2015

Stream of Consciousness

Alliance for Aquatic Resource Monitoring's Annual Publication

ALLARM has placed storm drain markers around Carlisle to help raise awareness about stormwater issues.

Adopt a Storm Drain Campaign in Carlisle

by Carmen Mann

When you walk around your hometown have you ever noticed a storm drain obstructed with leaves or trash? Have you witnessed how clogged storm drains can result in street flooding? This year, ALLARM has launched a new project—the Adopt a Storm Drain Campaign—in order to help address some of these issues in Carlisle. Through the campaign we have recruited volunteers to "adopt" storm drains by their house or in their neighborhood. By adopting a storm drain, the volunteers commit to clear their storm drains once a week for at least one year. This helps to keep storm drains free of debris and reduce street flooding, as well as keep potential pollutants out of our dear LeTort Spring Run.

Storm drains are found at multiple locations within a typical street block along the sidewalk's curb. Their main function is to drain rainwater and snowmelt off the streets to prevent flooding. However, they often become clogged with debris such as leaves, twigs, and litter. This is especially prevalent during the fall due to the excessive amount of leaves. Therefore, it is important that storm drains are clear so that when rainfall occurs, we are not left with flooded streets and excessive standing water.

Another aspect of the campaign is to raise awareness about the impact of stormwater pollution on the LeTort. Stormwater is rain, melted snow, or ice that flows over pavements or other impermeable surfaces and ends up in storm drains. However, this water picks up pollutants present on these surfaces and carries them into storm drains. Water entering a storm drain in Carlisle travels through drainage pipes and is discharged into the LeTort Spring Run, untreated, which can have negative effects on stream health. In short, whatever goes down a storm drain goes into the LeTort.

The LeTort is a world-renowned trout stream and has a rich history that intertwines with Carlisle's. Studies conducted by

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ALLARM was founded in 1986 as a project of Dickinson College. Today, our team of students, professional staff and faculty continues to provide community groups with comprehensive technical support for locally-driven watershed assessments, protection, and restoration efforts. For more information visit our website dickinson.edu/allarm. *Stream of Consciousness* is published every year thanks to the generous support of the Charles Merrill Kurtz Fund, established by Betty Puzak in memory of her father, Charles M. Kurtz, Dickinson Class of 1907.

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Photos by ALLARM unless otherwise noted.

Carmen Mann after a successful Adopt a Storm Drain supplies pickup event.

Dickinson's Department of Environmental Science has shown that stormwater is a major water quality issue for the stream. The studies showed that stormwater contained concentrations of contaminants such as lead and copper that exceeded stream criteria and could pose an environmental risk to aquatic life. Keeping the storm drains clear can help reduce stop some of these risks.

For the past five years, ALLARM has had a number of community volunteer opportunities connected to Carlisle's storm drains. One of the outcomes is markers on storm drains throughout the borough. Markers reading "Don't Dump, Drains to LeTort" help to increase awareness about dumping in Carlisle storm drains and raise awareness of the results of pollutants going down the storm drains. Many storm drains in Carlisle are now clearly marked, which makes the drains easier for community members to identify, serving as a reminder as to why clean storm drains are important.

The campaign started by reaching out to the South of South Street Neighborhood Association. Since then, ALLARM staff have attended community meetings and created a webpage for volunteers to sign up online. So far, more than 35 volunteers, some from the South of South Street community have adopted a storm drain in their neighborhood. The Adopt a Storm Drain Campaign had its first pick up date in October 2014 where volunteers came into the office to choose which storm drain to adopt and to receive a number of supplies needed to clear their storm drain. Some of these supplies included gloves, leaf litter bags, and orange safety vests to wear while cleaning since most storm drains are next to the street. In order to choose a storm drain, the volunteers look over a map of Carlisle and all of its storm drains, and pick storm drains close to their property or in their neighborhood they want to adopt.

With the commencement of its own adopt a storm drain campaign, Carlisle joins a nation-wide movement to adopt storm drains. From Seattle, Washington to Superior, Wisconsin, and Tavares, Florida to Oakland, California, adopt a storm drain campaigns are starting up all over the country. Many of these campaigns have the same goals as ALLARM's adopt a storm drain campaign: to help prevent flooding and help prevent pollutants from entering local waterways such as the Puget Sounds and Lake Superior. The adopt a storm drain program in Oakland started in early 2014 and residents have adopted hundreds of storm drains since then. While the program was started only a year ago, the Oakland Public Works office has reported that now there are only a third of the overflows and reported street flooding incidents as five years ago (Shi, 2014). Storm drain campaigns have been making a difference all over the country, and now ALLARM and Carlisle are joining in.

Resources

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Along with adopting storm drains, ALLARM is in the process of documenting where all of Carlisle's storm drains are as well as identifying the storm drains that are unmarked or need a replacement marker. The storm drain marking process is shown here.

A view of the stream restoration site near the Dickinson College Farm after the Phase II planting was completed.

Stream Restoration: A Riparian Buffer Update

by Emily Kaplita

A riparian buffer is a vegetative zone with trees and shrubs that help to filter runoff before it enters a stream. Dickinson's riparian buffer is located near the Dickinson College Farm, on five acres along the Yellow Breeches Creek that was previously used for cattle grazing. ALLARM teamed up with the College Farm in 2013 to transition this land into a riparian buffer site after the farm received a three year agro-forestry grant.

The development of a riparian buffer is a lengthy task. A feasible three-phase plan was created to organize the site and distribute the tasks over a two-year period. In Fall 2013, the first phase of the project was implemented and 125 trees were planted. Phase I is meant to stabilize the stream bank with native trees and shrubs that have large root systems (Palone & Todd, 1998), filter surface runoff, remove nutrients in groundwater, and reduce the impacts of flooding by acting as a natural floodplain (Alliance for the Chesapeake Bay et al., 2010).

To begin work on Phase II, Caroline Kanaskie '17 and I organized a tree-planting day that was held on Saturday, October 25, 2014. There was a lot of work that had to go into Phase II before the trees could be planted. We had to delineate the rows to make sure they were even and there was enough room to mow between the trees. Additionally, we mapped out where every tree would be planted based on where they would grow best. Twenty-four volunteers, as well as seven Farm employees and ALLARM's student Watershed Coordinators, planted, tubed, and mulched 185 trees in less than four hours! Phase II will serve to "remove, transform, or store nutrients, sediments and other pollutants flowing over the surface and through the groundwater" (Palone & Todd, 1998). The trees and shrubs planted in this zone should have large root systems to have a higher chance of reaching the groundwater table and removing nitrogen from the water (Palone & Todd, 1998). In addition to water filtration, these trees were specifically chosen because of their fruit-bearing and historical significance to the area. Once Phase II was completed, a maintenance plan was created for the future and I started to work on the plan for Phase III.

Phase III is the final phase of the buffer, but the work with the buffer didn't end once it was complete. Phase III consists of similar trees that were planted in both Phases I and II, as well more shrubs along the roadside to promote more biodiversity. The primary goals of Phase III in a riparian buffer are to alter the flow of stormwater runoff, filter out sediments and chemicals, and allow runoff to seep into the ground before it reaches Phases II and I (Palone & Todd, 1998). Phase III acts as a sort of shield from concentrated runoff by spreading it out

Left Above: Emily Kaplita '16 and Caroline Kanaskie '17 organized the Phase II and III planting days; Left Below: Volunteers and ALLARM staff take a picture after Phase II planting; Right Side: Staff and volunteers plant and stabilize trees.

and reducing erosion (Alliance for the Chesapeake Bay et al., 2010). This phase, unlike the others, is composed of mostly shrub species to provide a transition between the riparian buffer and the highway (Wertime, R. May 2, 2013). April 11, 2015 was chosen for the Phase III planting day, and other days during the weeks in April were used as maintenance days. ALLARM staff and volunteers planted 200 trees and shrubs in the remaining space of the field.

After completing the planting of the final phase, the project focuses on a space that was also set aside at the site in Phase II to establish an educational space. It is a 30ft by 30ft area right in the middle of the buffer to allow for maximum interaction and serve as an area of reflection. Currently our plan is to put benches in the area, and possibly plant some wild flowers. This space was created so that Dickinson and Carlisle community members can experience what the site has to offer and allow people to learn about riparian buffers, the area around the stream and the different types of trees and shrubs that are planted. The riparian buffer will be a great tool for the future in terms of education and for the environment.

Resources

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Case Studies of Pennsylvania Stormwater Management: Lancaster and Philadelphia

by Katie Mattern

About 60 miles east of Carlisle lies the city of Lancaster, Pennsylvania. With a population of about 60,000, the city might be defined as small[1]. However, after an examination of its stormwater management, it could also be defined as one of the most progressive cities with regards to its stormwater infrastructure.

With both a combined and separate sewer system, a portion of Lancaster's stormwater flows in the same pipes as sanitary sewage to be treated, whereas the other portion is collected through storm drains and discharges directly to the Constoga River. The combined sewer system can cause problems because during periods of heavy rain, the treatment plant does not have the capacity to handle the amount of incoming water. This can lead to the raw discharge of sewage into rivers through an overflow pipe. Alternatively, the separate sewer system accepts stormwater from storm drains that has flowed over roads and homeowner's properties, picking up pollutants from these surfaces such as oils, fertilizer, and road salt. Then underground pipes discharge this untreated water directly into Little Conestoga Creek. However, due to the total maximum daily loads policy established by the Environmental Protection Agency to reduce pollution to the Chesapeake Bay Watershed, Lancaster must prevent 750 million gallons of untreated stormwater from entering the Little Conestoga Creek and Conestoga River- sub basins of the Chesapeake Bay[2].

