# Water Resources Center
# University of Delaware

## Annual Technical Report
## 2019

**DE FY19 USGS Annual Report**
(Jun 18, 2019 - Dec 31, 2020)

**Statement of Purpose:** The University of Delaware Water Resources Center (DWRC) is dedicated to addressing the pressing issues of today including the global pandemic and challenges in achieving true racial equality. These issues are fundamentally important in researching and protecting the waters of Delaware and watersheds across the region. A healthy watershed that serves the needs of our citizens requires a focus on both public health and a healthy diversity of culture, race, viewpoints, and interests. A crosscutting focus on these issues can help ensure the DWRC's continued fulfillment of the University's land grant mission of research, education, and public service, through scientific study, outreach, and the training of future environmental scientists, engineers, policy experts, managers and other leaders in the field of water resources. The DWRC intends to address these concerns in the following ways.

**Public Health:** In accordance with the Governor's and UD administration's directives concerning the pandemic, the DWRC will move toward a phased reopening of the office by July 15, 2020 with more extensive reopening in the fall semester. The ongoing pandemic has borne out the fact that the DWRC is able to maintain a high degree of efficiency and efficacy through the recent disruptions to the physical parameters of the work environment. Most of the work undertaken has been and can continue to be effectively achieved from remote locations, using technology to remain in contact with co-workers, funders, colleagues, and students. All components of the phased reopening with regard to the pandemic will be closely guided by the University's own policies and time-table published here:
https://www.udel.edu/home/coronavirus/ud-campus-phased-reopening/guidelines/

- Wear face masks
- Wash hands frequently and disinfect surfaces
- Use closed conference table area
- Check health daily including temperature
- Stay home when sick
- Work from home when you can
- Provide sanitizer for visitors
- At office work socially distant

**Diversity:** Diversity is essential in civil society and in our scientific mission at the University of Delaware. The DWRC will redouble efforts to reach out and recruit talented minority and economically disadvantaged students and researchers. In the scientific world diversity is necessary for the evolution of knowledge and thus the protection of the environment on which everyone's well-being depends. The DWRC has long been dedicated to this ideal taking a leadership role in the development of youth in Wilmington through the Green Jobs program which develops the skills of tomorrow's leaders. Certainly more can and needs to be done.

Through the recruitment of an increasingly diverse population of faculty, policy scientist, and undergraduate/graduate research students, this diversity can be strengthened. In accordance with our mission as designated by Congress under the Water Resources Research Act of 1984, the DWRC will reach beyond the University of Delaware to strengthen partnerships across the state at research institutions of higher-learning at Delaware State University, Wesley College, and Delaware Technical Community College. In this way DWRC will strengthen and broaden its research and scientific reach and enhance its ability to serve the needs of Delaware and all Delawareans, to whom water is a crucial resource and a prerequisite to health and happiness. We will focus on:

1. Correspond with presidents of University of Delaware, Delaware State University, Wesley, and Delaware Tech requesting nominations of diverse students for DWRC undergraduate water research internships beginning with Fall 2020 semester.

2. Re-examine composition of DWRC Advisory Panel for diversity and request feedback from the DWRC Advisory Panel on ways DWRC may be increase diversity and inclusiveness among its students, board and project work.

3. Revisit with our DWRC student alumni and celebrate their stories and their background, see https://www.wrc.udel.edu/about-wra/student-research-assistants/.

4. Incorporate demographics of race, ethnicity, gender, and income of the study area into every research report such as the Delaware Inland Bays Economic Study. Assess how existing and future projects may be enhanced to improve diversity and inclusiveness.

5. Use Coalition for Del. River Watershed (CDRW) and UD resources to increase diversity.
- University of Delaware Office of Diversity and Inclusion https://sites.udel.edu/diversity/
- Coalition for the Delaware River Watershed (CDRW) http://www.delriverwatershed.org/deij

**Mission:** Established in 1965 as one of the 54 National Institutes for Water Resources (NIWR) at land grant universities in the 50 states, District of Columbia, and three island territories of Guam, Puerto Rico, and U.S. Virgin Islands. The DWRC is Congressionally-mandated by Section 104 of the Water Resources Research Act of 1984 and 1964 administered by the U.S. Department of the Interior and U.S. Geological Survey. As part of the NIWR network, the mission of the DWRC is to: (1) support research, education, and public outreach programs that focus on water supply, water management, and water quality - issues important to Delaware citizens and (2) foster/support training and education programs for future water scientists, engineers, managers, and policy-makers who will lead the water resources research, planning, and management efforts in our state.

