53rd Annual Meeting of the Delaware Water Resources Center

Interdisciplinary Science and Engineering Laboratory
University of Delaware
Newark, Del.
May 10, 2018

Gerald J. Kauffman, Ph.D., Director
University of Delaware
Water Resources Center

NIWR
THE NATIONAL INSTITUTES FOR WATER RESOURCES

UNIVERSITY OF DELAWARE | School of Public Policy & Administration
INSTITUTE FOR PUBLIC ADMINISTRATION

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MEMORANDUM

TO: Advisory Panel of the University of Delaware Water Resources Center
Undergraduate/Graduate Research Students and Advisors

FROM: Dr. Gerald J. Kauffman, Director
Delaware Water Resources Center

DATE: May 7, 2018

SUBJECT: 53rd Annual DWRC Advisory Panel Meeting

You are invited to the 53rd Annual Meeting of the Advisory Panel of the University of Delaware Water Resources Center at 10 am on Thursday May 10, 2018 in the 4th floor conference room 467 of the Harker Interdisciplinary Science & Research Laboratory (ISELAB) on Academy Street on the University of Delaware campus in Newark, Delaware. Our charge will be to review the research presentations of the FY17/18 water resources students and establish research priorities in Delaware (such as riverine/coastal flooding, algal blooms and PFOA contamination) for the upcoming year. Our business meeting will be in the morning followed by luncheon at noon and an afternoon field reconnaissance along the White Clay Creek National Wild & Scenic River. Our campus will be blooming beautifully by then and we hope to see you soon.

Agenda
Delaware Water Resources Center
53rd Annual Advisory Panel Meeting

10:00 am May 10, 2018	Rm 467 ISELAB Academy St. Newark, Del.
1. Introductions	10:00 am
2. FY17/18 Undergraduate/Graduate Research Presentations	10:15
3. DWRC FY18/19 Budget Submittal to DOI/USGS	11:00
4. FY18/19 Undergraduate Water Internship Proposals (start June or Sep 2018)	11:15
5. DWRC Advisory Panel Membership	11:30
6. DWRC and Delaware Sea Grant	11:45
7. Delaware Clean Water Campaign (Martha Narvaez)	11:55
8. Luncheon	noon
9. White Clay Creek Field Reconnaissance	1:00 pm

Delaware Water Resources Center (DWRC)

*A unit of the **Institute for Public Administration***
within the School of Public Policy & Administration in the College of Arts & Sciences

UNIVERSITY OF DELAWARE

DWRC Staff

Gerald J. Kauffman, Ph.D.
Director

Andrew R. Homsey
Associate Policy Scientist

Nicole M. Minni
Associate Policy Scientist
(Lewes Office)

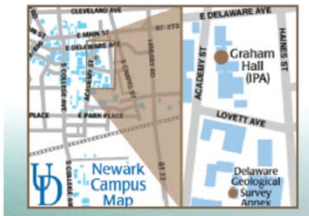
Martha C. Narvaez
Policy Scientist

Maria Pautler
DWRC Program Coordinator/
Research Associate III

Martin W. Wollaston
Policy Scientist

Bernard L. Dworsky
WRA Director (Emeritus)

Undergraduate and Graduate Research Fellows
bachelor's and master's degree students funded by the DWRC



What is DWRC?

Established on campus in 1965, the University of Delaware Water Resources Center (DWRC) is one of the 54 National Institutes for Water Resources (NIWRs) at land grant universities in the 50 states, District of Columbia, and island territories of Guam, Puerto Rico, and U.S. Virgin Islands. The DWRC is supported by the U.S. Geological Survey through Section 104 of the Water Resources Research Act signed into law by Lyndon Baines Johnson in 1964. The mission of the DWRC is to: (1) support water resources research, education, and public outreach programs in Delaware and (2) sponsor training of future water scientists, engineers, managers, and policy-makers in the First State.

What is WRA?

Established in 1977 and modified in 1990 and 1997, the Water Resources Agency (WRA) is a program of the DWRC and provides regional water resources assistance to governments in Delaware and the Delaware Valley through the University of Delaware's land-grant public service, education, and research role. The WRA is supported by federal, state, and local government partners, including the State of Delaware, New Castle County, City of Newark, and City of Wilmington.

Where is DWRC?

The DWRC is located in Newark, Delaware, on UD's main campus at 261 Academy Street in the Delaware Geological Survey (DGS) Annex, behind Penny Hall and the UD Rain Garden.

DWRC Partners

- Brandywine Conservancy
- Brandywine Valley Association
- City of Wilmington
- City of Newark
- Delaware Nature Society
- Delaware Center for Horticulture
- Delaware Greenways
- Delaware Department of Transportation
- Delaware River Basin Commission
- Delaware Department of Natural Resources and Environmental Control
- FishAmerica Foundation
- New Castle Conservation District
- New Castle County
- National Oceanic and Atmospheric Administration
- National Park Service
- Partnership for the Delaware Estuary
- SUEZ Water Delaware
- The Nature Conservancy (Delaware)
- UD Colleges
- U.S. Environmental Protection Agency
- U.S. Geological Survey
- William Penn Foundation

DWRC is involved with...

- Christina Basin Clean Water Partnership
- City of Wilmington Green Jobs Program
- Delaware Flora Database
- Delaware Source Water Assessment and Protection Program
- Delaware Water Supply Coordinating Council
- Delaware Watersheds
- Economic Value of Watersheds
- GIS Services/Education/Outreach
- Sussex Economic Development Action Committee
- Sustainable Coastal Community Initiative
- White Clay Creek Wild and Scenic Management Committee

www.wrc.udel.edu

Figure 1. Map of Newark and environs (source: Water Resources Agency, Institute for Public Administration, University of Delaware, 2008)*

The University of Delaware is fortuitously situated on campuses ideally suited by hydrology and geography to study water resources.

JFK signs 1961
DRBC Compact

LBJ signs 1964
Water Resources
Research Act

LYNDON B. JOHNSON

XXXVI *President of the United States: 1963-1969*

461 - Statement by the President Upon Signing the Water Resources Research Act.

July 17, 1964

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+1

THE Water Resources Research Act of 1964, which I have approved today, fills a vital need.

Abundant, good water is essential to continued economic growth and progress. The Congress has found that we have entered a period in which acute water shortages are hampering our industries, our agriculture, our recreation, and our individual health and happiness.

Assuming a continuation of current practices, by the year 2000 there will not be enough usable water to meet the water requirements of parts of the States of Arizona, California, Colorado, Delaware, Idaho, Illinois, Indiana, Iowa, Kansas, Louisiana, Michigan, Minnesota, Montana, Nebraska, Nevada, New Jersey, New Mexico, New York, North Dakota, Ohio, Oklahoma, Oregon, Pennsylvania, South Dakota, Texas, Utah, Wisconsin, and Wyoming.

This legislation will help us solve this problem. It will create local centers of water research. It will enlist the intellectual power of universities and research institutes in a nationwide effort to conserve and utilize our water resources for the common benefit. The new centers will be concerned with municipal and regional, as well as with national water problems. Their ready accessibility to State and local officials will permit each problem to be attacked on an individual basis, the only way in which the complex characteristics of each water deficiency can be resolved. The bill contemplates a high degree of interstate cooperation, and I urge that this be encouraged.

In large measure, this legislation is a tribute to the vision and wisdom of Senator Clinton P. Anderson of New Mexico. He has long recognized the problems. He developed the program. He guided it through Congress. He has been in the forefront of the effort to see that adequate supplies of water are available in all parts of the Nation.

COLLECTION:
Public Papers of the Presidents

Lyndon B. Johnson
1963-64: Book II

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Delaware Water Resources Center
at the University of Delaware

DWRC

Undergraduate Internships In Water Resources 2015

University of Delaware | College of Agriculture & Natural Resources

Delaware Water Resources Center (DWRC) Undergraduate Internships in Water Resources provide a unique opportunity for undergraduate students and faculty to become directly involved in research and education projects addressing water resource related issues of critical importance to Delaware and the Mid-Atlantic region.

Eligibility

All undergraduate students enrolled at an institution of higher learning in Delaware may apply, except for those graduating at the end of the spring semester. All students must have the active support of a faculty advisor and a minimum GPA of 3.0. (If a student applies for any other UD-sponsored summer research experience s/he must indicate this on the ***DWRC*** application. The ***DWRC*** intends to award internships to only those students who have not been awarded another internship within a calendar year.)

Program Details and Deadline

The ***DWRC*** provides $3500 in financial support for each undergraduate internship. Students typically work ten weeks full-time during the summer and additional hours during the fall and winter. Interns must submit a written report on their project and participate in a poster session at the UD spring undergraduate research conference. The application deadline for 2015 ***DWRC*** internships is March 27, 2015. See second page for more information. For details on past projects, current faculty advisors, application materials to submit, and requirements for reports and posters, visit the ***DWRC*** website:
http://ag.udel.edu/dwrc/

Delaware Water Resources Center (DWRC) interns

experience a complete research or education project. Students, in cooperation with faculty advisors, identify a topic of interest, develop

The DWRC Internship Program

All DWRC interns conduct a project consistent with the ***DWRC***'s research and educational interests (listed below in the green box) with the support of a faculty advisor from one of our **co-sponsor organizations.** Internships may be available in sponsorship with the following:

University of Delaware (UD) Water Resources Agency (http://www.ipa.udel.edu/wra/): Internships are supported which focus on water resource policy and management.

UD College of Agriculture and Natural Resources (http://canr.udel.edu): Projects are supported to work with faculty in the departments of *Animal and Food Sciences, Entomology and Wildlife Ecology, Applied Economics and Statistics,* or *Plant and Soil Sciences*. For example, an internship in the *Department of Plant and Soil Sciences* could relate soils, plants, and land management to water use and quality.

UD College of Arts and Sciences (http://www.cas.udel.edu/): Students can conduct internship projects in *Biological Sciences, Chemistry, Political Science, Public Policy,* or other subjects closely related to water resources.

UD College of Earth, Ocean, and Environment (http://www.ceoe.udel.edu/): Internships are supported in the areas of *Geography, Geology, Marine Biology and Biochemistry, Marine Policy, Oceanography,* or *Physical Ocean Science and Engineering*.

UD College of Engineering (http://www.engr.udel.edu/): Projects can be developed in areas such as *Chemical Engineering, Civil and Environmental Engineering,* or *Mechanical Engineering*.

Delaware Geological Survey (http://www.dgs.udel.edu/): Researchers offer internships focusing on hydrogeology, ground water supply, and water quality.

Delaware State University (http://cars.desu.edu/): Faculty support internships in the areas of agriculture, natural resources, aquaculture, and aquatic ecology.

Delaware Department of Natural Resources and Environmental Control (http://www.dnrec.delaware.gov/): Staff in DNREC offices related to water resources occasionally offer internships on topics such as soil and water conservation, water quality, and climate change.

Topics in water resources research and education of interest to the DWRC:

- Water pollutants - their sources, fate, cycling, and transport
- Water supply, demand, and conservation
- Groundwater identification and protection
- Nutrient management and water quality
- Management and control of storm water runoff

How to Apply for a DWRC Internship

Select your topic: ***DWRC*** internships are for students from a wide variety of backgrounds and research interests. Titles of past projects can be found at http://ag.udel.edu/dwrc/interns.html and http://ag.udel.edu/dwrc/publications/DWRCInternshipSpotlight2009.pdf and include: *White Clay Creek Shad Restoration Project* **(Water Resources Agency)**; *Developing Scientifically-Based Food Safety Metrics for Water Management and Irrigation Methods* **(Animal and Food Sciences)**; *The Returns to Best Management Practices: Evidence from Early Proposals for Nutrient Trading in the Chesapeake Bay Watershed* **(Applied Economics and Statistics)**; *Water Quality Management in Urban Ecosystems* **(Plant and Soil Sciences)**; *The Impacts of Redefining Navigable Waters under the Clean Water Act* **(Political Science)**; *Sediment Transport through Historic Mill Dams of the Christina River Basin* **(Geology)**; *Characterization of Viral Diversity within the Mantel Fluid of the Eastern Oyster,* Crassostrea virginica **(Marine Biology)**; *Preventing Formation of Toxic Chlorination Byproducts in Water Using Zerovalent Iron* **(Civil and Environmental Engineering)**; *Hydraulic Properties of the Columbia Aquifer* **(Delaware Geological Survey)**; and *Aquatic Health near Wastewater Discharge in Delaware Inland Bays Tidal Canal* **(Delaware State University)**.

Find a Faculty Advisor and Apply to the DWRC: Faculty contacts and their research interests are also listed on the ***DWRC*** website, under "Faculty and Staff". Contact the ***DWRC*** program coordinator, Maria Pautler (mpautler@udel.edu; 302-831-0847), to say that you are interested. Students should contact potential faculty advisors to discuss and identify a project topic of mutual interest and then submit their application to the ***DWRC*** by the deadline **(March 27, 2015)**. Faculty may not advise more than two interns concurrently and must provide matching funds consistent with ***DWRC*** guidelines, usually by committing a percentage of their time to the intern's project.

Delaware Water Resources Center

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50 Years of Water Research

NIWR & USGS A Model Partnership

NIWR THE NATIONAL INSTITUTES FOR WATER RESOURCES

USGS science for a changing world

...on by Danielle Quigley

PARTNERSHIP WITH USGS

- The National Institutes for Water Resources (NIWR) partners with the U.S. Geological Survey (USGS) through the provisions of the Water Resources Research Act (WRRA) to address water-related concerns by providing a national platform for research, training and collaboration.
- USGS provides each institute with a grant to target local priorities, recruit researchers and leverage federal funds with state money and private funding.
- 54 NIWR member institutes are housed in the country's land-grant universities in all 50 states, three U.S. territories and the District of Columbia.
- NIWR is the only federally mandated research program that focuses on applied water resource research, education, training and outreach.

Housed in the nation's leading research universities, NIWR

MAXIMIZING FEDERAL IMPACT

NIWR's ability to attract and match non-federal funds to USGS grant-sponsored research multiplies the federal investment in local water projects. The NIWR-USGS partnership also strengthens USGS's own funding model, as NIWR institutes often allow funds to pass through the institutes to USGS State Water Science Centers. The NIWR institutes open doors for the USGS at the state-level to other funding sources that may require non-federal matching funds. In recent years, the USGS State Water Science Centers have benefitted from funds that have flowed through NIWR institutes from external sources for technical assistance and scientific expertise on large-scale, multi-partner projects that address emerging water research needs.

WANTED: INTERNS

The USGS is encouraging NIWR institutes to take advantage of its nationwide internship program, details of which follow:

- The interns are hired by the NIWR institute but work with USGS Water Science Center researchers.

IMPACT & COLLABORATION

- NIWR member institutes assist public and private sector groups in their mission to protect human health, environmental resources and economic sustainability.
- Last year, NIWR member institutes sponsored more than 1,200 groundbreaking research projects.
- Grants from USGS and other sponsors are awarded through a competitive, peer-reviewed process.
- NIWR member institutes collaborated on projects with over 200 universities, 150 state agencies, 180 federal agencies, departments and divisions, and more than 165 local and municipal offices.

NIWR
THE NATIONAL INSTITUTES FOR WATER RESOURCES

SUCCESS FROM THE GROUND UP

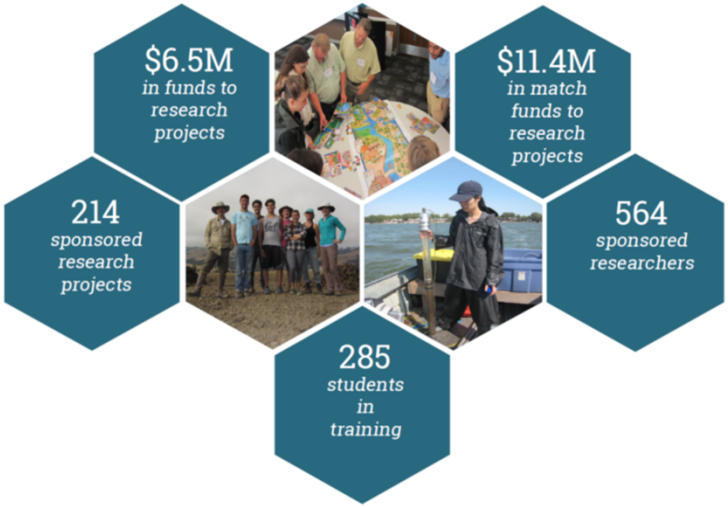
in water-related practices and policies

The National Institutes for Water Resources (NIWR) plays a major role in addressing water-related concerns by providing a platform for research, training, and collaboration at the state level. Housed in the nation's land-grant universities and four U.S. territories, the 54 NIWR member institutes leverage university expertise in research, education, and outreach to find solutions for the water management challenges we face. With our funding and educational services, water-related professionals and researchers receive support for the creation of local tools and policies to better manage our water. These successes start at the local level and have the ability to grow and make an impact across the United States.

In FY 2015, Congress appropriated $6.5 million dollars in WRRA grant funding, enabling cutting-edge research on the nation's most pressing water issues. This financial source requires matching from non-federal sourced funds from the public and private sector. This local financing significantly leverages the available federal dollars for water research.

NIWR BY THE NUMBERS

in 2015



Photos, starting clockwise at top:
2016 North Carolina Watershed Stewardship Network workshops
2016 Iowa State University PhD student holding a sediment core at East Okoboji Lake in Iowa.
2016 University of California field team assessing improvements in water quality during groundwater recharge

Our history started in 1964

Water Resources Research Act, USGS, and NIWR

The 1964 Water Resources Research Act (WRRA) established the nation's Water Resources Research Institutes. Pursuant to the WRRA of 1984 as amended, the United States Geological Survey (USGS) within the U.S. Department of the Interior assumed responsibility for administering WRRA funding, which targets local, regional, and national water priorities, helps train and recruit researchers, and aids in the transfer of technology and best practices.