Facing a possible fine of $37,500 per day if the city does not reduce the volume of polluted water entering the Chesapeake Bay Watershed, Lancaster decided to take action by forming the Green Infrastructure Advisory Committee. This group of residents, environmental organizations, institutions, and government officials were charged with the task of creating an equitable way to fund infrastructure programs capable of reducing pollution to the Chesapeake Bay. Ultimately, the Committee agreed to the Stormwater Management Fee[3]:

- Residents billed quarterly based on their tier assignment determined by the amount of impervious area on their property (Figure 1)
- Quarterly Stormwater Management Fee calculated based on a base rate of $30.96/1000 ft.^{2} per year for each tier
- Tier 0 is not charged a fee, Tier 1 pays 50% of the base rate, Tier 2 pays 150% of the base rate, Tier 3 pays 250% of the base rate, and Tier 4 pays according to their square footage and the base rate (Figure 1)

Lancaster uses the funds collected from the Stormwater Management Fee exclusively for stormwater management. Management projects include maintaining established stormwater structures as well as investing in new green infrastructure such as green parks, streets, roofs, and parking lots. All of these are examples of stormwater Best Management Practices (BMPs), which are methods and designs to help control the amount and flow of stormwater in a given area as well as improve its quality through techniques such as filtration. A green street or park would utilize vegetation to filter stormwater runoff as well as pervious pavement for parking lots so that water can infiltrate directly into the ground instead of creating runoff. Four parks have already undergone renovation to become green parks. A green roof would also use vegetation to hold water and filter it slowly. So far, the city has more than 100,000 ft.^{2} of green roofs. In the coming years, the city hopes to entice homeowner's to increase the green space on their property by offering incentives such as a rebate to help offset new stormwater BMPs and credits for individuals who already utilize BMPs such as rain gardens, rain barrels, and green roofs on their property[2].

For another look at how cities manage their stormwater, we can turn to Philadelphia. Like Lancaster, Philadelphia implemented a fee called the Stormwater Management Service Charge. With a combined sewer system, this city also struggles with stormwater overflows and sewage discharge into surface waters during heavy rain events. However, their stormwater is treated along with their sewage to help remove any pollutants[4]. This stormwater treatment is the basis for the Stormwater Management Service Charge. Residential customers pay a flat rate based on the average impervious surface area of their property in the city. Thus, every homeowner pays $14.15 per month, accounting for about 20% of the fee on a resident's water bill[5]. Unlike residential customers, commercial property owners pay $0.56 per 500 ft.^{2} of gross parcel area and $4.497 per 500 ft.^{2} of impervious parcel area, as well as a $2.15 monthly billing charge[6].

Philadelphia then uses the revenue generated from the Stormwater Management Service Charge to fund the maintenance of its existing stormwater infrastructure, which costs more than $100 million per year. The Service Charge also allows the city to implement new stormwater BMPs to help water infiltrate into the ground naturally and undergo some amount of filtration[7]. Since 2011, Philadelphia has implemented its Green City, Clean Waters plan, which involves building green stormwater infrastructure including green streets and green schools similar to Lancaster[4]. The city has utilized other stormwater BMPs such as stormwater infiltration/storage trenches and wetlands as well[8].

Philadelphia even operates an incentive program like Lancaster, except that Philadelphia's programs—the Stormwater Management Incentives Program (SMIP) and the Greened Acre Retrofit Program (GARP)—are only applicable to non-residential properties. The SMIP is a grant program offering assistance to property owners to build new stormwater BMPs, whereas GARP is a grant program for companies interested in constructing more elaborate stormwater BMPs at several sites[9].

Revenue from both Lancaster's Stormwater Management Fee and Philadelphia's Stormwater Management Service Charge quickly add up. For example, a single person living in a Tier 2 (1,001-2,000 ft.2) property in Lancaster pays approximately $48 per year[3]. On the other hand, a single person living in Philadelphia contributes about $170 per year in stormwater utility charges[5]. Some would consider this a substantial chunk of money, especially considering that PA American Water charges residential rates ranging from about $180 to $272 per year solely for drinking water and sewage services[10]. However, the cost for cities in need of stormwater

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Assigned Tier	Amount of Impervious Surface	Stormwater Management Fee per Quarter
Tier 0	0-300 ft^2	None
Tier 1	301-1,000 ft^2	$3.87
Tier 2	1,001-2,000 ft^2	$11.96
Tier 3	2,001-3,000 ft^2	$19.35
Tier 4	More than 3,000 ft^2	Various: calculated using square footage

Figure 1: Stormwater management tiers in Lancaster, PA.

Top: Rodney Park in Lancaster, PA includes rain gardens and pervious parking areas; Bottom Left: Porous pavement is also used on the park's basketball court; Bottom Middle: The stormwater wetland at Saylor Grove in Philadelphia treats some of the city's runoff before it enters Monoshone Creek; Bottom Right: A planter filters stormwater (see Resources for photo sources).

management could be greater if they do not invest in stormwater BMPs and infrastructure. For example, a city such as Carlisle which is underlain by carbonate bedrock can be sinkhole prone if stormwater is not properly managed (luckily there are storm drains in Carlisle!). The carbonate minerals in this type of bedrock can slowly erode and dissolve due to the slight acidity of rain, forming cracks and underground caverns beneath the ground called karst topography. When soil becomes saturated very quickly in a high rainfall event, the soil above these empty spaces can give way and fall down and create a sinkhole, causing property damage. Therefore, it can prove challenging for a city to decide whether or not to invest in stormwater infrastructure and impose some sort of stormwater fee that can not only help to prevent this damage, but also treat stormwater and prevent water pollution. Fortunately, there are different models available to examine when deciding if/how to implement a stormwater fee from Lancaster and Philadelphia, which have established successful stormwater management programs.

Resources

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[4]Stormwater Management in Philadelphia. Philadelphia Water Department. http://www.phila.gov/water/wu/Documents/StormwaterManagementPublicPrivate.pdf

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[6]What's in my Bill? Philadelphia Water Department. http://www.phila.gov/water/PDF/RatesInfo.pdf

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Park/backetball court photo: http://saveitlancaster.com/local-projects/parks/

Wetland photo: http://phillywatersheds.org/what_were_doing/green_infrastructure/tools/stormwater_wetland

Planter photo: http://www.phillywatersheds.org/what_were_doing/green_infrastructure/tools/stormwater-planter

A residential rain garden filled after a storm in Lancaster, PA (Photo courtesy Lancaster County Conservancy).

Members of the Middle Spring Watershed Association and volunteers at a stream cleanup event (Photo courtesy MSWA).

Meet the Middle Spring Watershed Association

An ALLARM Partner Profile of a Community in Action

by Megan Layman

Once a month in a small, cozy church basement there is a small group of people who get together and volunteer their time to their community and the environment. This group, though small in size, has big passions. The Middle Spring Watershed Association, or MSWA, is a non-profit organization located in Shippensburg Pennsylvania that has been operating for about ten years. MSWA started with the goal of promoting the protection and restoration of their local waters (Potts, 2015). The group's main concerns lie in developmental effects on the Middle Spring. They focus on things such as sewage treatment issues, development impacts, water quality, and increasing fish, wildlife, and plant habitats.

Just like ALLARM, promoting community stream education is close to the heart of MSWA. They coordinate with many groups such as the Cumberland County Conservation District, Franklin County Conservation District, student groups and faculty at Shippensburg University, students from Shippensburg High School, and other neighboring watershed associations. In the past they have conducted rain barrel and water conservation projects, set up educational presentations at local Earth Day events, and they continue to implement stream cleanups once or twice yearly (Potts, 2015).

In an interview on February 12, 2015 the current President of the MSWA, Blyden Potts, who has been involved with the MSWA for five years said, "We make a point to reach out to kids, and our events are directed at getting kids thinking about the stream." Potts understands that children "are the future" and they will have the biggest influence on the future state of our local streams.

There have been ongoing efforts to restore the habitat along streams and the MSWA has been the proud overseer of this project, getting local volunteers to help maintain stream restoration measures.

The Middle Spring Watershed has a rich historical significance to the area. Shippensburg used to be a center of commerce and trade in Pennsylvania and also contains many historic mills. The Middle Spring is a limestone stream with a large population of brown trout and twenty-four other fish species in addition to an immense diversity of wildlife. The Middle Spring was once classified as a "High Quality Cold Water Fishery," but after the sewage treatment plant was established in town near the stream, the Middle Spring was then demoted to a "Cold Water Fishery" (Potts, 2015).

In order for the MSWA to improve and maintain the health of the stream, from 2007-2012 they performed chemical monitoring tests monthly for at least eight months out of the year, and did physical assessments once a year. The goal of the group's monioring was to establish baseline data and identify problem areas. Such

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impacts include siltation from agricultural runoff, industrial pollution, wastewater facilities, and disturbances by commercial or residential development.

MSWA began monitoring the stream in 2007 with many goals in mind. Baseline data and identification of problem areas was to be used to identify areas in need of restoration. With these areas established they could then work with the community for everyone to be able to enjoy the stream. The group stopped monitoring in 2012 due to logistical constraints, but they are "still interested in monitoring water quality," says Potts, and he hopes to get the monitoring program up and running again.