**Staffing:** The DWRC hosts the following faculty, scientists and students to fulfill our mission:

| | |
|---|---|
| Gerald J. Kauffman | Director/Associate Professor |
| Andrew R. Homsey | Policy Scientist/GIS Manager |
| Nicole M. Minni | Associate Policy Scientist/GIS Laboratory Lewes Campus |
| Martha R. Narvaez | Policy Scientist/Associate Director |
| Sherri Martinez | Sponsored Programs Coordinator |
| Sophie Philips | Graduate Research Fellow (M.S. Energy and Environmental Policy) |
| Hayley Rost | Graduate Research Fellow (M.S. Energy and Environmental Policy) |
| Kelly Slabicki | Graduate Student (M.S. Water Science and Policy) |

**DWRC Water Resources Research and Education Priorities**

- Water quality (nutrients, pathogens, public health), harmful algal blooms, PFOA contamination
- Storm water runoff (management and control)
- Water supply, demand, and conservation (infrastructure/technology)
- Water policy (governance and economics)
- Climate change, sea level rise, riverine/coastal flooding
- Groundwater (remediation and treatment)
- Watershed management
- Wetlands (protection and restoration)
- Wastewater management (treatment and reuse)
- Water, food, and energy nexus

**Products**

Kauffman, G. M., 2020. Chapter 3: Watershed Ecology. The Delaware Naturalist Handbook: Cultural Studies of Delaware and the Eastern Shore. Mckay Jenkins and Susan Barton, editors. University of Delaware Press. Distributed by the University of Virginia Press. Newark, Delaware. 59-82.

Kauffman, G. J., 2020. Benefit-Cost Analysis of Water Quality Policy and Criteria in the Delaware River. Water Policy. Journal of the World Water Council. 22:313-327.

Kauffman, G. J., B. Diacopoulis, A. R. Homsey, and M. B. Narvaez, draft 2020. Water Resources Planning and Management in the National Park System. Journal of Contemporary Water Research and Education (JCWRE). Universities Council on Water Resources (UCOWR). 25 pp.

Kauffman, G. J. and A. R. Homsey, 2020. White Paper-Southern New Castle County Wastewater Plan. New Castle County Department of Public Works. 36 pp.

Kauffman, G. J., A. R. Homsey and K. Jacobs, 2020. Economic Value of the Delaware Inland Bays Watershed. Prepared for the Delaware Center for Inland Bays. Rehoboth Beach, Delaware. 45 pp.

Kauffman, G. J., A. R. Homsey, and K. Jacobs, 2020. Economic Value of the Nanticoke River Watershed in Delaware and Maryland. Nanticoke Watershed Alliance. Vienna, Md. 46 pp.

**Information Transfer Program**

One of the major ongoing activities of the DWRC is to disseminate information on water resources to all interested individuals in Delaware and other states. The DWRC has a website to facilitate this and published the December 2019 annual newsletter (DWRC Water News) which is distributed to 1,500 individuals and organizations and water-related faculty and staff at UD and many individuals in state/federal agencies, and local/regional water organizations. We have also established a formal link with the UD's undergraduate research program to distribute information to interested students about opportunities for water resources research. Students who participate in a research project will present their results during the undergraduate research poster session sponsored by the UD Office of Undergraduate Research. DWRC Director Dr. Gerald J. Kauffman represented DWRC and presented at the following seminars during FY19:

1. Brandywine and the Piedmont: Restoration and Revival of America's Most Historic Small Watershed. June 11, 2019. Universities Council on Water Resources (UCOWR)/National Institutes for Water Resources (NIWR) Annual Water Resources Conference. Snowbird, Utah.

