Meet the 2023-2024 UDWRC Graduate Research Fellows

Lydia Franks

Lydia is a second-year Master's student in the Water Science and Policy Program and Co-Chair for the University of Delaware Student Chapter of the American Water Resources Association (AWRA). She is from Northeast Ohio and completed her Bachelor's degree in Environmental Science at the University of Akron. Prior to joining the University of Delaware community, Lydia worked in county parks systems and environmental consulting. Currently, at the Water Resources Center, she conducts water quality monitoring for the White Clay Creek National Wild and Scenic River Program, works with the City of Wilmington to locate and inventory water service lines according to the EPA's Lead and Copper Rule, assists with GIS projects on shoreline conditions and stormwater management, and is assisting with an economic valuation report of the upper Delaware River watershed in New Jersey. Lydia's primary research interests include human impacts on water quality and watershed restoration.

Jhaney Hamlett

Jhaney is a 2019 graduate of Delaware State University where she received her bachelor’s degree in Mass Communications with a specialization in Public Relations. After graduation, Jhaney’s background of connecting with communities and personal affinity for protecting the environment led her to work at Delaware Nature Society as a Communications and Outreach Coordinator. In this position, Jhaney found an appreciation for nonprofit work to service and improve the community. Jhaney’s work experience, mentorship, and encouragement from colleagues have brought her to the University of Delaware to continue her studies at the Biden School’s Institute for Public Administration to pursue a Master of Public Administration (MPA) degree, where she will specialize in Nonprofit Management. During Jhaney’s time in the MPA program, she will be working as a fellow with the University of Delaware’s Water Resources Center. Jhaney hopes that specializing in nonprofit work will give her the skills to be an advocate and do work that can bring social justice.

Alex Makowski

Alex is in his final semester of the Master's in Public Administration (MPA) program. He is a Delaware native and obtained his Bachelor's in Agriculture and Natural Resources from the University of Delaware. He was selected as a Legislative Fellow for the House Majority Caucus for the 2022 legislative session. He was then selected as a Graduate Research Assistant for the Water Resources Center where he has worked on projects for the White Clay Creek National Wild and Scenic River Program, the Center for the Inland Bays, and the City of Wilmington's lead pipe inventory program in conjunction with the EPA's Lead and Copper Rule.

Elizabeth Shields

Liz is a Delaware native and recent graduate of the Biden School’s Master of Public Policy program where she concentrated in environmental policy and climate change studies. She also earned her Bachelor’s in Environmental Studies from the University of Delaware’s College of Earth, Ocean, and Environment in 2020. Her research involves various activities throughout the Delaware River Watershed and projects related to community engagement around water, climate, and Environmental Justice topics. Liz volunteers on the Executive Committee of the Delaware Chapter for the Sierra Club where she is Co-Chair of the Climate & Energy Committee. She currently lives in Pike Creek with her family and dog, Myla.

Megan Wassil

Megan is a first-year Master's student in the Water Science and Policy program. She is from Lincoln University, Pennsylvania, and received her Bachelor's degree from the University of Delaware in Environmental Engineering. Megan has worked on various projects with the Delaware Water Resources Center in her undergraduate career which included water quality testing of the White Clay Creek, sampling of the tidal Christina River, and PFAS testing in various locations. This past summer Megan reviewed work orders of public water lines in the City of Wilmington to track lead pipes in Wilmington’s drinking water system.

Meet the 2023-2024 UDWRC Undergraduate Research Interns

FY24 Student Support

Beginning in June 2023, the UDWRC is supporting seventeen students, thirteen undergraduate, and four graduate water research internships, during FY24 through the annual base (104b) grants. The UDWRC research students are scheduled to present their research findings at the 59th annual meeting of the UDWRC Advisory Panel next May at the University of Delaware

Student Research Projects

Aaron Balmer, Wildlife Ecology
City of Wilmington Lead Inventory

Sasha Altman, Environmental Studies & Public Policy
Assessment of PFAS in the Drinking Water Streams in Delaware

Ambre Crawford, Marine Science
Water Quality and Quantity Trends along the Nanticoke River in Delaware and Maryland

Cooper Feeny, Economics & Public Policy
Taste, Odor, Water Quality and Public Perception of Drinking Water Supplies in Delaware

Caroline Gilliard, Environmental Engineering
Hydraulic Analysis of Floods along the Brandywine River in Delaware

Catherine Gilman, Energy & Environmental Policy
Evaluating the Effectiveness of Reimplementing a Bottle Bill for Cleaner Waterways in Delaware

Nicole Gutkowski, Marine Science
Identification and monitoring of PFAS in ground and surface water supplies in Delaware

Elizabeth Manning, Environmental Engineering
Watershed Characterization of the Tributaries Along the Red Clay Creek

Summer Moals, Agriculture (DSU)
The Effectiveness of Artificial Floating Wetlands with Different Aquatic Plants to Remove Water Nutrients: A Case Study at Delaware State University Aquaponics Research Facility

Cole Palmer, Fisheries Management (DSU)
Consolidation of Delaware's Insects of Greatest Conservation Need and Associations With Nontidal Freshwater Wetlands

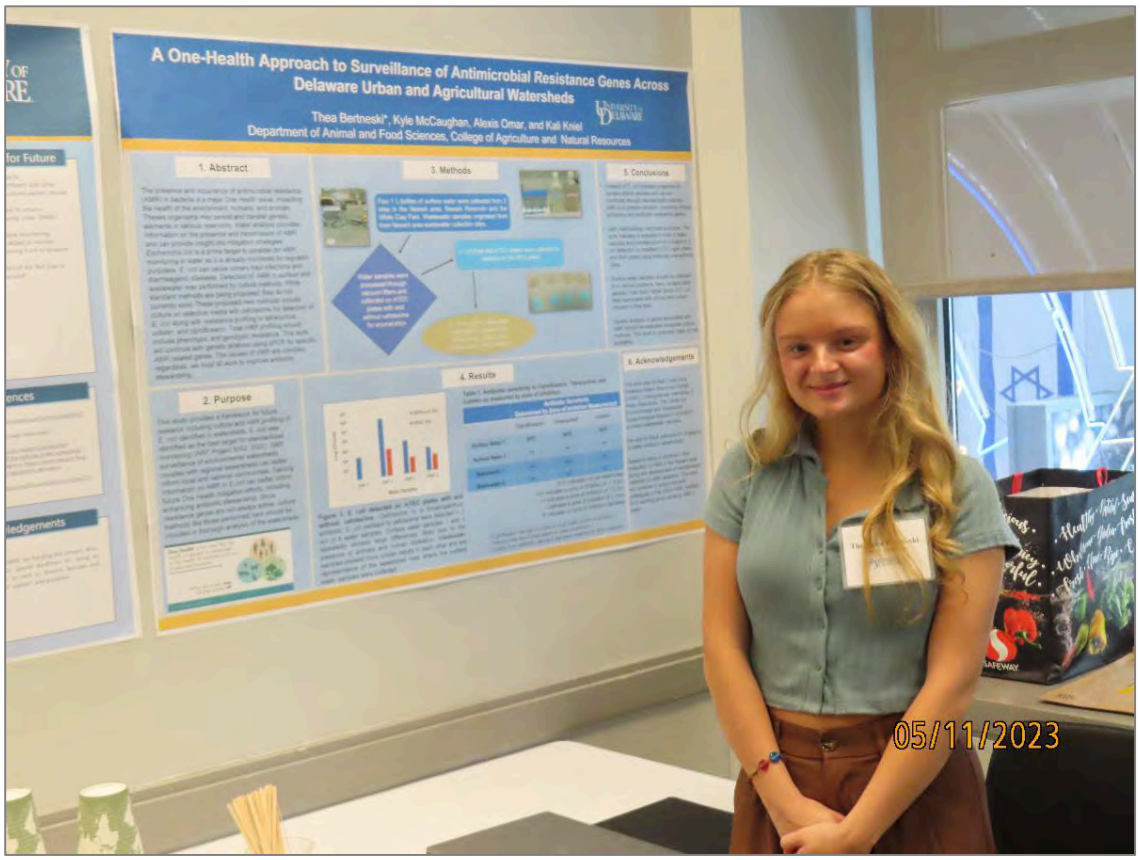
Brayden Rochester, Environmental Engineering
Soil Remediation Through Advanced Evaporative Treatment Technologies

