish has resulted in the partial loss of a local cultural identity and tradition.
- Today, the fish make up of the lake remains unknown.

**ENVIROMENTAL**
- Biodiversity Lost (Figure 1)
- Over harvesting of tilapia for fish processing.
- Algal Bloom
- Loss of native aquatic life

**SOCIAL**
- Local food loss - Identity loss
- Shift in accessible jobs
- Bigger fishing corporations have the upper hand and smaller fisheries are out of work and turn to different forms of jobs.
- HIV/AIDS increase

**CONCLUSION**
Environmentally, economically, and socially, the costs due to the introduction of the Nile Perch overtake the benefits of the fish. Environmentally, the predation of the Nile Perch has caused an imbalance in the food chain creating biodiversity loss. Socially, the Nile Perch has caused Lake Victoria locals to lose their native species and lose their typical jobs. Corporations trying to maximize production on the fish. Although, the introduction increased profits and job opportunities, ultimately the tragedy of the commons won. Overfishing caused profits to decrease leaving the area vulnerable due to the decreasing production levels.

**ECONOMIC**
- Increased profits (Table 1)
  
<table>
<thead>
<tr>
<th>Year</th>
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<tr>
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<td>12.00</td>
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<tr>
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<td>26.21</td>
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<td>1994</td>
<td>36.44</td>
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<td>2002</td>
<td>51.62</td>
<td>45.34</td>
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</tr>
</tbody>
</table>

**FUTURE STEPS**
- Reintroduction of native species to Lake Victoria, although logical, may be deemed unsuccessful. Instead, villages surrounding Lake Victoria should implement methods to control the Nile Perch population and fishing practices by introducing:
  - Fishing regulations
  - Local Protector Initiatives
  - Increasing export tax on a governmental level
  - Balanced wages between locals and corporaties.

**REFERENCES**
Alternative energy sources are a hotly debated topic in today’s world. Wind energy, solar energy, and biofuels are just some of the many ideas being tossed around. Each new source of “clean” energy has its benefits, as well as its drawbacks. The environmental impact, as well as the economic cost, must be fully understood before we begin to utilize these new sources of power.

We chose to focus our research on wind energy. There is a project wind farm currently being funded for construction in the Nantucket Sound, off the coast of Massachusetts. It is called Cape Wind, and when completed, it will be the first offshore wind farm constructed in the US. This project is very significant for the advancement of wind energy in the US, so we have decided to do an economic and biological impact analysis of the proposed project. This poster will examine the short- and long-term costs to build and operate the farm, as well as the returns gained from the energy production, in order to determine whether it is economically sound to invest in offshore wind farms. We will also analyze the predicted environmental impacts caused by construction of the farm, operation of the turbines, and any possible leaks or breakdowns during operation. The impacts on marine mammals, fish, and other local aquatic life will be discussed as well as the impact on birds and their migratory patterns. The impact of this project will be precedent for the future of offshore wind projects, so it is very important to determine whether the benefits of the Cape Wind project outweigh the drawbacks.
Cape Wind: The Effects of an Offshore Wind Farm
Colin Reed ‘16, Mike Yanez ‘15, Justin Pié ‘15

Objective
To identify the biological and economical impacts of the Cape Cod Wind Energy Project and ultimately determine if offshore wind can be considered a viable form of renewable energy.

Case Study: Cape Cod Wind Energy Project
- The project entails an electric generating facility consisting of 130 wind turbine generators arranged in a grid pattern in the Horsehoe Shoal region of Nantucket Sound, Massachusetts.
- Solid dielectric inner-array cables from each wind turbine generator would interconnect within the grid and lead to an electric service platform (ESP), which then would travel via transmission cables to land at Cape Cod.
- The Horsehoe Shoal was chosen as the site for the project because it fit five predetermined criteria set and used by the US Department of the Interior Minerals Management Service.

Marine Life
- Noise from construction:
  - induces behavioral changes, includes temporary avoidance and possible migratory pattern changes for several whale and fish species.
  - attracts sharks, posing threat for divers and sharks alike.
- Permanent loss of 3.56 km² of benthic habitat.
- Sea turtles attracted to monopiles for food or shelter, increasing exposure to commercial boating traffic.
- Loss of 41.5 million fish eggs, 6.9 million fish larvae, and 47.5 billion zooplankton.

Avian Life
- The type of bird most affected by this project is the piping plover. It is currently considered endangered and is known to migrate through the action zone on its way to nest in the Cape Cod National Seashore.
- A risk to avian life that is heavily dependent on avoidance rate is visibility. It was found that if the visibility on a given day was less than .25 miles, the chances of a bird colliding with a turbine went up exponentially.

Construction
- Installation of the monopile requires the use of a pile driving ram and a vibration hammer in order to drive the monopile base 26 meters below the ocean floor.
- The proposed scour protection scenario includes 106 turbines protected by scour mats covering 7,936 m² and 24 turbines protected by rock armor covering 35,417 m².
- Cables are laid using jet plowing which during construction will temporarily impact 3.2 km² of the sea floor.
- The total oceanic area occupied by the project is 25 mi² or 64.5 km².

Current Energy Production
- Massachusetts generates 63% of their electricity from natural gas combustion and 12% from coal.
- The current production from renewable sources comes from biomass and hydroelectric power.
- There is a heavy reliance on flow of electricity transferred into state from surrounding areas. In 2012, 74,1 million MWh was input into Massachusetts.

Benefits
- Cape Wind could produce 75% of the electricity used in the islands
- Reduce annual emissions of CO₂ by 734,000 tons
- Create 600-1000 jobs during construction and 50 permanent jobs
- Generate 468 megawatts of clean energy
- Enough to power 200,000 homes
- Replaces up to 500,000 tons of coal burned per year
- Reduction of energy prices- A study showed that cape wind would reduce wholesale electric prices in New England by over $7 billion
- Lower electric price by an average of 9.86/MWh

Conclusions
- Construction of Cape Wind will cause damage to local ecosystems and increased emissions from fuel
- Once in operation Cape Wind is a not a major threat to biodiversity, and may help ecosystems grow around it
- The reduction in greenhouse gas emissions over the life of the project will make up for any construction emissions
- Will produce up to 75% of electricity produced in the area

*Citations available upon request
Merrill Creek Reservoir: Benthic Macroinvertebrate Diversity and its Dependence on Watershed Health and Sediment Composition

Victoria Luongo, James Onorevole, and Scott Showak.

Within an aquatic system, there are many factors that play an important role in determining the ecosystem’s biodiversity. Among these influences are sediment composition and watershed quality, which are interdependent and create a certain environment within the system. These factors influence other aspects of freshwater systems through changes in nitrogen and phosphorus levels and have an impact on the types of aquatic organisms, specifically benthic macroinvertebrates, which typically inhabit these ecosystems.

Benthic macroinvertebrate populations are indicative of the health of aquatic ecosystems. As their abundance and diversity are strongly linked to sediment composition, the health of the ecosystem should be able to be derived from sediment analysis. Since any system’s watershed is determinate of water quality, it also indirectly affects the sediment profile of aquatic systems within their domain. Using previous literature to determine the influence of watersheds on sediment composition, we hoped to observe a relationship between sediment composition and macroinvertebrate abundance with Merrill Creek Reservoir and an adjoining stream.

