DELAWARE WATER RESOURCES CENTER

WATER NEWS

UNIVERSITY OF DELAWARE

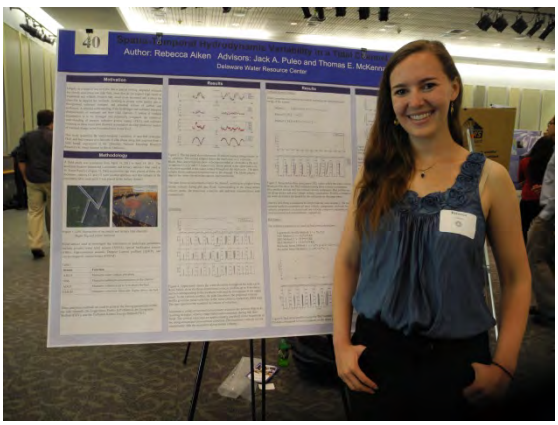
Fall – Winter 2011 and Spring – Summer 2012
Volume 12 Issues 1 & 2

Features

DWRC Annual Luncheon and Poster Session – April 20, 2012

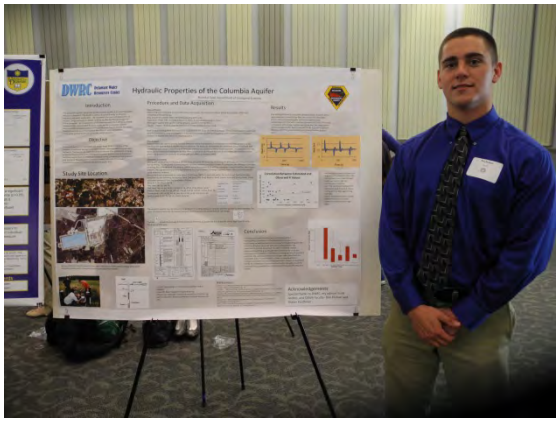
At the University of Delaware's Trabant University Center, 2011-12 ***DWRC*** *interns, graduate fellows, advisors, and* ***DWRC*** *Advisory Panel members enjoyed lunch and learned about research projects and interests. After lunch, the Advisory Panel held its annual meeting. The interns went on to discuss posters summarizing their projects as part of the larger UD 2012 Undergraduate Scholars poster session.*

2011-12 ***DWRC*** *interns (from left to right below): Chelsea Halley and Rebecca Aiken*
(All April 20, 2012 photos by M. Pautler)
Intern report abstracts are found on the ***DWRC*** *website (http://ag.udel.edu/dwrc/interns.html).*



DWRC Annual Poster Session – April 20, 2012

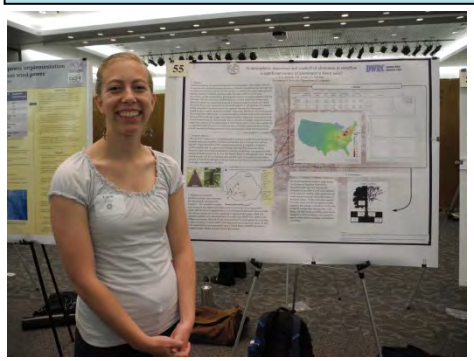
"The ***DWRC*** internship has been an incredibly rewarding experience. Prior to the internship, I had little field experience with hydrogeology, but over the summer I acquired skills including the construction of wells and aquifer-response testing. After working with my advisor, Scott Andres, I discovered my interest in this field of geology and I will now pursue a career in it. This is a great program for young scientists to develop their career objectives, and come out with skills to make them marketable in the world of employment." – *Nicholas Spalt*