Jordan Rosales, Geological Sciences
Introduction of Heavy Metals in the Christina

Dmitriy Rybin, Civil Engineering
City of Wilmington Lead Inventory

FY23 UDWRC Undergraduate Intern Research Projects

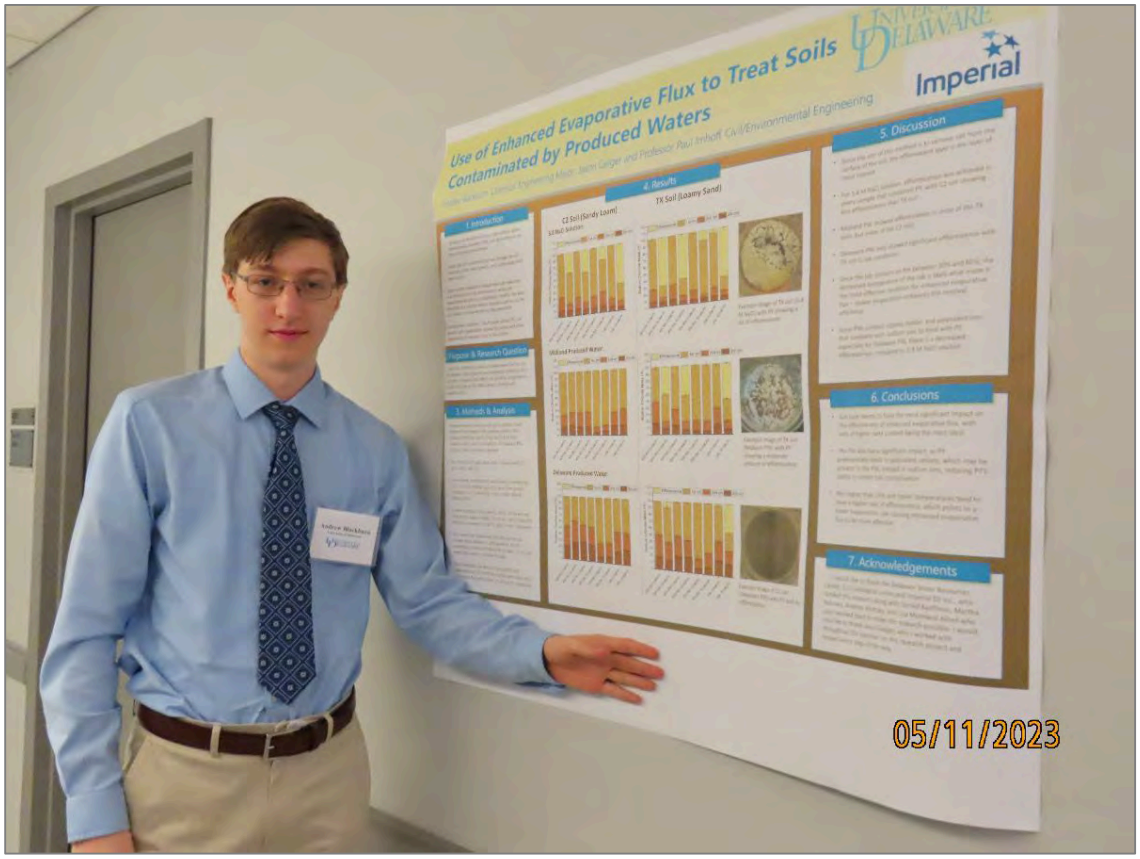
Surveillance of Antimicrobial Resistance Genes Across Delaware Watersheds
Theodora Bertnesk
Major: *Food Science*



The presence and occurrence of antimicrobial resistance (AMR) in bacteria is a major One Health issue, impacting the health of the environment, humans, and animals. These organisms may persist and transfer genetic elements in various reservoirs. Water analysis provides information on the presence and transmission of AMR and can provide insight into mitigation strategies. Escherichia coli is a prime target to consider for AMR monitoring in water as it is already monitored for regulator purposes. E. coli can cause urinary tract infections and diarrheagenic diseases.

Detection of AMR in surface and wastewater was performed by culture methods. While standard methods are being proposed, they do not currently exist. These proposed new methods include culture on selective media with cefotaxime for detection of E.coli along with resistance profiling to tetracycline, colistin, and ciprofloxacin. Total AMR profiling should include phenotypic and genotypic resistance. This work will continue with genetic analysis using qPCR for specific AMR-related genes. The causes of AMR are complex; regardless, we must all work to improve antibiotic stewardship.

Use of Enhanced Evaporative Flux to Treat Soils Contaminated by Produced Waters
Andrew Blackburn
Major: *Chemical Engineering*



During oil extraction, high-salinity waters are produced that can spill and contaminate the surrounding soil and groundwater. These high salt concentrations prevent plant life, modify hydraulic soil properties, and can pollute the local watershed enough to harm aquatic life. Currently, spills are most remediated using excavation and backfill, a process that is expensive and disruptive to the environment. In a less disruptive method, enhanced evaporative flux can be used to remove the salt from the soils using a crystallization modifier, potassium ferrocyanide, also known as Prussian yellow. More specifically, the Prussian yellow inhibits salt crystallization, which allows the water evaporation to carry the salt ions to the surface, where they can precipitate and be harvested. However, this method has not been properly studied under relevant environmental conditions. To explore the influence of atmospheric conditions, four different environments were used covering a range of temperatures and humidities. Two types of

soil were used, sandy loam and loamy sand, as well as three produced waters: two actual produced waters from the Permian Basin and a 3.8 M sodium chloride solution. Other studies involving this method of soil remediation claim that ferrocyanide can provide 60-90% efflorescence. However, the results in this study suggest that these removal rates depend on both the produced water composition and the environment since an increase in polyvalent ion concentrations and evaporation rates can decrease the removal efficiency. Soil structure has the most significant impact on the effectiveness of enhanced evaporative flux, with a preference for higher sand concentration. As for humidity, having a higher than 15% relative humidity and a cooler temperature result in a higher amount of efflorescence, which suggests that a lower evaporation rate will allow the enhanced evaporative flux process to remove more salt contaminants.

Water Quality Monitoring Along the Red Clay Creek and Tributaries in Delaware and Pennsylvania
Francesca Discenza
Major: *Environmental Engineering*

Jake Marren
Major: *Environmental Engineering*

The University of Delaware Water Resources Center (UDWRC) conducted water quality monitoring and trends analysis along the Red Clay Creek in Delaware and Pennsylvania. Water quality samples were collected at eleven stations, in Pennsylvania and Delaware for water quality criteria parameters. Appendix A contains a site map of all the locations sampled. Most of the location's samples contained concentrations below DNREC (Delaware Natural Resources and Environmental Control) and EPA (U.S. Environmental Protection Agency) standards. The only elements that contained traces above standards were nitrogen and phosphorus.