Through sediment analysis, the percentage of organic matter and sediment texture were discovered. From the same location as soil samples were obtained, benthic macroinvertebrates were collected and sorted based on functional feeding groups and taxonomic distinctions. Through a comparison between the makeup of sediment and the variations among the macroinvertebrates, a relationship was discovered between the two variables. This relationship allows for predictions to be made regarding macroinvertebrates based on knowledge of soil composition and watershed health.
Merrill Creek Reservoir: Benthic Macroinvertebrate Diversity and its Dependence on Watershed Health and Sediment Composition

Luongo, V., Onorevole, J., Showak, S.

Objective
To determine if sediment profile is predictive of benthic macroinvertebrate (BMI) abundance and diversity in streams and lakes/reservoirs, while considering impacts of the watershed as well.

Significance
The ability to predict biodiversity in aquatic ecosystems based on soil profiling and watershed knowledge would allow for predicting water quality in streams, lakes, and reservoirs.

Background Information
- Benthic Macroinvertebrates (BMI)
  - Invertebrates which live at the bottom of a body of water
    - Includes insects, aquatic worms, crustaceans, and other groups
  - BMI abundance and diversity is indicative of water quality
    - Sensitive to short and long term pollution
- Factors that affect BMIs
  - Temperature $T + BMI$ metabolism
  - $DO$ $- BMI$ abundance & diversity
  - Stream Velocity $V + BMI$ abundance
  - Soil Composition - May impact BMI diversity
- Watershed
  - An area of land where all of the water that drains off of it goes to the same place
  - A watershed’s health is largely determined by the quality of the runoff water.

Methodology
- Sampling was conducted at Merrill Creek Reservoir
- Sampling in reservoir: Droman Drags
- Sampling in stream: Surber Sampler
- Analysis of Samples
  - BMIs identified by functional feeding group and taxonomic group
  - Sediments: Organic matter and texture analysis were performed on sediment samples

Results

- Figure 1: Sediment Texture Propositions
- Figure 2: Organic Matter Content of Sediment

- Figure 3: Functional Feeding Group Composition in Lakes (A) and Streams (B)

- Figure 4: Percent Clay vs. Percent Organic Matter in Sediment

- Figure 5: Shannon Diversity vs. Percent Clay in Sediment
- Figure 6: Shannon Diversity vs. Percent Organic Matter in Sediment

Evaluating the Watershed
- Besides an approximately 760-acre stream buffer, the land surrounding Merrill Creek is composed of farmlands, county roadways, and small residential areas.
- Polished agricultural runoff collects in the creek carrying pesticides and fertilizers.
- Human development, both residential and agricultural, contributes fine particle pollution from increased construction.
- County roadways provide an impervious surface on which oil, gasoline, and various heavy metals collect and later wash into waterways.
- These heavy metals include lead, nickel, cadmium, zinc, and copper.
- These metals collect in low-velocity waterways forming superficies silt which can decrease benthic macroinvertebrate diversity and density.

Conclusion and Future Analysis
- Overall, the streams had a higher percentage of sand than the lakes, and fewer clay, silt, and organic matter.
- Additionally, the streams typically had a larger amount of diversity.
- Our findings support the idea that clay is the most influential factor of sediment composition when looking at BMI diversity.
- There was an inverse relationship between clay and Shannon Diversity as well as organic matter and Shannon Diversity.
- For future analysis, investigating other aspects of watershed runoff and pollution could be beneficial for understanding the whole picture.
- Fertilizers commonly used to promote plant growth are rich in nitrogen and phosphorus which are directly related to poor water quality and sediment composition.
- The poor water quality inhibits the success and reproduction of macroinvertebrates through oxygen depletion.

Reference

The Bushkill: Backyard Biodiversity

Samuel Kapner, Bonnie Malhotra, and Jaimie Sheppard

Recently, there have been some concerns regarding the levels of fecal bacteria in the Bushkill Creek, a signal for elevated pollution. The river's contamination is an environmental concern for the people and organisms that live nearby, since the river is a source of life and food, and is used for recreational purposes.

Contamination in the Bushkill could be the consequence of anthropogenic influences. Fecal bacteria generally indicates the presence of feces in the water. This could be a reflection of improper practices of treating wastewater and managing sewage systems. Pollution in the river could have also stemmed from factories along the Bushkill. This contamination has and still can effect humans and other organisms that use the river. Exposure to water with high concentrations of fecal bacteria can cause Hepatitis A, B, C, and Legionnaires disease in humans and cause other adverse effects to fishes. The fishes in the Bushkill are also effected by the river's tendency to dry up with disturbances to the pumps in the nearby cement plant, causing heavy fish losses.

The water quality of the Bushkill can be examined by tests of coliform and investigations of macro-invertebrates within the water. Examining data spanning multiple years and sections of the Bushkill will help define the change in health conditions of the Bushkill Creek, and may shed light on the future water conditions of the Bushkill Creek.
The Bushkill: Backyard Biodiversity Loss
Sam Kapner, Bonnie Malhotra, Jaimie Sheppard

The Bushkill Creek is an example of societal choices made without regard for consequences. The creek has suffered from human influence through an increase in fecal matter, loss of watershed, and contamination from factories that are located along the stream.

**Causes**

**Fecal and Total Coliform Tests**
- Fecal coliforms are harmless organisms that are used as an indicator of harmless bacteria in water systems.
- Fecal coliforms, mainly E. Coli, predict the presence of fecal matter in the water.
- Total Coliforms, which includes Fecal Coliforms, are indicators of contamination from soil, runoff, or fecal matter.

**Possible Fecal Contamination Reasons**
- Areas of high levels of fecal coliforms are located near areas of open land, specifically farmland.
- Farmland runoff can create higher concentrations of nutrients in the water.
- Animal runoff can cause higher levels of fecal coliforms.
- High fecal contaminated areas were located downstream of highly industrialized areas.

**Consequences**

**Harms of Fecal Contamination**
- Exposure to contaminated water can cause Hepatitis A, B, C and Legionnaires disease.
- Aerobic decomposition of untreated fecal matter can reduce dissolved oxygen levels which can lead to a decrease of marine organisms.
- In the past three years, elevated levels of fecal coliform have been observed.

**Macro-Invertebrates; Family Biotic Index**
- A study of macro-invertebrates can help assess water quality.
- Tolerant invertebrates can live in lower qualities of water, opposed to sensitive invertebrates that can only live in limited water quality conditions.
- Alkalinity, water temperature, turbidity, dissolved oxygen concentrations, nitrate concentrations, and pH levels all effect tolerant levels.
Hydraulic Fracturing and the Effects it has in Relation to Pollution, Along with an Economic Cost Benefit Analyses

Matt Hanson, Alana Persad and Faris Chugthai

The rapid growth in natural gas drilling is not only effecting human health but the environment as well. Over time there has been drilling for gas throughout the Rocky Mountains and the South, but current interest in drilling into soil on the East Coast has grown recently. What was previously unavailable to drill due to less advanced technology has now become accessible through hydraulic fracturing. The area of interest in particular is called the Marcellus Shale. This is a 600-mile-long expansion from West Virginia to western New York. However the technology associated with these new processes have not been fully understood, even though they are being widely implemented. As a result, hazardous and volatile hydrocarbons are being leaked into nearby areas. This is causing areas with unsafe drinking water, and even in regions that are not heavily populated, it is destroying natural wildlife. The intrinsic value of these spaces is difficult to measure directly; however, with a comprehensive understanding of a dynamic ecosystem, an economic value may be estimated. This can be done by combining aspects of the chemicals used in fracking, the impact that fracking has on local economies and the cost that it has on the environment. Through this project we are going to evaluate the environmental impacts of fracking while weighing the beneficial factors against the costs to see the impact that fracking may have on the nation’s economy.
What are the Economic and Chemical Aspects of Fracking?