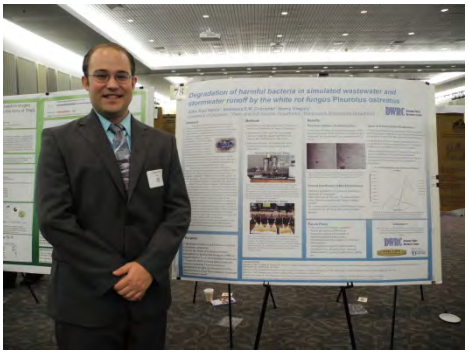


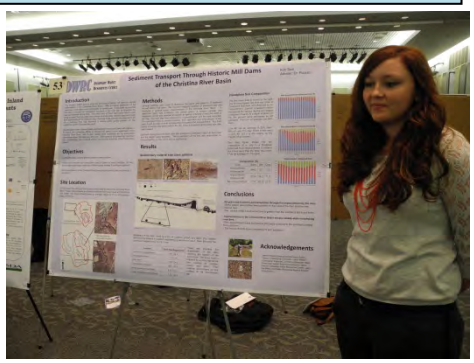
"Before this research experience, I was only a beginner. I wanted to be a scientist, but I didn't quite feel like one yet. Although I certainly do not claim to be one yet, I am definitely a lot closer now. There were challenges, there were difficulties; yet they all served to teach me how to think anew about how to turn the challenges and difficulties into opportunities, and also how to tackle the next challenge. I had knowledge before this program, and now I have experience. It is like football and baseball or apples and oranges. Learning in the classroom is nothing like learning in the field and in the lab. Thank you, ***DWRC***, for teaching me real life applications on how to be a scientist. You have made my dreams begin to take shape into reality, and for that experience, I will be forever grateful.

I learned that choosing a research location can be difficult unless a site visit takes place. This helps to ensure that the location is exactly what is needed to perform the task at hand. I have learned that taking larger water samples than required for testing is crucial in case you run out of a sample while testing them in the lab for any reason. I have learned that the weather can slow down activities that were planned, so plenty of time should be allocated for these kinds of changes. I have also learned how important it is to have a good plan, to organize your time well enough so that everything gets done in a timely manner, with no mistakes, and with plenty of time to fix any mistakes that may happen due to unforeseen circumstances. Expect the unexpected. And enjoy every moment, because this was a wonderful experience and I highly recommend it to anyone who wishes to become a serious scientist." – *Amy Cannon*

*2011-12 **DWRC** interns (from left to right below): Carrie Scheick, John Paul Harris, and Kimberly Teoli*







INTRODUCING OUR 2012-13 SPRING INTERNS

Intern: Lindsey Cook
Advisor: Dr. Kalmia Kniel
UD Department of Animal and Food Sciences
Developing Scientifically-Based Food Safety Metrics for Water Management and Irrigation Methods

Intern: Julia Hagemeyer
Advisor: Dr. K. Eric Wommack
UD Department of Plant and Soil Sciences
Characterization of Viral Diversity within the Mantel Fluid of the Eastern Oyster, *Crassostrea virginica*

Intern: Kayla Iuliano
Advisor: Dr. Shreeram Inamdar
UD Department of Plant and Soil Sciences
Water Quality Impacts of Landscape Best Management Practices that Enhance Vegetation in Urbanizing Watersheds

Intern: Daniel Kardashian
Advisor: Dr. Tom Sims and Mr. James Adkins
UD Department of Plant and Soil Sciences
Improving Irrigation Management through Soil Moisture Monitoring and Automated Control of Sprinkler and Sub-Surface Drip Irrigation

Intern: Tyler Monteith
Advisor: Dr. Joshua Duke
UD Department of Food and Resource Economics
The Returns to Best Management Practices: Evidence from Early Proposals for Nutrient Trading in the Chesapeake Bay Watershed

Intern: Timothy Schofield
Advisor: Drs. Susan Barton and Jules Bruck
UD Department of Plant and Soil Sciences
Water Quality Management in Urban Ecosystems

Intern: Wendi Xu
Advisor: Dr. Pei Chiu
UD Department of Civil and Environmental Engineering
Preventing Formation of Toxic Chlorination Byproducts in Water Using Zerovalent Iron

Mr. Dhillon expects to graduate in Fall semester 2012 with his M.S. degree then move on to a Ph.D. program at the University of Saskatchewan.