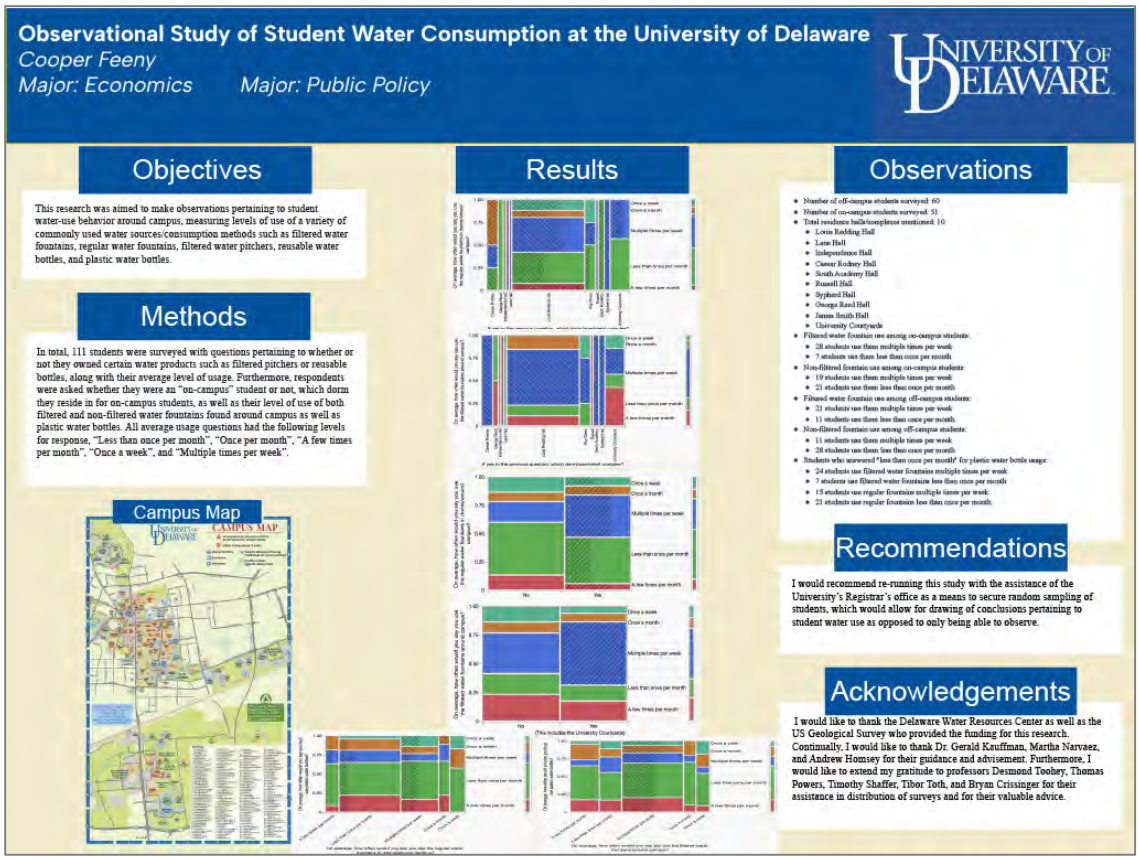
Vibrio parahaemolyticus bacteriophage VPMS1 DNA Polymerase I is active at a diverse range of temperatures

Owen Donnelly
Major: *Biology*

The removal of marine pathogenic bacteria via viral bacteriophage infection is a prominent way to control microbial communities and ensure safe drinking water availability. DNA polymerase I (polA), is present in 25% of dsDNA viruses that infect bacteria (phages) and is the sole replication enzyme for these phages. The 762 residue (E. coli numbering) is responsible for dNTP incorporation and amino acid substitutions at this single position can have profound effects on enzyme replication speed and accuracy. Tyrosine substitutions increase enzyme speed, compared to wild-type phenylalanine, and are associated with lytic viral life cycles, while leucine substitutions greatly increase fidelity at the expense of speed and are associated with temperate life cycles. The lytic Vibrio parahaemolyticus phage VPMS1 carries a polA with the wild-type phenylalanine 762 residue. Strengthening the connection between the 762 residue and the biochemical characteristics of polA can improve life-cycle predictions of unknown phages. This study sought to investigate whether the biochemistry of a viral polA under optimal conditions is predictive of the known lifestyle of the reference phage VPMS1. After producing and purifying a VPMS1 polA stock, contaminating nucleases such as DNase and RNase were found to be below the limit of detection. Primer extension and specific activity assays were performed within the VPMS1 isolation location's environmental temperature range (19℃ to 30°C). The VPMS1 polA strong primer extension throughout and beyond the range (19°C to 37°C), with peak performance observed at 28°C. The diverse range of successful primer extension temperatures was notable in this study due to the enzyme's tolerance of high temperatures ranging to

37°C. Specific activity assays found VPMS1 PolA to be slower than that of a Tyrosine 762 residue, thus supporting the 762 residue hypothesis.

Observational Study of Student Water Consumption at the University of Delaware
Cooper Feeny
Major: *Economics and Public Policy*

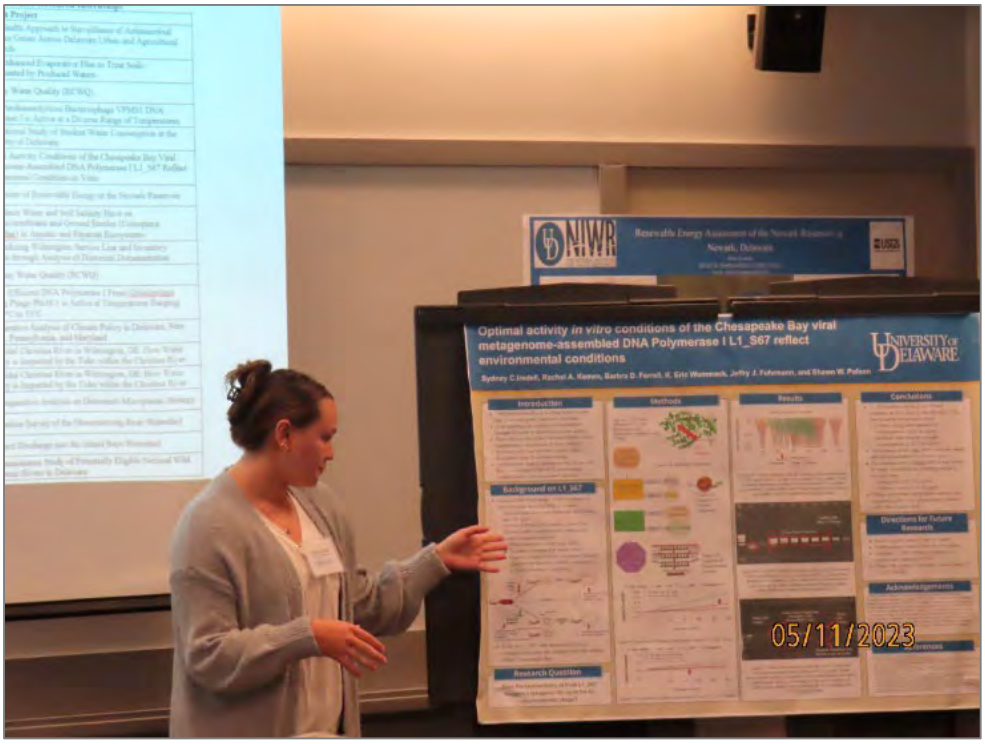


The University of Delaware, throughout the school year, provides education to 23,613 students (University of Delaware), these students being a mix of undergraduates, graduate, and professional/continuing studies students, with the vast majority of them being undergraduates with a total of 18,618. These students are split, each year, into students living in university-provided living spaces (on-campus students), as well as students living in nearby apartments, and those who commute to campus for classes (off-campus students). Each year, according to the University, at least 7500 of the total students are considered "on campus" students, with their housing being provided to them by the University in one of "22 buildings on 4 areas of campus: Central, East, Laird, and Apartment-style living" (University of Delaware). As divided by the aforementioned regions of campus, the dorms and their respective date of construction, as marked on the cornerstones of each respective building, are as follows: Central: Brown (1941), Caesar Rodney (1966), Cannon (1952), Harter (1917), Kent (1956), New Castle (1925), Sharp (1951), Smyth (1952), South Academy (2017), Sussex (1917), Squire (1957), and Sypherd (1957); East: Gilbert (2013), Harrington (1960), Lane (1969), Thompson (1957), Redding (2013), and Russell (1963); Laird: George Read (2005), Independence (2004), James Smith (2005), Thomas McKean (2005), and Ray Street (2004); Apartment Style Living: University Courtyards (1999, later redeveloped in 2019 after being acquired by the University). As shown, students living on campus are subject to living in buildings built across an almost century-long span, leading to these students experiencing strikingly different living conditions when it comes to utilities

across campus. As the main focus of this study, older residence halls tend to have non-filtered water fountains with newer dorms having filtered fountains. This study aims to observe differences in water consumption among both on and off-campus students when it comes to their level of usage of different sources of water around campus.