By Matt Hanson 15’, Alana Persad 15’, Faris Chugthai

Goal: Explore the environmental and economic hazards of fracking

Hydraulic Fracturing
- The process of extracting “hard” energy from geological formations deep in the earth’s ground.
- Fracturing with the combination of horizontal drilling, has allowed industries to access natural gas reserves previously considered uneconomical.

Horizontal Drilling
- Drilling into the ground at horizontal distances
- Well is then hydraulically fractured and water, proppants, and chemicals are pumped underground to crack impermeable rock
- The cracks then provide the conductivity necessary to allow natural gas and oil to flow to surface

The Process
- During the fracking process, the materials include a proppant
- Quartz sand or ceramic material
- Gels are then added to increase the hydro fracture fluid viscosity and reduce fluid loss from the fracture

Environmental Factors
- Air Pollution, Water Contamination, Soil Contamination

Air Pollution
- Allows for Release of Methane
- Increase GHGs
- Ground level Ozone
  - VOCs+Nox+UV= Ozone
  - Increased particulate matter

Water Contamination
- Contamination occurs through cracks in casings
- Increases in methane in water

Soil Contamination
- Back water contamination
- Increased soil acidity
- Methane uptake
- Heavy metal uptake

Economic Factors
- Profits and costs from fracking not distributed evenly
- Costs to the town are not evenly distributed

- Reduces incentives for alternate energy
- Future costs not planned for

*Sources available upon request*

A Daunting Climate Footprint

Emissions of methane and indirect CO2 increase with increased use of natural gas.
The Effects of Dam Structure on Aquatic Biological Diversity

Jacob Strock, Michael Fogarty, and Michael Kelly

In the United States alone there are over 80,000 dams over six feet and countless others of smaller size as estimated by the US Army Core of Engineers. Such structures have been placed on nearly all waterways in the U.S. With the sheer number of dams that have been built, mostly in the past century, it would be impossible to know every alteration to the ecosystem that could occur. However there are several major factors when considering a specific dam structure that can help determine the habitability by a variety of species. Each aquatic organism such as fish and macroinvertebrates, have a very specific window of conditions that they can survive at.

In our study, we looked specifically at how differently engineered dam structures can alter such factors and thus the habitability of aquatic organisms. Stream conditions including temperature, pH, dissolved oxygen, and conductivity were recorded at several dams in the region, each with considerably different structure for comparison. Continuous data collected from the local Bushkill Creek were referenced as well. We then took a broad view of the entire issue looking at the anthropogenic factors at play like the social benefits and costs that might come, not just from the use of the dam itself, but also the inadvertent consequences such as the damage, stress, and alteration placed on the biologic community.
The Effects of Dam Structures on Biodiversity

By Jacob Strock, Michael Kelly, and Michael Fogarty

Environmental Chemistry, Environmental Studies, Environmental Engineering
Lafayette College, Easton Pennsylvania

Objective
Determine how different dam structures could affect the diversity of life in streams.

Background
Why We Use Dams:

Dams in the US and Globally:
- The US Army Corps of Engineers has catalogued at least 60,000 dams greater than 8 feet along the waterways of the United States. (Why We Remove Dams 2014)
- Increase of dam use in developing nations. Nigeria has proposed additional 234 dams by 2015 alone (Abdullahi 2012)
- Destruction of forests, parks, and arable lands (Abdullahi 2013)
- Poor representation in developing nations.

Biodiversity at Eminent Risk:
- Migrating fish are prevented from reaching spawning grounds.
- Water conditions including dissolved oxygen, temperature, and sedimentation can be altered thereby affecting what can survive.

Different Structures
- In deep stratified water, bottom release tends to release cold anoxic water from the hypolimnion.
- In surface release dams and other structures that release the top layer of water, they tend to release warmer water. (Lesserd & Heyes, 2005)
- Without a fish ladder, species like salmon, steelhead, suckers, sturgeon and more would be stranded.
- Fish ladders have been shown to have very limited success depending on the river.

Chemical Changes
- Each aquatic species has a limited window of temperature and dissolved oxygen in which they can survive.
- The three major factors determine release temperature on a surface release dam:
  1) surface area,
  2) depth
  3) residence time of the water in the above reservoir. (Lesserd & Heyes, 2003)
- Decelerating deepening water just above the dam frequently diminishes in oxygen concentration (Butts & Evans, 1978)
- As water flows sediments fall out. Decomposition of sediments consume oxygen by bacteria particularly when organic carbons are in abundance.
- Lower dissolved oxygen levels can increase the toxicity of heavy metals. (Lloyd, 1961)
- Increased pressures from dam release cause increased seepage through the surrounding rock and soil as well as the dam itself.
- Changes in conductivity and pH can be a result

Example of potential acid neutralization reaction caused by seepage through limestone:

\[
\text{CaCO}_3(s) + H_2CO_3(aq) \rightarrow Ca^{2+}(aq) + 2HCO_3^- (aq)
\]

Data
Water conditions above and below the Frances E. Walter Dam

<table>
<thead>
<tr>
<th></th>
<th>100m above</th>
<th>3m above</th>
<th>3m below</th>
<th>100m below</th>
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</thead>
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<tr>
<td>Temp. (C)</td>
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<td>14.9</td>
<td>11.9</td>
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<tr>
<td>Conductivity (ms/cm)</td>
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<td>0.063</td>
<td>0.099</td>
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<tr>
<td>Dissolved Oxygen (%)</td>
<td>78.8</td>
<td>72.8</td>
<td>68.3</td>
<td>93.8</td>
</tr>
</tbody>
</table>

The previous measurements were taken relative to the Frances E. Walter Dam on the Lehigh River, Pennsylvania.

Results
- Higher average temperatures were witnessed at reservoir surface as compared to the bottom release water.
- Dissolved oxygen quickly rebounded after being released from the reservoir.
- On small low head dams dissolved oxygen drops was still evident.
- Large increase in Baeididae Mayfly nymphs below the dam structure.

Conclusion
- Certain low head dam structures may actually help increase dissolved oxygen concentrations from the impounded water above.
- Larger reservoir dams such as the Frances Walter create large bodies of water with depleted oxygen but turbulent waters can quickly raise dissolved oxygen levels again.
- Larger reservoir dams that bottom release can easily produce a several degree difference.
- Lowered Dissolved oxygen concentrations can dramatically affect certain macroinvertebrate abundances.
- Changes in water condition may not necessarily cause a decrease in species richness but could cause species substitution (Lesserd & Heyes, 2003)
- Dam construction and biodiversity loss threaten cultural and biological rights.

References
The Florida Everglades: The Effect of Burmese Pythons on Biodiversity

Nicholas Gates, Ingrid Yovo and Thomas Doolittle

In recent years, the United States has spent nearly $120 billion annually, in an attempt to control over 50,000 different types of invasive species. In the Florida swampland known as the Everglades, one of the most problematic invasive species is the Burmese Python. Since emerging as a serious threat in 2000, Florida has spent more than $1.5 million removing the elusive reptile that exists in growing numbers.

Our goal is to examine the impacts on biodiversity that result from the python’s invasion and to analyze current restoration efforts through an interdisciplinary approach encompassing, economics, government policy and local involvement.

The basis of economic research will analyze the current costs to removing the snakes and the subsequent economic damages to the local community through outlets like tourism loss and increased taxes due to restoration efforts.