Coordination and interaction between the Institutes and USGS is facilitated by NIWR. A volunteer-led organization, the NIWR network represents the only authorized federal-state program that focuses on applied water resource research, education, training, and outreach.

NATIONAL INSTITUTES FOR WATER RESOURCES

NIWR Board Officers

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Past President: Dr. Richard Cruse, Iowa State University • rmc@iastate.edu

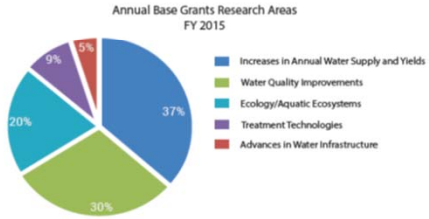
Visit us at *niwr.info*

Fact Sheet 2017

TOOLS FOR

Annual Base Grants

The largest of the USGS-NIWR research grant programs is the 104(b) Annual Base Funding grant program. Approximately $5 million in 104(b) grants are awarded annually to NIWR member institutes to help each institute plan and conduct applied and peer-reviewed research, education, and outreach activities on water.



National Competitive Grants

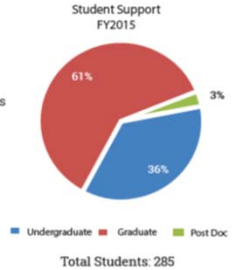
The 104(g) National Competitive Grants program funds research in water issues that are of a regional or interstate nature or relate to a specific program priority identified by the Secretary of the Interior and the Institutes.

Approximately $1 million is available each year. In 2015, 104(g) funding was awarded to four research projects studying important national priority issues in water quality and quantity. These projects were:

- "Trace Organic Contaminants in Urban Stormwater and Performance of Urban Bioretention Systems: a Field and Modeling Study" in Colorado
- "Using bioavailability to assess pyrethroid insecticide toxicity in urban sediments" in Illinois
- "Human and Ecological Health Impacts Associated with Water Reuse: Engineered Systems for Removing Priority Emerging Contaminants" in South Carolina
- "Hydrologic Life Cycle Impact of Mountain Pine Bark Beetle Infestations" in South Dakota

TRAINING OUR FUTURE LEADERS IN WATER

The National Institutes for Water Resources supports learning opportunities for students with funded research projects. Both undergraduate and graduate students explore new ideas and learn new skills. This fosters successful entry into a competitive water resources job market and allows them to make life-long positive water resource impacts.



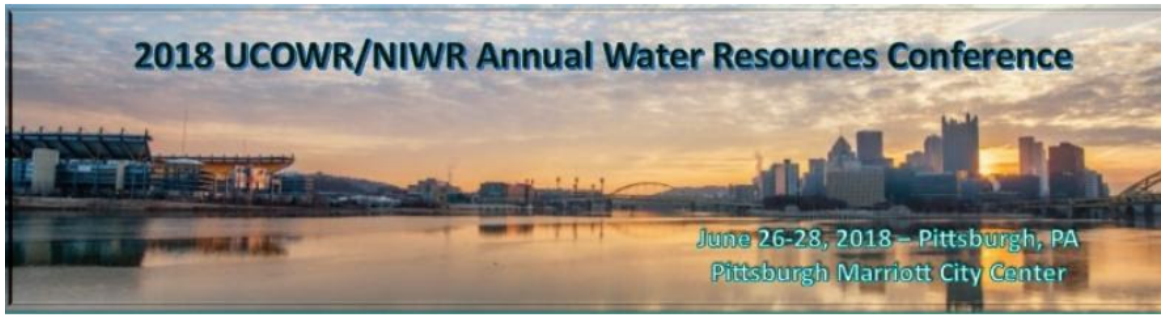
Total Students: 285

The Network of Water Resources Research Institutes

State	NIWR	University	Department	City	Director	Rank
Alabama	Water Resources Research Institute	Auburn	Agriculture Economics Rural Sociology	Auburn	Dr. Samuel Fowler	Associate Professor
Alaska	Water & Environmental Research Center	Alaska	Institute of Northern Engineering	Fairbanks	Dr. William Schnabel	Associate Professor
Arizona	Water Resources Research Center	Arizona	Agriculture and Resource Economics	Tucson	Dr. Sharon Megdal	Neely Endowed Professor
Arkansas	Water Resources Center	Arkansas	Agriculture/Coop Extension	Fayetteville	Dr. Brian Haggard	Professor
California	Institute for Water Resources	California	Agriculture/Natural Resourc.	Oakland	Dr. Doug Parker	Professor
Colorado	Water Institute	Colorado	Soil and Crop Sciences	Fort Collins	Dr. Reagan Waskom	Professor
Connecticut	Institute of Water Resources	Connecticut	Natural Resources	Storrs	Dr. Glenn Warner	Professor
Delaware	Water Resources Center	Delaware	Public Policy and Administration	Newark	Dr. Gerald Kauffman	Assistant Professor
District of Columbia	Water Resource Research Institute	D.C.	Agriculture/Environment	D.C.	Dr. Tolessa Deksissa	Associate Professor
Florida	Water Resources Research Center	Florida	Sustainable Infrastructure	Gainesville	Dr. Kirk Hadfield	Professor
Georgia	Water Resources Institute	Georgia Tech.	Civil and Environmental Engineering	Atlanta	Dr. Aris Georgakakos	Professor
Guam	Water Research Institute Western Pacific	Guam	Water Resources Engineering	Mangilao	Dr. Khosrowpanah	Professor
Hawaii	Water Resources Research Center	Hawaii	Sea Grant	Honolulu	Dr. Darren T. Lerner	Research Faculty
Idaho	Water Resources Research Institute	Idaho	Civil Engineering	Boise	Dr. John Tracy	Professor
Illinois	Water Resources Center	Illinois	Sea Grant	Urbana	Dr. Brian Miller	Director
Indiana	Water Resources Research Center	Purdue	Agronomy	West Lafayette	Dr. Ronald Turco	Professor
Iowa	Water Center	Iowa State	Agronomy	Ames	Dr. Rick Cruse	Professor
Kansas	Water Resources Institute	Kansas State	Agricultural Resources and the Environment	Manhattan	Dr. Daniel Devlin	Director
Kentucky	Water Resources Research Institute	Kentucky	Civil and Environmental Engineering	Lexington	Dr. Lindell Ormsbee	Raymond-Blythe Professor
Louisiana	Water Resources Research Institute	Louisiana State	Civil and Environmental Engineering	Baton Rouge	Dr. Frank Tsai	Associate Professor
Maine	Water Resources Research institute	Maine	Senator George Mitchell Center for Sustainability	Orono	Dr. John Peckenham	Senior Research Scientist
Maryland	Water Resources Research Center	Maryland	Civil and Environmental Engineering	College Park	Dr. Kaye Brubaker	Associate Professor
Massachusetts	Water Resources Research Center	Massachusetts	Engineering	Amherst	Dr. Paula Rees	Director
Michigan	Institute of Water Research	Michigan State	Agriculture, Recreation and Resource Studies	East Lansing	Dr. Jon Bartholic	Professor
Minnesota	Water Resources Center	Minnesota	Humphrey School of Public Affairs	St. Paul	Dr. Deborah Swackhamer	Professor
Mississippi	Water Resources Research Institute	Mississippi State	Cooperative Extension	Starkville	Dr. Joe E. Street	Associate. Director
Missouri	Water Resources Research Center	Missouri	Civil and Environmental Engineering	Columbia	Dr. Baolin Deng	C.W. LaPierre Professor

Montana	Water Center	Montana State	Ecology	Bozeman	Dr. Wyatt Cross	Associate Professor
Nebraska	Water Center	Nebraska	Civil Engineering	Lincoln	Dr. Chittaranjan Ray	Professor
Nevada	Water Resources Research Institute	Desert Res. Inst.	Hydrologic Services	Reno	Dr. James Thomas	Director
New Hampshire	Water Resources Research Center	New Hampshire	Environmental Science	Durham	Dr. William McDowell	Professor
New Jersey	Water Resources Research Institute	Rutgers	Environmental Resources	New Brunswick	Dr. Christopher Obropta	Director
New Mexico	Water Resources Research Institute	New Mexico State	Agriculture	Las Cruces	Dr. Alexander Fernald	Professor
New York	Water Resources Institute	Cornell	Earth and Atmospheric Sciences	Ithaca	Dr. Susan Riha	Professor
North Carolina	Water Resources Research Institute	North Carolina St.	North Carolina Sea Grant	Raleigh	Dr. Susan White	Executive Director
North Dakota	Water Resources Research Institute	North Dakota St.	Civil and Environmental Engineering	Fargo	Dr. Eakalak Khan	Professor
Ohio	Water Resources Center	Ohio State	Civil and Environmental Engineering	Columbus	Dr. Linda Weavers	Professor
Oklahoma	Water Resources Research Institute	Oklahoma State	Environmental/Natural Resources Engineering	Stillwater	Dr. Garey Fox	Orville and Helen Buchanan Chair
Oregon	Institute for Water and Watersheds	Oregon State	Water Resources Science	Corvallis	Dr. Todd Jarvis	Assistant Professor
Pennsylvania	Water Resources Research Center	Penn. State	Ecosystem Science	University Park	Dr. Elizabeth Boyer	Associate Professor
Puerto Rico	Water/Environmental Research Institute	Puerto Rico	Environmental Science	Mayaguez	Dr. Jorge Santos	Director
Rhode Island	Water Resources Center	Rhode Island	Civil and Environmental Engineering	Kingston	Dr. Leon Thiem	Associate Professor
South Carolina	Water Resources Center	Clemson	Strom Thurman Institute	Clemson	Dr. Jeffrey Allen	Assistant Professor
South Dakota	Water Resources Research Institute	South Dakota State	Agricultural Engineering	Brookings	Dr. Van Kelley	Associate Professor
Tennessee	Water Resources Research Center	Tennessee	Institute for Secure and Sustainable Environment	Knoxville	Mr. Tim Gangaware	Associate Director
Texas	Water Resources Institute	Texas A&M	Institute of Renewable Resources	College Station	Dr. Roel Lopez	Professor
Utah	Center for Water Resources Research	Utah State	Civil and Environmental Engineering	Logan	Dr. Mac McKee	Director
Vermont	Water Resources and Lake Studies Center	Vermont	Rubenstein School of Environment Resources	Burlington	Dr. Breck Bowden	Patrick Professor of Watershed
Virgin Islands	Water Resources Research Institute	Univ. of Virgin Islands	Water Resources	St. Thomas	Dr. Henry Smith	Director
Virginia	Water Resources Research Center	Virginia Tech.	Forest Resources	Blacksburg	Dr. Kevin McGuire	Associate Professor
Washington	Water Research Center	Washington State	Economic Studies	Pullman	Dr. Jonathan Yoder	Professor
West Virginia	Water Research Institute	West Virginia	National Research Center for Coal and Energy	Morgantown	Dr. Paul Ziemkiewicz	Director
Wisconsin	Water Resources Institute	Wisconsin	UW Aquatic Sciences Center/Sea Grant	Madison	Dr. James Hurley	Director
Wyoming	Office of Water Programs	Wyoming	Research/Economic Development	Laramie	Dr. Greg Kerr	Director/Lecturer

UCOWR
UNIVERSITIES COUNCIL ON WATER RESOURCES



We are pleased to announce that registration for the 2018 UCOWR/NIWR Annual Water Resources Conference is **NOW OPEN!**
The conference will take place June 26-28, 2018 at the Pittsburgh Marriott City Center, Pittsburgh, Pennsylvania.

Please visit the
2018 UCOWR Conference Website
for all of the details.

Early Bird Rates for both Registration and Hotel are valid through May 4, 2018.

Be sure to register for the conference & book your hotel room before May 4th, to receive these great rates.

REGISTER TODAY!

PLENARY SPEAKERS

Clean Water

A Bi-State Solution

May 3, 2018 | Mendenhall, PA

Brandywine Conservancy

Brandywine Red Clay Alliance

Natural Lands

The Nature Conservancy

Stroud Water Research Center

University of Delaware

water

MDPI

Article

The Cost of Clean Water in the Delaware River Basin (USA)

Gerald J. Kauffman

Water Resources Center, School of Public Policy and Administration, University of Delaware, Newark, DE 19716, USA; jerryk@udel.edu; Tel.: +1-302-831-4929

Received: 22 September 2017; Accepted: 8 January 2018; Published: 24 January 2018

Abstract: The Delaware River has made a marked recovery in the half-century since the adoption of the Delaware River Basin Commission (DRBC) Compact in 1961 and passage of the Federal Clean Water Act amendments during the 1970s. During the 1960s, the DRBC set a 3.5 mg/L dissolved oxygen criterion for the river based on an economic analysis that concluded that a waste load abatement program designed to meet fishable water quality goals would generate significant recreational and environmental benefits. Scientists with the Delaware Estuary Program have recently called for raising the 1960s dissolved oxygen criterion along the Delaware River from 3.5 mg/L to 5.0 mg/L to protect anadromous American shad and Atlantic sturgeon, and address the prospect of rising temperatures, sea levels, and salinity in the estuary. This research concludes, through a nitrogen marginal abatement cost (MAC) analysis, that it would be cost-effective to raise dissolved oxygen levels to meet a more stringent standard by prioritizing agricultural conservation and some wastewater treatment investments in the Delaware River watershed to remove 90% of the nitrogen load by 13.6 million kg N/year (30 million lb N/year) for just 35% ($160 million) of the $449 million total cost. The annual least cost to reduce nitrogen loads and raise dissolved oxygen levels to meet more stringent water quality standards in the Delaware River totals $45 million for atmospheric NOX reduction, $130 million for wastewater treatment, $132 million for agriculture conservation, and $141 million for urban stormwater retrofitting. This 21st century least cost analysis estimates that an annual investment of $50 million is needed to reduce pollutant loads in the Delaware River to raise dissolved oxygen levels to 4.0 mg/L, $150 million is needed for dissolved oxygen levels to reach 4.5 mg/L, and $449 million is needed for dissolved oxygen levels to reach 5.0 mg/L.

Keywords: river basin; water quality; water pollution; economic valuation


RESOURCES CENTER
1965 - 2015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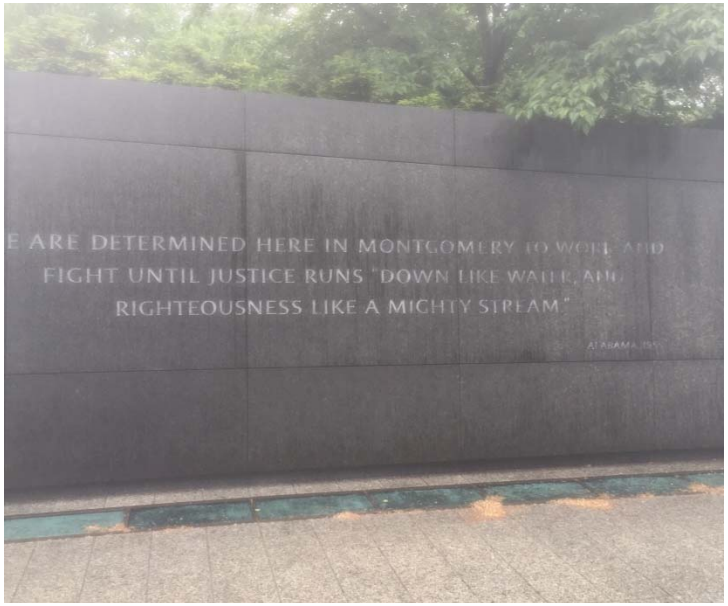
SCHOLARSHIP
For superior scholarship and interest in the field of water resources planning, management or policy
2001 WILLIAM J. SMITH, JR.
2002 JUSTIN M. BOWER MARTHA B. CONNOR
2003 KEVIN J. VONCK
2005 AMARDEEP DHANJU
2006 KEVIN VONCK
2007 MELISSA ZECHEL
2008 MAUREEN H. SEYMOUR
2009 KELLY J. WOLFE
2010 SARAH CHATTERSON ERIN McVEY
2011 STACEY MACK
2012
2013 KATE MILLER
2014 JOSEPH R. BROWN
2015 LAURA ASKIN
2016 KRISTEN MOLFETTA
2017 BRIANA DIACOPOULOS


E ARE DETERMINED HERE IN MONTGOMERY TO WORK AND
FIGHT UNTIL JUSTICE RUNS "DOWN LIKE WATER, AND
RIGHTEOUSNESS LIKE A MIGHTY STREAM."

DELAWARE WATER RESOURCES CENTER

WATER NEWS

UNIVERSITY OF DELAWARE

June 2017
Volume 16
No. 1

View the newsletter online

DWRC Director's Message

$2H_2 + O_2 = 2H_2O$. Q = VA. Q = ciA

These are the scientific equations that guide the movement of dihydrogen monoxide on Earth. Water is the most valuable chemical in society and it is one of the few compounds in nature that exists in the three forms of matter: solid, liquid, and gas. It's been said that water always flows downhill by gravity, yet it flows uphill toward money. My professor at Rutgers taught us that science is rational, linear, and logical yet policy (or politics) can be irrational, nonlinear, and chaotic. Maybe this explains what is going on these days.

Gerald Kauffman attends World Water Day Reception after the White House Water Summit near the Lincoln Memorial and the U.S. Institute for Peace at the George P. Schultz Great Hall.