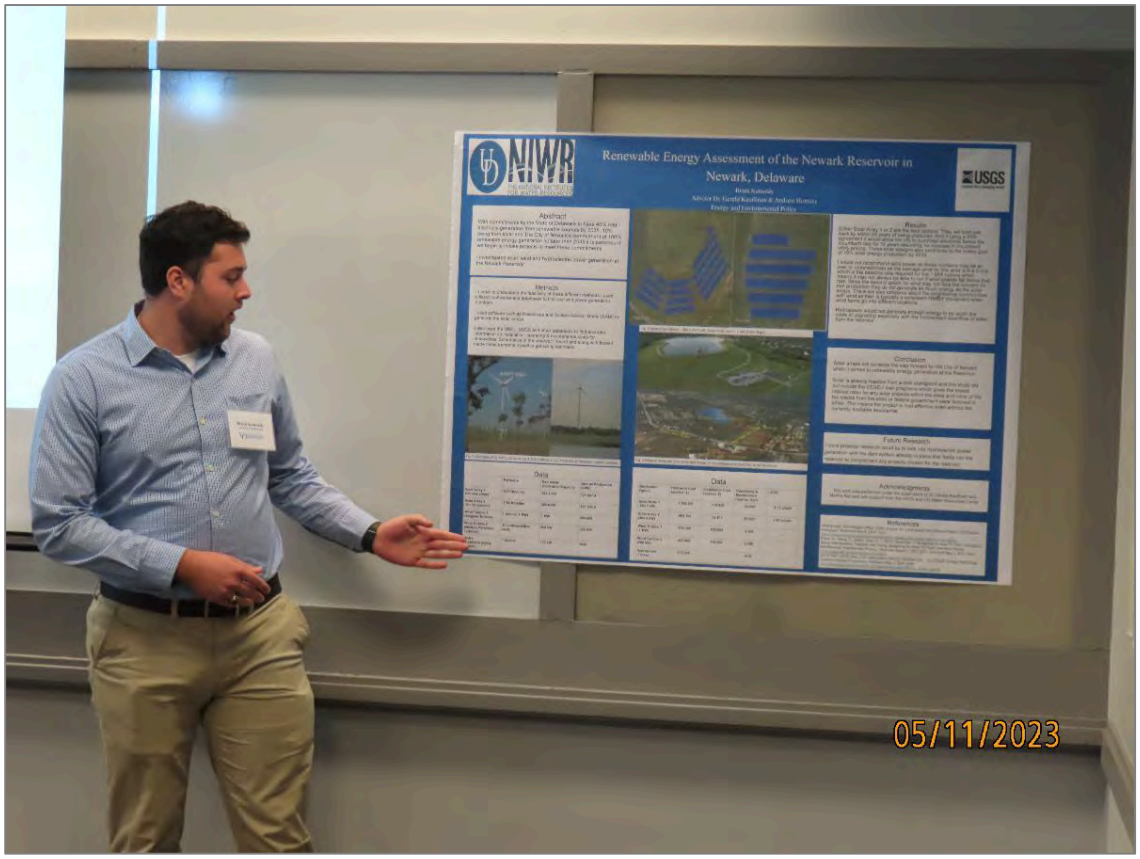
Optimal Activity in vitro conditions of the Chesapeake Bay viral metagenome-assembled DNA Polymerase I L1_S67 reflect environmental conditions

Sydney Iredell
Major: *Biology*



Viruses are the most abundant and diverse biological entities on the planet. Family A DNA Polymerase I (polA) is present in 25% of dsDNA phage with the sole function of genome replication. The 762 residue (E. coli numbering) within the polA is our area of interest, as prior studies have suggested the amino acid identity at this position will indicate the phage life cycle. Position 762 is responsible for dNTP incorporation, and substitutions at this site have been shown to alter the fidelity, speed, and accuracy of polA. A leucine substitution has been shown to slow down the enzyme by 1000 fold, but increase its accuracy by 10 fold as compared to the wild-type phenylalanine residue. A virome polA, L1_S67, contains a leucine amino acid at the 762 residue and is the highlight of this study. L1_S67 was assembled from a virome collected in the Chesapeake Bay where environmental water temperatures range from 6.3℃–25.6℃. We hypothesized that optimal conditions for L1_S67 activity should fall in the environmental range of temperatures. This work assessed several biochemical characteristics of L1_S67 as a potential link to lysogenic life cycles of the environmental phage populations represented by this assembled contig. A variety of tests were run to help determine if the phage life cycle is determined by the amino acid at the 762 residue. Tests ran included DNase and RNAse contamination tests, primer extensions, and exonuclease assays. Results suggest that the optimal conditions in vitro match the maximum temperatures of the environment.

Feasibility Analysis of Renewable Energy Generation at the Newark Reservoir
Brian Kennedy
Major: *Environmental Engineering*



The Newark Reservoir provides a superb opportunity for the City of Newark to engage in renewable energy generation for the local community. The Reservoir provides many renewable energy generation options for the city to engage in, three will be discussed in this research: solar, wind, and hydroelectric. Solar is a primary method to research due to the decrease in the cost of arrays over the past decade and the face of the reservoir hill facing southward along with the lack of tree cover provides the optimal conditions for a solar array. Solar arrays are also modular and can be incorporated in many ways including ground mounts and carports where the panels provide shade for parked cars underneath.

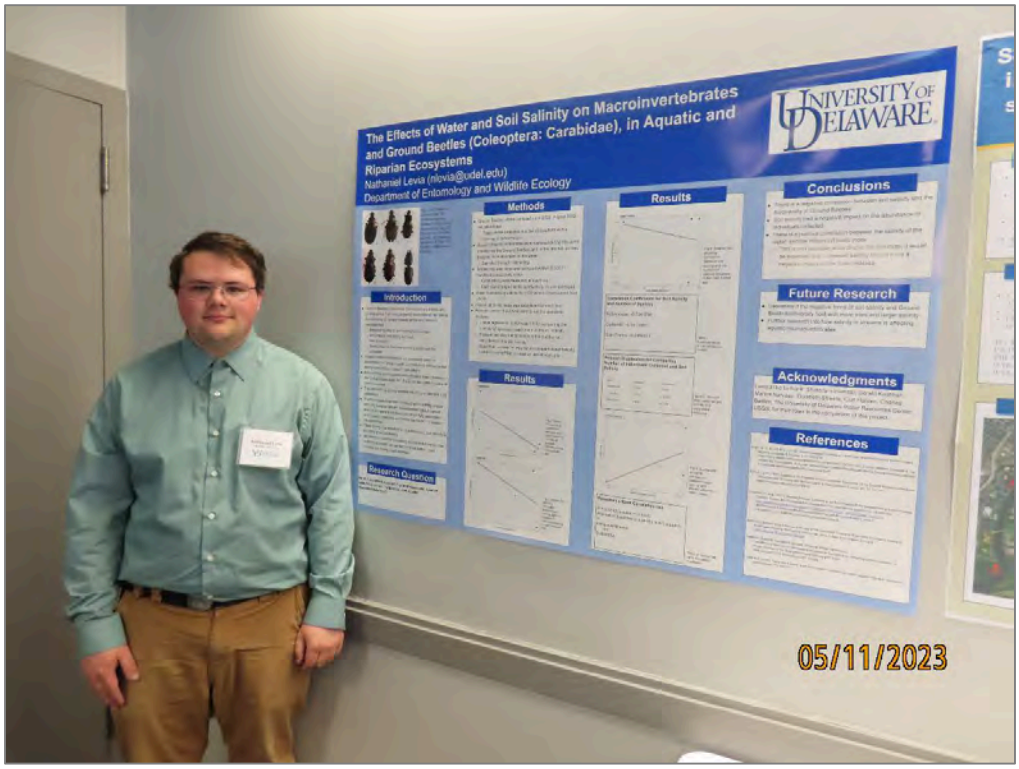
Wind is another option to consider due to the reservoir's elevation. Different sized turbines are explored and by doing power calculations we can determine the cost effectiveness of different turbines. Challenges to wind will be the sound and view disruption of the community members living around the reservoir. Along with average wind speeds in New Castle County potentially not meeting the requisite speed for certain turbines to be operational.