From a government perspective, multiple agencies, both federal and local, are working to restore the ecosystems of The Everglades. For example, The National Invasive Species Council allocates funds and supports research that will help further the restoration efforts. When government policy doesn’t suffice, the community can play a role by developing innovative techniques for restoration. Campaigns like the “Don’t Let it Loose” have had a high level of influence on local communities in the Everglades. Our research will analyze similar efforts and their overall success.

We will conclude by developing our own opinion on the success of current restoration efforts and offer a feasible approach to restoration in the future.
The Florida Everglades: The Effects of Burmese Pythons on Biodiversity
Nicholas Gates, Thomas Doolittle, Ingrid Yovo
Lafayette College

The Problem in the Everglades
- The Burmese Python was introduced to the Everglades in the 1980’s and have spread rapidly ever since. The snakes thrive in the warm, temperate climate.
- Native species populations have suffered since the invasion of the snakes. For example, sightings of the White Tailed Deer have declined 54% in the past decade. It is believed that the snakes play a role in the local biodiversity loss.
- The damage caused by the snakes is a burden to the local economy, tourism, and the strength of biodiversity in the Everglades.
- As the population increases, the cost to restore the ecosystem steadily rises.

Research Questions
- What impacts on biodiversity and the economy have invasive species caused in the Everglades?
- What is being done to restore the damaged areas? What are the costs of restoration? What policies or values do these actions incorporate? What is being done locally?
- Is enough being done? What does the future of biodiversity in the Everglades look like?

The Economics of Restoration
- The Everglades’ $46 billion value is underestimated by the increasing costs created by the python problem. However, it is difficult to place a dollar value on the damages as biodiversity is a non-market good.
- Government agencies have spent $101 million protecting endangered species like the Wood Stork but only $6 million on controlling and eliminating the pythons.
- Economists use probability of predation and species valuation to determine the damages in monetary terms.
- Average cost of biodiversity loss from a single python feeding is $255 dollars but can be stretched to $254,000 for animals like the Wood Stork.
- Annual costs of biodiversity loss range from $84,000 to $6,000,000.
- Time lags and monitoring costs make valuation difficult.

Policy Response
- In 2012, the U.S. Fish and Wildlife Service listed the pythons as injurious under the Lacey Act. This banned the importation and interstate trade of the species.
- Organizations such as the ECIUSA, the USFWS, and the FFWCC are regulating policy regarding the control of invasive species. However, this work has largely been ineffective to date.
- An individual can be fined up to $175 if caught releasing the species into the environment.
- Released burmese pythons allow for more widespread killing of the snakes. However, there are still excessive requirements that need to be met before obtaining the proper credentials.
- The USDA’s Wildlife Research Center developed a trap for the humane capture of the Burmese Python.

Conclusions
- The government needs to create stronger policy, offering economic incentives for the removal and penalties against the release of the Burmese Python. Better monitoring and enforcement will also address the local community to rely around the cause and work towards the restoration of biodiversity in the Everglades.
- Better policy will help manage the growth of the python populations. If properly enforced, the economic costs of biodiversity loss will remain around $83,000 annually per snake rather than $6 million.
- The current fines are insufficient and the FFWCC and state government must increase penalties and monitoring of the Everglades to ensure that fewer pythons are released. While the Lacey Act has begun to do this, it isn’t enough.
Recycling and the Earth’s Oceans

Austin Bashline and Kieran Proper

Plastics are an integral part of our lives. Life without them is hard to imagine. Plastics, however, are far from perfect. They are made with fossil fuels, can be harmful to humans and other animal life, and cannot be disposed of easily. We use too much plastic to keep up our habits. This behavior is not sustainable. However, with recycling, we can reduce our fossil fuel use, increase biodiversity, and promote economic growth.

There are six main types of plastic, each with its own unique properties and uses. Over the years, many processes have been developed to recycle plastics. There are many difficulties associated with recycling plastics, and not every type is easily recyclable or recyclable at all. Along with difficulties in recycling it, plastic has had a significant impact on the ocean since its mass production. Plastics have killed organisms living at the bottom of the ocean to its surface. In addition to the environmental costs, the process of recycling is not cheap and can sometimes be more expensive than making new plastic.

Our poster looks at the pros and cons of recycling, specifically the impact plastics have had on biodiversity in Earth’s oceans and the economic impacts of recycling. We start with an introduction to the different kinds of plastics and a brief discussion of recycling techniques. Following this is an examination into the impact plastics have had on the biodiversity of Earth’s oceans. We conclude with an examination of the economic costs in the short and long terms to see whether recycling makes economic sense.
Preserving the Oceans Through Recycling: An Environmental and Economic Analysis

Austin Bashline and Kieran Proper, ChE 370 and Chem 252

Objectives
- Briefly describe the different types of plastics and how they are recycled
- Evaluate the effect of non-recycled plastics to the world’s oceans and the organisms that live off the ocean
- Discuss the economic benefits and drawbacks of recycling

Background
- Types of plastics
  - Recycled Identification code (RIC) developed in 1988 to help recyclers
  - Polyethylene Terephthalate (PET/PETE)
  - High Density Polyethylene (HDPE)
  - Polyvinyl Chloride (PVC)
  - Low Density Polyethylene (LDPE)
  - Polypropylene
  - Polyethylene
  - Others
- Types of recycling
  - Mechanical
  - Chemical

Economics
- Depends on two main factors: cost of raw materials (oil) and cost of recycling vs cost of disposal
  - Cost of disposal
    - Depends on city’s proximity to recycling centers and the price to dump in landfills
  - University of California at Berkeley study found that Los Angeles and San Francisco could gain economic benefit of $2.10/bottle for recycling
- Prices
  - Clear post-consumer PET pellets 68-76 cents/pound
  - Virgin PET bottle resin: 146-152 cents/pound

Biodiversity Impacts
- Scientists say that approximately 6.4 million tons of plastic debris end up in the ocean every year
- Plastics account for more than 1,000,000 deaths a year for seabirds, and more than 100,000 deaths for marine mammals
- Fishing equipment losses in East Asia
  - Floating in the ocean
    - Chemicals leaching into the water and harming the organisms in the ocean floor
  - Floating on surface
    - Becomes a habitat for some organisms
- Effects of small plastic debris in the ocean
  - Small plastic objects floating in the ocean are often ingested by sea birds
  - Effects include hindering the ability to catch and consume food, escape from predators, and reproduce
  - Some of the smaller plastics are even ingested by fish
  - The plastic litter can also sink onto shore: this can potentially destroy habitats
- The Great Pacific Garbage Patch
  - Sits in the Eastern and Western parts
  - Formed by swirling currents

Conclusions
- There are many different types of plastics and each one has to be treated differently, making the process of recycling plastics somewhat difficult
- Plastics have had a major negative impact on the oceans and their inhabitants. Plastic has killed many sea birds, marine mammals, and fish through consumption and destruction of habitat
- Currently recycling does not have a positive effect on economics
- However, as the material to make plastics dwindles, recycling plastics is going to be necessary

References
- References available upon request
Existence Value of Biodiversity Along the Elwha River

Emily Lindahl and Alexandra Eglow

Dams provide great benefit to society as they are a source for irrigation and hydro-electric energy. However, they also can cause great damage to the surrounding ecosystems by contributing to biodiversity loss. In order to solve this problem many dams are now being considered to be removed. The Glines Canyon Dam, located along the Elwha River in Washington, is one dam being considered for removal. If this dam were removed there would be a gradual return of biodiversity to both plant and animal species along the river and throughout surrounding areas in the Olympic National Park where the dam is located. This would essentially undo all of the problems caused by the installation of the dam.