During his interview Potts said, "I was raised as a fisherman with a pack-it-in, pack-it-out mentality." So when he moved to Shippensburg in 2004 and saw trash and debris polluting his local stream, he became interested in what he could do with the MSWA to protect these habitats that he enjoyed as a child. As MSWA continues working with both ALLARM and its local communities, President Blyden Potts recommends to those who want to make a difference in their community "pursue what gets you up in the morning, what makes you go." He says, "People have to follow their hearts" and understands that "we still have people finding new ways to do things. Don't do things the way they have always been done just because that is the way they have always been done." MSWA's busiest month is April, with public events and workshops for kids in their neighborhood. For a small group with big passions they have come a long way, and will continue to fight to protect the aquatic habitats that surround them.

Resources

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The Social Implications of Hydraulic Fracturing

by Claire Jordy

The natural gas industry has been experiencing expansive growth since the turn of the 21st century. Billions of dollars are invested in and are generated by this industry's extractive process. Individuals and regulatory agencies have been challenged to keep up with the potential environmental and social changes from hydraulic fracturing. In the last ten years the Environmental Protection Agency (EPA) began to conduct research on the environmental impacts of hydraulic fracturing (US EPA 2004 and 2011). These studies primarily focus on environmental impacts of fracking, not the societal costs. Independent researchers have begun their own work on the societal impacts of hydraulic fracturing. A number of these researchers embrace the value of community knowledge, information that cannot always be pinpointed by doctors or captured by environmental tests.

Signs displayed outside a community member's house in PA.

Societal impacts of hydraulic fracturing can be broken down into five categories: health, infrastructure and development, economic, environmental, and social (Figure 1). Two recent studies (Brasier et al. 2011; Evensen et al. 2013) looked at the community perception of fracking's costs and benefits through comparison of communities in Pennsylvania and New York. Both studies show that environmental and social impacts of fracking are referred to with a negative valence, or tone, economic impacts with a positive valence, and health impacts with unknown (neutral) valence. Some of the social impacts are an increase in drug and gang activity, and a rise in prices of goods due to increased demand. Social impacts tie in with economic impacts, showing increased inequality from hydraulic fracturing because of unequal distribution of leases and royalties (Brasier 2011). This inequality is seen in housing changes, increase

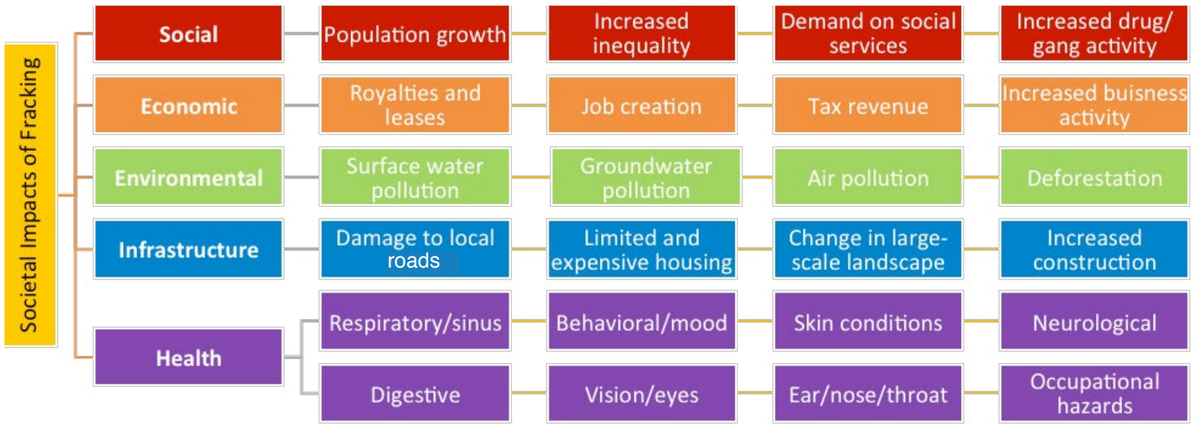

Figure 1: Graph showing societal impacts of fracking broken down into impacts and possible consequences.

in the prices of goods/services, and collection and use of tax revenue. With more people moving into a town for the natural gas industry, there is an increase in demand of housing and goods but not always accompanying increases in supply. Even if there were to be an increase in supply (i.e. more houses built), there would be new environmental and social costs. With pressure on the housing market, rent and related prices increase, often pushing people out of the market because they cannot afford rent (Brasier 2011; Williamson 2011). This trend is similar in other areas of impact from hydraulic fracturing – the lower class is impacted first and most often (Schafft 2013).

Similar to the work that the Alliance for Aquatic Resource Monitoring does with citizen-based science monitoring, these new studies surrounding hydraulic fracturing are focusing on the value of citizen-based knowledge and community-based participatory research (Brasier 2011; Kinchy and Perry 2012; Perry 2012; Steinzor 2013). Community input and knowledge are especially valuable when studying health impacts of hydraulic fracturing. Steinzor emphasizes this by saying "greater understanding of the experiences reported by individuals living near gas facilities can play an important role in pointing the way forward to preventing these problems" (2013). Community members know their bodies and their communities better than officials, and acknowledging this could be helpful in studies on fracking in which symptoms and exposure vary tremendously. Kinchy and Perry, in their article "Can Volunteers Pick up the Slack? Efforts to Remedy Knowledge Gaps about the Watershed Impacts of Marcellus Shale Gas Development," address the knowledge gaps on research on hydraulic fracturing. They acknowledge the gap between scientific research and local watershed monitoring and urge for "bottom-up, community-based assessment of research needs, matched with top-down political, technical, and financial support" (Kinchy and Perry, 2012).

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An anti-hydraulic fracturing sign displayed in Pennsylvania.

There is a great need for research on the health, economic, social, and environmental impacts of hydraulic fracturing. The use of community knowledge and volunteer monitoring could be a great source to obtain this information, part of a way to holistically understand the impacts of hydraulic fracturing. Research shows that economic impacts of hydraulic fracturing are often positive but other impacts are largely negative, causing harm to the community and the land.

Resources

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Photos http://energy.usgs.gov/GeneralInfo/HelpfulResources/MultimediaGallery/HydraulicFracturingGallery.aspx

Fracking brings with it a dramatic increase in truck traffic to an area from construction to operation to water transporation. Pictured here are pumps, generators, fuel, chemicals, sand, pipes, service trucks, and other infrastructure required for the involved process of hydraulic fracturing. (Photo courtesy Doug Duncan, USGS).

Pipelines: Natural Gas Transportation

by Joan Smedinghoff

Enbridge Northern Gateway Pipeline spans across northern Alberta to the B.C. coast (Photo courtesy of Shutterstock).

On Monday, February 23rd 2015, the Alliance for Aquatic Resource Monitoring (ALLARM) co-hosted its first event on pipeline development: Pipelines in Pennsylvania, in collaboration with Heather Bedi of the Environmental Studies Department of Dickinson College, with funding support from CSE, Student Life and the Sociology Department. This event marked another stage in the evolution of ALLARM's mission. While originally focusing on the effects of acid rain, ALLARM has expanded its focus to include issues such as the effects fracking can have on streams. This has led to new water monitoring protocols as well as an exploration of issues such as policies on fracking and natural gas transportation, including pipeline regulation.

What are Pipelines?

There are three main types of pipelines. First are gathering lines, which are small lines (6 -20" diameter) transporting gas from the gas well to processing facilities or to larger pipelines. Second are transmission lines (20-48" diameter), which transport gas across long distances. There is generally a compressor station every 40-60 miles to keep the gas at a high enough pressure for transport. Third are distribution lines, which are smaller lines that bring gas into homes or businesses (Messersmith, 2015).

Within these categories of pipelines are two distinctions: interstate and intrastate. Interstate pipelines carry natural gas over state lines. For example, the Tennessee Pipelines in Figure 1 is an interstate pipeline. Intrastate pipelines transport gas completely within one state. This distinction is important in terms of federal regulations; intrastate pipelines do not fall under the jurisdiction of the Federal Energy Regulatory Commission (FERC) whereas interstate lines do (Messersmith, 2015).

Pipelines are essential for natural gas transportation and constitute a large amount of infrastructure. Even before drilling in the Marcellus began, there were over 8,600 miles of pipelines in Pennsylvania, the 8th most in the United States (Johnson, Gagnolet, Ralls, Stevens, 2011). There are many issues surrounding this large network of pipelines, including environmental impacts.

The largest environmental

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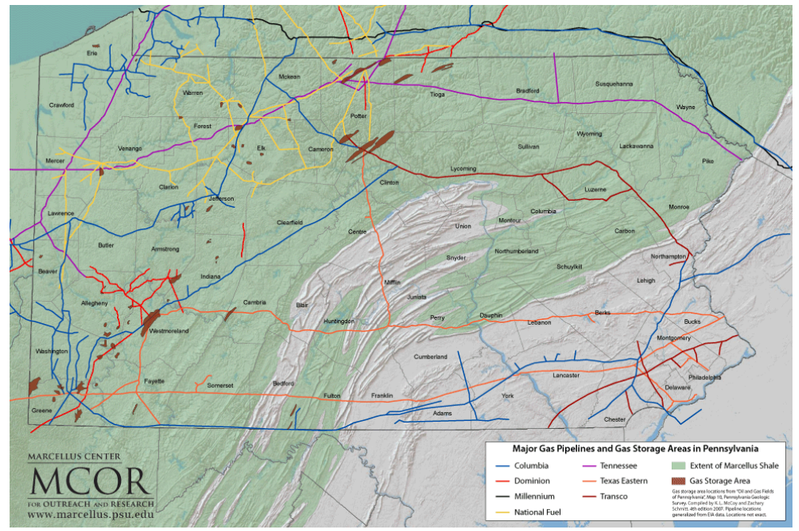

Figure 1: Major gas pipelines and gas storage areas in Pennsylvania (Photo courtesy Marcellus Center for Outreach and Research).

concern with pipelines is the increased risk for erosion and sedimentation. Erosion is when natural forces such as wind and rain cause soil to become detached and move from its original location. Sedimentation is when that eroded soil is deposited either on another piece of land or in a body of water (Atkins, 2000). Both erosion and sedimentation are natural processes, but when humans clear vast amount of land, those processes accelerate and can lead to an excessive amount of sediment in waterways, disrupting vegetation and fish populations. Pipelines require cleared land on either side, for example, transmission lines require 50 feet on either side. As you can see on page 15, this can lead to a lot of exposed dirt and sediment, increasing the opportunity for erosion and sedimentation.