2. Brandywine Shad 2020. UpStream Alliance. Dec 15, 2020.

3. Brandywine Christina State of the Watershed. Brandywine Christina Task Force. Dec 4, 2020.

**Student Support**

The University of Delaware Water Resources Center supported 11 undergraduate and graduate water research internships during FY19 through the annual base (104b) grants. The DWRC research students presented their research findings at the 55th annual meeting of the DWRC Advisory Panel on May 14, 2020 at the University of Delaware:

**FY19 Delaware Water Resources Center Undergraduate/Graduate Internships**

| Last | School | Major | Research Advisor | Title of Proposed Research |
|---|---|---|---|---|
| Sicily Bordrick | UD | Environmental Engineering | Anastasia Chirnside | Optimization of HPLC Analysis of Ergosterol to Quantify Fungal Biomass within Bioreactors |
| Zach Burcham | UD | Environmental Engineering | Anastasia Chirnside | Optimization of HPLC Analysis of Ergosterol to Quantify Fungal Biomass within Bioreactors |
| Ji Zhendong | UD | Environmental Science | James Pizzuto | Discriminating between Mill Dam and Flood Deposits along White Clay Creek |
| Justin Leary | UD | Environmental Engineering | Jerry Kauffman | Hercules Red Clay Creek Watershed Monitoring Plan |
| Savanah Love | Wesley | Environmental Science | Stephanie Stotts | Interactive art exhibit focused on salinification of wetlands |
| Aaron Nolan | UD | Environmental Engineering | Jerry Kauffman | Duck Pond Creek Watershed Plan at Winterthur Gardens, Wilmington, Del. |
| Polly Ni | UD | Environmental Engineering | Jerry Kauffman | Brandywine Piedmont Field Monitoring Plan |
| Emily Symes | UD | Geological Sciences | James Pizzuto | Sediment Fingerprint Red Clay Creek Watershed |
| Mary Kegelman | UD | Environmental Engineering | Jerry Kauffman | Water Quality Trends in New Castle County (Delaware) Streams, 2000-2020 |
| Matt Kirchman | UD | M.S. Energy & Environ. Policy | Andrew Homsey | White Clay Creek Water Quality Modeling |
| Kelly Jacobs | UD | M.S. Energy & Environ. Policy | Martha Narvaez | Effect of Marcellus Shale Gas Drilling on the Delaware River Watershed. |

Beginning in June 2020, the DWRC supported 18 undergraduate and graduate water research internships during FY19 through the annual base (104b) grants. The DWRC research students presented their research findings at the 56th annual meeting of the DWRC Advisory Panel on May 13, 2021 at the University of Delaware:

**FY20 Delaware Water Resources Center Water Research Internships**

| Water Research Student | Major | Research |
|---|---|---|
| Hayley Rost | Master of Public Administration, Biden School | White Clay Creek Wild and Scenic River Water Quality Sampling Network. |
| Sophie Phillips | Master of Energy & Environ. Policy), Biden School | Environmental Justice and Water Use in Rural Delaware. Research |
| Anna Singer | Environmental. Studies/ Public Policy | Water Quality Trends in White Clay Creek Nat'l Wild & Scenic River, Delaware and Pennsylvania |
| Emily Jimenez | Environmental Engineering | Frequency of Peak Flood and High Tide Events in Delaware with Climate Change and Sea Level Rise |
| Karmyn Pasquariello | Environmental Engineering | Economic Value of Properties in the Coastal/Riverine Floodplain in Delaware with Sea Level Rise |
| Delaney Doran | Environmental Engineering | Watershed Characterization of First Order Tributaries along the Brandywine River in Delaware |
| Elizabeth DeSonier | Environmental Science | Stratigraphy of Valley Fill Deposits Upstream of a Small Colonial-Age Mill Dam, White Clay Creek, Pennsylvania |
| Lillian Peterson | Environmental Engineering | Stream Habitat Sampling along Tributaries of the Red Clay Creek in Delaware |
| Tommy Breevold | Environmental Engineering | Stream Habitat Sampling along Tributaries of the Red Clay Creek in Delaware |
| Sitlaly Avelino | Environmental Engineering | Watershed Characterization of First Order Tributaries along the Brandywine River in Delaware |
| Jady Perez | Environmental Engineering | Forest Hydrology and Stream Health in the Hickory Run Watershed at Mt. Cuba Center |
| Grace Hussar | Environmental Studies | The Effects of Reforestation and Invasive Species Removal on Stormwater Flooding Events in Baltimore |
| Bridgette Kegelman | Geography/Greek Roman Studies | Updating Land Use and Impervious Cover Change for the State of the Bays Report |
| Alexis Cervantes | Environmental Science | Historic Significance of the Brandywine River as Drinking Water Supply in Wilmington, Delaware |
| Brendan Benson | Environmental Engineering | The Effect of Biochar on Infiltration Rate and Soil Aggregation in Both the Field and Lab |
| Shannon Bushinsky | Environmental Engineering | Intergovernmental River Basin Management, the International Joint Commission Model |
| Patrick McGay | Environmental Engineering | White Rot Fungi with Solid State Bioreactors to Reduce Pathogens in Dairy Manure Runoff |
| Brielle Bianchini | Environmental Engineering | Water Quality Trends in White Clay Creek Nat'l Wild & Scenic River, Delaware and Pennsylvania |

**Intergovernmental River Basin Management: The International Joint Commission Model**

Shannon Bushinsky, University of Delaware, Environmental Engineering major

**Abstract:**This research summarizes the International Joint Commission's (IJC) role in river basin protection and international treaties concerning water quality and aquatic ecosystem health between Canada and the United States. The analysis of the IJC includes its structure, policies, first-hand interviews of Canadian and American staff, and a case study within the Great Lakes-St. Lawrence River watershed. By exploring the structure of the IJC, it will provide an overview of how a large international agency can oversee several river basins throughout 5,525 miles of shared land and water boundaries. Analyzing the IJC's policies will unfold information on how Canada and the United States negotiate policies based upon different views and regulations of water quality and environmental health. Moreover, the case study will analyze the IJC's management of the 2012 Great Lakes Water Quality Agreement a framework between Canada and the United States to mitigate and prevent water quality degradation of the Great Lakes ecosystem. In addition to analyzing the IJC, its policies and actions compared with two other international river basin organizations – the International Boundary and Water Commission and the Amazon Cooperation Treaty Organization – to determine organizational structure successfully implement water protection. and management practices for transboundary river basins such as the Delaware River and Chesapeake Bay basins.

**Watershed Characterization of 1st Order Tributaries along Brandywine River in Delaware**

Delaney Doran and Sitlaly Avelino, University of Delaware, Environmental Engineering major

**Abstract:** The Brandywine River provides drinking water to 10% of the residents of New Castle County, Delaware including the First State's largest city, Wilmington. The river enters Delaware on the northern border with Pennsylvania and exits into the Delaware River. This research focuses on 14 first order tributaries that flow into the Brandywine River with the goal to better understand and characterize the waters that constitute a major source of drinking water for the state of Delaware. Field studies were conducted at reaches along the tributaries to analyze the flow and velocity of the tributaries as well as nitrogen, turbidity, and conductivity. Watershed delineation and characteristics were determined using the USGS STREAMSTATS model. The streams were classified according to the EPA stream habitat assessment method and stream geomorphology. The results of these different methods were analyzed further to assess the ecological health of each tributary that drains to the Brandywine River. Further studies focus on analyzing the health of ephemeral tributaries in the headwater streams in urban areas.