This poster project focuses on calculating the existence value of the biodiversity along the Elwha River in Washington State. Existence value is the value derived from something simply because it exists, despite the fact that you will most likely never see it. We were able to calculate this by using a contingent valuation survey to find out individuals’ willingness to pay to remove this dam. The respondents’ willingness to pay will reveal whether the river’s biodiversity is highly valued and therefore whether the dam should be dismantled.
Existence Value of Biodiversity Along the Elwha River
Emily Lindahl and Alexandra Eglow
Economics 202

Objective
To measure the existence value of biodiversity along the Elwha River by measuring individuals’ willingness to pay for dismantling the Glines Canyon Dam.

Existence Value: Willingness to pay for the existence of an environmental resource without on-site use.

Methods
Contingent Valuation Survey: Way to measure environmental services by directly asking people’s stated preferences.
Non use value: values that are not associated with actual use, or even an option to use, the biodiversity and environmental services of the Elwha River.

Results
The survey revealed that the average willingness to pay (WTP) for the dam dismantlement was $71.80 per year added on to federal taxes. The median WTP was $20 per year. If this was a representative example of the United States adult population the total existence value of biodiversity would be roughly $4 billion. This significantly exceeds the cost of dismantlement, which is $325 million.

Benefits to Biodiversity from Dam Dismantlement
- Increase level of dissolved oxygen in the water
- Return flow of fine sediments and plant seeds downstream
- Return 5 species of salmon to the river
- Return of bear & eagle populations to the river ecosystem

Discussion
Sources of error:
- Source bias
- Not enough information given in survey
- Hypothetical answers
- Social pressure

References
Available upon request
Endocrine Disruptors and Biodiversity
Samuel Haines, Jessica Lewy and Naomi Zucker

We researched the effect of endocrine disruptors on the biodiversity in our ecosystem, focusing on the negative effects caused by hormones in pharmaceutical waste and pesticides and ways we can alleviate the problems associated with these chemicals. Our research addresses how these chemicals enter the ecosystem, their effect on life around them and what we can do as scientists and as a community to reduce their overall impact. Endocrine disruptors are chemicals that interfere with the hormonal systems in mammals and other high functioning animals. Because of the qualities the affected animals possess, there is additionally controversy over, not only the safety of these endocrine disruptors, but also the morality of using products that contain the disruptors. These endocrine disruptors have had a severe effect on certain members of the biodiversity, such as deformities in the developmental process for reproductive systems in fish, the inhibition of birds to effectively raise their young, as well as endocrine related diseases in humans.

Through our research of multiple studies conducted across the country, we concluded that due to the ethical dilemma associated with endocrine disruptors the public needs to be informed of the dangers of these chemicals and push for change in policy. In addition, wastewater treatment plants can better their treatment to remove additional endocrine disruptors by means of chlorination, increased time in oxidative treatment and by utilizing the nitrification process.
The Effects of Endocrine Disruptors on Biodiversity
Sam Haines, Jess Lewy & Naomi Zucker

Research Question
What impact do endocrine disruptors have on their surrounding environment and how can we minimize it?

Effect on Biodiversity:
- EDCs impact the reproductive organs of organisms by disrupting the quantity or timing of the body’s response to a stimulus and the hormones produced.
- EDCs have been shown to increase the rate of intersex organs in fish and other species, which has been shown to limit reproductive performance.
- Other potentially fatal consequences of EDCs include slowed rate of physical development, lack of temperature regulation, less brain development, behavioral changes and injury to organs.

Endocrine Disrupting Compounds (EDCs)
Chemicals or compounds of anthropogenic origin that interfere with an organism’s endocrine system. Pharmaceuticals and pesticides are both known to contain EDCs. Compounds from the former enter our water systems through excretion and disposal of personal products while compounds from the later enter our environment through storm water runoff and natural drainage.

Case study: Terrestrial Agricultural Landscapes of Canada:
- American Robin eggs were collected in orchards where there was heavy use of insecticides.
- Areas of these orchards bio accumulated DDE, a form of the insecticide DDT, which entered the food chain through the soil and was measurable in the Robin’s eggs.
- Use of DDT chemicals affected the American Robin across multiple generations by inhibiting its ability to reproduce and raise its young. Certain levels of DDE were measured in every stage of the bird’s life, and when compared to Robins elsewhere showed that there is loss of population.

Ethics:
- These man-made chemicals have sub lethal effects that alter reproduction and survival in certain susceptible and other aquatic species.
- EDCs are an issue of degradation, one that is not caused by consumption, but instead as a byproduct of an activity.
- When a species quality of life declines due to an exposure to endocrine disruptors, its moral considerability is ignored.
- A long term solutions are based on a change in biophysical values. Changing our attitude to include overt forms of sacrifice for the environment in everyday life, and realizing the extent of problems caused by anthropogenic forcings, we would put more value in all species.
- This could be accomplished through a reduction of impervious surfaces, urbanization trends and the creation of incentives for industries to stop using known EDCs.

Possible solutions at a Wastewater Treatment Plant:

| Process                      | Biodegradation | Cost | Efficiency | Additional Drawbacks
|------------------------------|----------------|------|------------|---------------------|
| Membrane Bioreactor          | Combination of a micro-filer and a suspended growth reactor | Varies greatly by location and size of plant | 2/3 studies, over 90% EDCs were removed and 90% of the studies offered a 90% removal rate | Performance decreases with filtration time; Membrane fouling
| Chlorination                 | Used for disinfection by oxidizing cellular matter | Average annual cost for a low flow river with a dose of 1 mg Cl₂ is $49,300 | Chlorination is not effective in sufficiently removing pharmaceuticals although it can still be added as a back-up step | Toxic to aquatic life, corrosive chemical, creates other hazardous compounds in the water
| Oxidation                    | Cross waves with micro pollutants, eliminates bacteria, viruses and other organic and inorganic contaminates | Simply the Oxygent feed, gas and compressor costs $245,500 per year of wastewater. A large unassociated cost is that of electrical power | The research done on some greatly varies depending on the environmental conditions so the results are less reliable
| Other oxidation Processes    | Oxidative processes degrade organic contaminants in water and include chlorination, ozone, permanganate and UV light | Varies greatly by type used | For the most part, ineffective on their own and serve better when paired with other processes such as a biological activated carbon process | Varies by type used

Sources available upon request
The Florida Everglades have been subject to biodiversity loss through climate change and the introduction of invasive species. Beginning 7,000 years ago, the Florida Everglades took shape as an ecologically diverse wetland area. Over the past few decades, anthropogenic effects such as land development, sea level rise, and the introduction of invasive species have greatly affected biodiversity. These problems have made the Everglades more adaptable and habitable for the introduced wildlife to thrive in, creating more stress on the current native plants and animals.

The loss of biodiversity created by introduced invasive species in the Florida Everglades is harmful to ecological systems in all of the southeastern United States. This project is designed to research and evaluate the most significant and prominent invasive problems that the Florida Everglades is facing today. This research will be conducted using an interdisciplinary approach. Economic and environmental impacts will be examined with the help of previous scientific research. Economic impacts are important to understand because before action can be taken, researchers must know what people are willing to pay or give up in order to protect biodiversity loss in this exact location. In order to proceed with those calculations, researchers must have a solid grasp on the prominent issues environmentalists are attempting to combat. This study will connect the two disciplines in order to provide the best analysis of the major problems and possible solutions to biodiversity loss in the Florida Everglades.
Invasive Species in the Florida Everglades

Christie Behot ’16, Kristen Berger ’15, Matthew Musso ’15
Lafayette College: 2014 Environmental Poster Session

Why are invasive species detrimental to the Florida Everglades in respect to biodiversity? What’s being done to control it?