In the week after the November 2016 election, I drove north from sea level in Delaware through the Schuylkill Valley and up and over the ridge through the Appalachian coal fields on the way to the Bucknell symposium on the Susquehanna River. And in towns like Frackville and Minersville, there was the election, downtowns tilted away from the past with economies shackled by the future. And after descending through the valley to the campus by the river on the other side, I realized that the quest for knowledge is an undeniable truth. Science and the classroom have always brought hope for a brighter future to towns just like these throughout America.

So for the first time in 30 years I went to a protest and took the train down from UD to DC to the March for Science on Earth Day on April 22, 2017. Emerging from Union Station I was proud to see on the right the Delaware flag, representing the First State in the Union. It was raining, with lots of water vapor, a perfect day for science. I rode the Citibike over to briefings at the American Association for the Advancement of Science (AAAS) and American Geophysical Union (AGU). A million scientists marched from the Washington Monument, past the White House, and up Constitution Avenue by the Smithsonian museums on the National Mall then over to the Capitol. I never saw science so strong. We marched with kids cured of cancer, biology teachers, physicians, nurses, teachers, a 95-year old astrophysicist, mobilized citizen scientists. You couldn't help get the feeling that there will be more scientists in D.C. by 2018.

At UD we are fortunate to be one of the 54 National Institutes for Water Resources in a science network that stretches from Maine to Micronesia at land grant universities in the 50 states, D.C., and the three island territories of Guam, Puerto Rico, and U.S. Virgin Islands. The 54 NIWR colleges educate over a million students annually and have over 10 million alumni from throughout the U.S. and the world. Over the last 15 years, the DWRC has supported the water research of over 250 young scientists and engineers who have gone on to productive careers in society. With the start of the fall 2017 semester in September, we are excited to be part of the Biden School of Public Policy and Administration and look forward to working with Professor Biden on the cross-cutting environmental sustainability issues of the day.

These are turbulent times. Environmental budgets are being cut. Science funding is under scrutiny. Natural-born rights are being challenged. Yet with all this uncertainty, it's reassuring to know that water always obeys the universal laws of nature. And with science as our foundation, at the University of Delaware Water Resources Center we search for new knowledge and train future scientists in an unfettered way with openness to the policies and viewpoints of all. As I tweeted before, I embrace all on Earth who seek peace and love in this nation of inalienable rights that each are born with and no government may take away.

And as they say in the NIWR, water is clear--it is neither red or blue.

DWRC 2017 Annual Update

The past year (2016-2017) has been another productive year for the Delaware Water Resources Center. During the summer of 2016, thirteen DWRC undergraduate water resources interns began work on their research with faculty advisors. In August 2016, our two U.S. Senators, Tom Carper and Chris Coons, visited the offices of the DWRC in Newark, Delaware to discuss water science and policy issues critical to the First State such as coastal flooding, drinking water quality, and water quality impacts on coastal tourism. In November 2016, DWRC Director Gerald Kauffman was invited to present plenary remarks at the 11th Annual Susquehanna River Symposium hosted by the Bucknell University Watershed Sciences and Engineering Program in Lewisburg, Pennsylvania. Also in November, DWRC Policy Scientist Martha Narvaez handed over the gavel as she completed her term as the 51st President of the American Water Resources Association (AWRA). During the fall of 2016, Andrew Homsey was elected to the Board of Directors at the Brandywine Red Clay Alliance, an organization formed in 1946, and the oldest small watershed organization on the U.S. In February 2017, DWRC Director Gerald Kauffman met with institute directors from throughout the United States at the annual National Institutes for Water Resources (NIWR) meeting in Washington, DC to discuss the changing water resources landscape and meeting with our congressional delegation to support the Water Resources Research Act appropriation. On April 28, 2017, the Advisory Panel met for the 52nd annual meeting of the DWRC at the University of Delaware campus in Lewes, Delaware and selected new water resources interns who will start their research during the summer and fall of 2017. On May 5, 2017, the DWRC research interns presented the results of their water resources research at the University of Delaware undergraduate research poster session at the Perkins Student Center on the Newark campus.

Jerry Kauffman speaks at the 11th Annual Susquehanna River Symposium, sponsored by the Watershed Sciences and Engineering Program at Bucknell University.

Undergraduate Water Research Students

2016-2017 DWRC Undergraduate Interns

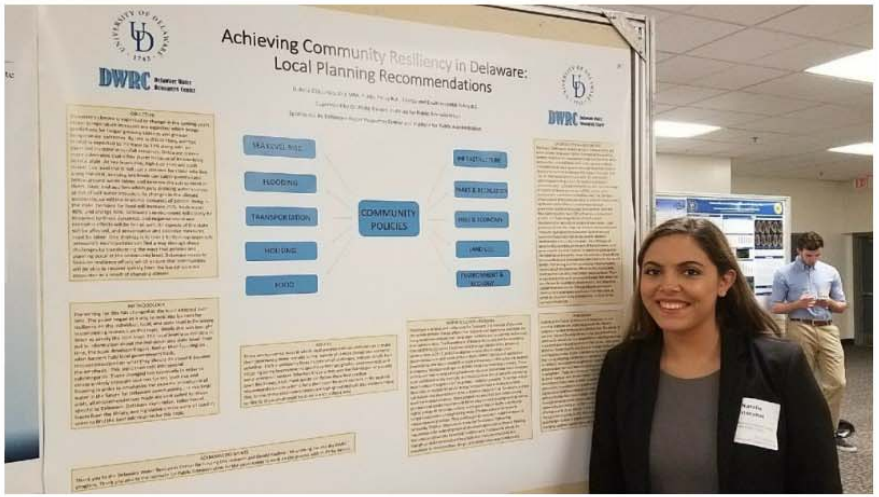
- **Natalie Criscenzo** (Energy & Environmental Policy and Public Policy), Advisor: Philip Barnes (Institute for Public Administration), Overcoming Policy and Planning Barriers to Resilient and Sustainable Communities in Delaware.
- **Lauren Glinko** (Geography), Advisor: Afton Clarke-Sather (Geography), Causes of Change of Irrigation in the Eastern United States.
- **Madison Gutekunst** (Environmental Engineering), Advisor: Rodrigo Vargas (Plant and Soil Sciences), Linking Below Ground Greenhouse Gas Concentrations with Water Chemistry in the St. Jones Estuary.
- **Benjamin Jenkins** (Delaware State University), Advisor: Dewayne Fox (Delaware State University Dept. of Agriculture & Natural Resources), Estimating the Spawning Population of Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) in the Delaware River
- **Maya Kassoff** (Environmental Science), Advisor: Gerald Kauffman (School of Public Policy and Administration), Water Quality Monitoring in the White Clay Creek National Wild & Scenic River Watershed
- **Andrea Miller** (Environmental Studies), Advisor: Gerald Kauffman (School of Public Policy and Administration), UD Water Resources Center), Water Quality Monitoring in the White Clay Creek National Wild & Scenic River Watershed
- **Courtney Rempfer** (Environmental Science), Advisor: Rodrigo Vargas (Plant and Soil Sciences), Designing an Automated System to Monitor O_2, CO_2 and CH_4 from Sediments in a Salt Marsh
- **Ilana Schnaufer** (Chemistry and Environmental Science), Advisor: Delphis Levia (Geography), Variations in the Residence Time and Isotopic Signature of Stemflow along an Edge-to-interior Transect
- **Jacob Shelton** (Environmental Studies), Advisor: Maria Pautler (Plant and Soil Sciences), Sustained Water Quality Monitoring of Possum Creek and Noxontown Pond, Delaware
- **Patrick Wise** (Biological Sciences and History), Advisor: Angelia Seyfferth (Plant and Soil Sciences), Variable Regulation of Silicon Transporter Gene Expression in Rice

2017 UDWATER Interns

- **Shailja Gangrade** (Environmental Engineering), **Natale Depase** (Environmental Science), **Catherine Medlock** (Environmental Science), Advisor: Andrew Homsey, Gerald Kauffman (UD Water Resources Center), Restoration of the Fairfield Run Watershed at the UD Arboretum

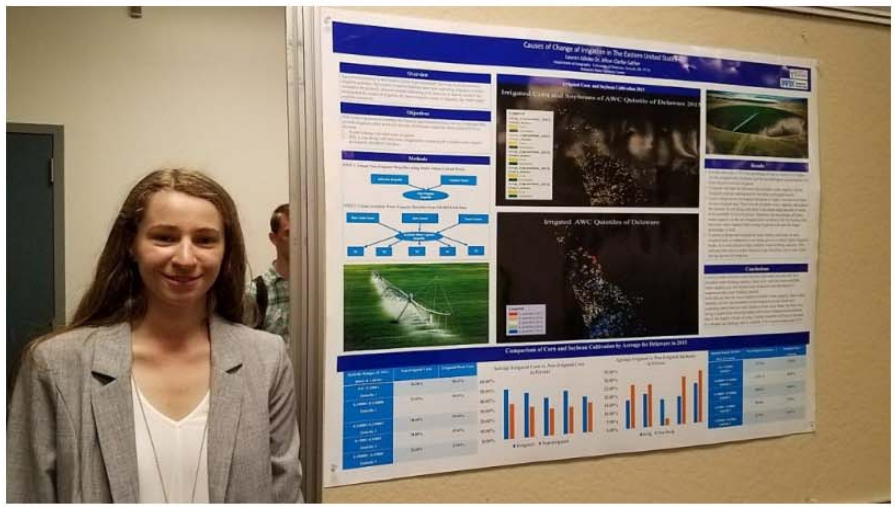
Intern: Natalie Criscenzo
Major: Energy and Environmental Policy and Public Policy
Department: School of Public Policy and Administration
College: Arts and Science
Advisor: Philip Barnes (Institute for Public Administration)
Title: Overcoming Policy and Planning Barriers to Resilient and Sustainable Communities in Delaware

Abstract: With predictions for climate change all over the world in the coming years, Delaware needs to be a state that adapts. It is important to look at the combination of policies and planning when discussing climate change in order to see how local municipalities can deal with the issue. This paper initially began looking at individual, municipal, and state levels of planning sustainably. As federal and state level initiatives can sometimes be backed up by red tape, it is best to look at what local communities can do now in order to not only make changes to prepare for the consequences of sea level rise, but also what they can do to increase their town's overall sustainability. The two largest sections of recommendations fall under sea level rise and flooding, as the issue of water creates some of the most urgent and large-scale problems in Delaware. The state is incredibly vulnerable to the upcoming risks of sea level rise and the increased flooding that comes with it since all of Delaware is at less than 500 feet above sea level and all counties have coastline. Other sections include recommendations on housing, food, land use, transportation, and infrastructure. The focus in each section is community policies that can positively affect a town both environmentally and economically. Recommendations range from implementing stormwater fees to using low impact development techniques. The current planning choices in Delaware are no longer acceptable, and needs to evolve. There does not need to be a choice between a resilient community or an economically flourishing community. Delaware can take advantage of numerous policies and planning guidelines in order to have both. While there is much work to do, this subject is constantly changing as policies on the state and federal level change as well.



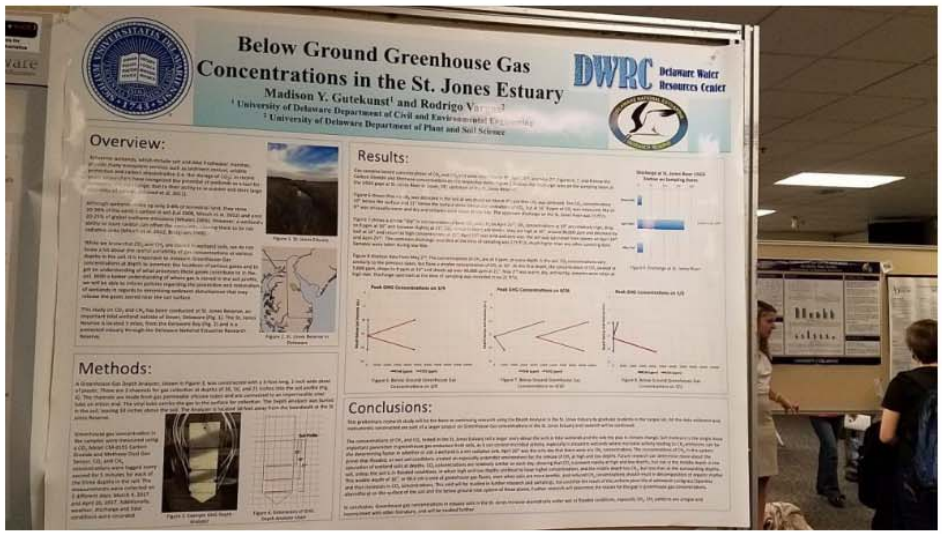
Intern: Lauren Glinko
Major: Geography
Department: Geography
College: Earth, Ocean and Environment
Advisor: Afton Clarke-Sather (Geography)
Title: Causes of Change of Irrigation in the Eastern United States

Abstract: Irrigation historically has not occurred on the East Coast of the United States, but in recent few decades, irrigation has begun to occur on the East Coast. It has been assumed that corn has been the driving factor of the irrigation wave on the East Coast, but there has been no empirical data supporting this. Our goal was to analyze this increase of irrigation in Delaware using irrigation points (year 2010, created by James Atkins approximately 2000 center pivots) along with National Agricultural Statistics Service Cropscape Data for the year of 2015. These datasets would then be extracted to highlight the crops grown on irrigation pivots and then compared the available water capacity derived through the SSURGO Web Soil Survey. The water capacity data was broken up into quintiles to discover which of the ranges held more corn. The soil that had lower available water capacity had a significantly larger amount of corn grown on irrigated land, which was surprising because this usually represents a lighter soil that can hold less water. The heavier soils which have a higher capacity of water available, cultivated less corn which is surprising because these soils can hold more water, but they cultivated less corn on these soils. This trend was continued with the soybean crop as well. Research is recommended for the 2013-2010, 2008 and 2002 available Cropscape data, along with further research to compare Delaware's irrigation to the historic irrigator Minnesota.



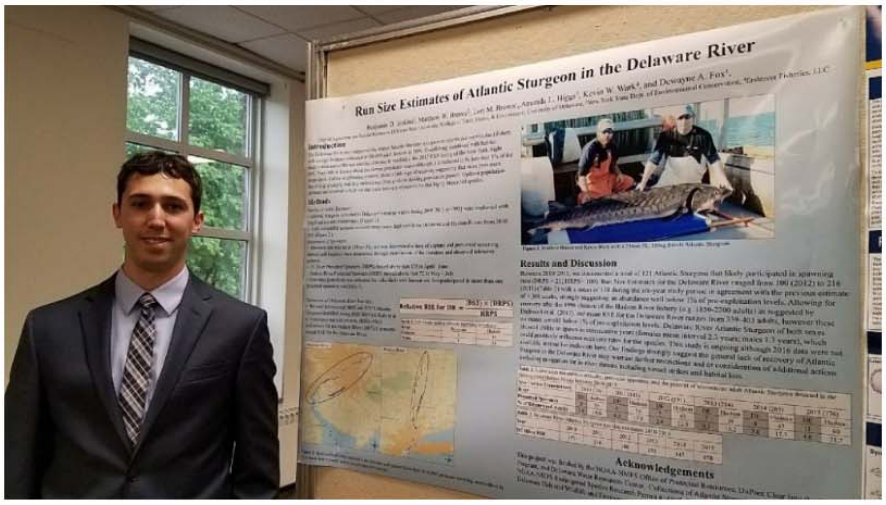
Intern: Madison Gutekunst
Major: Environmental Engineering
Department: Civil and Environmental Engineering
College: Engineering
Advisor: Rodrigo Vargas (Plant and Soil Sciences)
Title: Linking Below Ground Greenhouse Gas Concentrations with Water Chemistry in the St. Jones Estuary

Abstract: Estuarine wetlands provide many ecosystem services and have the ability to sequester carbon from the environment. Estuarine wetlands are also large sources of methane emissions. This project seeks to investigate the below ground greenhouse gas concentrations, specifically methane and carbon dioxide to gain a broader understanding of what is occurring at varying depths in a tidal marsh, specifically the St. Jones Estuary near Dover, Delaware. A greenhouse gas depth analyzer was built to carry gases to the surface of the soil, to be tested using a CO_2Meter CM-0191 Dual Gas Sensor. The analyzer was buried in the soil at the St. Jones Reserve and concentrations at depths were collected on 3 different dates. The project found a layer in the soil profile that seems to emit less greenhouse gases and that methane is only produced in the tidal marsh on high flow days when the soil is completely saturated. This preliminary study will continue in the Vargas lab, and more tests will be done to provide an in-depth analysis of the gases underneath the soil in the St. Jones Estuary.