Outside of environmental concerns, there are also regulatory issues and landowner concerns. Pipelines are considered by most to be the safest way to transport natural gas, but they still present their problems, namely: not all pipelines are regulated. Gathering and transmission pipelines in more populated areas have federal and/or state supervision. However, in less populated, rural areas, gathering pipelines are exempt from federal regulations. The federal government has left it up to the judgment of the state to determine if those pipelines should be regulated, and Pennsylvania has decided not to regulate them (COGENT).

Pipelines in Pennsylvania

There has never been a better time to focus on pipeline development. Residents of Cumberland County recently received flyers in the mail announcing a new pipeline proposed for the area as well as the updating of an existing pipeline. The Pipelines in Pennsylvania discussion was organized to give residents and students the chance to consider and learn about the many different aspects of pipeline development. The purpose of this event was to educate attendees on the ecological, social, and cultural considerations of natural gas transportation.

The Pipelines in Pennsylvania event included presentations from three representatives of stakeholder groups as well as a Q&A, moderated by Professor Heather Bedi. First to speak was Faith Zerbe of the Delaware Riverkeeper Network (DRN), who spoke about the environmental effects of pipeline development, including the construction process and DRN's Pipeline Watchdog program. She gave an overview of pipeline development, including an explanation of the different components accompanied by photos from flyovers she has done of the Delaware Watershed area. Zerbe then went on to explain DRN's Volunteer Watchdog program and what they do to hold pipeline developers accountable. She said that they collect information about the development process by taking photos, filling in datasheets, and collecting soil samples. They also make sure that the construction process follows all regulations, such as having the correct signage and following erosion and sedimentation guidelines.

Faith Zerbe of Delaware Riverkeeper Network speaks at Pipelines in Pennsylvania.

Both aspects are important to protecting an area from potential pipeline impacts because, as Zerbe notes, correct signage ensures that areas outside of pipeline right-of-ways are left undisturbed. In addition, it ensures that correctly installed and maintained erosion and sedimentation measures keep the extra exposed sediment from reaching water bodies and other areas where it could harm ecosystems. After pipelines have been installed, Zerbe says it is important to check on them because companies can draw out the restoration phase of the project, leaving areas open and disturbed. Faith Zerbe made clear the potential environmental harms of pipeline development, and outlined how DRN is trying to minimize their impacts.

Chief Carlos Whitewolf of the Northern Arawak Tribal Nation of Pennsylvania spoke second on the Native American viewpoint of the proposed pipelines, the cultural significance of the land that will be affected, and his efforts to keep the pipelines off of those lands. Some of the land that the pipeline will cut through is sacred to the Northern Arawak, the Conestoga, and other Native Americans in the area so they are working to make sure the lands are registered in order to protect them from development. Artifacts have been discovered on lands that will be affected by the pipelines—proof, Chief Whitewolf says—of Native American inhabitation and use of these lands. He spoke about some areas specifically, including Chief's Hill, an area where it is believed that Chief Civility of the Susquehannock is buried. However, the pipeline developers did not recognize these claims because there are no federally recognized tribes in Pennsylvania. Chief Whitewolf talked about his fight for recognition in order to protect these lands, including demonstrations and acts of civil disobedience.

Pipeline installation in progress (Photo courtesy Delaware Riverskeeper Network).

"To the Northern Arawaks, we have a belief… that when our spirit is called to the other side… we have a choice [to go to heaven, or back to our land]. We believe that our people always chose to go back to our lands… We believe that the spirits of the Susquehannocks and the Conestogas still roam in these lands, so we always want to sing a prayer to show support… we as a people are together and we will fight for them and bless the lands. Our heritage, our culture is protecting the land." Chief Whitewolf brought a cultural perspective about the importance of preserving heritage and preventing abuse of culturally significant land.

Lastly, Lynda Farrell of the Pipeline Safety Coalition spoke on pipeline regulations, safety issues, and landowner rights. Farrell formed the Pipeline Safety Coalition when she had a pipeline in her farm field, but realized that she didn't know what her rights were as a landowner, what others' rights were, what the process was, and how regulations worked. Pipeline Safety Coalition holds workshops teaching people what they need to know about pipeline development and why it is important. During her presentation, Farrell explained who regulated which types of pipelines, the Federal Energy Regulatory Commission (FERC) process, and landowner rights.

"The whole process [of regulations] is very confusing," Farrell said. The most important point she stressed was that different types of pipelines fall under different regulations, creating that confusion. Pipelines are categorized by where they go and what they carry. Does the pipeline stay within the state or cross boundaries? What is it carrying? By knowing the answers to those questions, landowners can know what rights they have and how a pipeline is regulated.

The three presentations were followed by a question and answer period, then roundtable discussions. Topics included the proposed Sunoco pipeline, landowner and community rights-based approaches to the pipeline, Native American concerns, and ecological impacts.

The event had a great turnout, with 150 people filling the Allison Hall community room, including Dickinson students, Carlisle residents, and representatives from eleven different environmental organizations. With such a diverse group of attendees, a panel representing a range of perspectives on pipeline development, and roundtable discussions to cover the rest, the Pipelines in Pennsylvania event brought together a diverse group of people to talk about the many issues surrounding pipeline development. Pipelines are an increasingly discussed issue, both in Pennsylvania and across the country, and ALLARM will continue to research their development, educate people on their impacts, and facilitate conversations about their development.

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Flowback Water & Fracking: Potential Impacts

by Helen Schlimm

If you live in Pennsylvania, New York, West Virginia, Ohio, or Maryland, chances are you have heard of shale gas extraction and the process of hydraulic fracturing, also known as unconventional drilling or fracking. In 2007, there were only 144 permitted unconventional wells in all of Pennsylvania. As of February 2015, that number had increased to around 16,000 permitted unconventional wells (marcellusgas.org). The practice of unconventional well drilling has literally sprung out of the ground in the last five years in the northern tier and western part of Pennsylvania. One of the most prominent areas of study surrounding the fracking process is that of flowback water, which is the waste fluid that flows back up to the surface after a well has been fracked. In the latter half of this natural gas boom, the pace of drilling has slowed enough to allow some research into the potential impacts of flowback water on the environment and human health.

The study of flowback water is continuously producing new findings, including insights into its geochemical makeup, which is a significant fingerprint for its origin in the Marcellus Shale play, as well as more advanced tracing technologies and methods. Of the roughly 4-8 million gallons of water that are pumped into an unconventional well, "only about 20% comes back up to the surface and needs to be properly treated and disposed of" (Stokstad). Flowback water contains high concentrations of salts, heavy metals, drilling chemicals, and naturally occurring organic and radioactive materials from within the shale itself. The specific composition of flowback water is still under question, "but it's undeniable that if fracking should continue at this rate, we must figure out safe disposal methods for these massive volumes of waste water" (Stokstad).

As of 2013, 67% of the flowback water was recycled and reused for further fracking, and this percentage has increased in the past year (Harkness et, al). Alternate methods for waste disposal include injection into underground wells in Ohio and West Virginia, road-spreading as a liquid deicer, and trucking to treatment facilities. Of the 502 brine treatment facilities in PA, many may not be fully equipped to handle the scope of the waste water cleaning that is necessary prior to surface water discharge (marcellusgas.org). It is important to note that discharges from the fracking industry, as of now, are largely exempt from regulations including the Safe Drinking Water Act and the Hazardous Waste portion of the Resource Conservation and Recovery Act (Harkness et. al).

Flowback water at a wellpad near Waynesburg, PA (Photo courtesy Getty Images).

Beyond inadequate treatment before discharge, there is concern about the occurrence of accidental leaks from temporary storage pits, spills, and even illegal dumping. Susan Brantley, a researcher at Penn State who chairs the Shale Network research project, recently conducted a study on the frequency of well violations in relation to the amount of leaks and spills, either of the flowback water or of the natural gas itself (Brantley et. al). Typically, the issue is with faulty well casings and construction issues in the drill-hole, in which the gas and/or flowback water can contaminate shallow underground aquifers. Fortunately, her report concluded that "the frequency of big problems is pretty low" (Stokstad).

Flowback water is a potential pollutant of surface waters, including drinking water sources, with high amounts of salts, metals, and a chemical cocktail of uncertainty that has launched this wave of research. In the last six months, new reports citing more advanced scientific and technological methods of tracing this fluid have surfaced. This shows that it is contaminating waterways in Pennsylvania and West Virginia fairly consistently. Some of these studies include using noble gases and hydrocarbons as well as strontium, boron, chloride, bromide, and lithium isotope ratios as tracers of flowback water (Darrah et. al, Kolesar et. al, Warner et. al).