Background

Fast Facts
- Historically a 5,184,000 acre wetland, covering 1/3 of Florida
- Original settlers drained major portions of wetlands to build and farm.
- 1,000,000 acres designated to the Everglades National Park
- 500,000 acres reserved for water conservation area to help control flooding
- Water flows as a 60 mile wide, 300 mile long river

Biodiversity
- Biodiversity leads to thriving ecosystem
- Biodiversity threatened by invasive species due to human activity

Invasive Species
- Invasive species, also called introduced species, alien species, or exotic species, are non-native species that significantly modifies or disrupts the ecosystem & colonies.

How they are introduced
- Arrival through: Horticulture, Trade, Exotic pets (released by owner), International food market, Cargo ships

intensity
- 100 invasive plant species
- 500 non-native fish and wildlife species

Problem

Reasons for thriving:
- High amounts of nutrients due to human induced pollution
- No natural enemies

Harm caused:
- Multiply population rapidly
- Use valuable resources; sunlight, water, nutrients
- Crowds out through:
  1. Predation
  2. Parasitism
  3. Disease
  4. Competition
  5. Creates monocultures
- Change natural landscape and processes
- Water, nutrients, energy cycles

Health Problems
- Invasive species carry disease
- Increased global transportation
- Increased transport of invasive species and foreign disease
- Costly

Most Unwanted Species
- Cuban Tree Frog
- Africanized bees (Killer bees)
- Domestic Pigs, Dogs, Cats
- Red Fire
- Burmese Python
- Saltwater Fish
- Feral Boars
- Non Banded Armadillo
- Common Giraffe
- Brazilian Peccary
- Australian Pine
- Old World Climbing Fern
- Melaleuca Tree
- Hydrilla

Most Endangered Species
- Florida Panther
- Alligators/Crocodiles
- Wood Stork
- Florida Leafywing Butterfly
- Garber’s Spangle
- Granulare Tad Plant
- Southern Cattail

Remediation Efforts

Timeline of Economic Events
Comprehensive Everglades Restoration Plan
1990’s
- Began as $7 billion effort
- Now $17 billion over 40 years
2009
- Governor Charlie Crist announced $1.75 billion land purchase plan. Buying from US Sugar.
- 387,000 acres
- Completed purchase totaled $197.4 million
- 20,800 acres

Tamiami Trail Project
2009
- $81 million
- Relocating elephants that allow water to flow freely into Everglades National Park.

Biodiversity and Economics
- Biodiversity hard to monetize
- Cost done with cost benefit analysis:
  - Cost of cleaning up or reducing or limiting activity
  - Benefit gained from those actions

Economic Resources
Important Sector: How much has this helped?
- Commercial Fishing
- Recreational Fishing
- Residential construction
- Tourism
- Agriculture
- Hunting

Valuation of Lafayette’s Campus
Survey of 37 students on campus:
- Would be willing to give an average of $63 to a fund aimed at saving biodiversity in Everglades
- Low: $0, High: $500
- 45% aware of biodiversity loss in Florida Everglades
- 389 of those aware of biodiversity loss
- 93% said the university would be willing to get involved
- 75% said the university would be willing to get involved if it were from Florida

Worth the Investment?
Research shows return on investment:
- 50 year period (adjusted)
- Water Supply: 13%
- 20 year period (2.5% discount rate)
- $2.04 billion increase in fisheries
- Total: 110.4 of 4.04

*Resources available upon request.
Reusable Stormwater for Irrigation

Georgia Papagianis, Emily Turcotte, and Tawfiq Alhamedi

With an increase in education concerning our environment, water conservation and reusable stormwater initiatives have been established across the nation. Stormwater reuse involves an accumulation of large amounts of rainfall water using a surface detention pond or other water storage systems. This water is then recycled for human and environmental benefits, one being irrigation.

A local environmental activist, along with our poster project team and an Eagle Scout Troop, is working towards creating a large community garden plot on the Johnston Estate in Bethlehem, PA. With the use of stormwater, we hope to grow approximately 2 acres of farmable land for the production of vegetables to be used locally while staying environmentally friendly. The site is located on route 191 and San-tee Mill Road in Bethlehem. The vegetables produced at this farm will be distributed to a local food bank and used at a community kitchen.

Our overall goal for this project is to collect the stormwater runoff that has been collected in a drainage tank and design a sustainable way to water the crops with the reused stormwater. We have designed a pumping system which will extract the stromwater from the drainage ditch, store it in an external tank, and use a wind turbine to pump the stored rainwater out to the field. We have worked with the owner of the farm, an Eagle Scout and his father, and another individual who has done this before for a one acre farm. After we finalize the design, we will hand it over to an Eagle Scout Troop who will build the system.
Reusable Stormwater for Irrigation

Georgia Papagianis – Chemical and Biomolecular Engineering (CE 321)
Emily Turcotte – Civil and Environmental Engineering (CE 321)
Tawfiq Alhamed - Civil and Environmental Engineering (CE 321)

Objective

Our project objective is to collect stormwater runoff in a drainage tank and design a sustainable way to irrigate a 1-acre plot of land with the reused stormwater.

Introduction

- Stormwater reuse involves an accumulation of large amounts of rainfall water using a surface detention pond or other water storage systems.
- This water is then recycled for human and environmental benefits, one being irrigation.
- Farms offer biodiversity

Site Details

- Friends of Johnston Estate located on Santee Mill Road in Bethlehem, PA.
- Stormwater comes from north of drainage ditch near Northampton Community College and Freedom High school.
- After the drainage ditch, the stormwater continues into the Monocacy Creek

Unit Operations

Piping ($2.33/foot ~ $50910.50)
- Poly(Vinyl Chloride), 2” diameter
Pump ($49.95/Pump)
- Centrifugal, 1.5 hp, 15gal/hr
Storage Tank ($926.95/Tank)
- 2500 gallon tank
Wind Pump ($452.00/Wind Pump)
- 1kW wind turbine, 80Vdc, 3-4 mph Wind

Process Flow

Biodiversity

- When managing this project we must keep in mind the biodiversity of the land: the microorganisms in the water, the animals living in the habitat, and the humans consuming the vegetables, and the vegetables themselves.
- Microorganisms: We do not want to disrupt the balance of microorganisms living in the ditch and in the creek just downstream.
- Animals in the habitat: Our project is designed with the safety of the animals in mind. We do not want to harm any wildlife such as frogs or other reptiles that might be living in the drainage ditch.
- Humans: The vegetables grown in the garden must be safe for human consumption, and therefore tests will be conducted to ensure that the water is safe for vegetation irrigation.
- Vegetables: The vegetables to be grown are tomatoes, peppers, cabbage, squash, kale, lettuce, and sweet potatoes, as well as some herbs. With all of these in mind, we have to ensure that the “thirstiest” vegetable will have enough water collected to keep it alive.

Problem Solving

Conclusions

Problem: Road salts contaminate stormwater
Solution: The vegetables in the garden will grow in the warm weather months and the garden so that the irrigation system will only be in use from April-mid October.