Hydropower can be implemented at this location through the incorporation of turbines into the pipes, the water flows down when the reservoir is drained to provide drinking water to the residents of Newark. By finding out how much head the water has we can then calculate the power a turbine installed in the pipe could generate annually.

These options can all be explored in order to demonstrate the feasibility and cost-effectiveness of each method in generating renewable electricity for the City of Newark. Each renewable energy type does not have to be used in isolation and there can be benefits to combining multiple types of renewable energy to work in tandem with one another if cost-effective.

The Effects of Water and Soil Salinity on Macroinvertebrates and Ground Beetles (Coleoptera: Carabidae), in Aquatic and Riparian Ecosystems

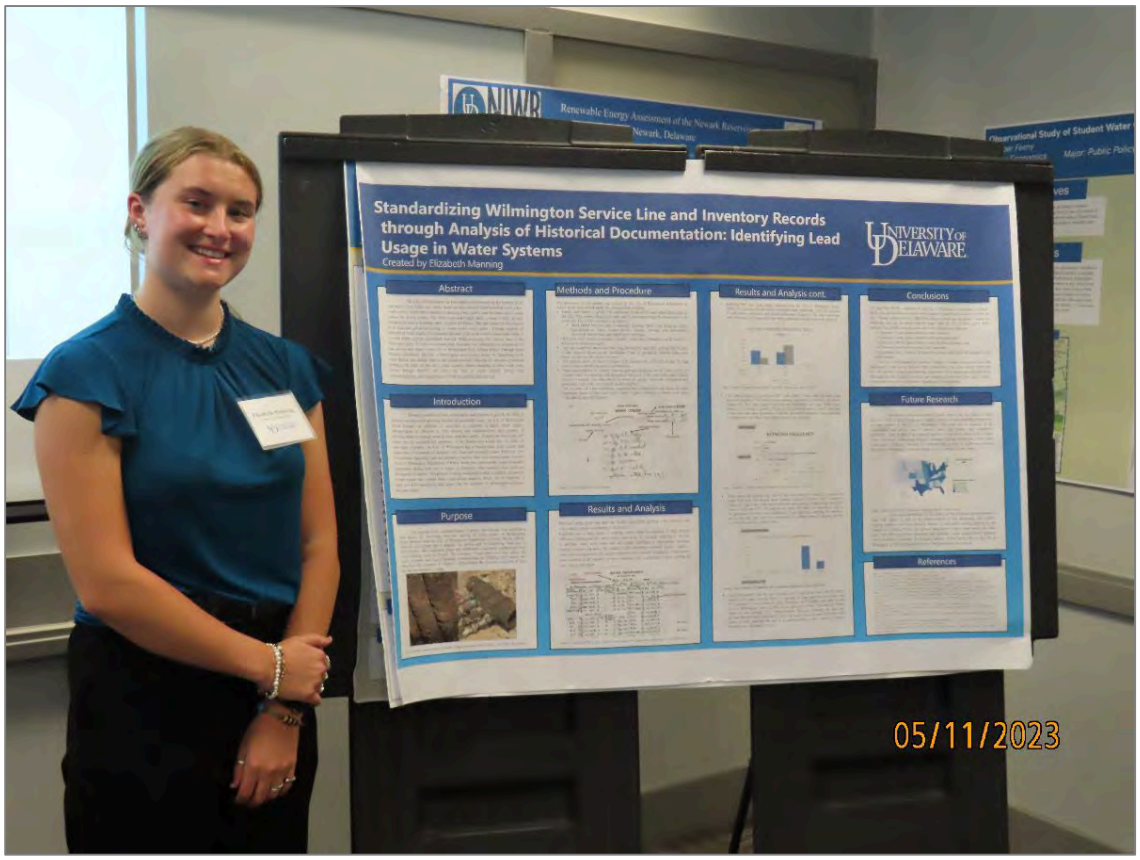
Nathaniel Levia
Major: *Insect Ecology and Conservation*



A common way to de-ice roads in the United States is to apply salt to them, but there is little understanding of how this salt affects insects once it gets washed into the environment. Ground Beetles (Coleoptera: Carabidae) are a large and diverse group of insects that are frequently used to examine human impacts on the environment. This is due to the fact that they respond to environmental changes quickly, and can be easily and cost-effectively sampled. While many studies have examined the effects of various pollutants on Ground Beetles, few studies have examined how soil salinity due to human activities is affecting Ground Beetle communities. Ground Beetles were sampled across three sites, via pitfall traps. Aquatic macroinvertebrates are frequently used as a metric of steam health, but little is known about how salt pollutants from road deicing are affecting them. We found that soil salinity has a negative impact on the species richness and number of individuals present in Ground Beetle Populations. Our result on aquatic macroinvertebrates should be ignored, as it does not align with the findings of the majority of the literature.

Standardizing Wilmington Service Line and Inventory Records through Analysis of Historical Documentation: Identifying Lead Usage in Water Systems

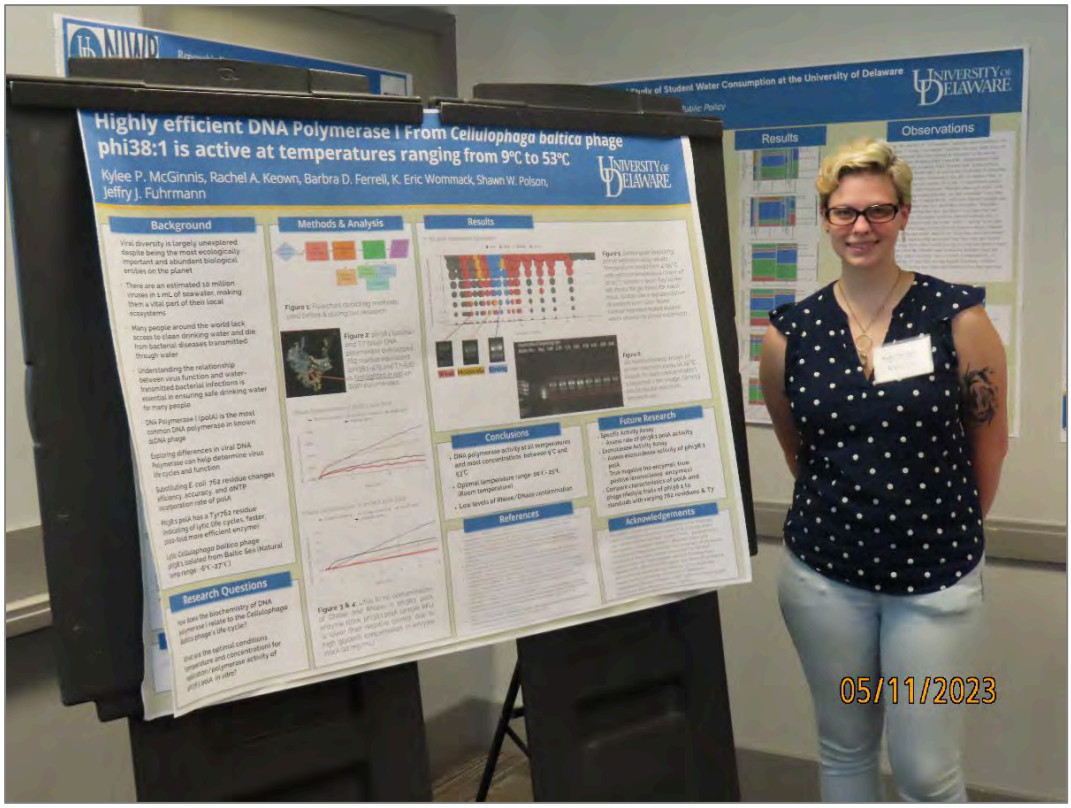
Elizabeth Manning
Major: *Environmental Engineering*