In addition to discoveries of more accurate and efficient ways to detect flowback water in the natural environment, a study last month from Duke University found high concentrations of some components of flowback water that are of particular concern: ammonium, iodide, and bromide (Harkness et. al). Ammonium in high concentrations is directly toxic to fish and aquatic organisms while the halide group of elements (chloride, iodide and bromide) can contaminate source waters for downstream drinking water treatment plants and can react with disinfectants like chlorine to make carcinogenic byproducts (Harkness et. al). The surge of research on flowback water and its potential impacts has several common results: significant environmental and ecosystem impacts of flowback water disposal are occurring and there is a need for further review and regulatory action, as well as the importance of a broad set of transparent and accessible data (Brantley et. al). The EPA is due to publish a report on fracking and its water quality implications, and perhaps stricter regulation of the waste water treatment and disposal of flowback water will be forthcoming.


Flowback water has been found with high levels of ammonium, iodide, and bromide (Photo courtesy Environmental Science and Technology/Warner et. al).

The Marcellus Shale natural gas fracking boom of the last five years has reshaped the oil and gas industry in this state but is still a relatively new practice, thus providing unique opportunities for ongoing research. Susan Brantley aptly remarked that it is "like a giant experiment being run in our backyard" (Stokstad). Pennsylvania's ubiquitous waterways are extremely important to its identity and its residents, which is why the ALLARM shale gas flowback water protocol and chemical monitoring decision tree are important. Our community monitors want to have the skills to locate a potential flowback water contamination event, and providing the means and knowledge to do this is essential to who we are as an organization. For now, it does not look like fracking is going anywhere, and neither are the potential issues concerned with flowback water. Maybe in five more years, a different story will be surfacing.

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God's Country Waterdogs
Protecting Potter County Streams

by Caroline Kanaskie

The Germania branch of Kettle Creek runs by Susan Haythornthwaite's house in Potter County (Photo courtesy Susan Haythornthwaite).

Located in the center of the northern tier of Pennsylvania, Potter County is home to an abundance of natural resources. Whether you're looking for the darkest night skies, dense forests, or rich farmland, you'll find it in Potter County—also called God's Country. In the water world, Potter County is known for the Triple Divide: the start of three major rivers, all of which drain into different large bodies of water. The Susquehanna flows into the Chesapeake Bay, the Genesee flows into the Gulf of St. Lawrence, and the Allegheny flows into the Gulf of Mexico. Potter County also houses a hidden resource: below ground, natural gas is trapped in the Marcellus shale.

In 2009, drilling and hydraulic fracturing of Marcellus shale gas wells began in Potter County. At the same time, the Potter County Conservation District established a Natural Gas Task Force to address community questions and educate the public about the fracking process. Mary Anne Heston, a retired Potter County schoolteacher, attended the task force meetings—and in the spring of 2011, she joined other concerned citizens to form God's Country Water Dogs (GCWD). Inspired by Tioga County's Pine Creek Water Dogs and Trout Unlimited's Cold Water Conservation Corp, God's Country Water Dogs seek to monitor local waterways in order to provide quality data to agencies involved in water protection, and began a partnership with ALLARM in 2014. GCWD is a group of engaged volunteers who have developed big picture awareness of how drilling affects their community and beyond. Mary Anne is an unofficial leader of the group, coordinating meetings and representing the organization throughout the county. She credits Loren Fitzgerald, the first leader of the Water Dogs, with the galvanization of the group.

GCWD Quick Facts
Established: 2011
Shale gas monitoring sites: 35
Shale gas wells: 69 (as of 2/10/15)

Every two months, Mary Anne represents God's Country Water Dogs at the Water Quality Work Group meetings. The work group brings together many groups throughout the county, including Potter County Commissioners, the Triple Divide Watershed Coalition, and the County Conservation District. These meetings keep communities up-to-date and informed and allow each of the organizations to gain support.

Just as drilling reached its peak in Potter County in 2012, Susan Haythornthwaite joined the Water Dogs. Susan attended ALLARM's Shale Gas Workshop in Coudersport that March, and has been monitoring the stream that runs through her front yard near Germania nearly every weekend ever since. Over the past three years, Susan has created an extensive data set for her local stream. Her attention to detail and understanding of the science behind her monitoring led to an interesting discovery in the winter of 2014. She noticed a sudden spike in conductivity, and levels stayed high for days. The cause of the elevated conductivity was not apparent, as there were no active wells upstream of her site. After split-sample analysis—testing and then sending a sample of stream water to ALLARM for quality assurance— it was determined that road salt was most likely entering the stream, as has been happening all over the state. When road salt mixes with stream water, the result can be a brine less salty but with similar conductivity measurements as flowback water. Susan described this event as her most memorable monitoring experience in her three years of baseline monitoring.

The Water Dogs are truly engaged in water quality monitoring. Their participation in ALLARM's Shale Gas program has broadened their view of the importance of the waterways in their watersheds and in the state. The group has also been involved in writing letters and testimonies to state government officials to voice their concerns. Mary Anne collaborated with Laurie Barr of Save Our Streams, PA to locate and plug abandoned oil and gas wells. One dedicated monitor, Tony Adami, now sits on Galeton's water council as a result of his concerns tied to monitoring.

Recently the Water Dogs have mainly collected baseline data, but Utica Shale drilling may be a threat to Potter County waterways in the future. Increased drilling activity could inspire increasing volunteer participation in current and new monitors. God's Country Water Dogs, Trout Unlimited, the Allegheny Watershed Association and Genesee River groups are working together to interpret and map their data in order to determine next steps in their monitoring programs. GCWD has been involved in a lot of meaningful programs and projects that have protected Potter County and its natural resources. Their concerns have led to discovery, greater community involvement, and important discussions. Who knows what the future will bring for God's Country Water Dogs, but they have the resources, volunteers and dedication to face local and statewide challenges.

Watershed Coordinator Caroline Kanaskie with the God's Contry Water Dogs.

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Water Access Inequalities in Costa Rica

by Noah Burchard

While studying in Costa Rica last year, I was surprised to learn that while the country is a forerunner with some of the most environmentally progressive policies in the world, it struggles with crippling water issues. These issues have caused Costa Rica to drop drastically in the rankings of the Environmental Performance Index, which rates countries' management of important environmental issues (Yale University 2014). Sadly, there is a prominent disparity in water access in some communities, due to affluent tourist populations heavily burdening local freshwater supplies.

An example of this tension is evident in the more impoverished and arid province of Guanacaste, which has several golf courses targeted to tourists, consuming about as much water as a village daily for irrigation (Honey et al. 2010).

To find out about the relationship between the tourism industry and water issues, I traveled to Playa Santa Teresa on the Nicoya Peninsula. Growth of tourism to the area in the 1900's sparked rapid changes. Increasing tourist and resident populations, in addition to poor water infrastructure, magnified water shortages in the area and led to the depletion of underground water reservoirs by unregistered private wells. Population growth also exacerbated other issues, such as the lack of treatment of most of the area's sewage, which ends up in waterways (Delgado Fernandez 2014).

A community organization is working to address these water issues partially through partnerships with restaurants in the area, which largely depend on tourists for business. The organization hopes to find innovative solutions to the often-overlooked issues for waterways created by restaurant waste disposal, such as

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A panoramic view of Costa Rica. The tourism industry can have positive and negative environmental impacts on Costa Rica.

composting and collecting kitchen grease for biogas production (Delgado Fernandez 2014). For one week, I partnered with this organization by surveying restaurant owners and workers on their relationship with waste and local water concerns. While many of those surveyed are engaged in sustainable practices, many restaurants are improperly disposing of grease, organic waste, and sewage. Moreover, many people expressed concern over water access issues and the lack of water in general.

The issues faced by Santa Teresa troubled me, but I realized that I didn't even need to leave the community I was staying in, a suburb of San José, to learn about such problems. Even in the wet season, my host family would have no running water after the early morning. As I hiked into the hills of a gated, residential community known as Roca Verde located adjacent to their home, I found that the story there was completely different. People living in Roca Verde are predominately tourists from United States or Europe. They enjoy an abundance of water coming from their private wells. From private pools on their manicured lawns, they can admire a panoramic view of the Central Valley.

My host mother passionately ranted at me that, in Costa Rica, water is a business and those with more money have more water. I knew that her words ring true for people around the world, but it did not lessen the significance of the inequality she faces each day. Access to water is a human right that should not be affected by race or socioeconomic class.

Despite these issues, the tourism industry undeniably provides many benefits to communities throughout Costa Rica, and contributed to the country's reversal in its relationship with the environment as it strived to attract foreigners interested in ecotourism. Although Costa Rica experienced one of the highest deforestation rates in the world in the 1970s, it now leads with some of the strongest environmental protection efforts, including a goal to attain carbon neutrality by 2021 (Rosero-Bixby and Palloni 1996; Aguero and Eduardo 2014). However, as the nation moves forward it must not neglect its own people, or the importance of water for community health.

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Keeping Lakes, Rivers and Streams Beautiful and Our Aquatic Research Current

by Max Egener

According to the 2011 U.S. Fish and Wildlife report, recreational fishing attracted 33.1 million individuals spending a total of $41.8 billion as a result of that activity. Furthermore, the World Resources Institute values global freshwater ecosystems in the trillions of U.S. dollars. It goes without saying that people love to fish and that the health of our freshwater ecosystems is an integral part of our societies, globally. However, despite the progress we have made in the U.S. over the past half-century in improving water quality, our freshwater ecosystems face old and new challenges everyday. From eutrophication (a suffocating overabundance of algal growth caused by high nutrient runoff) to the increasingly more apparent temperature and precipitation effects induced by climate change, addressing these issues and preserving our highly valuable freshwater ecosystems is going to require more research and more collaboration between scientists and management organizations in the future.

In Pennsylvania, there is no shortage of beautiful lakes, rivers, and streams that people can enjoy year-round. Unfortunately in many parts of the state, there is a shortage of people conducting new, innovative research on freshwater ecosystems and collaborating with management organizations as well as state park services. This kind of collaboration can be a crucial ingredient in maintaining these valuable natural places and preserving them for public enjoyment across generations.