Intern: Benjamin Jenkins
Major: Fisheries Management
Department: Agriculture and Natural Resources
College: Natural Resources (Delaware State University)
Advisor: Dewayne Fox (Delaware State University Dept. of Agriculture and Natural Resources)
Title: Estimating the Spawning Population of Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) in the Delaware River

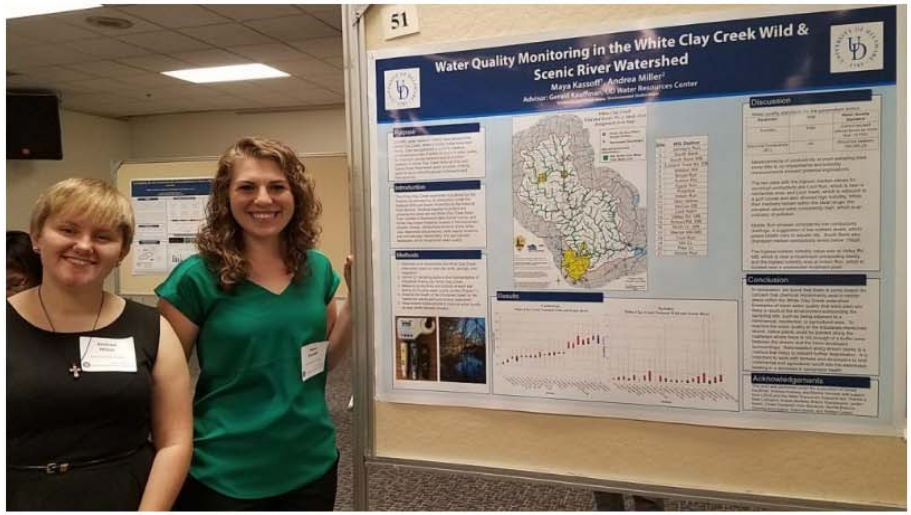
Abstract: Atlantic Sturgeon (*Acipenser oxyrinchus oxyrinchus*) were once abundant in most major Atlantic coastal rivers, but overharvest and habitat loss eventually led to their 2012 listing under the Endangered Species Act. Although the Delaware River once supported the largest population, its present status is poorly understood and was estimated at less than 300 annual spawners in 2007. The Hudson River population has been extensively studied and supported an estimated run of 863 individuals in 1996 prior to the close of the fishery in 1998. We estimated run size in the Delaware River relative to the published Hudson River estimate using an at-large population of 392 telemetered individuals and acoustic arrays deployed in both systems from 2010-2015. We determined likely spawners by size (≥150 cm FL) and occupancy of presumed spawning regions during known spawning times. Relative run size estimates for the Delaware River ranged from 100 (2012) to 216 (2011) with a mean of 158. Ten likely spawners (four females and six males) returned during multiple years to the Delaware River while 44 (10 females and 34 males) did so to the Hudson River. We recorded 2-3 years between spawning events for Delaware River females and 1-2 years for males. In the Hudson River, we saw 1-2 years between spawning events for both sexes. Our findings suggest that the present Delaware River population of Atlantic Sturgeon is less than 1% of pre-exploitation levels, heightening concern given ongoing habitat modifications (e.g. dredging) and sources of mortality (e.g. vessel strikes) in the system.



Intern: Maya Kassoff
Major: Environmental Science
Department: Geography
College: Earth, Ocean and Environment
Advisor: Gerald Kauffman (School of Public Policy and Administratio
Title: Water Quality Monitoring in the White Clay Creek National Wild

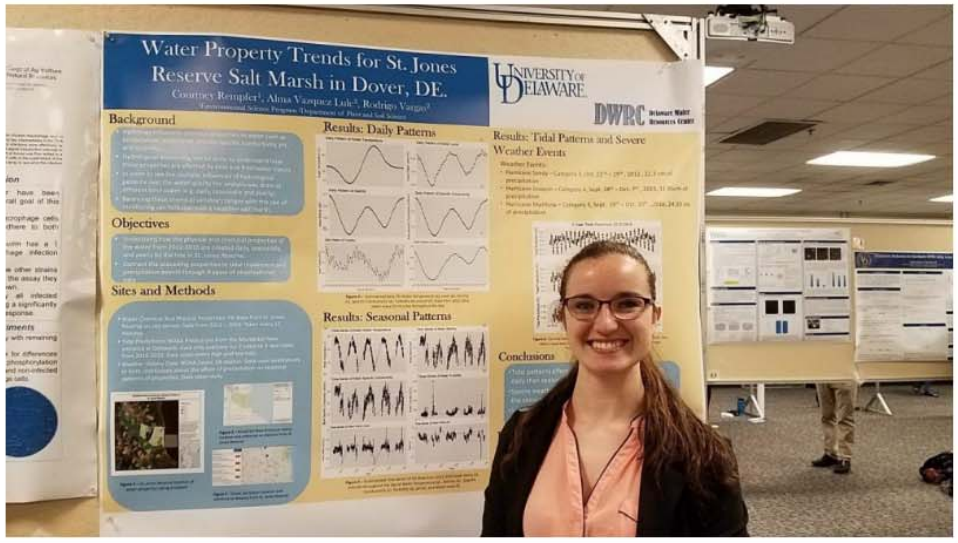
Intern: Andrea Miller
Major: Environmental Studies
Department: Geography
College: Earth, Ocean and Environment
Advisor: Gerald Kauffman (School of Public Policy and Administration)
Title: Water Quality Monitoring in the White Clay Creek National Wild and Scenic River Watershed

Abstract: UDWRC water research interns have sampled the White Clay Creek, where turbidity levels have been rising. Data was gathered in order to create a comprehensive plan of action to improve water quality by helping to narrow nonpoint source pollution locations in White Clay Creek National Wild and Scenic River Watershed, which provides drinking water to about 200,000 people in Delaware and Pennsylvania. The White Clay Creek watershed is protected by the Federal Government by its designation under the National Wild and Scenic Rivers Act by the National Park Service. Working together to protect and preserve the creek are the White Clay Creek State Park, located in Delaware's New Castle County, and White Clay Creek Preserve, located in Pennsylvania's Chester County. While these sections of the White Clay Watershed are protected, other nearby locations are commercially, residentially, and agriculturally developed, which impacts the water quality. In conclusion, we found that there is some reason for concern that chemical impairments exist in certain areas within the White Clay Creek watershed. Examples of lower water quality that were seen are likely a result of the environment surrounding the sampling site, such as being adjacent to a commercial, residential, or agricultural area. To improve the water quality of the tributaries mentioned above, native plants could be planted along the roadways where there is not enough of a buffer zone between the stream and the more developed surroundings. Reforestation along stream banks is a method that helps to prevent further degradation. It is important to work with farmers and developers to limit commercial and agricultural runoff into the waterways, leading to a decrease in ecosystem health.



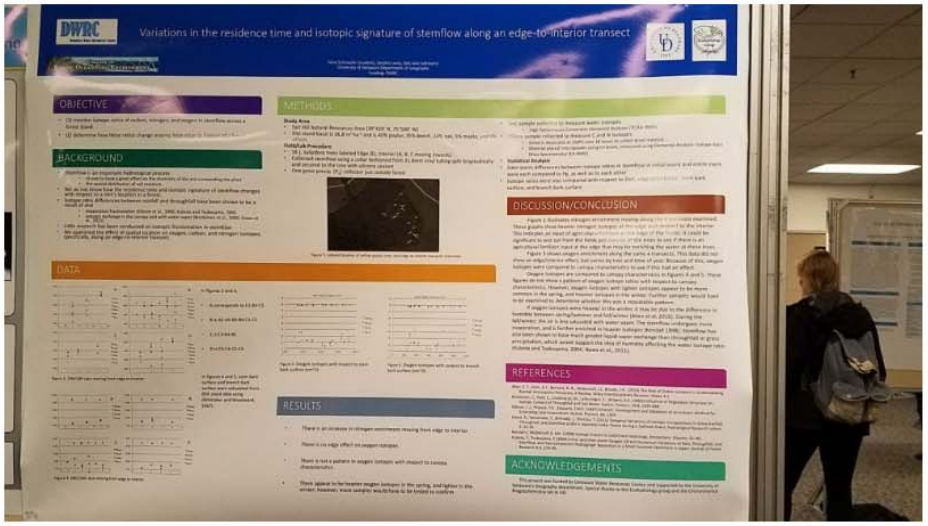
Intern: Courtney Rempfer
Major: Environmental Science
Department: Geography
College: Earth, Ocean and Environment
Advisor: Rodrigo Vargas (Plant and Soil Sciences)
Title: Designing an Automated System to Monitor O_2, CO_2 and CH_4 from Sediments in a Salt Marsh

Abstract: Analyzing smaller entities of the water movement in tidal salt marshes can advance the understanding soil-water-vegetation interface and its potential implications in ecosystem processes. St. Jones Reserve in Dover, DE is a brackish salt marsh that experiences a semi-diurnal tidal pattern, which influences the properties of the water column at different time scales (daily, seasonality and yearly). The following study analyzes observations of chemical and physical properties in the water column and connects them to tidal movement and precipitation events through 4 years of observational data at the St. Jones Reserve tidal saltmarsh. It was found that tidal patterns affect the properties daily pattern while seasonal climate affect the properties seasonal pattern.



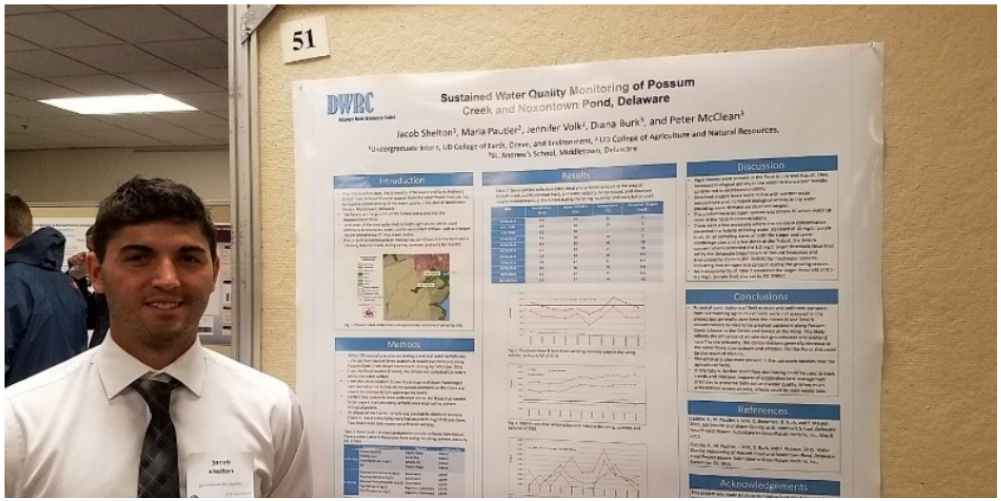
Intern: Ilana Schnaufer
Major: Chemistry and Environmental Science
Department: Geography
College: Earth, Ocean and Environment
Advisor: Delphis Levia (Geography)
Title: Variations in the Residence Time and Isotopic Signature of Stemflow along an Edge-to-interior Transect

Abstract: Stemflow has a significant impact on chemistry of both the tree and the surrounding environment. This study sought to understand the movement of water through a forest canopy of *L. tulipifera* using stemflow. By measuring isotopic ratios across an edge-to-interior transect, we were able to determine the amount of mixing in the canopy and effects of surrounding environment on nutrient input in the system. Although more sampling is yet to be finished, the preliminary results indicate that: (1) there is a significant input of anthropogenic nitrogen deposition in water on the edge of the forest; (2) there appears to be a seasonal effect of humidity on the amount of mixing between canopy water and the atmosphere. More sampling needs to be completed to confirm the validity of these results, but they give insight into the processes occurring in this forest stand.



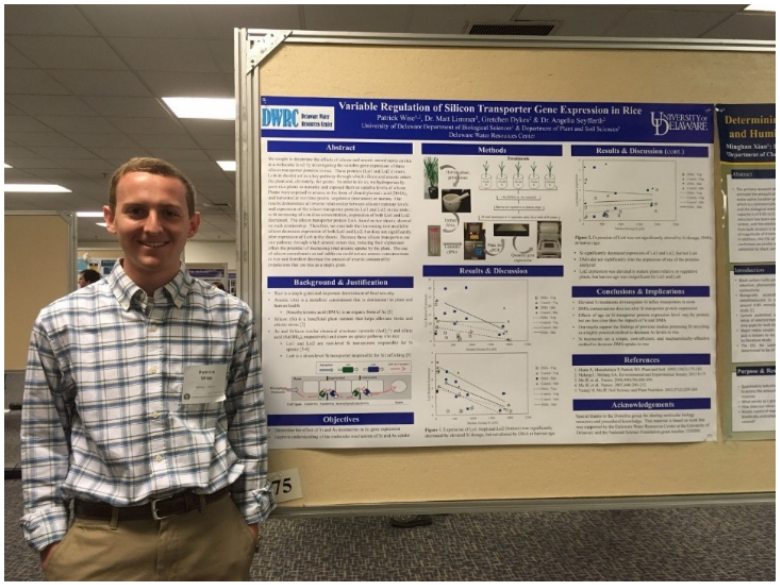
Intern: Jacob Shelton
Major: Environmental Studies
Department: Geography
College: Earth, Ocean and Environment
Advisor: Maria Pautler (Plant and Soil Sciences)
Title: Sustained Water Quality Monitoring of Possum Creek and Noxontown Pond, Delaware

Abstract: To build on past water quality monitoring efforts in Noxontown Pond and a tributary (Possum Creek), as well as recommendations that were developed for best management practices on surrounding agricultural lands to deter nutrient inflows, this project's focus was to continue sampling after stormflows into and out of the Pond in the spring, summer, and early fall months of 2016. This completed an all-seasons monitoring scenario and collection cycle that was initiated in the winter of 2015. Samples were taken at three locations: both footbridges over the creek and the T-dock on Noxontown Pond itself. Total precipitation amounts were recorded; rainfall varied from about half an inch to over five inches. *In situ* measurements of temperature, visibility, dissolved oxygen, and pH were made. A one-liter sample was collected at each of the three locations for laboratory analysis. Each sample was analyzed for dissolved ammonium nitrogen (ammonium-N) and nitrate nitrogen (nitrate-N), dissolved orthophosphate (ortho-P), total nitrogen (Total N), and total phosphorus (Total P). It was found that: Algal blooms were present in the Pond in the summer, thus, increased biological activity in the water in the warmer months contributed to decreased visibility. On a few occasions, the nitrate-N concentration exceeded the federal drinking water standard of 10 mg/L and the Total N concentrations exceeded the 3.0 mg/L target threshold set by the Delaware Department of Natural Resources and Environmental Control (DNREC) for freshwater streams. This indicates that nitrogen is a concern during the growing season. No measurements of Total P exceeded the target threshold of 0.1-0.2 mg/L also set by DNREC. If cover crops had indeed been planted in fields that drained to the Creek and/or Pond then that could have lowered the potential for sediment particles containing phosphorus to enter the waterways through overland runoff during and after precipitation events.



Intern: Patrick Wise
Major: Biological Sciences and History
Department: Biological Sciences
College: Arts and Science
Advisor: Angelia Seyfferth (Plant and Soil Sciences)
Title: Variable Regulation of Silicon Transporter Gene Expression in Rice

Abstract: We sought to determine the effects of silicon and arsenic treatments on rice at a molecular level by investigating the variable gene expression of three silicon transporter proteins in rice. These proteins (Lsi1 and Lsi2 in roots, Lsi6 in shoots) act as a key pathway through which silicon and arsenic enters the plant and, ultimately, the grains. In order to do so, we hydroponically grew rice plants to maturity and exposed them to variable levels of silicon. Plants were exposed to arsenic in the form of dimethylarsinic acid (DMA), and harvested at two time points, vegetative (immature) or mature. Our results demonstrate an inverse relationship between silicon treatment levels and expression of the silicon transporter proteins Lsi1 and Lsi2 in rice roots; with increasing silicon dose concentration, expression of both Lsi1 and Lsi2 decreased. The silicon transporter protein Lsi6, found in rice shoots, showed no such relationship. Therefore, we conclude that increasing root-available silicon decreases expression of both Lsi1 and Lsi2, but does not significantly alter expression of Lsi6 in the shoots. Because these silicon transporters are one pathway through which arsenic enters the plant, reducing their expression offers the potential of reducing total arsenic uptake by the plant. The use of silicon treatments as soil additives could reduce arsenic concentrations in rice and therefore decrease the amount of arsenic consumed by populations that use rice as a staple grain.

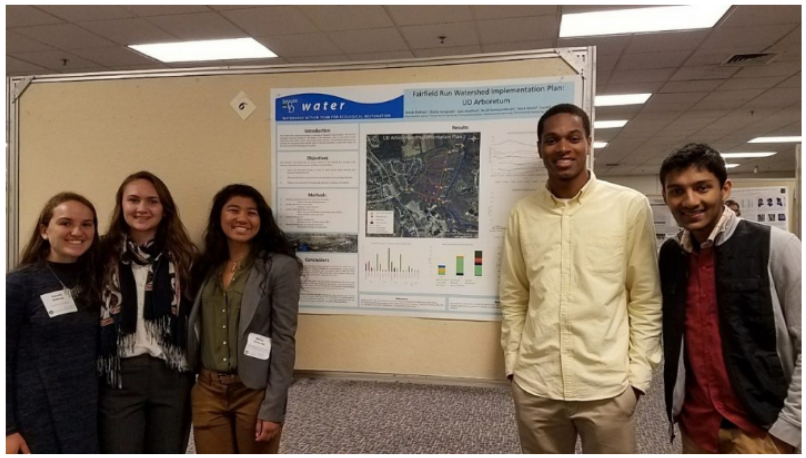


Intern: Shailja Gangrade
Major: Environmental Engineering
Department: Civil and Environmental Engineering
College: Engineering

Intern: Natale Depase
Major: Environmental Science
Department: Geography
College: Earth, Ocean and Environment

Intern: Catherine Medlock
Major: Environmental Science
Department: Geography
College: Earth, Ocean and Environment
Advisor: Gerald Kauffman (School of Public Policy and Administration)
Title: Water Quality Monitoring in the White Clay Creek Wild & Scenic River Watershed

Abstract: The objective of this study was to conduct research on the Fairfield Run in the Piedmont of the University of Delaware Laird Campus to assess watershed health in terms of water quality, forest diversity, and biological habitat potential, delineate Fairfield Run watershed, analyze water quality, and evaluate stream habitat/forest health. The Fairfield Run watershed at the University of Delaware's Laird campus is the site of a proposed university arboretum. The design of the arboretum relies on the health of the watershed: good water quality and strong habitat potential. Impervious surface runoff is the main contributor to high turbidity in Fairfield Run and Blue Hen Creek. The most feasible improvements that can be made include: increasing the number of pool v. riffle zones, decreasing bank erosion, and increasing riparian vegetation. More structural heterogeneity in the area will increase biological potential and encourage a stable ecosystem, increasing the value of the proposed arboretum. Watersheds with less anthropogenic interactions had higher tree density, species diversity, and increased maturity. Therefore, the areas closer to campus may require forest restoration.