The City of Wilmington has been tasked with identifying the location of all lead service lines within city limits, based on data collected from historical work orders. Lead is a toxic metal that is harmful to drinking water quality and has been used in water systems for over a century. The EPA's Lead and Copper Rule, revised in 2021, set new standards for lead in drinking water: 15 parts per billion. This rule called for the removal of all lead and galvanized piping to ensure better water quality. Through analysis of hundreds of work orders, it is estimated that half of all work orders contain lead, while ¼ of work orders contain galvanized material. When analyzing only service lines in the Wilmington area, 72.7 percent contain lead. Therefore, the estimated cost of removal for lead service lines alone in the City of Wilmington is 2.2 billion dollars. Through the analysis of these historical documents, the City of Wilmington aims to save money by identifying work orders that do not contain lead or galvanized material, to reduce the amount of removal needing to be done on the city's water systems. Future mapping of these work order records through ArcGIS will allow the city to easily identify service line locations/materials, allowing for ease of both recognition and removal.

Highly efficient DNA Polymerase I From Cellulophaga baltica phage phi38:1 is active at temperatures ranging from 9℃ to 53℃

Kylee McGinness
Major: *Biology*

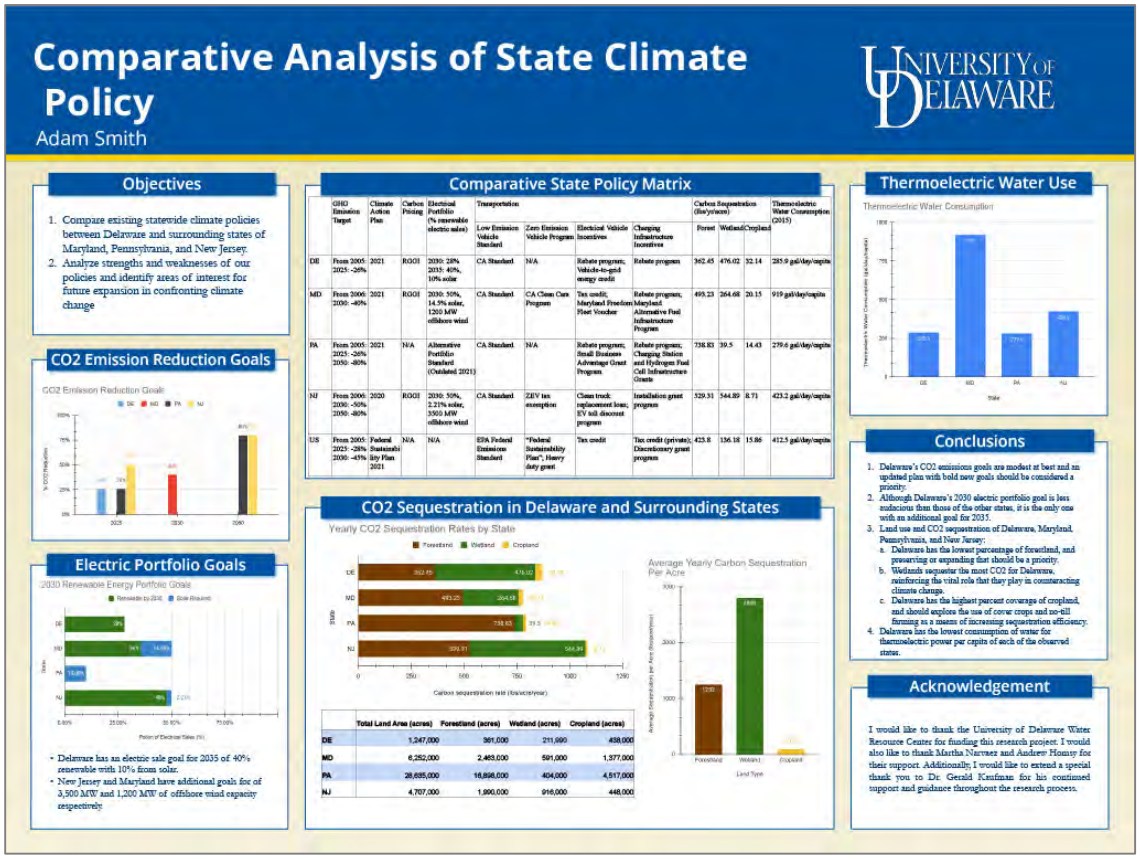


Viruses are the most abundant and ecologically important biological entities on Earth. DNA Polymerase I (polA) is the most common DNA polymerase in dsDNA phage, present in approximately 25% of environmental dsDNA phage populations. The main function of a phage is replication, so evaluating sequence differences between phage polA enzymes can help elucidate differences in biochemical characteristics across known polA diversity. An amino acid substitution at the polA 762 residue (E. coli numbering) has been shown to alter the replication efficiency and fidelity of the enzyme and is hypothesized to be predictive of the phage life cycle. The focus of this research, Cellulophaga baltica phage phi38:1 polA, contains a Tyrosine (Tyr) amino acid at the 762 residues. Tyr762 has been associated with highly lytic phages and mutagenesis has shown this residue to be present in faster, 1000-fold more efficient enzymes as compared to enzymes with the wild-type phenylalanine residue. This work investigates the relationship between the biochemistry of a Tyr762 polA and the known lifestyle of Cellulophaga baltica phage phi38:1 by characterizing polymerase activities over temperature and concentration gradients. The synthesized phi38:1 polA protein sequence was cloned into and produced by E. coli, and the resulting enzyme stock was relatively pure showing minimal DNase and RNase contamination levels. In vitro primer extension was observed at a range of temperatures (9°C–53°C), with the strongest activity at 20°C–25°C. Strong activity for primer extension at both high (5ug/rxn) and low (0.04ug/rxn) concentrations at every temperature tested confirms the high efficiency of phi38:1 polA.

Comparative Analysis of State Climate Policy in Delaware and Surrounding States

Adam Smith

Major: *Political Science and Criminal Justice*



The threat of climate change is more apparent than ever, and a challenge of such a magnitude requires bold, coordinated responses at every level of government. While individual state policy may seem insignificant, in an era of hyperpartisanship, state governments in the United States can act as laboratories of democracy, combating climate change in their own individualized ways.