This past summer, Professor Kristin Strock of the Dickinson College Environmental Studies Department and I conducted research on several Pennsylvania lakes by sampling and analyzing lake physiology, biology, and chemistry. Our intent was to begin to better understand the lake systems in the south-central Pennsylvania region and share our findings with the management organizations and state park services that oversee the lakes.

Professor Kristin Strock conducting field work (Photo courtesy Dickinson College).

In Altoona, PA at the Altoona Drinking Water Authority reservoirs, we measured total phytoplankton biomass so that we could help inform the reservoir managers about what kinds of filtration standards would be ideal for their drinking water. We also found a rare species of phytoplankton within one of their reservoirs that has been shown to appear in lakes in Greenland. Our most heavily monitored man-made lake, Opossum Lake, is located roughly 5 miles northwest of Carlisle and is a hotspot for fishing since the lake was drained and then refilled in 2013, getting stocked with rainbow trout in the process. Unfortunately for the fish in this lake and the fishermen who visit this lake during the summer, the fish habitat in the lake toward the end of summer is scarce. By our final sampling date on July 31st, 2014, dissolved oxygen (Figure 1) sufficient to support fish life was only available in the top meter of surface water, but the temperature (Figure 2) in that top meter of water was far too high to support fish like rainbow trout. This suggests that any fish still living in that water during the late summer were having an extremely difficult time surviving. This process of lake anoxia is common in this state and

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is often the main barrier to high quality fish habitats.

In addition to sampling and analyzing lakes in the south-central Pennsylvania region, Professor Strock and I were invited to stay in the Watres Lodge on the Lake Lacawac Wilderness Sanctuary & Biological Field Station. During our stay at the sanctuary, we took lake sediment core samples from Lake Lacawac and a nearby lake called Lake Glies. Lake sediments provide excellent records of environmental conditions because they are the lowest point in a landscape. As sediments and other organic materials accumulate on the lakebed, species of phytoplankton called diatoms are fossilized and well preserved due to their high quantity of silica in their cell walls. This silica-based structure makes them look like glass kaleidoscopes. Since diatom species have known preferred aquatic conditions, we can extrapolate the environmental conditions of the lake and its landscape at any given time by analyzing the species compositions within layers of a sediment core sample. This process was the senior research focus of Tabea Zimmerman (Dickinson '15).

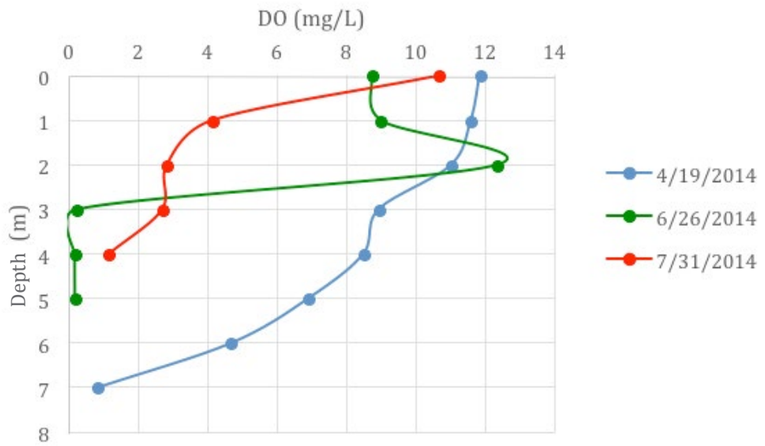

Figure 1. Dissolved oxygen (DO) profile by depth of Opossum Lake at the outlet site (deep point of lake). The blue, green, and red plots show sampling dates: 4/19/2014, 6/26/2014, and 7/31/2014, respectively.

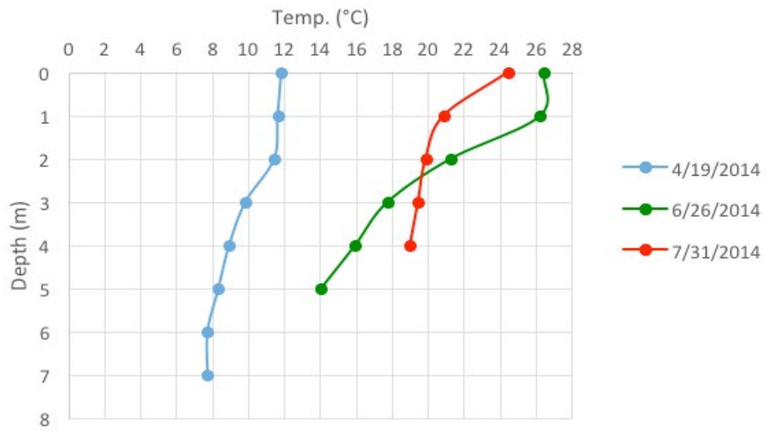

Figure 2. Temperature profile by depth of Opossum Lake at the outlet site (deep point of lake). The blue, green, and red plots show sampling dates: 4/19/2014, 6/26/2014, and 7/31/2014, respectively.

As a result of this summer research, I have been able to formulate my own research questions that I will begin to study for the next year. I will be focusing on the effects of the increasing frequency of extreme rain events induced by climate change on freshwater ecosystems that have been observed in Pennsylvania. I will also be looking at how seasonal changes affect key ecological factors in the lakes in this area.

The South Mountain Foundation along with Dickinson College have been able to give Professor Strock and I the funding to get aquatic monitoring equipment that will be placed on Laurel Lake in the Pine Grove Furnace state park. To contrast data from Laurel Lake's surrounding landscape of highly forested land, I will also include Opossum Lake in my research because this lake is surrounded by agriculture. Hopefully projects like these will continue into the future to better connect students to the management organizations and state park services interested in using science to preserve the lakes, rivers, and streams we love.

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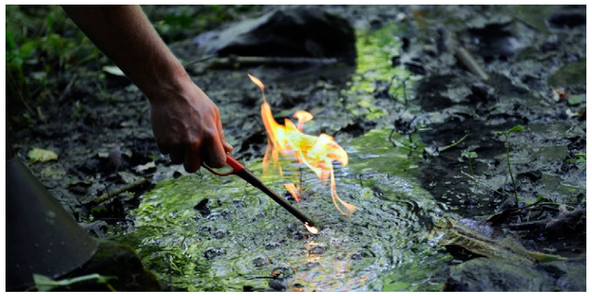
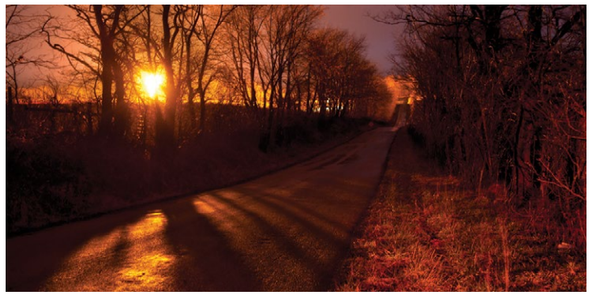
Art as a Story: Documenting Shale Gas Activity





Left: A farmer's stream catches fire due to methane migration from shale gas activity (Photo courtesy Scott Goldsmith); Right: A flaring well lights the landscape in Jefferson Township, Greene County (Photo courtesy Martha Rial).

by Ilana Unger

Data and diagrams are not the only ways to tell a story. Photography is an effective tool of communication when done carefully and thoughtfully. The Marcellus Shale Documentary Project tells the stories of how people's lives in Pennsylvania have been affected by the Marcellus Shale industry. Six photographers: Noah Addis, Nina Berman, Brian Cohen, Scott Goldsmith, Lynn Johnson and Martha Rial have compiled images of the people and places most affected by fracking, highlighting both the positive and negative aspects of shale gas development and how the environment and communities are being shaped by the industry. The project began in 2011 and ended in 2013.

I had the opportunity of interviewing Brian Cohen, the creator of the project. Originally from London, Brian has lived and worked in Africa, the Middle East, Europe, and the United States. During our conversation Brian shed light on how art, specifically photography, can be an extremely effective communication tool. The photographers were inspired by how many people were being affected by fracking and were surprised by the media's lack of attention. The goal of the project was to cast a light on the story of Marcellus Shale drilling, what the process looks like, and to give an honest account of what was going on. The photographers approached the project with an open mind and wanted to be as honest as they could. Some of the most profound photographs are of those who were victimized.

One of the most interesting parts of the interview was Brian's explanation of the powerful effects photography has on viewers. He said that photography draws the viewer in and goes beyond one's immediate world to show what is going on elsewhere. Brian found that the photographs sparked conversation, and helped people find their voice and validate their feelings about fracking in ways they never thought possible. In a way, the photographer has the ability to manipulate the photograph and evoke different emotions from the viewer. Photographers have to be careful not to abuse this power. Brian has watched people go through the exhibit and has had many conversations with people afterwards who have expressed the photographs helping them form their thoughts and understand the effects of the Marcellus Shale industry.

The Marcellus Shale Documentary project offers a look at how fracking operations have impacted communities for better and for worse. I think that it is important to highlight the honest approach the photographers have taken. They are showing both sides, which is extremely important in understanding the story. Robert Hughes, a famous art critic, quite eloquently describes the role of art in his book *The Shock of the New*, "The basic project of art is always to make the world whole and comprehensible, to restore it to us in all its glory and its occasional nastiness, not through argument but through feeling, and then to close the gap between you and everything that is not you, and in this way pass from feeling to meaning." I think that this quote perfectly describes art's role in telling a story. Communicating science through art makes people care about what they are doing, and what better way than to highlight people and how their lives have been changed due to the Marcellus Shale industry. I look forward to visiting the exhibit.