**Economic Value of Properties in Delaware Coastal/Riverine Floodplain w/ Sea Level Rise**

Karmyn Pasquariello, University of Delaware, Environmental Engineering Major

**Abstract:** Climate change is a rising environmental crisis which threatens the United States with unpredictable storms, flooding, and natural disasters imposing menace on many structures and homes. This research into the economic value of properties in the coastal/riverine floodplain in Delaware with sea level rise seeks to assess the real-estate value of properties in Delaware and how it has changed since 1975 in relation to sea level rise and flooding. We analyze flood insurance premiums, claims, and coverage in Delaware to find high-flood risk areas and determine whether the flood insurance program is adequately funded or subsidized by FEMA. Through ArcGIS, we overlay FEMA and NOAA flood inundation maps with parcel/property value maps to estimate the value of real estate at risk for flooding given that nearly 1/5 of Delaware rests in the 100-year floodplain. Our research indicates the floodplain in Delaware affect a large portion of the First State's population and that flood damage claims are not adequately funded by flood insurance premiums meaning the market is subsidized by FEMA and the U.S. Treasury

**Frequency and Intensity of Peak Flood Events in Delaware with Climate Change**

Emily Jimenez, University of Delaware, Environmental Engineering

**Abstract:** The research seeks to determine if peak flood events and high tides are increasing in Delaware with the warming climate. We will examine DEOS precipitation, USGS stream gage, and NOAA tide gage records in Delaware and conduct temporal trend analysis to assess whether riverine and coastal flood conditions are increasing in frequency and magnitude over time. Review and synthesize the literature regarding changes in peak flooding and sea level rice in Delaware and the Mid-Atlantic coast. Gather long term precipitation and temperature at three DEOS weather stations in New Castle, Kent, and Sussex counties, Delaware. Obtain annual peak streamflow data from the following USGS stream gages. Obtain annual peak high tide data from USGS and NOAA tide gages. Conduct statistical analysis to determine if peak stream flow and coastal high tides are changing with precipitation and temperature in Delaware watersheds. Prepare and present report and poster summarizing the research.

**Synthesis of COVID19 DNA in Wastewater in the U.S.**

Thomas Breedveld, University of Delaware, Environmental Engineering

**Abstract:** The research seeks to examine the state of practice in COVID19 testing in wastewater in the United States. Results of the new Castle County COVID19 in wastewater testing program will be examined and summarized. Review and synthesize the literature regarding COVID19 DNA analysis in wastewater in the US and internationally. Examine new Castle County COVID19 in wastewater testing program. Review and summarize water quality lab analysis at the stations for the DNA between October 2019 and the present. Conduct statistical analysis of the DNA samples (min/max, median, standard deviation, probability). Prepare and present report and poster summarizing the research.

**Water Quality Trends in White Clay Creek Nat'l Wild & Scenic River, Delaware and Pennsylvania**

Anna Singer, University of Delaware, Environmental Engineering

**Abstract:** The University of Delaware Water Resources Center (UDWRC) proposes to conduct water quality monitoring and trends analysis along the White Clay Creek in Delaware and Pennsylvania. Water quality samples will be collected at 6 stations, 3 in each state for the visible pollutants. Using ArcView GIS, delineate and map the watershed to include the following layers: (a) hydrology, (b) aerial photography, (c) roads/railroads, (d) topography, (e) subwatershed boundaries, (f) land use/land cover, (g) soils, (h) wetlands/hydric soils, (i) floodplain. Establish stream flow and water quality monitoring stations at 6 locations. In DE and PA. Once per week and during storms over a 6-month period, record flow depth and velocity to estimate stream flow. At each of the 4 water quality monitoring stations over a 6-month period, sample water quality for a base (low) flow and a storm (high) flow event and transmit for analysis at the University of Delaware Agriculture Laboratory: Dissolved Oxygen, Total Suspended Solids, Turbidity, Conductivity, Nitrogen, Phosphorus, Metals (Cu, Pb, ZN, Fe, Mn, Hg). Develop a TR55 hydrologic model for the watershed to estimate 2-, 10-, and 100-year discharge to evaluate the benefits of reforestation and other land cover changes on the creek and also to design best management practices (BMPs) to restore the watershed and the stream. Prepare a field report that summarizes the field work to characterize the watersheds according to the following parameters: stream cross-sections, stream habitat, biology, streamflow, water quality, geomorphology, soils, hydrogeology, wetlands, forests, hydrology, and rain garden implementation. Conduct statistical analysis of water quality (stream flow) and water quality parameters for temporal and spatial trends.