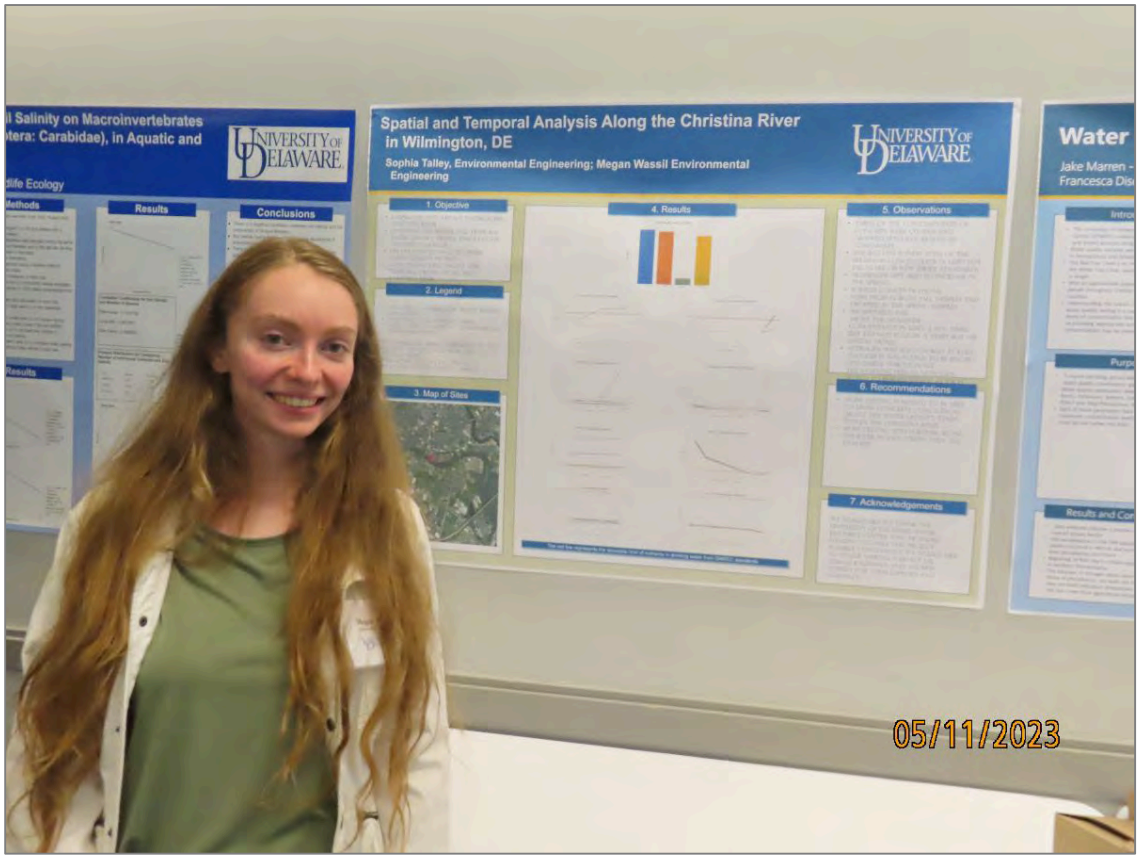
This research aims to compare and evaluate the climate policies of Delaware with those of the surrounding states of New Jersey, Pennsylvania, and Maryland. In doing so, I hope to provide recommendations to strengthen Delaware's climate policies going forward so as to more effectively confront the climate crisis. Additionally, I will provide grounds for future research on the subject of state climate action.

To evaluate the climate policies of Delaware, New Jersey, Pennsylvania, and Maryland, I have created a policy matrix comprising topics of greenhouse gas emissions plans, climate action plans, carbon pricing programs, electric portfolio goals, transportation, carbon sequestration, and thermoelectric water consumption. Upon comparison with the surrounding states, I have found that although Delaware's current climate policies are adequate, bold steps can and must be taken moving forward in order to rise to such a monumental challenge as climate change.

Temporal and Spatial Analysis of the Christina River in Wilmington, Delaware

Sophia Talley
Major: *Environmental Engineering*

Megan Wassil
Major: *Environmental Engineering*



The Christina River is a cornerstone for local recreation and businesses as well as supporting an expansive ecosystem. Due to its importance, it is vital that the water quality is closely monitored and that water quality trends can be identified to help protect and ensure the health of the river. This research set out to analyze the temporal and spatial trends within the Christina River.

Three sampling locations were chosen in the fall of 2022 and samples were taken from the fall of 2022 throughout the spring of 2023. These sites were visited on 2 occasions each semester. These dates include 10/28/2022, 11/29/2022, 03/14/2023, and 04/18/2023. On these dates, field measurements were collected as well as water samples to then be tested in a laboratory. These samples tested for potential contamination in the forms of nutrients as well as metals and other elements. It was found that Aluminum (Al), Nitrate-Nitrogen (NO3-N), Phosphorus (P), and Sodium (Na) reached concentrations above the water quality standard for either Delaware or New Jersey. These four contaminants were then graphed spatially and temporally to understand the trends in the results. Aluminum concentrations increased in the spring. Nitrate-nitrogen levels remained steady throughout the study but were consistently above the standard of 1.0 mg/L. Phosphorus had elevated levels in the spring but this may have

been an outlier in the dataset. Sodium appeared to follow a temporal trend of high concentrations in the fall and decreasing concentrations in the spring.

Additional sampling locations are recommended as these locations only spanned three sites. This would allow for a larger, more comprehensive understanding of the spatial distribution of the data. It is also recommended that more samples are collected at low tide. The Christina River of Wilmington, Delaware is tidal and these tidal fluctuations could potentially affect the results. Many of the samples were collected at high tide but collecting at low tide would also be advised for future research on this river.

A Comparative Analysis To Improve Delaware's Statewide Microplastic Strategy
Alyssa Wentzel
Major: *Energy and Environmental Policy*

Microplastics are so small in size that they easily spread through the air and accumulate in the environment. They are extremely persistent and it is almost impossible to remove them from the environment where they accumulate. Plastics are not biodegradable, instead, they break into fragments and form microplastics over time. Microplastics are ingested by people and animals. They are often mistaken as food by small organisms like plankton or even large animals like
sharks. The biggest problem that can be seen is how microplastics affect fish as well as other marine and aquatic animals. These animals will ingest the plastics which can cause these animals to reduce food intake and impede on development stages.

Many issues of microplastics revolve around uncertainty and a lack of consistent and viable methods, standards, and consistency of observed exposures. Addressing microplastics is difficult because it requires a global approach, linking industry, and academia in order to solve problems and offer solutions. Right now, minimal action is being taken on a legislative scale, causing microplastics to still be produced all over the United States. California is the only state that has a state-wide microplastics policy initiative plan. In Delaware, research has been taking place to discuss how microplastics are affecting organisms' health, such as mud crabs and blue crabs.
However, Delaware does not focus on the policy side of microplastics and what can be done to reduce microplastics.

Some of the big problems and questions that will be addressed are:

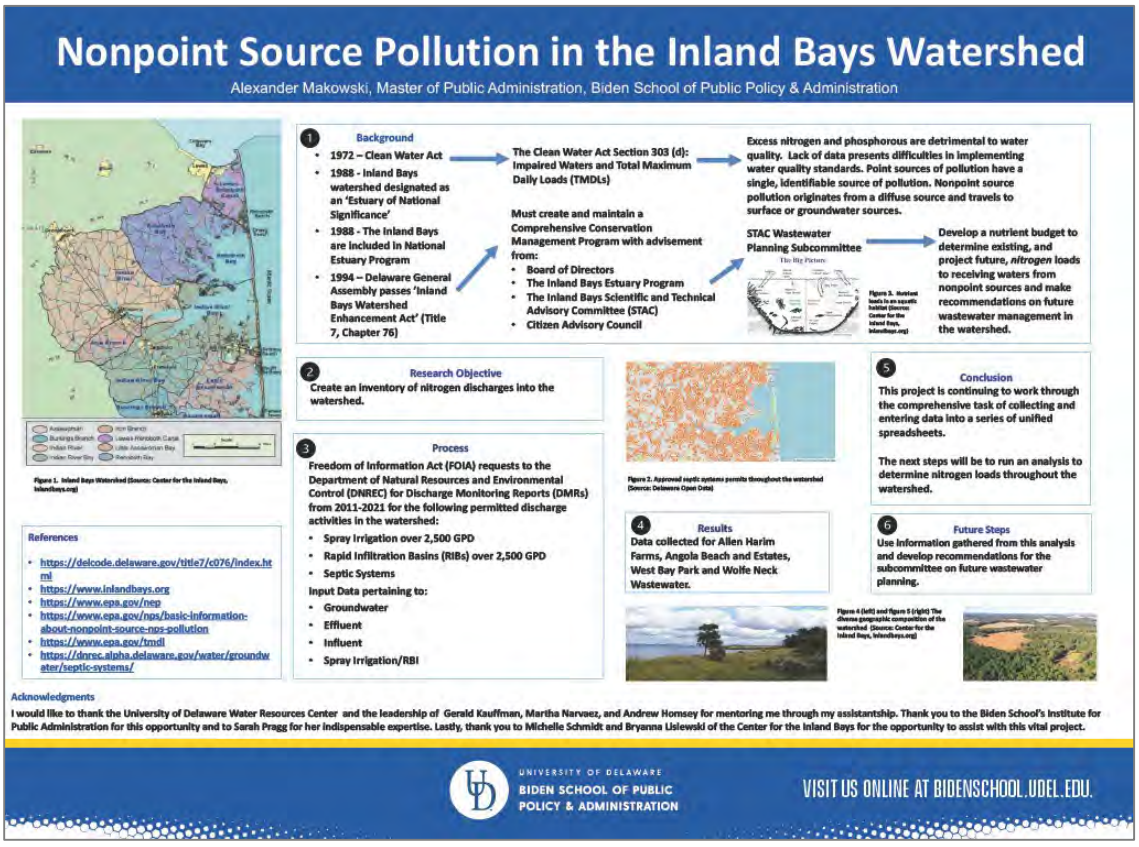
- What implementation strategies are taking place in other states and are they effective?
- How can science and research about microplastics be communicated clearly to the public?
- How can we encourage and incentivize more microplastic clean-up within the community?
- How can the reintroduction of certain bills improve the statewide initiative of reducing microplastics?
- What are some possible implementations or policies Delaware could adopt for microplastic prevention?
- What is a Microplastic Statewide Initiative and should Delaware adopt it?