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Contaminants of Emerging Concern

by Andrew McGowan

In the past decade, a growing number of scientists and the general public have become more interested in certain compounds present in our water resources. These include pharmaceuticals, household chemicals such as fragrances, antimicrobials, surfactants (soaps) and fluorescent whitening agents. Together, they are called "Contaminants of Emerging Concern" or CECs. This group includes "any synthetic or naturally occurring chemical or any microorganism that is not commonly monitored in the environment but has been recently detected in the environment" (EPA, 2008).

In general, CECs differ from 'conventional' environmental pollutants such as pesticides, metals, and polycyclic aromatic hydrocarbons because many CECs are used in typical households rather than in large-scale settings.

These chemicals have likely been entering the environment as long as they have been in use. What is "emerging" is the awareness in both the scientific community and general public that these chemicals are being released into the environment while lacking adequate data to determine their actual risk (Younos, 2005; Soin and Smagghe, 2007).

Microplastics

This class of contaminants is one of the most recent to make the list. Microplastics are pieces of polymer that are a fraction of a millimeter in diameter. Weathering and erosion is one way for them to form; however, many current manufacturers use microbeads in personal care products (like toothpaste and shampoo). These plastics, being so small, can easily separate through the filters during the water treatment process and leave in the discharged water. Once in our waterways, these tiny pieces of hydrocarbon attach to sediment particles and can bind with other more persistent toxic compounds. These toxin-plastic complexes can then enter into the food chain, where the complexes can accumulate within organisms and can have disastrous effects (Bakir et al, 2014). Still, more research must be done so we can better comprehend the potential effects of microplastics on the ecosystems and individuals.

ALLARM staff and Dickinson community members tour a local wastewater treatment plant, learning how the facility processes contaminents found in wastewater.

Endocrine Disrupting Chemicals (EDCs) and Pharmaceuticals

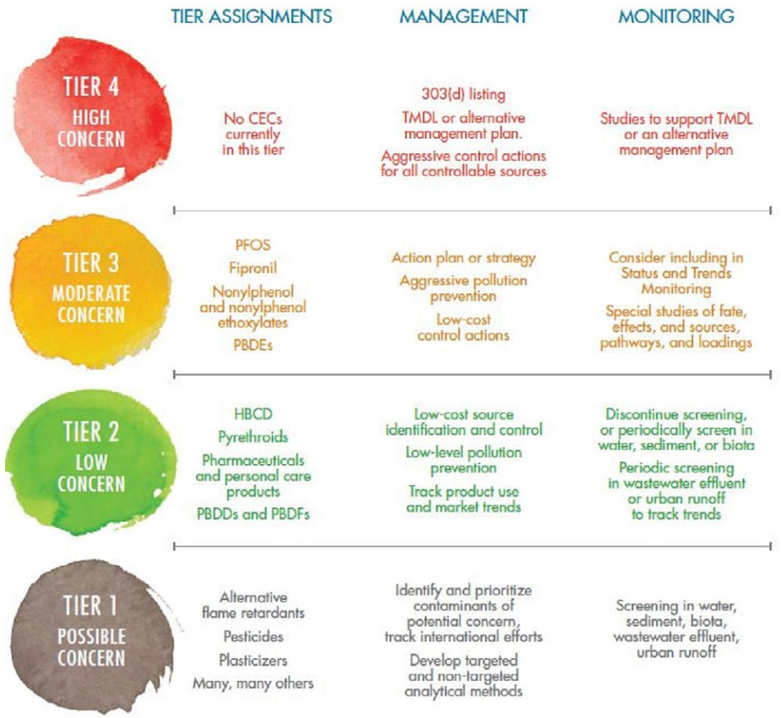
EDCs interact with the normal functioning of the endocrine (hormonal) system. EDCs can either mimic estrogen or androgen, or block one of the receptors in the estrogenic system. The observed effects of EDCs are numerous: the disruption of sex determination and sex ratios, feminization or demasculinization of adult male fishes, and alterations in reproductive behaviors, as well as contraceptive-like actions in both male and female fishes. Similar disruptions are reported for amphibians, reptiles, birds, and mammals exposed via various routes. Some pharmaceuticals present in wastewater are also neuroactive agents, such as antidepressants (e.g., fluoxetine) and beta-blockers, whereas others are metabolically active agents such as anticholesterol drugs. Responding to concerns, the World Health Organization released a 2011 report concluding that EDCs pose a very low risk to human health, but knowledge gaps still exist (Anway et al., 2005).

Polybrominated Diphenyl Ethers (PBDEs)

PBDEs are a class of chemicals widely used as flame retardants in the manufacture of products including textiles, polyurethane upholstery foams, and plastic components of electronic equipment. Commercial production of PBDEs began in the 1970s and researchers first reported their presence in the environment in the 1980s. In recent years, a number of studies conducted in the U.S. and Europe since 2000 confirm that PBDEs biomagnify in the food-chain and accumulate in fish and human tissue. PBDEs have been associated primarily with endocrine disruption and neurodevelopmental toxicity; this has made many people nervous given the fact that PBDEs are widely distributed and persistent in the environment. This past year, researchers have discovered that the two most used PBDEs (TBBPA and 3-OH-BDE-47) were found to inhibit an enzyme that helps remove a form of estrogen from the body, thus allowing this hormone to build up over time (Betts, 2013).

For human and environmental exposure to CECs, additional studies must be conducted to determine the concentrations of both the intact chemicals, as well as any metabolite and dibutyl phthalates (DBPs) that may be formed during wastewater and drinking water treatment processes. This information may assist state and federal regulators in deciding how to improve the treatment of human and animal wastes and maintain a safe drinking water supply for the public. One prominent group, the Consortium for Research and Education on Emerging Contaminants (CREEC) is leading this movement. This consortium includes scientists and engineers from the local, state, and federal government and from several universities with expertise ranging from hydrology and environmental geochemistry to wildlife toxicology, as well as drinking water and wastewater treatment technology. Through collaboration, communication, and education, CREEK is strengthening the science and public understanding of the issues regarding emerging contaminants

Going forward, scientists and the public should focus on developing public policies to fully understand whether some CECs are potentially harmful to ecological or human health, and if there are safe limits of exposure or ingestion (Ashton et al., 2004).



Tiered risk levels of CECs (Photo courtesy San Francisco Estuary Institute).

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Changing Streams: How Climate Change is Affecting Waterways and Watersheds

by Jess Poteet

The climate is changing (IPCC 2014). Our human activities are increasing the amount of greenhouse gases, such as carbon dioxide and methane, in the atmosphere. These reflective particles trap the sun's heat and warm the earth like a greenhouse. The climate is a very complex system; one change can cause an almost infinite number of rebounding effects. For example, there may be a major snowstorm in the eastern United States because the warming of the Pacific Ocean caused a typhoon that whipped the jet stream off its course (Lewis 2014).

The earth has already warmed an average of 1.5°F (0.85°C) since the start of the industrial revolution in 1880 and we are seeing the effects of this warming in the most vulnerable ecosystems. Drought in East Africa, massive coral bleaching in the Pacific, and melting glaciers in the Artic are all connected to climate change (Lott et al. 2013; Mathiesen 2014; Cramer 2014). In the Northeast United States, temperatures over the next few decades will rise an average of 2.5°F to 4°F in the winters and 1.5°F to 3.5°F in the summers regardless of emission decisions we make now. Future temperatures for the end of the century could raise around 6-12°F under a high emission scenario or 3-8°F under drastic reductions in greenhouse gas emissions (UCS 2008).

Higher temperatures create increased water vapor in the atmosphere, which leads to more intense precipitation events. In Pennsylvania, annual precipitation has increased between 5 and 20 percent (depending on the region) in the last century. The resulting trend is that the Pennsylvanian winter, spring, and fall seasons have had distinctly more rain, while the summers have gotten slightly less. Precipitation is expected to increase more than 5 percent above the historical average over the next several decades (UCS 2008).

With increasing summer temperatures coupled with slight decreases in summer rainfall, streams will have low volume and low flow (UCS 2008). Many streams are already under stress due to excessive water withdrawals or land development. Water taken to be used in the hydraulic fracturing process is often taken from nearby waterways. Around 4.4 million gallons of water are used to frack one well, over half of which is withdrawn from local rivers and streams (Lu 2013).

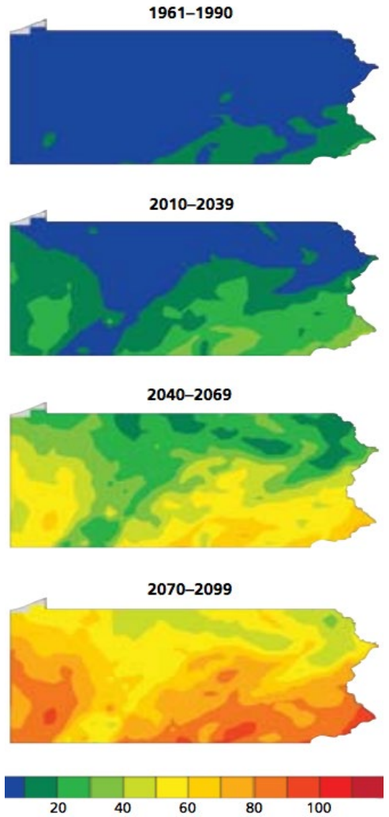
The Susquehanna River is the largest tributary of the Chesapeake Bay.