**Forest Hydrology and Stream Health in the Hickory Run Watershed at Mt. Cuba Center**

Jady Perez, University of Delaware, Environmental Engineering

**Abstract:** The University of Delaware Water Resources Center (UDWRC) proposes to work with Mt. Cuba Center to conduct field studies and streamflow and water quality monitoring during 2016 along the Piedmont tributary of Barley Mill Run that flows east and joins Red Clay Creek near Hoopes Reservoir in Ashland, Delaware. The 430-acre watershed is largely undeveloped and covered by 53% forest, 0.1% wetlands, and just 0.2% impervious cover. The objective of the watershed-based research program is to quantify the benefits of reforestation at Mt. Cuba Center on the water quality and water quality of Barley Mill Run. To characterize subcatchments, the DWRC proposes to employ a team of University of Delaware undergraduate research interns to analyze field data collected at four (4) monitoring stations would be established where the creek flows by roadway and railroad crossings. Using ArcView GIS, delineate and map the Barley Mill Run watershed to include the following layers: (a) hydrology, (b) aerial photography, (c) roads/railroads, (d) topography, (e) subwatershed boundaries, (f) land use/land cover, (g) soils, (h) wetlands/hydric soils, (i) floodplain. Establish stream flow and water quality monitoring stations at the following 4 locations: (a) Barley Mill Road, (b) Ramsey Road, (c) Mt. Cuba Road, and (d) Wilmington and Western Railroad. Using a surveying rod, level, and tape; survey 19 stream cross sections along 9,500 linear feet at 500 foot intervals along Barley Mill Run and its tributary (near Ramsey Road) tied to mean sea level (msl) datum. At the 4 water quality monitoring stations over a 6-month period, sample water quality for a base (low) flow and a storm (high) flow event and transmit for analysis at the University of Delaware Agriculture Laboratory: Dissolved Oxygen, Total Suspended Solids, Turbidity, Conductivity, Nitrogen, Phosphorus, and Metals (Cu, Pb, ZN, Fe, Mn, Hg). Prepare a field report that summarizes the field work to characterize the watersheds according to the following parameters: stream cross-sections, stream habitat, biology, streamflow, water quality, geomorphology, soils, hydrogeology, wetlands, forests, hydrology, and rain garden implementation. Conduct statistical analysis of water quality (stream flow) and water quality parameters for temporal and spatial trends.

**Historic Significance of the Brandywine River in Wilmington, Delaware**

Alexis Cervantes, University of Delaware, Environmental Engineering

**Abstract:** This research seeks to assess the historic significance of the Brandywine River as the largest and sole drinking water supply for the City of Wilmington in the State of Delaware. Brandywine Shad 2020 has identified involved resources that are listed in the National Register of Historic Places (NRHP), and properties that might be considered eligible for listing that are located within the geographic area of the potential effect (APE) of the proposed project. As a means to identify historic properties under 36 CFR 800.4, we have completed a preliminary review of available information on previously identified historic properties to determine if any are located within the APE of this undertaking. The review of existing information revealed that: Dam 2 is listed as a contributing element to the Brandywine Park Historic District listed on the National Register of Historic Places in 1976 (CRS# N01566.024). Dam 4 is listed as a contributing element to the Bancroft and Sons Cotton Mills Historic District listed on the National Register of Historic Places in 1984 (CRS# N03646.048).

**Environmental Justice and Stormwater Mitigation Through Reforestation in West Baltimore (Stillmeadow Community Fellowship Project)**