FY23 UDWRC Graduate Assistant Research Projects

Economic Recreation Survey of the Musconetcong River Watershed
Lydia Franks
Master of Water Science & Policy

The New Jersey tributary watersheds of the Delaware River span five counties throughout the northwestern part of the state and provide significant economic benefits to local communities and the regional economy. Within this area is the Musconetcong River watershed, which is situated in northern New Jersey and reaches across Hunterdon, Morris, Sussex, and Warren counties. The Musconetcong River is a Partnership Wild and Scenic River and National Water Trail, supporting extensive outdoor recreational opportunities and attracting visitors from across the region to its 157-square-mile watershed. Examining how residents and non-residents spend time and money in this watershed, as well as in other New Jersey tributary watersheds of the Delaware River, is essential in demonstrating their economic value and providing information for management decisions. This survey-based study, as a collaboration between the University of Delaware Water Resources Center, Musconetcong Watershed Association, and Environment New Jersey, analyzes recreational use and spending in the Musconetcong River watershed and uses these dollar values to estimate the economic value of recreation in the larger study area of northwest New Jersey tributaries to the Delaware River (Figure 2). Using these values and existing research, the total expenditure range for recreation in the northwest New Jersey tributaries of the Delaware River was estimated as a low of nearly $133 million to a high of almost $353 million annually.

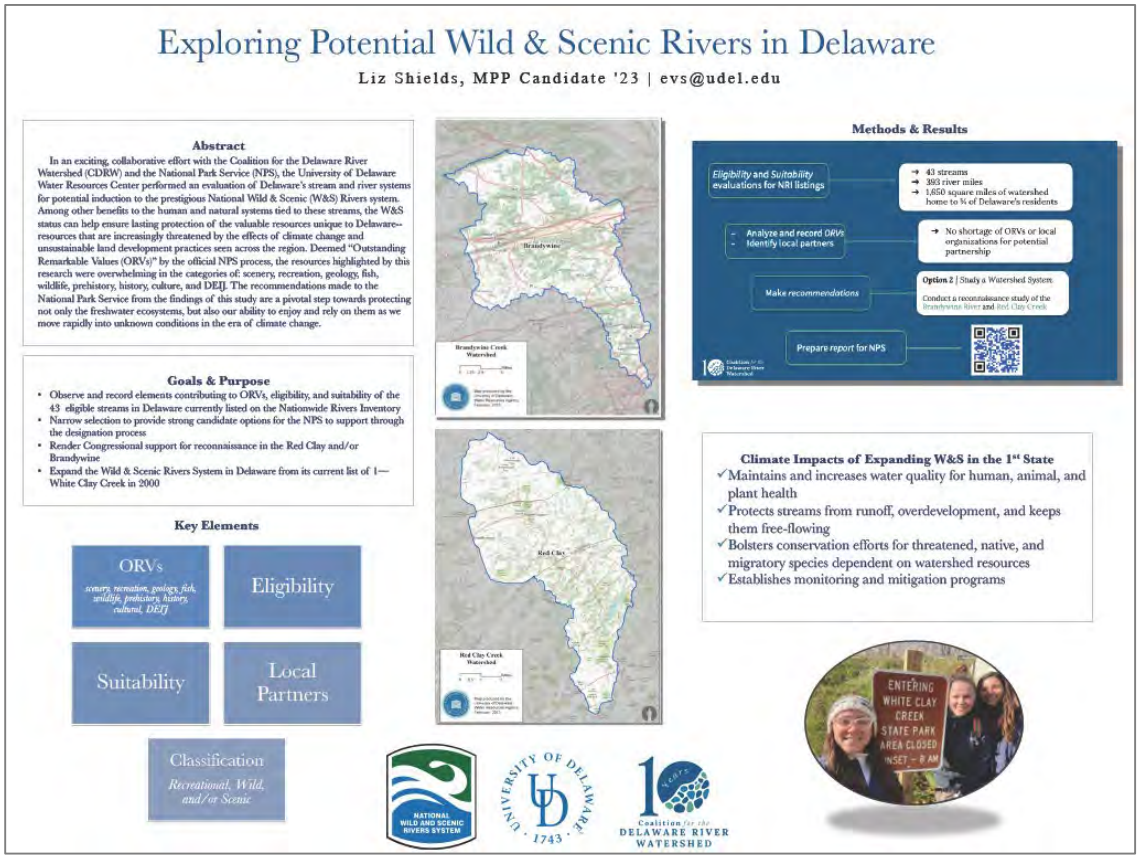
Center for the Inland Bays Nutrient Budget
Alex Makowski
Master of Public Administration



The Clean Water Act of 1972 identified the Delaware Inland Bays as an "Estuary of National Significance" in addition to their inclusion in the National Estuary Program. In 1994, the Delaware General Assembly passed the Inland Bays Watershed Enhancement Act to create and maintain a Comprehensive Conservation Management

Program with advisement from a Board of Directors, the Inland Bays Estuary Program, the Inland Bays Scientific and Technical Advisory Committee (STAC), and a Citizen Advisory Council. The STAC oversees the Wastewater Planning Subcommittee which is developing a comprehensive nutrient budget to determine existing and projected nitrogen loads to receive water from nonpoint sources. Information garnered from these efforts will be considered in making recommendations on future wastewater management decisions within the watershed. Freedom of Information Act (FOIA) requests were filed with the Delaware Department of Natural Resources and Environmental Control (DNREC) to obtain information related to monitoring for facilities within the watershed with discharge permits for 2,500 gallons or more per day. Data was collected for information in relation to groundwater monitoring, effluent, influent, spray irrigation, and rapid infiltration basins. The project is extensive and ongoing.

Exploring Potential Wild & Scenic Rivers in Delaware
Elizabeth Shields
Master of Public Policy



In collaboration with the Coalition for the Delaware River Watershed and the National Park Service, the University of Delaware Water Resources Center (UDWRC) continues to advance on the process of evaluating potential National Wild and Scenic Rivers both in the state and across shared watersheds with neighboring states. This project will involve extensive research to explore the eligibility and suitability aspects of the Brandywine River and Red Clay Creek watersheds. The intended outcome is the construction of a robust profile for the consideration of these identified segments as additions to the Wild and Scenic River system in the United States.