On the other hand, a general increase in precipitation during all other seasons means increased stormwater runoff and sedimentation. One study found that dams and reservoirs were of particular concern. Because of the trend in increased high volume precipitation events, reservoirs may have inadequate capacity to handle future rain events and dams may overflow more often (Palmer et al. 2008). Furthermore, combined sewer systems, which are found in older cites in the Great Lakes and New England Regions, could overflow more often with increased heavy precipitation events. More sewage in waterways means more nutrients, toxic chemicals, microbial pathogens, suspended solids, and debris in streams and rivers (EPA 2008).

Along with issues of flow, discharge, and runoff, climate change can mean changes in oxygen content of streams. Warmer air temperatures tend to produce warmer water temperatures; warmer waters are able to hold less oxygen. If dissolved oxygen decreases, waterways will see an increase in dead zones which can suffocate aquatic life (UCS 2008).

Once these watersheds begin to empty into the sea, more issues arise. For example, the Chesapeake Bay is cited as one of the most vulnerable regions in the nation with regards to climate change impacts. Already a degraded ecosystem, the Chesapeake Bay would suffer from warming temperatures and increased nutrients, a rise in sea level, changes in wildlife and ocean acidification. Sea-level rise is caused by both the thermal expansion of the water and land glaciers melting into the ocean. Water in the Chesapeake Bay has risen one foot over the past century, and is predicted to rise another 1.3 to 5.2 feet over the next century. This is happening faster than the global average because the Bay is, at the same time, sinking; this is mostly due to intensive groundwater withdrawals (Chesapeake Bay Program 2012).

Rising sea levels could also worsen Philadelphia's water supply problems by increasing the salinity in the Delaware River/ Estuary system (UCS 2008). The Chesapeake Bay will need to adapt to these issues and others concurrently. Nutrient fluxes from increased runoff to tributaries, a decrease in primary productivity from warming waters and ocean acidification, inundated wetlands and marshes due to sea level rise, and distribution changes in aquatic life due to temperature shifts will all affect the Bay during this century.



Past and projected days per year with temperatures over 90°F in Pennsylvania (Union of Concerned Scientists).

Climate change is important to consider in both a local context in adapting to the impacts and a global framework in mitigating greenhouse gases. The United Nations Framework Convention on Climate Change is by far the largest convention to negotiate the rules of mitigating greenhouse emissions. Every country that is a signatory to the UN sends delegates to negotiate a climate agreement every year.

I attended the 20th Conference of the Parties in Lima, Peru in the fall of 2014 with Dickinson College. Although most countries recognize climate change as a personal threat to security, it is very difficult to come to an agreement on who should be reducing emissions and how much they must cut back. The negotiations in Lima ended with a fairly weak agreement in which countries each pledged voluntary cuts in emissions, but the major climate change agreement was held in Paris in 2015. Even if governments are too slow for effective action, the potential for grassroots social movements to stimulate change should not be undervalued.

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Senior Reflections

2014-2015 ALLARM Staff: Back Row, Left to Right: Joan Smedinghoff, Andrew McGowan, Julie Vastine, Helen Schlimm, Emily Kaplita, Katie Mattern; Front Row, Left to Right: Ilana Unger, Noah Burchard, Claire Jordy, Megan Layman, Caroline Kanaskie, Jess Poteet, Carmen Mann, Max Egener, Holden Sparacino. Not Pictured: Jinnie Monismith, Candie Wilderman, Nikki Dutta.

Left to Right: Noah helps shale gas volunteers at a workshop; While traveling, ALLARM gets a picture at PA's grand canyon.

Noah Burchard

I am incredibly grateful for how ALLARM has shaped my college experience. I believe that Dickinson College is absolutely one of the best colleges in the country for pursuing environmental passions, largely because of organizations like ALLARM. My favorite memory from ALLARM was going on a road trip through the Northern tier of Pennsylvania last summer as we led workshops for community volunteers in some of the most fracked areas of the country. Hearing communities' stories and meeting people passionate about the issue, like folks from Energy Justice, was unforgettable. After the final workshop of the trip, we talked to a family from Dimock, PA whose water had been polluted by drilling activity. Water deliveries to their neighborhood had ended, and they had taken it upon themselves to deliver clean drinking water to their neighbors. Moments such as these have increased my passion for the importance of water access rights, community health, and healthy waterways. As I look for jobs in the future, I would love to work for a nonprofit organization that combines community organizing with environmental protection efforts like ALLARM.

Carmen Mann

Even though I did not start working at ALLARM until I came back from my time abroad in junior year, it has been one of the most rewarding experiences of my entire college career. During my time at ALLARM I have acquired and perfected skills I never had the chance to learn in the classroom. I have learned how to reach out to different community groups and members, as well as organize and run different events and workshops. I was also able to learn a lot more about issues I was interested in and how they are addressed at a local level. In my studies, I was very interested in water and water security, and someday would like to work in local communities around the world to help address water management issues. ALLARM has given me the opportunity to see water issues that affect communities first-hand, and to hear from volunteers in the area about their opinions, concerns, and what they are doing to help or combat the issues their communities face. These experiences will be invaluable for me in the future. One of the most unique and enjoyable things about an ALLARM experience is the responsibility given to the students who work there. Not only is it helpful in developing important skills, but is also so incredibly empowering. I was especially lucky that I had the opportunity to help launch a brand new stormwater campaign at ALLARM. I was able to lay the groundwork on a project that will hopefully continue to grow in the future.

Left to Right: Carmen maps adopted storm drains; ALLARM poses for Water Day; Jess plants a tree during a service day.

Jess Poteet

I began my work at ALLARM starting my sophomore year of college. I had already experienced some of the organization's impact when I helped organize volunteers in my hometown to attend an ALLARM water quality monitoring workshop the summer before. As I became more deeply immersed in the organization, I came to understand the incredible power of ALLARM that many may not see at first glance. It empowers community members with science, prepares students for professional careers, and helps to protect one of our most valuable resources, water. I am proud to have been able to be a part of it. As an environmental educator, I worked with local students of all ages and a Girl Scout troop to engage them about water quality issues. These experiences enriched my college experience by allowing me to be part of Carlisle as a community member, not simply as a student of Dickinson College. My two years as a lab coordinator gave me the opportunity to learn new skills in analyzing water samples as well as an opportunity to connect with some of ALLARM's partner groups and help them visualize their data. Working for ALLARM has prepared me for the future career I aspire for - working for a nonprofit organization. My passion for the environment, community, and citizen science has been strengthened and validated through my work. Still, my favorite aspect of ALLARM has to be the family of staff and directors that I have become a part of. I wish them all the best as they continue into the future, I know we will keep in touch!

Joan Smedinghoff

I have had the opportunity to work at ALLARM since my freshman year through the Montgomery Service Leaders (MSL) program. MSL is a three-year program that partners freshmen with a Carlisle non-profit and allows them to learn and grow with the organization. I was happy to have this opportunity and thrilled to learn that ALLARM was a possible partner, since I already knew at the time that I wanted to be an environmental studies major. As happy as I was to be placed at ALLARM, though, I didn't understand why it was a part of the MSL program, which focused on community service. ALLARM was an environmental organization, not a community service organization, right? It wasn't until my first workshop that it all clicked and I realized those terms weren't mutually exclusive. In the workshop, my colleagues and I taught residents of Rochester, PA about fracking, its environmental impacts, signs of contamination, and how to test their stream water. We went through the hands-on activities with them, allowing them to become experienced and comfortable with the meters and choosing monitoring sites. It was at this workshop that I saw how science and environmental awareness could be a form of community empowerment. Working at ALLARM has been such a blessing both because of the skills I've gained and the people I've worked with. ALLARMies are such wonderful people; the other students bring such creativity and energy to the office and the unwavering support from our directors, Julie, Jinnie, and Holden, have helped push me into trying new things and developing as a person. My time at ALLARM has been one of the most meaningful experiences at Dickinson, and I can't imagine my college experience without it.

Left to Right: Joan edits Stream of Consciousness; Ilana & Joan meet with an NPR reporter; Ilana plants trees near a stream.

Ilana Unger

I have only worked at ALLARM for a year but it has been such an enriching part of my final year of college. What drove me to ALLARM was the integration with communities. I have really enjoyed being able to work with a variety of stakeholders that are all interested in a similar goal. I have had so many great experiences at ALLARM. I am really going to miss my ALLARM family. Being an outreach coordinator has allowed me to learn more about working with communities. Throughout this experience I have realized that I greatly enjoy working with different people and communities. I can see myself in the future doing something community based. I had the opportunity to present at a shale gas monitoring workshop in Butler County, plant trees for stream restoration projects and continued to pursue my passion in photography. I am so grateful to have been able to work at ALLARM. I made some amazing new friends, engaged with communities and most of all found a place at Dickinson that is truly making a difference. Thanks for all of the great memories!

ALLARM in Pictures

1: Helen, Emily and Katie teach Camp DIG attendees about biological monitoring over the summer; 2: Helen and Caroline talk with Gwen Lehman of FracTracker.org at the community 'Pipelines in Pennsylvania' event; 3: Emily trains shale gas volunteer monitors to use equipment; 4: staff members meet with PA Department of Environmental Protection's Oil & Gas Deputy Secretary Scott Perry to discuss regulations and protections; 5: Julie reports Pennsylvania updates at the Mid-Atlantic Volunteer Monitoring Conference; 6: Andrew works in ALLARM's lab; 7: Cheyenne, Alec and Jinnie gather equipment to monitor the LeTort Spring Run; 8: Butler County volunteer monitors at a shale gas workshop; 9: Volunteer monitors catch macroinvertebretes to assess stream health.

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