Grace Hussar, University of Delaware, Environmental Science

**Abstract:** This research is uniquely conducted through hands-on experiences and a series of interviews compiled as a long-form journalism piece. It is a year-long project that will be assessing the positive impacts of reforestation on a community in west Baltimore that has historically suffered the negative effects of stormwater. Establish a nursery: spread sawdust and woodchips evenly, fill more than 1,080 pots with fertilizer, line up pots on plot of land, set up fencing to keep predators (deer) out, and plant native tree saplings in pots. Clear dead/fallen trees: Use chainsaws to cut dead or fallen Ash trees, remove them from their scattered location on the 10 acre-plot of land behind the Stillmeadow Church. Conduct interviews: ask residents about their personal encounters/thoughts on stormwater in the area; ask U.S. Forestry employee about the importance of projects like Stillmeadow (reforestation, stormwater mitigation, invasive species removal, etc.), ask members of the church how this project has impacted their community, environment, livelihood, and perspective. Create story map: use pictures to show progress on project; publish quotes from interviews to establish narrative and credibility of information; list native/invasive species descriptions with images; include introductions for important interviewees; use GIS to show trails and patterns. Plant trees: move native trees saplings from nursery to the 10 acres of land when they are big enough to transfer and plant. Eliminate/transform paved surfaces: find different ways to repurpose the large, paved parking lot in front of the church (garden, new nursery, fill in with soil, etc. -- the possibilities are endless and every-changing).

**Modification of Peroxidase Enzyme Analytical Methods for Solid State Bioreactors use to Reduce Pathogens in Dairy Manure.**

Patrick McGay, University of Delaware, Entomology & Wildlife Ecology

**Abstract:** Certain white rot fungi (WRF) are capable of killing bacteria present in manure waste streams (Chirnside, 2016). The WRF *Pleurotus ostreatus* grown in small bench-scale bioreactors was able to reduce the number of *E. coli* naturally present in aqueous dairy manure. Currently, bioreactors containing both *P. chrysosporium* and *P. ostreatus* are being evaluated for their ability to degrade *E. coli* and antibiotics within aqueous dairy manure. The reduction could be related to their secondary metabolism responsible for their ligninolytic activity. During lignin degradation, the WRF produce non-specific, oxidative extracellular enzymes that degrade the lignin structure. These enzymes may be involved in *E. coli* degradation or the production of the $H_2O_2$, which has antimicrobial properties, may be the mode of action for the reduction. The objective of this research is to monitor the fungal bioreactors during treatment of dairy manure containing *E. coli* for both Lignin Peroxidase and Manganese Peroxidase. The standard enzyme assays used to monitor the ligninolytic enzymes use colorimetric methods. The complex media from the bioreactors interferes with the standard enzyme assays. Therefore, a review of the literature will be done to modify the methods so the assays will be effective for the dark-colored media from the bioreactors. The tests will be run on the clear growth solution containing the fungus in order to confirm the success of the analyses. Once the tests are confirmed successful, the assays will be performed on samples taken from the bioreactors during the *E. coli* degradation experiments.

**Updating Land Use and Impervious Cover Change for the 2016 State of the Bays Report**

Bridgette Kegelman, University of Delaware, Environmental Science

**Abstract:** This research seeks to collect and create updated data, graphs, and charts on variables such as land use and impervious cover for the updated 2016 State of the Bays Report. An analysis and interpretation will be written comparing the past status and trend reports. Compare the latest available data, either raster data from NOAA or Vector data from the state, for the Your Creek Project variables (listed below). Decide which of the available data would be best to use. Use a replicated Buffer tool from the Center of Inland Bays (CIB) in GIS to generate buffer areas around water bodies, agriculture, and developed area for the 2016 updated State of the Bays report. Update datasets for variables for the Your Creek Project such as Bacteria, Dissolved Oxygen, Land Use, Nutrient Concentration, Nutrient Loads, and possibly Septic, and/or Submerged Aquatic Vegetation (SAV). Analyze and manipulate data that has been collected. Calculate medians over time to determine trends. Create charts and trend graphs for interpretation and write up. Write up methodologies of analysis and the interpretation of data trends for updating the 2016 State of the Bays Report.