FY2017/18 UD Water Resources Center Undergraduate Internships

Samuel Furio (Economics), Advisor: Dr. Kent Messer (Applied Economics & Statistics), Understanding the Social Behavior within a Competitive Environment: An Experimental Investigation of Agri- Environmental Policies

Lauren Glinko (Geography), Advisor: Dr. Tracy Deliberty (Geography), Linking Causes of Irrigation to Available Water Capacity

Reid Williams (Environmental Engineering), Advisor: Dr. Paul Imhoff (Civil and Environmental Engineering), Effectiveness of Bio-Char to Reduce Nitrate Concentration in Storm Water Runoff

Margaret Krauthauser (Geology), Advisor: Dr. James Pizzuto (Geological Sciences), Quantifying Floodplain Sediment Storage Rates and Identifying Rate-Changing Characteristics in the White Clay Creek Watershed, Pennsylvania

Jack Protokowicz (Biochemistry), Advisor: Dr. Shreeram Inamdar (Plant and Soil Sciences), Nuclear Magnetic Resonance Analysis of Particulate Organic Matter from Forested Watershed

Nicholas Tobia (Geology), Advisor: Dr. James Pizzuto (Geological Sciences), Quantifying the Rate of Bank Migration in the White Clay Creek Watershed, Pennsylvania

Christina Valenti (Environmental Engineering), Advisor: Dr. Anastasia Chirnside (Entomology and Wildlife Ecology), Assessment of the Leaching Potential of Fibrous Plastic Inert Support Material from a Fungal Biocell Reactor

Michael Rechsteiner (Environmental Engineering), Advisor: Dr. Paul Imhoff (Civil & Environmental Eng'g.), Reducing Stormwater Runoff & Pollutant Loading with Biochar Addition to Highway Greenways

FY2018/19 UD Water Resources Center Undergraduate Research Proposals

Student	Advisor	Major
Michaella Becker	Paul Imhoff	Environmental Engineering
Nicolette Bugher	Gerald Kauffman	Environmental Engineering
Chelsea Caplinger	Gretchen Bauer	Political Science
Alyssa Cortese		Environmental Science
Monica Crosby	Paul Jackson	Environmental Studies
Andrew Dorazio		Mechanical Engineering
Liam Warren	Syed Shah	Energy/Environmental Policy
Veronica Hill	Leah Palm-Forster	Environmental/Resource Economics
Allison Kaltenbach	Gerald Kauffman	Environmental Engineering
Thomas McGlaughlin	Joshua Duke	Business Management/Economics
Rebecca Steiner	Nina David	Environmental Studies/Public Policy
Mia Kane		Environmental Science

Identifying the Differences in Soils from Various Land Uses by Fluorescence Spectroscopy

Jack Protokowicz[1]
Advisor: Shreeram Inamdar, UD Department of Plant and Soil Sciences
[1]Biochemistry Major

Purpose

Sediment from sources known to contribute to local waterways was collected and separated by land use and particle size in order to identify and examine key chemical differences in organic carbon released from these sources.

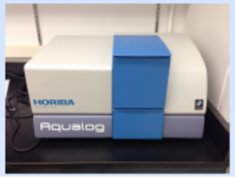
Introduction

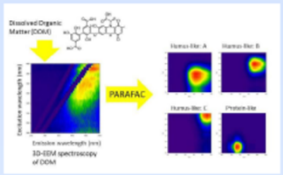
The increase in both the magnitude and occurrence of storm events locally and globally poses a great threat to water quality and natural ecosystems. These storms have a great potential to mobilize sediment sources and carry sediment-associated molecules large distances, which could lead to disastrous environmental impacts. The chemical character of these particles is significantly influenced by their local environment, i.e. land use, and understanding the chemistry behind these molecules is key to identifying their sources as well as mitigating the molecules' consequences to the natural environment.

(Left) taken from the Fair Hill NRMA site, and (right) the Chesapeake Bay, demonstrate the possibility of large sediment influxes over long distances due to large storm events.

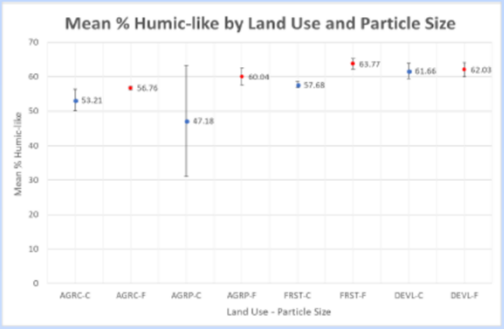
Methods

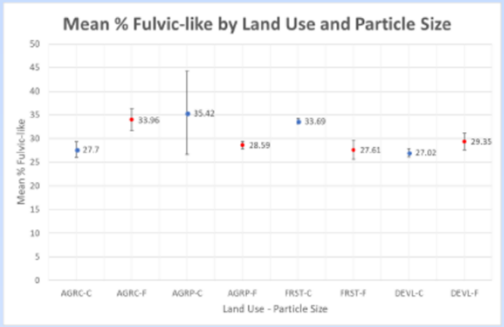
1. Sediments were collected from 4 land uses: agriculture cropland (AGRC), agriculture pasture (AGRP), developed land (DEVL), and forested land (FRST)
2. Sediments were dried and sieved into two particle class sizes: coarse (C, > 1mm diameter) and fine (F, < 1mm diameter)
3. 40mL extracts were made with 0.5g of each sediment
4. Dissolved carbon in the filtrate was analyzed using fluorescence spectroscopy
5. EEM data were normalized with a PARAFAC model, calibrated to local area

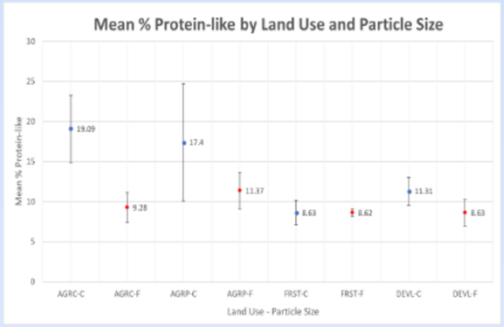




Results







Note: Axes arranged to best demonstrate the differences between land use and particle sizes. The plots are not scaled the same.

Discussion

A z-test assessment of the data at the 95% confidence level showed significant differences ($p < 0.05$) in the mean % for each component, based on their land use and particle class size. These differences are listed below, and the sources they compare move from left to right on each respective plot.

For the mean % humic-like component, it was determined that AGRC-C was significantly different from AGRP-F, FRST-C, FRST-F, DEVL-C, and DEVL-F. Furthermore, AGRC-F was significantly different from AGRP-F, FRST-C, FRST-F, DEVL-C, and DEVL-F. FRST-C was significantly different from FRST-F, DEVL-C, and DEVL-F.

It was also found that the mean % fulvic-like component also had significant differences between land uses and particle class sizes. AGRC-C was significantly different from AGRC-F and FRST-C. AGRC-F was significantly different from AGRP-F, FRST-F, DEVL-C, and DEVL-F. Finally, FRST-C was significantly different than FRST-F, DEVL-C, and DEVL-F.

The mean % protein-like component showed the least amount of significant differences between the land uses and particle sizes. AGRC-C was significantly different than AGRC-F, AGRP-F, FRST-C, FRST-F, DEVL-C, and DEVL-F. Also, the mean for FRST-F was significantly different than DEVL-C.

Conclusion

The significant chemical differences between the land uses and particle class sizes will help to identify the main contributors to watershed chemistry. Resolving models for better accuracy in predicting the contributing factors to a watershed's chemistry will lead to more precise prevention and mitigation strategies for dealing with the repercussions of anthropogenically-modified lands. Assisting to reinforce the natural environment's resilience to anthropogenic sources would benefit the ecology itself as well as the ecosystem services the environment provides us.

Acknowledgements

I would like to thank the DWRC for offering me an internship position that supported this project. I'd also like to thank my advisor, Shree, for his guidance and oversight on this project and others during my time at the University of Delaware.

The Effect of Varying Properties of Biochar and its Impact on Soil Hydraulic Conductivity

Reid Williams[1], Paul Imhoff[1], Ali Nahkli[1], Yudi Yang[1]

[1]Department of Civil and Environmental Engineering, University of Delaware

Background

Biochar is a charcoal product that, due to its high porosity and surface area, has the potential to change the properties of soil. Biochar is known to be able to increase or decrease the hydraulic conductivity of the soil, however it is a complex process dependent on many variables. In this experiment, soil column experiments were taken place to understand exactly how biochar affects Ksat. The following variables that were inspected are:

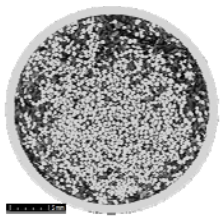
Biochar Particles

- **Biochar Particle Size:** The larger the Biochar particles are, the larger the porosity of the soil will be, thus having an affect on the flow of water through the medium.
- **Biochar Elongation:** Testing the effect of the shape of the Biochar on the Ksat. Longer particles may have different properties than more spherical particles.
- **Biochar Segregation:** Generally, in the field the biochar tends to clump together and segregate. How much does this affect the Ksat of the soil?

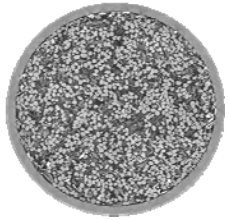
Objectives

- Quantify how the size of the added biochar particles affects the difference in hydraulic conductivity of the soil
- Quantify how the shape, or elongation, of the added biochar particles affects the difference in hydraulic conductivity of the soil
- Quantify how the segregation of the added biochar particles and the soil particles affects the difference in hydraulic conductivity of the soil

Segregation Images – Using X-ray Tomography



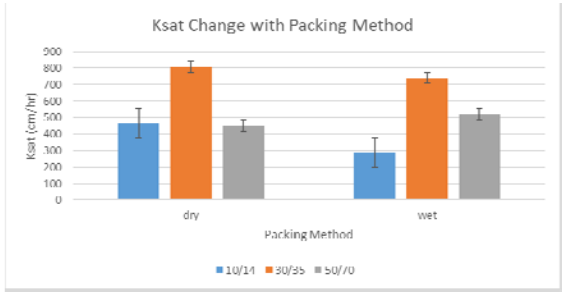
Microstructural Images for Dry Packed Biochar-Soil Mixture by Kalehiwot Nega Manahiloh

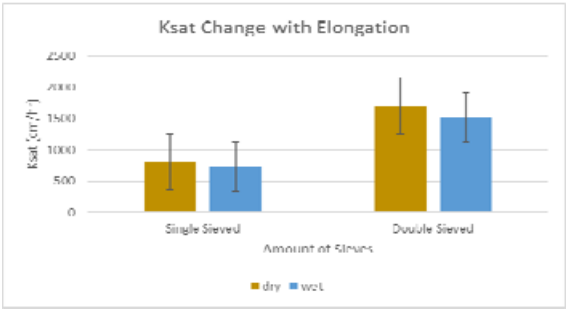


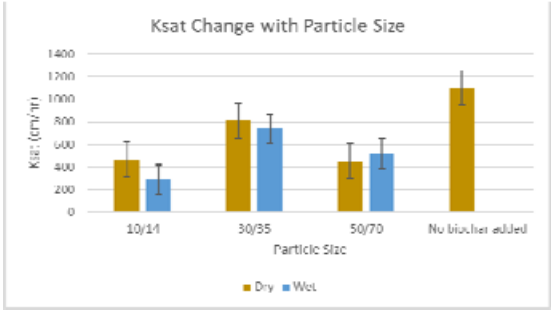
Microstructural Images for Wet Packed Biochar-Soil Mixture by Kalehiwot Nega Manahiloh

RESULTS

Type	Pure Sand (30/35)	Sand with Large Biochar (10/14)	Sand with Medium Biochar (30/35)	Sand with Small Biochar (50/70)	Sand with Double Sieved Medium Biochar
Sand Size (mm)	0.0197 -0.0234	0.0197 - 0.0234	0.0197 -0.0234	0.0197 - 0.0234	0.0197 - 0.0234
Biochar Size (mm)	-	0.0555 - 0.0787	0.0197 -0.0234	0.0083 - 0.1170	0.0197 - 0.0234
Bulk Density (g/cm3)	1.646	1.250	1.210	1.330	1.085
Total Porosity	0.378	0.504	0.520	0.473	0.570
Inter Porosity	0.378	0.449	0.467	0.414	0.522

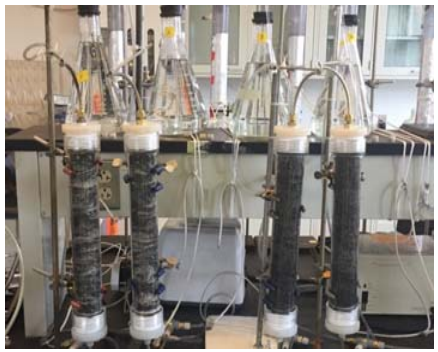






Note: All Results in the graphs above are the mean value from triplicate data, and all error bars represent standard error.

Methods



Dry packing

Wet Packing

Sieving

- Unsieved biochar is placed in a three-sieve configuration. A standard shaker time of 8 minutes was used.
- Elongated particles were sieved once, then collected on the 30 sieve in a over a smaller 1 minute run.

Column Packing

- Wet: To prevent soil segregation, water is added before the mixture is put into the columns. The mixing with water creates a virtually unsegregated mixture.
- Dry: To mimic the real world, no water is added in the mixing stage. The particles are still put together and mixed, however they do not stick together, and the particles tend to stay next to their own type. So, the soil is mostly segregated.

Measuring Ksat

- To reliably measure the Ksat of the columns, water was pumped through the columns to achieve full saturated, meaning all voids are filled with water.
- To measure the Ksat, the volumetric flow of water out of the column was measured and then Darcy's law was used to find the Ksat. Containers filled with water are suspended at a know height h2, the h1 is the height where the water drips out of the column, L is vertical length of the column, and A is the cross-sectional area of the column.

Conclusion

- The total porosity of the medium size biochar is the largest, due to the properties of biochar
- The larger porosity of the medium biochar causes it to have the highest Ksat compared to small and large.
- The particle Elongation had the greatest effect out of any variable, nearly doubling the Ksat compared to single sieved.
- The elongated particles were the only biochar particles to increase Ksat
- The fully segregated particles only slightly decreased the Ksat, with the Ksat of the smaller particles actually increasing.

References and Acknowledgments

Li, Liqing, and Allen P. Davis. "Urban Stormwater Runoff Nitrogen Composition and Fate in Bioretention Systems." *Environmental Science & Technology*, vol. 48, no. 6, 2014, pp. 3403–3410., doi:10.1021/es4055302.

Olson, Nicholas C., et al. "Remediation to Improve Infiltration into Compact Soils." *Journal of Environmental Management*, vol. 117, 2013, pp. 85–95., doi:10.1016/j.jenvman.2012.10.057.

Yan, Yudi. "PREDICTING IMPACT OF BIOCHAR ON SATURATED HYDRAULIC CONDUCTIVITY OF NATURAL AND ENGINEERED MEDIA." *University of Delaware*, 2017.

I Would like to thanks Professor Imhoff for this opportunity to do this research, and for the guidance and teaching he provided throughout the process. I would like to thank Yudi Yan (Conrad) and Tian Jing for providing a helping hand as well. And finally, I would like to give my fullest gratitude to Seyyedaliakbar Nakhil (Ali) for everything he did to make this process as smooth as possible, I feel very lucky that I got to work with him.

Using ArcGIS as a Tool to Map Areas of Deposition and Erosion Along the Powder River, Wyoming Between 1973 and 1991

Presented by Margaret Krauthauser

1. Introduction

ArcGIS is a platform used to create, manage, share and analyze spatial data in a variety of different fields. In this project, ArcGIS was used to:

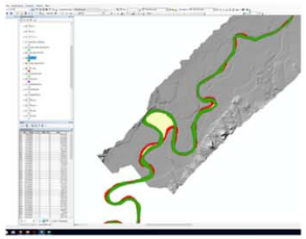
- Outline areas of overlap between the river reaches during 1973 and 1991
- Identify whether such areas were erosional or depositional during the time frame
- Find the value of the area in square meters of erosional or depositional polygons

3.Methods

- A hillshade of the region, a single polygon showing the river reach from 1973 and a single polygon showing the river reach in 1991 were provided in advance
- Three main ArcGIS tools were used: **Erase**, **Merge**, and **Explode**
- **Erase** was used to subtract the 1973 river reach from the 1991 river reach, thus showing all of the areas of overlap (i.e. all potential areas where deposition and erosion could have occurred)
- **Merge** was used to combine the areas of river overlap with any ground that may have been developed within the 20 year time span
- Finally, **Explode** was used to fully separate all the different polygons that had been outlined
  - Up until **Explode** was used, the program considered the whole layer to be one unit, as opposed to several different units; this tool was necessary in order to establish the individual areas
- Once the areas were separated, ArcGIS used the hillshade datum to establish area of the selected regions in meters
- Once the areas were established within the attributes table, the table was then transferred to Excel, where individual areas were classified as being Erosional or Depositional based on where they were in relation to the river reaches

Example of **Merge**; Why was it necessary?