Problem: Friends of Johnston is a non-profit and therefore has little budget for project
Solution: A local Eagle Scout group will construct the system. No large excavations will be necessary, as they are very costly. Furthermore, a 25 gallon drum windmill will be used to power the pump.
The Effects of Acid Rain on the Salmon Population In Nova Scotia, Canada

Wenxin Ye, DaMarcus Ingram, and Anthony Loyacona

Industrial processing and vehicles emit primary pollutants which decrease the biodiversity of salmon in the lakes and rivers of Nova Scotia, Canada. Sulfur dioxide and nitrogen dioxide are the primary pollutants that react with ozone and hydrogen peroxide to form acids, which dissolve into rain and lower the pH. Acid rain indirectly causes the loss of salmon because the high concentration of hydrogen ions from the rain displace aluminum and other metal ions from the soil, which seep into nearby bodies of water, and intoxicate the fish. Salmon are especially vulnerable to acid rain because they require freshwater during early development. Also, acid rain is an international issue because wind currents carry pollutants to neighboring countries. In order to research the causes and consequences of the harmful effects of acid rain on the aquatic life in Nova Scotia, as well as implement an efficient and cost-effective solution, we combined the collaborative efforts of environmental chemists, engineers, and economists. The most environmentally effective approach is using alternative forms of energy that produce little acid-forming pollutants such as wind energy and solar energy. However, the transition from hydrocarbon-oil to renewable energy is not an economically feasible or practical approach within the next decade. An effective approach to decrease acid rain is to create international protocols that require countries to reduce sulfur and nitrogen emissions. Catalytic and non-catalytic converters are an economically feasible method that can be placed in industries and vehicles to decrease the emission of pollutants.
Effects of Acid Rain On Salmon Population in Nova Scotia, Canada

Objective: Combine the collaborative efforts of an environmental chemist, engineer, and economist in order to research the causes and consequences of the harmful effects of acid rain on the aquatic life in the northeast Atlantic as well as to implement an efficient and cost-effective solution.

**Causes of Acid Rain**
- Most natural causes of acid rain are volcanoes, and lightning
- Human causes are vehicles, coal mining and fossil-burning industries
- Anthropogenic causes contribute the most to acid rain

**What is Acid Rain?**
- The deposition of sulfur and nitrogen containing compounds
- Sulfur Dioxide (SO₂) and nitrogen dioxide (NO₂) are dissolved in water droplets in the rain
- Converted to sulfuric acid and nitric acid
- Sulfuric acid and nitric acid release protons in the water which lowers the pH

**Primary Sources Of Pollution?**
- The majority of pollutants come from the northeast region of the U.S.
- The most coal mining and fossil burning industries have highest emission of sulfate and nitrate anions

**Acid Rain In the Future**
- The most severe effects on biodiversity lower than rain acid is through alternative forms of acid rain
- Currently, alternative energy on the national scale is not economically feasible

**Government Protocols and Catalytic Converters**
- Converter reduces NOx and SOx emissions in vehicles
- Government policies regulate emissions of pollutants
- Clean act of 1990: caused reduction of SOx emissions by 70% since 1970
- Acidity has increased in eastern U.S. due to prolonged winter conditions

**Wet Scrubbers and Cost Washing**
- scrubber removes acid from the air
- corrosion with untreated material is adheared and monitored
- cost reduces 25% with sulfur

**Severe Impact of Acid Rain**
- Low pH causes chronic deformities in fish
- High concentration of aluminum and other cations disrupts osmolarity in the blood, which causes lysis
- Thick blood clots arteries, which causes heart attack
- Aluminium directly kills the fish, not the acid water
- Severe crisis of Salmon in 24 out of 65 rivers in Nova Scotia
- 51% Salmon Loss from 1975-2010 in Nova Scotia

**What Are the Consequences?**
- Acid Rain is absorbed by the soil
- The high concentration of protons displace cations (Al³⁺, Ag⁺, Ca²⁺) and acids from the soil
- These chemicals seep through the nearby lakes and rivers, which lowers pH of lakes and forms toxic environment
- Decreased critical load (endurance) of soil
- Lowest critical load in Eastern Canada

**Liming in N.S.**
- Addition of calcium carbonate to rivers
- Aims to buffer to neutral pH
- Not economically efficient in N.S. (bottom)

**References available upon request**
Causes and Consequences of Biodiversity Loss in the Coral Reef

Russell Lambert, Ashley Kunow, and David Perlow

Coral reefs are some of the most biodiverse ecosystems in the world, providing homes to hundreds of aquatic species. Many communities rely on coral reefs as a source of income; the rich abundance of aquatic life that they provide is relied upon heavily for food, and the reefs also provide an attraction for many tourists. The microorganisms that make up the coral reefs are extremely sensitive both to water temperature as well as to water acidity, and if the conditions that they need to thrive are not met, they perish. Much of the world’s coral reefs are already threatened, threatening with it the rich biodiversity that the reefs provide.

Some of the main contributors to coral reef loss are the effects that humans have caused in regards to global climate change. As humans continue to produce more and more greenhouse gases, both global temperature and the acidity of the ocean rise. This is a result of the greenhouse effect as well as ocean acidification. As the coral polyps that create reefs are introduced to warmer, more acidic waters, they become unable to obtain the nutrients that they need, and also produce less of the calcium-based coral. Many organisms that live in the reefs, or rely upon the reefs as a source of food, are in turn forced to move elsewhere or perish. In a sense, biodiversity within the reefs is not only reduced, it is eliminated.
Causes and Consequences for Biodiversity Loss in Coral Reefs
Ashley Kunow, Chemical Engineering, CHEM 252
Russell Lambert, Chemical Engineering, CHEM 252 & EVST 100
David Perlow, Biology, EVST 100

Background
- Coral organisms, called polyps, are tiny, soft-bodied organisms related to sea anemones and jellyfish
- Reefs begin when a polyp attaches itself to a rock on the sea floor, then divides, or buds, into thousands of clones
- Corals secrete a hard calcium carbonate skeleton, which serves as a uniform base or substrate
- When stressed by temperature change or pollution, corals will evict their boarders, causing coral bleaching that can kill the colony if the stress is not mitigated
- Coral reefs are important sources of food and building materials in developing countries
- Worldwide coral reefs provide a net income of 29.8 billion dollars

Consequences
- Over the last 16 years the growth rate of coral in the Great Barrier Reef has decreased 20.6%
- The loss of structural integrity of coral reefs leads to lower quality habitats for fish as well as a loss in diversity
- Since skeletal growth and density is reduced by the carbon increase, coral must use extra energy to try and maintain growth, leading to a lack of reproduction
- 75% of all coral reefs are considered endangered
- By 2050 it is estimated that every coral reef will be endangered

Causes

Global Warming and Ocean Acidification
- Approximately 25% of the CO₂ emitted from anthropogenic sources enters the ocean
- Figure A illustrates how CO₂ reacts in the water, decreasing the concentration of carbonate-ions and reducing the rate of calcification of marine organisms

Biodiversity
- 32 of the 34 recognized animal phyla can be found in coral reefs
- Over 20% of the world’s fish population is found in coral reefs
- The reefs support more than 800 coral species and 4000 fish species
- Approximately 10% of global fisheries involve reefs
Deforestation in the Congo Basin

Lori Lombardo, Michael Bossman, and Paige Crowley

Our research focuses on the policies surrounding the deforestation occurring in the Congo Basin. The Basin is the world’s second largest rainforest and is found in ten central African countries. It harbors a large number of endemic and rare species that would disappear with the destruction. This forest also plays an important global role as a carbon sink; it accumulates and stores carbon (such as Carbon Dioxide) preventing it from being released into the atmosphere where in excess it contributes to climate change. This forest has such importance on a global scale that its protection has brought many countries into the picture, both from inside and outside of the continent. This rainforest finds itself in an area of political instability, making the issue of protecting the forest more difficult. Over the past few decades, many policies have been put in place in order to protect the timber and biodiversity found in the basin by numerous groups and countries. Our goal is to analyze these policies and their successes and failures in order to determine which proves to be the more viable option to prevent further unsustainable use. We will look at policies from each of the countries that contain the Basin, as well as policies that have been suggested or put in place by NGOs, non-African countries and other organizations, such as the UN. At the conclusion we will base our suggestion on the best policy based off of reports of successes and scientific articles on the conservation of biodiversity.
Deforestation in the Congo Basin
Paige Crowley, Lori Lombardo, and Michael Bossman

Rainforests in the Congo Basin
The Congo Basin contains parts of 10 countries and is the second largest rainforest in the world at over 250 million hectares, with 60 million existing as protected areas.