**Milldam Deposits in White Clay Creek**

Liz DeSonier, University of Delaware, Geology Department

**Abstract:** By examining the sediments in White Clay Creek I am identifying how the soil profile has changed since human settlement. As an indicator of the arrival of people, I am looking for Milldam deposits in the profile. Milldam deposits are a result of soil that accumulated behind milldams and then was released when the milldams were removed, and the soil flowed downstream. The presence of this would determine how the soil layers have changed since people settled here which would help people decide how to manage the creek. Using a measuring stick note the heights of the different layers of soil, these will be graphed in core logs. Then take soil samples from the different sections. Use the core logs and other observations to draw a cross-section. Analyze soil samples for mud/sand ratios and loss of ignition (LOI). This is done in the lab with by using hydrogen peroxide to remove the organic matter, sieving out the mud from the sand using calgon and then weighing the dried samples. Using Jacobson (1986) and Walter (2008) compare findings to their research. Prepare a poster that summarizes the work done characterizing the soils.

**Watershed Characterization of 1st Order Tributaries along the Red Clay Creek in Delaware**

Tommy Brevold and Lillian Peterson, University of Delaware, Environmental Engineering

**Abstract:** This research seeks to characterize the watershed of first order tributaries of the Red Clay Creek in Delaware by assessing stream geomorphology, stream habitat, and water quality. Using the Rosgen (1994) Stream Geomorphology Classification system. Classify each stream reach according to the following parameters: Single Thread Channels, Entrenchment ratio (Floodprone width Record stream habitat along each reach as optimal (16-20), suboptimal (11-15), marginal (6-10), and poor (0-5) based on ten parameters using a 0 to 200 point metric adapted from the EPA rapid stream bioassessment technique (Barbour, Gerritsen, Snyder, and Stribling 1999) for steeply sloped (Piedmont) streams. Along each tributary, sample water quality for a base (low) flow and storm (high) flow event for pH, dissolved oxygen, turbidity, and conductivity. Parameters such as nutrients (nitrogen/phosphorus), bacteria, sediment, metals, and organics analyzed by the UD Water Quality Laboratory. Prepare a field report that summarizes the summer work to characterize the watersheds according to the following parameters: stream cross-sections, stream habitat, biology, water quality, geomorphology, soils, and hydrogeology.

**Notable Achievements and Awards**

In FY19, DWRC Director Dr. Gerald Kauffman was elected to the Board of the Universities Council on Water Resources (UCOWR) at the annual meeting in June 2019.

National Park Service/White Clay Creek National Wild & Scenic River ($10,000): Staff and student assistance to implement White Clay Creek watershed management plan.

DELDOT Coastal Flood Inundation Grant Phase II ($63,382): Research and prioritize flood prone road and bridge improvements due to sea level rise and coastal flood and hurricane inundation on Delaware transportation infrastructure

Brandywine Shad 2020/US Fish & Wildlife Service ($241,000): Work with Center for Historic Architecture and Design (CHAD) and UD Sea Grant in CEOE to restore the Brandywine River for passage of anadromous fisheries.

DRBC Delaware River Benefit/Cost Analysis ($32,000): Estimate the costs and benefits to society of improved water quality in the Delaware River between Trenton, Philadelphia, and Wilmington.

William Penn Foundation (Phase 2/Year 3) Brandywine/Christina ($31,500): Develop a water fund as a market-based financial investment model for the Brandywine/Christina watershed in Delaware and Pennsylvania.

Delaware Nature Society Clean Water Campaign ($30,000): Research and conduct outreach in public opinion and advocacy of clean water investment introduced by Senate Resolution 30.

**DWRC Advisory Panel**

Jayme Arthurs
USDA Natural Resources Conservation Service, Dover, DE 19904

Chris Bason
Center for the Inland Bays, 39375 Inlet Rd.
Rehoboth, DE 19971

Ethan Robinson
City of Newark, Dept. of Public Works
Newark, DE 19711

Jeff Downing
Mt. Cuba Center, 3120 Barley Mill Rd.
Wilmington, DE 19707

Asia Dowtin
Dept. of Forestry, Michigan State University
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Thomas McKenna
Delaware Geological Survey
Newark, DE 19716

Kristin Travers
Delaware Nature Society
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Chris Oh
City of Wilmington, Dept. of Public Works
Wilmington, DE

Betzaida (Betzy) Reyes
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Jim Jordan
Brandywine Valley Association.
West Chester, PA 19382

Jennifer Volk
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