- The green shows the river reach in 1973
- The red shows the river reach in 1991
- The yellow shows the expanse of land that the river traveled over between 1973 and 1991; it could for instance represent a flood plain in that area
- This area would not have been accounted for if only the **Erase** tool had been used; it essentially combined both the area of the river as well as the flood plain making it one single polygon
- **Merge** was not used often, but it was necessary in some parts of the reach

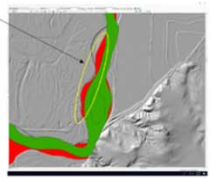


2. Study Area

- The Powder River was chosen as a study site due to the fact that it is a well defined area of research, with multiple studies going on
  - There are decades of almost annual cross section survey data
  - It is a major river with little to no anthropologic disturbances (for instance, no dams)
  - It is the site of various other research including channel migration, terrace aggradation and floodplain development
- It was the site of a geomorphic tree analysis study that was also being run by Dr. Jim Pizzuto
- The area that was focused on using ArcGIS covered roughly a 50 kilometer section of the pictured study area

3.2 Erosional Example

In this image, the river reach of 1991 goes past the banks of the reach in 1973; this indicates erosion of the banks in this section

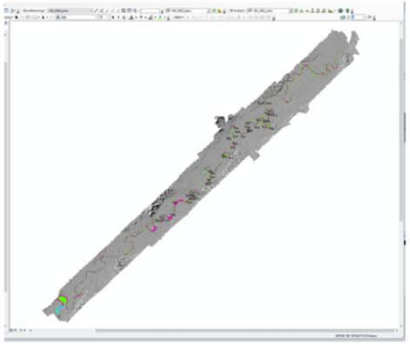


3.3 Depositional Example

In this image, the river has jumped from it's position in 1973 to the bank position in 1991; in this case it is indicative of deposition, possibly a flood plain

River Reach 1973 | River Reach 1991 | Region covered during deposition between 1973 and 1991

4.1: Erosional and Depositional Polygons



4. Results

- In total, there were 124 polygons classified as being depositional, and 115 polygons classified as erosional
- In image 4.1, the depositional polygons are shown in pink, and the erosional polygons are shown in green
- The total area of deposition was calculated to be roughly 2,555 square kilometers
- The total area of erosion was calculated to be roughly 1,722 square kilometers
- Based on these numbers, it appears that the river, at least in this section, is depositing more sediment then it is eroding

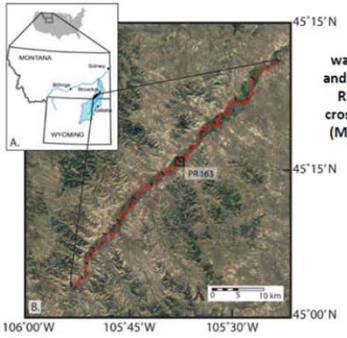
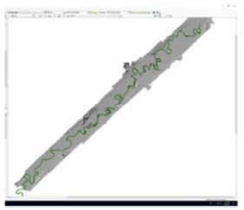
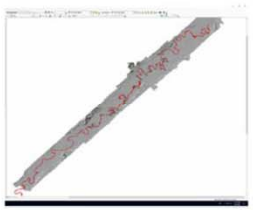


Figure 2.1: A. Powder River watershed location map. B. Moody and Meade study reach of the Powder River outlining annually surveyed cross sections with PR163 highlighted (Moody and Meade, 1990 and 2018; Moody et al., 2002).

2.2 Study area of Powder River: 1973



2.3 Study Area of Powder River: 1991



Acknowledgements

- Dr. Jim Pizzuto for his patience
- Tara Metzger for help figuring out how to differentiate between erosional and depositional polygons

Causes of Change of Irrigation in The Eastern United States

Lauren Glinko, Dr. Tracy Deliberty, Dr. Afton Clarke-Sather
Department of Geography University of Delaware, Newark, DE 19716
Delaware Water Resource Center

Overview

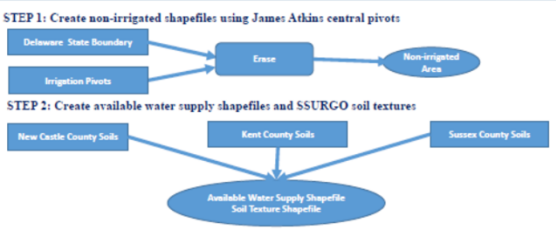
Agricultural practices in the Eastern United States historically have not involved extensive irrigation, but recently irrigation practices have been expanding. Irrigation is widely assumed to be primarily directed towards cultivating corn, however, to date no research has investigated the drivers of using irrigation. By understanding the irrigation practices, the water supply can be quantified and conservation measures initiated.

Objectives

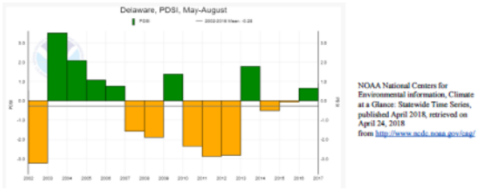
This research combines the National Agricultural Statistics Service Cropscape data set for the years of 7 years (2002, 2008, 2012, 2013, 2014, 2016 and 2017) and irrigation center pivots for the state of Delaware created by James Atkins(2010) to discover:

1. If corn is solely being cultivated under irrigation
2. Identify if climate trends are influencing crop cultivation
3. If there is a trend of increase in irrigated corn and irrigation
4. If soil conditions have influenced where irrigation is occurring

Methods

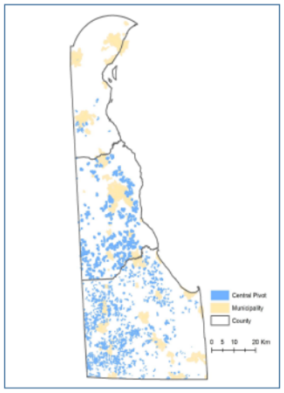


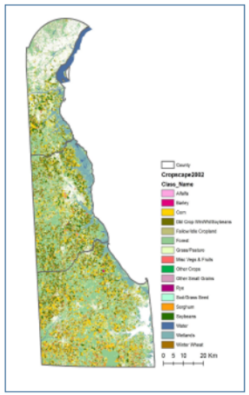
Palmer Drought Index Climate Data 2002-2017

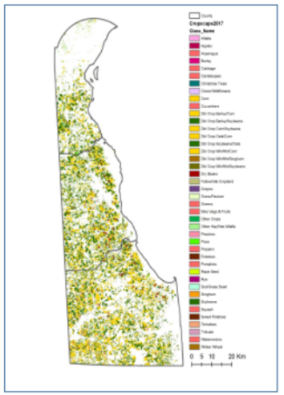


NOAA National Centers for Environmental information, Climate at a Glance: Statewide Time Series, published April 2018, retrieved on April 24, 2018 from http://www.ncdc.noaa.gov/cag/

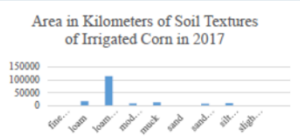
Irrigation Pivots and Cropscape Data

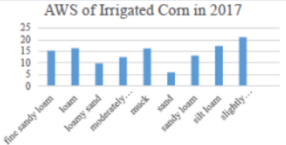






Soil Data Charts from 2017





Results

- Over the years the area of cultivation has decreased, yet the quantity of crop types has increased significantly.
  - Total corn cultivation has increased over the years from 22% in 2002 to 43% in 2017.
  - Soybeans are consistently more widely cultivated on non-irrigated land as compared to.
- Presence of irrigation in agriculture has increased from 15% to 21% over 15 years.
  - Total percent of irrigated corn increased from 45% to 58%.
- Available water supply and soil texture do not reflect any trends in irrigation or cultivation for corn.
  - Primary soil texture of irrigated corn is loamy sand.

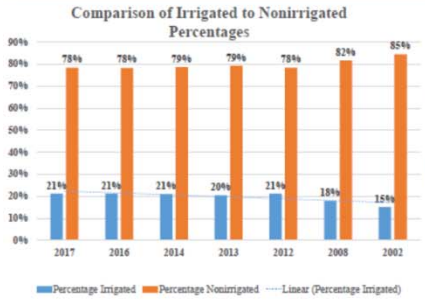
Conclusions

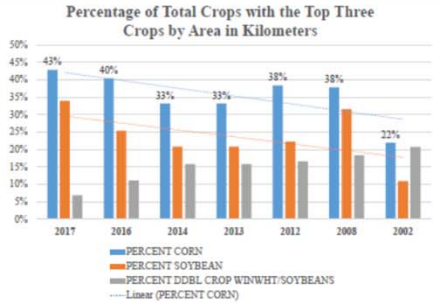
Over the past 15 years corn has undergone an extensive increase in cultivation. This cultivation trend is reflected across all cropland, with corn cultivate doubling from 22% to 43%.

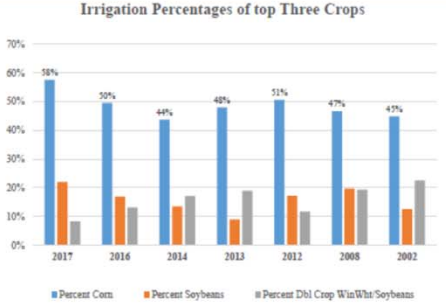
Irrigation has increased in Delaware over the past 15 years. The percentage of irrigation area increased from 15% to 21%, with corn representing the majority of the irrigated crops under cultivated. The percentage of irrigated corn started at 45% in 2002 and increased to 58% in 2017.

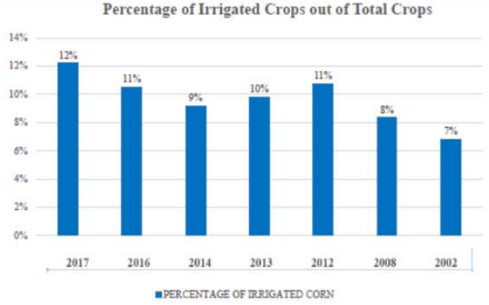
One of the possible causes of the increase of irrigation is reflected by the climate data from NOAA. The graph of climate data depicts the Palmer Drought Severity Index which utilizes temperature and precipitation data to estimate relative dryness. From this graph, the years of 2013 and 2016 were considered wet years, and the rest of the years were drought years. Comparing the "wet years" to the "dry years", the decreases in irrigated cultivation correlate to more precipitation. The relationship between irrigation and precipitation, as depicted by the graphs, is an inverse correlation. The increase of irrigation and cultivation of corn correlate, proving that corn is a water intensive crop and one of the driving factors in the trend of increase of irrigation in Delaware, and possibly the eastern United States.

Charts and Tables









WATER RESEARCH GRANTS

The state water resources research institutes authorized by section 104 of the Water Resources Research Act of 1984 are organized as the National Institutes for Water Resources. The NIWR cooperates with the U.S. Geological Survey to support, coordinate and facilitate research through the Annual Base Grants, National Competitive Grants, Coordination Grants, and in operating the NIWR-USGS Student Internship Program. The Annual Base Grants, 104(b), and National Competitive Grants, 104(g), make up the backbone of the USGS 104 program. Below is a brief explanation of these two similar, but different grants.

State Water Research Grants - USGS 104(b) Program

These grants provide competitive seed grant funding opportunities for faculty members or affiliates at institutions of higher education. Applications must be submitted through your State Water Research Institute or Center. The Institutes or Centers may only consider project proposals from faculty members or affiliates at institutions of higher education in its State. To find out where your state's Institute or Center is located visit the Institutes webpage here and click on your state.

Unique characteristics of this program include:

- Research priorities are set by each institute in consultation with its state advisory board.
- Research focuses on state and regional water resources problems that can be addressed by researchers at academic institutions in states with common problems.
- All federal funds must be matched by at least two non-federal dollars for each federal dollar.

For more information on the USGS 104 program visit the USGS Water Resources Research Institutes website here.

National Water Research Grants - USGS 104(g) Program

The goals of the National Competitive Grants program are to promote collaboration between the USGS and university scientists in research on significant national and regional water resources issues; promote the dissemination and results of the research funded under this program; and to assist in the training of scientists in water resources. The USGS 104(g) Program provides the major mechanism to meet the growing needs not filled by state or federal research programs.

Unique characteristics of this program include:

- Research priorities are set jointly by the National Institutes for Water Resources and the U.S. Geological Survey.
- The program focuses on regional and interstate water resources problems beyond those of concern only to a single state.
- All federal funds must be matched by at least one non-federal dollar for each federal dollar.

For more information on the USGS 104 program visit the USGS Water Resources Research Institutes website here.

U.S. Geological Survey
Department of the Interior

STATE WATER RESOURCES RESEARCH INSTITUTE PROGRAM
FISCAL YEAR 2018 REQUEST FOR APPLICATIONS

under Section 104 of the
Water Resources Research Act of 1984, as Amended

ANNOUNCEMENT G18AS00008
Revised November 01, 2017

CLOSING DATE
JANUARY 18, 2018
5:00 P.M. Eastern Standard Time

OMB Number: 1028-0097
Expiration Date: 2/29/2020

Water Resources Research
National Competitive Grants Program

Fiscal Year 2018 Announcement

Announcement No. G18AS00009
under Section 104(g) of the
Water Resources Research Act of 1984, as Amended
November 1, 2017

Closing Dates
5:00 PM, Eastern Time, February 15, 2018 (Preproposals)
5:00 PM, Eastern Time, June 1, 2018 (Institutes)

Department of the Interior
U. S. Geological Survey

National Institutes for
Water Resources

OMB Number 1028-0097
Expiration Date: Pending: 2/29/2020

Past USGS 104(g) National Water Research Grant Recipients:

Year	Institute	Title	Principle Investigator(s)
2015	CO	Trace Organic Contaminants (TOrCs) in Urban Stormwater and Performance of Urban Bioretention Systems: A Field and Modeling Study	Christopher Higgins, Edward Furlong, Terri Hogue, John McCray
2015	IL	Using BioAvailability to Assess Pyrethroid Insecticide Toxicity in Urban Sediments	Michael Lydy, Amanda Harwood, Kara Huff Hartz, Samuel Nutile
2015	SC	Human and Ecological Health Impacts Associated with Water Reuse: Engineered Systems for Removing Priority Emerging Contaminants	Susan Richardson, Dionysios Dionysiou, Daniel Schlenk
2015	SD	Hydrologic Life Cycle Impact of Mountain Pine Bark Beetle Infestations	James Stone, Scott Kenner, Heidi Sieverding
2014	IA	Development of a Comprehensive Hazard to Loss Modeling Methodology for the Residential Damage Associated with Inland Flooding from North Atlantic Tropical Cyclones	Gabriele Villarini, Jeffery Czajkowski, Erwann MichelKerjan
2014	IN	Can there ever be enough? Analysis of the adoption, penetration and effectiveness of urban stormwater best management practices	Laura Bowling, Linda Prokopy
2014	MD	Environmental Concentrations and Exposure Effects of Environmental Gestagens on a Sentinel Teleost Fish	Edward Orlando, Michael Meyer, Patrick Phillips
2014	NE	Nitrate Mediated Mobilization of Naturally Occurring Uranium in Groundwater	Karrie Weber, Daniel Snow
2014	OK	Hydrogeophysics and Geochemistry of the Boone Aquifer in the Vicinity of the Tar Creek Superfund Site, Ottawa County, OK	Kumar Ramachandran, Cas Bridge, Bryan Tapp
2012	AL	Submarine Groundwater Discharge (SGD) Dynamics at the Gulf Shores of Alabama: Characterization of Nutrient Loading and Saltwater Intrusion using Numerical Modeling Constrained by Geophysical Field Data	Geoffrey Tick, Natasha Dimova
2012	IA	Watershed Scale Water Cycle Dynamics in Intensively Managed Landscapes: Bridging the Knowledge Gap to Support Climate Mitigation Policies	Thanos Papanicolaou, Keith Schilling, Douglas Schnoebelen, Christopher Wilson
2012	MN	Understanding Pesticide Photolysis in Prairie Potholes for Water Management Strategies	William Arnold
2012	NY	The Remote Monitoring of Surface Velocity, Bathymetry, and Discharge	Edwin Cowen

NIWR
THE NATIONAL INSTITUTES FOR WATER RESOURCES

2018 ANNUAL MEETING
"Determining Priorities and Finding New Opportunities"
February 25 – 28, 2108
All events take place at the Phoenix Park Hotel Ballroom unless otherwise noted

PROGRAM

SUNDAY, FEBRUARY 25, 2018

5:00 to 7:00 pm Board meeting with light dinner provided

MONDAY, FEBRUARY 26, 2018

7:00 am to 5 pm Registration Desk Open

7:30 am Breakfast Buffet Available

8:00 am New Directors' Breakfast
Sam Fernald (NM), NIWR President
All NIWR directors are welcome

9:00 am Welcome, Meeting Overview, Introductions and NIWR Update
Meeting Overview and Introductions: NIWR President-Elect Dan Devlin (KS)
NIWR Update: NIWR President Sam Fernald (NM)
Reflections on NIWR 2016-2017: NIWR Past-President Stephen Schoenholtz (VA)

10:00 am Coffee Break

10:15 am Comments and Update from Van Scoyoc Associates
Leslee Gilbert, Van Scoyoc Associates

10:45 am United States Senator Jerry Moran (KS)
(invited)

11:15 am UCOWR-NIWR Partnership Update
Doug Parker (CA) and Sharon Megdal (AZ)