Importance of the Congo Basin
The Congo Basin acts as a carbon sink for the entire world, not just the African continent.

Biodiversity in the Congo Basin
The Congo Basin contains 10,000 species of plants (30% endemic to region); 1,000 species of birds; 700 species of fish; 400 species of mammals (39 endemic)*.

Current Policies
Overall, policies in place have the aim of trying to limit illegal logging and managing the forests in a way that benefits everyone, as well as the environment.* Ways of doing this include monitoring forests, imposing labels of legally obtained wood, implementing licensing, reformation of Environment Ministry*. Many countries, NGOs and local governments and organizations have put forward policies to protect this important resource.

Forest to Faucet
Oregon's forests naturally filter pollution, sediment, and harmful bacteria out of our drinking water.

Moving Forward
More local support, stronger efforts from within the countries needed. This will make the policies more accepted and beneficial. Policies should also be unified and more focused to increase their authority.

*References available upon request
How Stratification and Turnover Contribute to Depth-dependent Dynamics in Zooplankton Feeding Interactions

Alaina Young, Kathleen Robinson, and Ethan Ossolinski

Our project approaches the subject of biodiversity through a combined biology and engineering perspective. Biodiversity is beneficial when there are more niche opportunities available. After overturn, differences between the epilimnion and hypolimnion shrink dramatically, and there is less variety in niche opportunities. Too much biodiversity will lead to a decrease in abundance of each individual species and result in a more fragile trophic system.

Zooplanktons are vital secondary consumers in a lake’s trophic system. They can be functionally categorized broadly as Rotifers, Cladocerans, and Copepods, which all exhibit populations that range from suspension feeders to predators. Given the nature of their size-selectivity, we can analyze how abundance and diversity of different functional groups of zooplankton impact trophic web interactions, which cascade down to affect grazing and nutrient cycling rates, and ultimately biodiversity of the entire lake ecosystem.

In addition to this biological analysis, there will be further investigation into how pH, conductivity, and water quality correlates to a healthier ecosystem. These will provide a more diverse outlook onto the reservoir’s health, through an environmental engineering approach. Furthermore, a brief description of these measurements will be portrayed along with an engineering outlook on the reservoir as a structure itself. A quick summary will present the significance of the reservoir’s characteristics and how engineering can help to describe the reservoir to the viewer in a way that compliments the biological findings.
How Stratification and Turnover Contribute to Depth-dependent Dynamics in Zooplankton Feeding Interactions

By Katie Robinson, Alaina Young, Ethan Ossolinski

Biol 332 & CE321

Can biodiversity be achieved through biological engineering methods?

Through different methods of analysis, we can make assumptions about how seasonal turnover leads to changes in abundance and diversity in zooplankton, which can be used to assess the stability of the entire trophic system. Furthermore, using sustainable engineering a more biodiverse ecosystem may be supported in the reservoir.

Introduction

- Fully functioning lake systems of sufficient depth exhibit stratification and turnover in response to seasonal changes in temperature.
- Stratification leads to a diversification in niche availability.
- When there are many niche opportunities, biodiversity increases, and when niche availability shrinks, biodiversity decreases.
- Abundance and diversity of different functional groups of zooplankton impact trophic web interactions.
- This cascades down to affect grazing and nutrient cycling rates, and ultimately biodiversity of the entire lake ecosystem.
- Without the unique application of engineering in the building of Merrill Creek Reservoir, the biodiversity it exhibits would not be possible.

The Engineering Marvel that is Merrill Creek Reservoir

- Merrill Creek Reservoir:
  - Harmony Township, NJ
  - Cost of Construction: $230,000,000
  - Volume of Reservoir: 51,000 acre-ft. or 61 million m³
  - Depth: 210 ft., 80 ft. (avg.)
  - Volume of fill required for dam and 3 bays: 3.2 million yd³
  - Designed to output: 5.6 m³/sec for 115 days
  - Contains both a cold and warm water fishery

- Round Valley Reservoir:
  - Clinton, NJ
  - Volume of reservoir: 370,000 acre-ft. or 230 million m³
  - Depth: 180 ft., 60 ft. (avg.)
  - Oligotrophic environment

Differences in water quality coupled with different engineering practices have led to two very different ecosystems. Round Valley reservoir is considered by the state to be an oligotrophic environment, therefore not as productive and unsustainable for many freshwater organisms, especially zooplankton. However, Merrill Creek, which was built several years later supports aquatic plankton as well as both a warm and cold water fishery.

Conclusion

- Merrill Creek Reservoir exhibits a natural thermal profile that undergoes stratification and turnover.
- Biodiversity is much higher in summer stratification than fall turnover, where niche opportunities decrease.
- The biodiversity in Merrill Creek Reservoir is similar to, and in some cases supersedes that of other lakes.
- Other reservoirs, such as Round Valley, are unable to support biodiversity in conjunction with seasonal changes.
- Zooplankton abundance is similarly affected by seasonal changes in thermal profiles; shallow and deep samples are much closer in percent abundance when the lake is in turnover versus when the lake is stratified.
- The engineering of this reservoir allows for it to support a fully functioning and biodiverse ecosystem, in contrast to the trophic conditions in other engineered and natural aquatic systems.

References:

A. Figure 1: Temperature profile of Merrill Creek Reservoir
B. Figure 2: Zooplankton abundance
C. Figure 3: Abundance of primary producers
D. Figure 4: Abundance of primary consumers
E. Figure 5: Abundance of secondary consumers
F. Figure 6: Abundance of tertiary consumers

Figure 1: Temperature profile of Merrill Creek Reservoir
Figure 2: Zooplankton abundance, by functional group, for summer stratification & fall turnover.
Figure 3: Primary producer abundance, by functional group, for summer stratification & fall turnover.
Figure 4: Primary consumer abundance, by functional group, for summer stratification & fall turnover.
Figure 5: Secondary consumer abundance, by functional group, for summer stratification & fall turnover.
Figure 6: Tertiary consumer abundance, by functional group, for summer stratification & fall turnover.

Figure 3: Zooplankton Abundance by Functional Group for Summer Stratification & Fall Turnover.
Photo Gallery
Event Introduction and Faculty Recognition
Event Photos
Production Team

Faculty Leadership Team

Professor James DeVault, Ph.D., Professor and Department Head Economics

Professor Melissa Galloway, Ph.D., Assistant Professor of Chemistry

Professor Jessica Hejny, Ph.D., Assistant Professor Environmental Science and Environmental Studies

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Jake Lazer ‘15
Stephen Maggio ‘15
THANK YOU JUDGES!

The success of this event is made possible each year by you. Hope you enjoyed this year’s poster session and we look forward to seeing you all next year.

2014 Judges

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Travis Barr '15
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