11:30 am National Water Priorities
Panel Discussion: Reagan Waskom, Water Priorities in the West
Rick Cruse, Water priorities in the Midwest
John Fear, Water priorities in the Southeast
Gerald Kauffman, Water priorities in the Northeast

12:30 pm NIWR Networking Lunch – Regional Groups

1:30 pm USGS Opportunities and Priorities

Understanding and Working with Your USGS Water Center
Eric Reichard, California Center Director
Stephen Anthony, Pacific Islands Center Director
Mark Bennett, Virginia/West Virginia Water Center Director

Overview and Priorities of USGS Programs
Gary Rowe, Program Coordinator for the National Water Quality Program
Mike Woodside, Acting Program Coordinator for the Groundwater and Streamflow Information Program
Mindi Dalton, Acting Program Coordinator for the Water Availability and Use Science Program

3:15 pm Coffee Break

3:30 pm US House of Representative Ken Calvert (CA)
invited)

4:00 pm USGS WRRI Program Updates
Earl Greene, Program Coordinator, Water Resources Research Act Program, USGS

4:45 pm NIWR. Net Update
Earl Greene (USGS) and Mark Newman (FL)

5:50 pm Wrap-Up and Adjourn for the Day

UNIVERSITY OF DELAWARE | School of Public Policy & Administration
INSTITUTE FOR PUBLIC ADMINISTRATION
WATER RESOURCES CENTER

DGS Annex
261 Academy Street
Newark, DE 19716-7380
Phone: 302-831-4929
Email: jerryk@udel.edu

March 6, 2018

Senator Chris Coons
127A Russell Senate Office Building
Washington, D.C. 20510

Re: Water Resources Research Act
Fiscal Year 2019 Interior, Environment and Related Agencies Appropriations Bill

Dear Senator Coons:

As Director of the University of Delaware Water Resources Center, I
continuing support of the Water Resources Research Act (WRRA) pr
your support of the Senate Subcommittee to provide $9 million for th
program in the Fiscal Year 2019 Interior, Environment, and Related A

The Water Resources Research Act, signed by Lyndon Baines Johnso
Institutes for Water Resources (NIWR) at 54 land grant universities (su
in the 50 states, Washington D.C., and three island territories of Guam
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public. Each state contributes a minimum of a 2:1 match, thus ensur
priorities are addressed and the impact of federal dollars is maximize
Water Resources Center was established in 1965 and since then we ha
training, and research of thousands of students (many from Delaware h
the significant water resources issues of the day in Delaware and the D

Please don't hesitate to contact me at jerryk@udel.edu or cell 302-89
about this important appropriation concerning our state and national w

Warmly,

Gerald J. Kauffman, Director
University of Delaware
Water Resources Center
Newark, Del. 19716

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INSTITUTE FOR PUBLIC ADMINISTRATION
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261 Academy Street
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Phone: 302-831-4929
Email: jerryk@udel.edu

March 6, 2018

Congresswoman Lisa Blunt Rochester
1123 Longworth House Office Building
Washington, DC 20515

Re: Water Resources Research Act
Fiscal Year 2019 Interior, Environment, and Related Agencies Appropriations Bill

Dear Congresswoman Blunt Rochester:

As Director of the University of Delaware Water Resources Center, I wish to respectfully request your support of the House Subcommittee to provide $9 million for the Water Resources Research Act program in the Fiscal Year 2019 Interior, Environment, and Related Agencies Appropriations bill.

The Water Resources Research Act, signed by Lyndon Baines Johnson in 1964, established the National Institutes for Water Resources (NIWR) at 54 land grant universities (such as the University of Delaware) in the 50 states, Washington D.C., and three island territories of Guam, Puerto Rico, and Virgin Islands. These institutes provide a Federally-supported and state-based network dedicated to solving problems of water supply and quality in partnership with universities, local governments, water industry, and the public. Each state contributes a minimum of a 2:1 match, thus ensuring that local, state, and regional priorities are addressed and the impact of federal dollars is maximized. The University of Delaware Water Resources Center was established in 1965 and since then we have supported the education, training, and research of thousands of students (many from Delaware high schools) who have focused on solving the significant water resources issues of the day in Delaware and the Delaware Valley.

Please don't hesitate to contact me at jerryk@udel.edu or cell 302-893-1571 if you have any questions about this important appropriation concerning our state and national water resources.

Warmly,

Gerald J. Kauffman, Director
University of Delaware
Water Resources Center
Newark, Del. 19716

UNIVERSITY OF DELAWARE | School of Public Policy & Administration
INSTITUTE FOR PUBLIC ADMINISTRATION
WATER RESOURCES CENTER

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261 Academy Street
Newark, DE 19716-7380
Phone: 302-831-4929
Email: jerryk@udel.edu

March 6, 2018

Senator Tom Carper
513 Hart Senate Office Building
Washington, DC 20510

Re: Water Resources Research Act
Fiscal Year 2019 Interior, Environment and Related Agencies Appropriations Bill

Dear Senator Carper:

ersity of Delaware Water Resources Center, I wish to thank you for your
e Water Resources Research Act (WRRA) program and respectfully request
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UNIVERSITY OF DELAWARE
School of Public Policy & Administration
INSTITUTE FOR PUBLIC ADMINISTRATION
WATER RESOURCES CENTER

DGS Annex
261 Academy Street
Newark, DE 19716-7380
Phone: 302-831-4929
Email: jerryk@udel.edu

March 6, 2018

Senator Lisa Murkowski, Chair,
Subcommittee on Interior and Environment
Appropriations Committee
SD-131, Dirksen Senate Office Building
Washington, DC 20510

Senator Tom Udall, Ranking Member,
Subcommittee on Interior and Environment
Appropriations Committee
SH-125 Hart Senate Office Building
Washington, DC 20510

Dear Senators Murkowski and Udall:

Thank you for the Subcommittee's continuing support for the Water Resources Research Act program. I write to urge your continued support for the Water Resources Research Act (WRRA) in FY 2019. WRRA is a proven and effective program in effect since 1964 and is a vital resource for many constituencies, including regional water managers and local business leaders.

The Water Resources Research Act (32 USC 109 et seq.) established National Institutes for Water Resources (NIWR) at 54 land grant universities in the 50 states, District of Columbia, and island territories of Guam, Puerto Rico, and Virgin Islands to research water-related phenomena, aid the entry of new research scientists into water resources fields, train future water scientists and engineers, and distribute the results of sponsored research to water managers and the public.

The U.S. Geological Survey administers the program that provides valuable support for water research critical to local, state, and regional communities. These state programs match federal funds with a 2:1 match-that leverages federal support to address regional needs. These funds support long-term water planning and management and foster the next generation of water scientists, managers and engineers.

Although the WRRA program is responsive to water needs of states and regions, it also addresses major national concerns related to drought, harmful algal blooms, flooding, and water contamination. The institutes collaborate with over 150 state agencies, 100 federal offices, and more than 165 local and municipal offices. In each year, Federal dollars are leveraged to support nearly 300 students in training, over 200 research projects, and more than 550 researchers. Such support fosters successful entry into the STEM job market regionally and nationally.

I appreciate the Subcommittee's support for the Water Resources Research Act and request that you continue funding this program in the FY19 Interior, Environment, and Related Agencies bill.

Warmly,

Gerald J. Kauffman, Director
University of Delaware
Water Resources Center
Newark, Del. 19716

Cc: Senator Tom Carper, Senator Chris Coons

UNIVERSITY OF DELAWARE
School of Public Policy & Administration
INSTITUTE FOR PUBLIC ADMINISTRATION
WATER RESOURCES CENTER

DGS Annex
261 Academy Street
Newark, DE 19716-7380
Phone: 302-831-4929
Email: jerryk@udel.edu

March 6, 2018

Hon. Ken Calvert, Chair,
Subcommittee on Interior, Environment,
and Related Agencies
House Committee on Appropriations
2007 Rayburn House Office Building
Washington, DC 20515

Hon. Betty McCollum, Ranking Member,
Subcommittee on Interior, Environment,
and Appropriations
House Committee on Appropriations
1016 Longworth House Office Building
Washington, DC 20515

Dear Chairman Calvert and Ranking Member McCollum:

I write to urge your continued support for the Water Resources Research Act (WRRA) program in FY 2019. WRRA is a proven and effective program in effect since 1964 and is a vital resource for many constituencies, including regional water managers and local business leaders.

The Water Resources Research Act (32 USC 109 et seq.) established National Institutes for Water Resources (NIWR) at 54 land grant universities in the 50 states, District of Columbia, and island territories of Guam, Puerto Rico, and Virgin Islands to research water-related phenomena, aid the entry of new research scientists into water resources fields, train future water scientists and engineers, and distribute the results of sponsored research to water managers and the public.

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I appreciate the Subcommittee's support for the Water Resources Research Act and request that you continue funding this program in the FY19 Interior, Environment, and Related Agencies bill.

Warmly,

Gerald J. Kauffman, Director
University of Delaware
Water Resources Center
Newark, Del. 19716

Cc: The Honorable Lisa Blunt Rochester

NIWR Advocacy

Leslee Gilbert
Van Scoyoc Associates

February 8, 2018

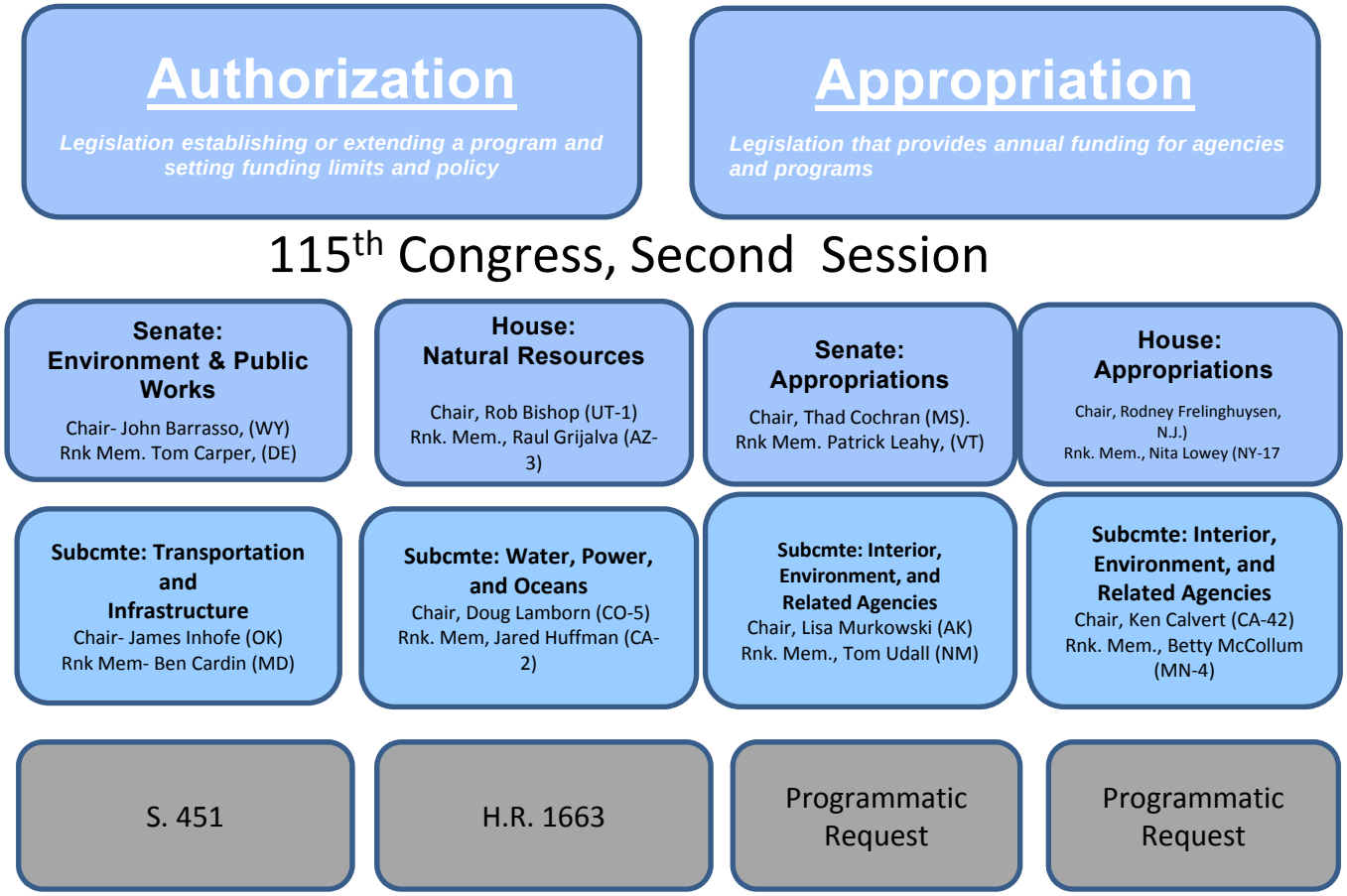
Agency Outlook

- Department of Interior

  Secretary of Interior—Ryan Zinke

  Assistant Secretary for Water and Science-Tim Petty (Just Confirmed)

- USGS—James Reilly has been nominated as head of USGS. He is awaiting Senate confirmation


Authorization
Legislation establishing or extending a program and setting funding limits and policy
Appropriation
Legislation that provides annual funding for agencies and programs
115th Congress, Second Session
Senate: Environment & Public Works
Chair- John Barrasso, (WY)
Rnk Mem. Tom Carper, (DE)
House: Natural Resources
Chair, Rob Bishop (UT-1)
Rnk. Mem., Raul Grijalva (AZ-3)
Senate: Appropriations
Chair, Thad Cochran (MS).
Rnk Mem. Patrick Leahy, (VT)
House: Appropriations
Chair, Rodney Frelinghuysen, N.J.)
Rnk. Mem., Nita Lowey (NY-17
Subcmte: Transportation and Infrastructure
Chair- James Inhofe (OK)
Rnk Mem- Ben Cardin (MD)
Subcmte: Water, Power, and Oceans
Chair, Doug Lamborn (CO-5)
Rnk. Mem, Jared Huffman (CA-2)
Subcmte: Interior, Environment, and Related Agencies
Chair, Lisa Murkowski (AK)
Rnk. Mem., Tom Udall (NM)
Subcmte: Interior, Environment, and Related Agencies
Chair, Ken Calvert (CA-42)
Rnk. Mem., Betty McCollum (MN-4)
S. 451
H.R. 1663
Programmatic Request
Programmatic Request

115th Congress
Senate Committee on Environment and Public Works

Majority Members

John A. Barrasso (R-WY) *Chairman*
James M. Inhofe (R-OK)
Shelley Moore Capito (R-WV)
John Boozman (R-AR)
Roger F. Wicker (R-MS)
Debra S. "Deb" Fischer (R-NE)
Jerry Moran (R-KS)
M. Michael "Mike" Rounds (R-SD)
LTC Joni K. Ernst, ARNG (Ret) (R-IA)
Daniel S. "Dan" Sullivan, USMCR (R-AK)
Richard C. Shelby (R-AL)

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Thomas R. "Tom" Carper (D-DE) *Ranking Member*
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Bernard "Bernie" Sanders (I-VT)
Sheldon Whitehouse (D-RI)
Jeff Alan Merkley (D-OR)
Kirsten Elizabeth Gillibrand (D-NY)
Cory A. Booker (D-NJ)
Edward J. "Ed" Markey (D-MA)
LTC Ladda Tammy Duckworth, ARNG (Ret) (D-IL)
Christopher "Chris" Van Hollen, Jr. (D-MD)

SUBCOMMITTEE ON TRANSPORTATION AND INFRASTRUCTURE

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John Boozman (R-AR)
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Jerry Moran (R-KS)
LTC Joni K. Ernst, ARNG (Ret) (R-IA)
Daniel S. "Dan" Sullivan, USMCR (R-AK)
Richard C. Shelby (R-AL)
John A. Barrasso (R-WY) *Ex Officio, Non-Voting*

Minority Members
Benjamin L. "Ben" Cardin (D-MD) *Ranking Member*
Bernard "Bernie" Sanders (I-VT)
Sheldon Whitehouse (D-RI)
Jeff Alan Merkley (D-OR)
Kirsten Elizabeth Gillibrand (D-NY)
Edward J. "Ed" Markey (D-MA)
LTC Ladda Tammy Duckworth, ARNG (Ret) (D-IL)
Thomas R. "Tom" Carper (D-DE) *Ex Officio, Non-Voting*

115th Congress
Senate Committee on Appropriations

Majority Members

William Thad "Thad" Cochran (R-MS) *Chairman*
Addison Mitchell "Mitch" McConnell (R-KY)
Richard C. Shelby (R-AL)
Lamar Alexander (R-TN)
Susan M. Collins (R-ME)
Lisa Murkowski (R-AK)
Lindsey O. Graham, USAFR (Ret) (R-SC)
Roy Blunt (R-MO)
Jerry Moran (R-KS)
John H. Hoeven, III (R-ND)
John Boozman (R-AR)
Shelley Moore Capito (R-WV)
James Lankford (R-OK)
Steve Daines (R-MT)
John Neely Kennedy (R-LA)
Marco Rubio (R-FL)

Minority Members

Patrick J. Leahy (D-VT) *Vice Chairman*
Patty Murray (D-WA)
Dianne Feinstein (D-CA)
Richard J. "Dick" Durbin (D-IL)
John F. "Jack" Reed (D-RI)
Jon Tester (D-MT)
Thomas S. "Tom" Udall (D-NM)
Jeanne Shaheen (D-NH)
Jeff Alan Merkley (D-OR)
Christopher A. "Chris" Coons (D-DE)
Brian E. Schatz (D-HI)
Tammy Baldwin (D-WI)
Christopher S. "Chris" Murphy (D-CT)
Joe Manchin, III (D-WV)
Christopher "Chris" Van Hollen, Jr. (D-MD)

Program Name: Water Resources Research Act Program (WRRA)

- **Program Purpose:** The Water Resources Research Act (32 USC 109 et seq.) established university-based institutes to research water and water-related phenomena, aid the entry of new research scientists into the water resources fields, train future water scientists and engineers, and distribute the results of sponsored research to water managers and the public. The U.S. Geological Survey administers the program that provides valuable support for water research that is critical to local, state and regional communities. In turn, these state programs match the federal funding—in some cases with a 2:1 match—that leverages federal support to address regional needs. These funds support superior long-term water planning and management, and foster the next generation of water scientists, managers and engineers.
- **Fiscal Year 2017 Funding Received:** $6.5 million
- **Fiscal Year 2018 Funding Received: TBD** $6.5 million proposed by H&S
- **Level of Funding Requested for Fiscal Year 2019: $ 9 million**

Water Resources Research Institute Program

Funding History

Fiscal Year	Budget Request	House Bill	Senate Bill	Enacted
FY 2014	$1,000,000	Supportive Language	$6,500,000	$6,500,000
FY 2015	$3,500,000	$6,500,000	$6,500,000	$6,500,000
FY2016	$6,500,000	$6,500,000	$6,500,000	$6,500,000
FY2017	$6,500,000	$6,500,000	$6,500,000	TBD
FY2018	$0	$6,500,000	$6,500,000	TBD

WRRA Reauthorization

- WRRA Reauthorization Legislation Introduced in House and Senate
  - House: H.R. 1663 (Sponsored by Wittman and Napolitano)
  - Senate: S. 451 (Sponsored by Boozman and Cardin)
- Urge Members to co-sponsor the legislation

DWRC Advisory Panel

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

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

Mr. Tom Coleman, City Manager
City of Newark Public Works & Water
220 S. Main St.
Newark, DE 19711

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

Ms. Asia Dowtin, Student Section, AWRA
Department of Geography
University of Delaware
Newark, DE 19716

Dr. Mingxin Guo
Department of Agriculture and Natural Resources
Delaware State University, 1200 N. DuPont Highway
Dover, DE 19901

Ms. LeeAnn Haaf
Partnership for the Delaware Estuary
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Wilmington, DE 19801

Mr. Stephen Hokuf
Dept. of Planning, NCC Government Center
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New Castle, DE 19720

Dr. Shreeram Inamdar
Department of Plant & Soil Science
University of Delaware, Townsend Hall
Newark, DE 19716

Dr. Paul Imhoff
Department of Civil and Environmental Engineering
University of Delaware
344A DuPont Hall
Newark, DE 19716

Mr. Richie Jones
The Nature Conservancy – Delaware
Community Building
Wilmington, DE

Dr. Thomas McKenna
University of Delaware
223 Delaware Geological Survey
Newark, DE 19716

Mr. Matt Miller
Aqua Pennsylvania
762 W. Lancaster Ave.
Bryn Mawr, PA 19010

Ms. Martha Narvaez
Water Resources Center
University of Delaware, DGS Annex
Newark, DE 19716

Ms. Ginger North
Delaware Nature Society
P.O. Box 700
Hockessin, DE 19707

Ms. Betzaida (Betzy) Reyes
U.S. Geological Survey
1289 McD Drive
Dover, DE 19901

Mr. Kash Srinivasan
603 E. Matson Run
Wilmington, DE 19802

Mr. Robert Struble
Brandywine Valley Association
1760 Unionville-Wawaset Rd.
West Chester, PA 19382

Ms. Jennifer Volk
Kent County Cooperative Extension, University of Delaware
69 Transportation Circle
Dover, DE 19904

Mr. Robert Palmer
Delaware DNREC, Division of Watershed Stewardship
89 Kings Highway
Dover, DE 19901

Ms. Jennifer Walls
Sussex County Planning and Zoning Office
2 The Circle P.O. Box 589
Georgetown, DE 19947

DWRC Water Resources Research and Education Priorities

- Water quality (nutrients, pathogens, and public health)
- Storm water runoff (management and control)
- Water pollutants (sources, fate, cycling, and transport)
- Water supply, demand, and conservation (infrastructure/technology)
- Water policy (governance and economics)
- Climate change, sea level rise coastal flooding (variability)
- Groundwater (remediation and treatment)
- Watershed management
- Wetlands (protection and restoration)
- Wastewater management (treatment and reuse)
- Water, food, and energy nexus

Research priorities for discussion:

- Riverine/coastal flooding
- Algal blooms
- PFOA contamination
- Other

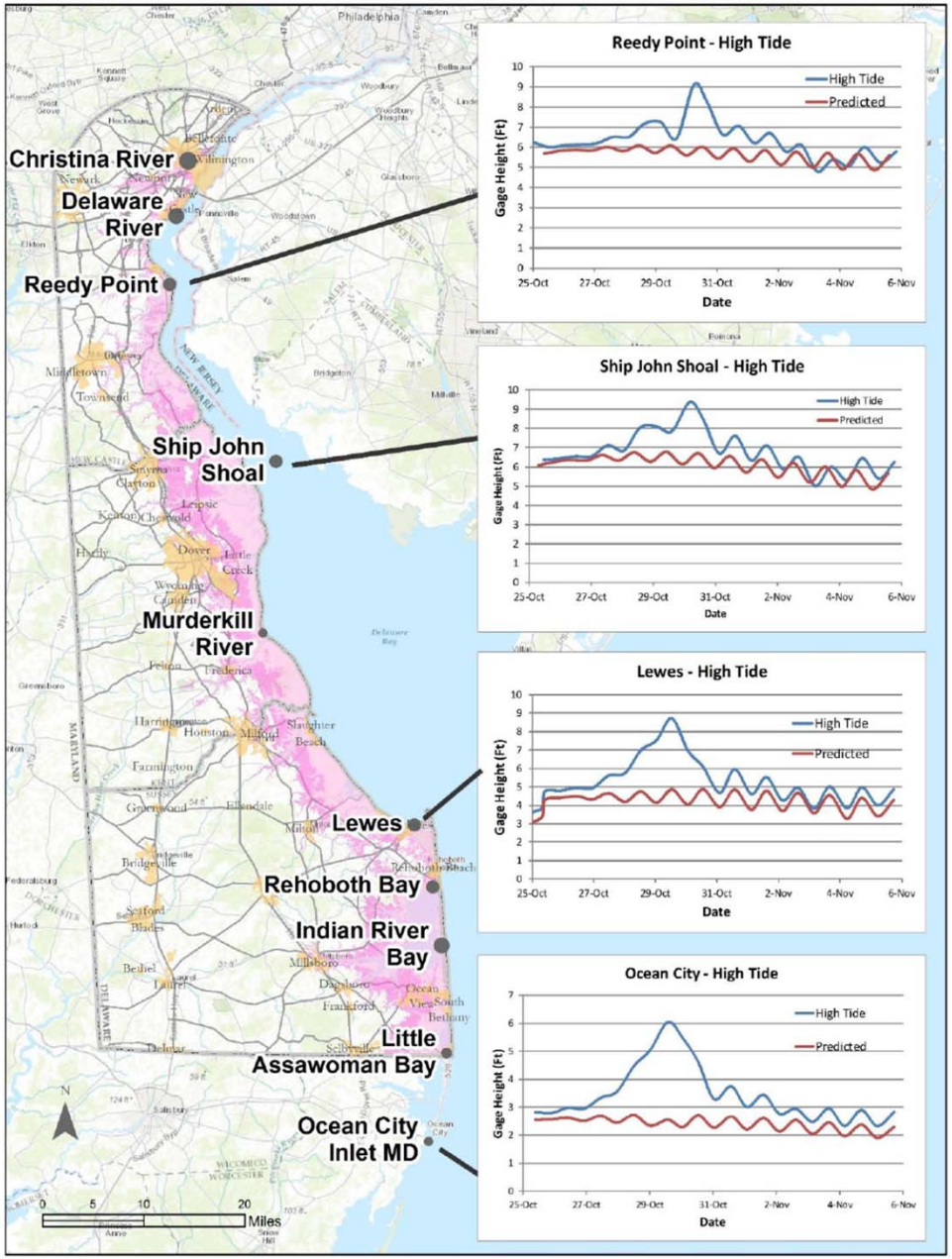

Figure 6.4 Tide levels at NOAA gages, Delaware Bay and River, Superstorm Sandy (October 2012)

Sussex town's residents told not to drink or cook with water because of PFC contamination

Maddy Lauria, The News Journal Published 7:22 p.m. ET Feb. 8, 2018 | **Updated 10:58 a.m. ET Feb. 12, 2018**

PFCs found in the drinking water in Blades Jason Minto/The News Journal/USA TODAY

(Photo: Jason Minto, The News Journal)

A tiny town in southern Delaware is facing a major water crisis.

Residents and businesses in Blades, a Sussex County town just south of Seaford, have been told not to use their tap water for drinking and cooking after perfluorinated compounds, or PFCs, were

Algae bloom prompts swimming prohibition at Newark Reservoir

No impact on drinking water, officials say

By Josh Shannon jshannon@chespub.com Aug 19, 2017 0

A triathlete swims in the Newark Reservoir during last year's Top of Delaware Triathlon. This year's triathlon had to be converted to a duathlon because of algae in the reservoir.

NEWARK POST FILE PHOTO BY DAVID MELLON

Latest e-Edition

More issues

STRATEGIC PLAN
for the
UNIVERSITY OF DELAWARE
WATER RESOURCES CENTER
Draft Dec 2016

Mission Statement

Established in 1965 as one of the 54 National Institutes for Water Resources (NIWR) in the U.S., the mission of the University of Delaware Water Resources Center (DWRC) is to provide water-science and policy assistance to governments and the public through the University's land-grant public service, education, and research role. The DWRC is a unit of the Institute for Public Administration within the School of Public Policy and Administration in the College of Arts and Sciences.

Water Resources Center

The University of Delaware Water Resources Center (DWRC) was established on campus 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 supported through Section 104 of the Water Resources Research Act of 1984 administered by the U.S. Department of the Interior and U.S. Geological Survey. As part of the national NIWR network at land grant universities throughout the nation, 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 of importance 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 the First State.

Water Resources Agency

For 40 years, the Water Resources Agency has provided water assistance to governments in Delaware through the land-grant public engagement (service), learning (education), and scholarship (research) role of the University of Delaware. Since 1977 and amended in 1990/1997, the Water Resources Agency has been sponsored by a board of the State of Delaware, New Castle County, and Newark and Wilmington to provide for clean and plentiful water supplies in Delaware. A regional, intergovernmental approach is essential for water management since watersheds and aquifers cross many political jurisdictions. The Brandywine-Christina watershed in northern Delaware with headwaters in Maryland and Pennsylvania provides drinking water to a half million people and 2/3 of the population of Delaware, ¾ of New Castle County, and all of Newark and Wilmington. Public/private water purveyors deliver drinking water from sole source aquifers to 1/3 of the State in southern New Castle, Kent, and Sussex counties. Delaware watersheds contribute $6 billion annually to the First State economy and support 70,000 jobs and $2 billion in wages.

Goals

The goal of the University of Delaware Water Resources Center is the one of the preeminent water resources institutes in America through contributions in the public engagement (public service), learning (education), and scholarship (research) role of a land grant university.

Goal #1 - Sharpen the Focus of Public Engagement (Public Service): Provide water-science and -policy assistance to governments and the public.

Significance
The DWRC is supported by governments and foundations to provide water-resources outreach and translate research to the public. This public service and engagement role is significant to the University's land-grant mission.

Challenges
Expand and diversify revenue sources to continue providing water-resources assistance to governments in Delaware, the Delaware Valley and along the Atlantic seaboard.

Future Steps
Seek opportunities to pursue more supported work with governments and foundations in the Delaware River and Chesapeake Bay watersheds in Delaware, Pennsylvania, New Jersey, New York, and Maryland. Expand the capacity of GIS laboratory (the first water resources–based GIS laboratory in the U.S., est. 1970s) to conduct more outreach with federal, nonprofit, and business partners.

Goal #2 – Enhance the Quality of Learning (Education): Offer courses, seminars, and forums with a water-resources focus and mentor undergraduate and graduate students with funded fellowships and assistantships.

Significance
The goal to provide water resources education opportunities at the University is significant to the DWRC interdisciplinary science and policy education mission. Education is a basic role of the University of Delaware. The DWRC strives to educate students who will thrive and build careers as future leaders in water resources with public-, private-, and nonprofit-sector partners.

Challenges
The challenge is to participate in water resources education opportunities on campus while expanding DWRC support from funding federal, state, and local government and foundation partners.

Future Steps
Strengthen courses for water-resources specializations in the undergraduate majors of environmental studies/science, civil/environmental engineering, geology, geography, environmental humanities, and natural resources management and graduate programs of the MPA and MA in Urban and Regional Planning graduate programs. Continue to build the Interdisciplinary Graduate Program in Water Science and Policy and partner with the graduate

programs of Water Resources Engineering, Geography, and Marine Science and Policy. Sponsor a course and seminar in water policy in the School of Public Administration and Public Policy.

Goal #3 - Strengthen Programs of Scholarship (Research): Seek opportunities to collaborate with University faculty, scientists, and students to fund, conduct, and publish supported water-resources research.

Significance
Research and scholarship, the search and quest for new knowledge, is central to the mission of the University of Delaware.

Challenges
The challenge is to obtain federal, state, private, and foundation support to carry out water-science and -policy research while maintaining a focus on the public service and education role of the DWRC.

Future Steps
Pursue funded research and partnerships in emerging water-resources areas of GIS-based watershed modeling, food-energy-water nexus, impact of climate change on water resources, sustainable-watershed funding, economics, and finance, and watershed-ecosystem services and socioeconomic value of water.

UD Strategic Initiatives

The University of Delaware has made important strides forward guided by the 2008 *Path to Prominence* and now by the 2015 campus-driven *Delaware Will Shine* strategic planning process. The aim of the University of Delaware is to build on our progress and be a model of distinction in higher education with firm commitments to student success, affordability and access. Our goal is to be a pre-eminent learner-centered research university led by exceptional faculty and staff dedicated to excellence. Faculty effort, long defined in terms of teaching, research and service, will emphasize learning, scholarship and engagement, reaffirming that our work must have a meaningful impact for our students and the world. The University of Delaware Water Resources Center seek to contribute to these strategic initiatives as part of the ***Delaware Will Shine*** planning process.

Strategic Initiative 1: A Welcoming and Collaborative Campus Community

- Collaborate with the UD Environmental Institute (DENIN).
- Co-chair with the College of Agriculture & Natural Resources on the UD-WATER project.
- Develop a UD-business alliance with water-resources firms to conduct on-campus research at the STAR campus.
- Bring on board a DWRC Program Coordinator to provide administrative and budget assistance for the DWRC Director.
- Over the short term, renovate the DGS Annex Building to serve as modern offices of the University of Delaware Water Resources Center as one of the 54 National Institutes for Water Resources (NIWR).
- Over the longer term, develop a strategic plan to raise capital to construct a new building and laboratory for the DWRC as a center for innovation for the UD campus community.

Strategic Initiative 2: Innovative Education Design

- Teach multidisciplinary undergraduate courses based in the College of Agriculture and Natural Resources, College of Arts and Sciences, College of Engineering, and College of Earth, Ocean, and Environment:
  - CIEG 440 Water Resources Engineering
  - UAPP 411/611 Regional Watershed Management
  - UAPP 452 Natural Resources and Public Policy
  - GIS in Public Policy (UAPP 652)
  - GIS in Public Policy (UAPP 655)
  -GEOG and 432/632 Environmental Hydrology.
- Sponsor an annual Delaware water-science and -policy forum on campus.

Strategic Initiative 3: Multidisciplinary Research and Scholarship

- Utilizing USGS and NIWR funding with faculty advisors from colleges throughout the University of Delaware, support a cohort of 15-20 students per semester in undergraduate water research internship program.
- Advise and support graduate research students through DWRC research assistantship program. Fund graduate research fellowships through the DWRC, Institute for Public Administration, and MPA/MA programs in the School of Public Policy & Administration. Fund and advise graduate students in the interdisciplinary water-science and -policy graduate program.
- Partner on research with nonprofit organizations such as the William Penn Foundation.
- Develop a study-abroad program in water science and policy and advise international students interested in water resources (e.g., Uzbekistan, Kyrgyzstan, Brazil, Portugal, Germany, New Zealand, Russia, Georgia, Ukraine, China, and South Korea).
- Work with the International Joint Commission between the United States and Canada.

Strategic Initiative 5: Community Engagement

- Partner with the State of Delaware, New Castle County, City of Newark, and City of Wilmington in funded support to conduct regional water-resources planning and management.
- Serve as Delaware's Water Coordinator and technical advisor to the Delaware Water Supply Coordinating Council as required by state law.
- Served as watershed coordinator of the Christina Basin Clean Water Partnership among Delaware and Pennsylvania, Delaware River Basin Commission, and USEPA.
- Serve as watershed coordinator of the White Clay Creek Wild and Scenic River Committee with the National Park Service.
- Continue partnerships in Sussex County with the College of Earth, Oceans, and Environment at the UD Lewes campus.
- Partner with Delaware State chapter and UD student section of the American Water Resources Association (AWRA).
- Coordinate the Wilmington Green Jobs program for high school students. Provide service-based and problem-based learning opportunities for undergraduate students within the White Clay Creek National Wild and Scenic River watershed.

Future University of Delaware Water Resources Center Building