Quantifying the Role of Carbon Amount and Quantity for Transport of Contaminants on Our Landscapes: A Watershed Scale Model
Abstract by current ***DWRC*** Fellow Gurbir Dhillon

A total of 14 storm events were evaluated over a 15-month period in a 12 ha forested catchment in the mid-Atlantic region of USA to determine the temporal variability in dissolved (DOC) and particulate organic carbon (POC) and to compare the relative contribution of DOC and POC to the total carbon export. The concentrations of DOC and POC both increased with storm-event discharge. However, the POC concentrations increased more rapidly resulting in higher concentrations of POC compared to DOC at peak stream discharge. POC was the dominant form of organic carbon export, accounting for 82% of the total organic carbon flux. The contribution of POC ranged from 61% to 91% of the total C export. Most of the carbon export occurred in the early part of the event with 51% of carbon exported on rising limb of the hydrograph which accounted for an average of only 19% of the total duration of the event. The amount of precipitation and the seasonal timing of the storm event were important factors controlling the exports of carbon. The summer events had the highest concentrations and exports for both POC and DOC. The three largest events were contributed to 72% and 63% of the exports of POC and DOC, respectively. The storm event POC-discharge relationships were generally clockwise while DOC-discharge relationships alternated between clockwise, anticlockwise and mixed patterns. These results highlight the importance of POC in the exports of carbon from watersheds during storm events. The differences in responses of DOC and POC to the hydrologic events allude to the different sources and pathways of POC and DOC in the watershed.

Microbiome of the Eastern Oyster, *Crassostrea virginica*
Abstract by current ***DWRC*** Fellow Eric Sakowski

The eastern oyster, *Crassostrea virginica*, is an important economic and ecological resource along the east coast of North America. Since the 1950s, populations within the Chesapeake and Delaware Bays have been subject to outbreaks of MSX and Dermo two diseases caused by parasitic protozoans. Interest in oyster microbiology has primarily focused on the causative agents of these two diseases, *Haplosporidium nelson* and *Perkinsus marinus*, respectively, as well as human pathogens associated with consumption of raw shellfish. Little is known about the commensal microbiome associated with oysters despite an increasing appreciation of the impacts of these communities on the biology and health of their metazoan hosts. In this study, the microbial communities within oyster extrapallial fluid and the surrounding water were compared monthly from October 2010 to February 2011. Bacterial and viral abundances were significantly greater in extrapallial fluid than water for three of the five months ($p<0.05$). 16S rRNA gene amplification and high-throughput sequencing were leveraged to investigate bacterial community composition. Bacterial diversity was similar between environments when measured with both Shannon and Chao1 indices. However, bacterial community composition was different between extrapallial fluid and water samples. Several OTUs were associated exclusively with oyster samples. Furthermore, Deltaproteobacteria were significantly enriched ($p<0.05$) in oyster samples as compared to water. A better understanding of the unique microbial community commensal with the eastern oyster may provide new direction for improving the fitness of this species.

Mr. Sakowski is just about through the second year of his Ph.D. program.

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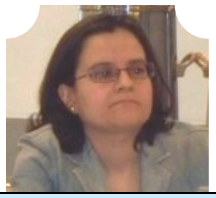
DWRC Spotlight on Graduate Research



Seismic Imaging and Hydrogeological Characterization of the Potomac Formation in Northern New Castle County, Delaware
Dissertation abstract by former ***DWRC*** Fellow Claudia (Velez) Zullo

The Potomac Formation consists of Cretaceous non-marine deposits and includes the most important confined aquifers in the Coastal Plain of northern Delaware. Water supply demands of a growing population in the area make detailed understanding of aquifers increasingly important. Therefore, this study aimed to delineate the stratigraphic architecture of the Potomac Formation with a focus on the sand bodies that provide significant volumes of groundwater. Previous studies based on borehole correlations indicate that the stratigraphy of the Potomac Formation is complex and lithologically heterogeneous, making aquifer sands difficult to correlate.

This project utilized an unconventional seismic system for collecting near-surface, high-resolution seismic reflection data to better define the stratigraphy of the Potomac Formation and its aquifers. A 20-km land-streamer seismic survey (LSS) was conducted on seven public roadways in an area with significant suburban development where long, continuous conventional seismic lines cannot be obtained. The seismic survey was conducted on paved and unpaved roadway surfaces at a variety of orientations relative to the regional stratigraphic dip, yielding a dataset with moderate-to-low S/N ratio. To calibrate the seismic data to lithologies, a 500-ft-deep (152-m-deep) borehole was drilled adjacent to one of the seismic lines using a continuous coring system. Wireline geophysical logs, including gamma, resistivity, and sonic, were obtained after the completion of drilling. The processed seismic sections, core lithologies, and geophysical log data were integrated to develop the stratigraphic interpretations. To evaluate the efficiency of the data collection process and the data quality obtained with this survey, a conventional land survey was conducted on farm fields adjacent to one of the LSS lines. The land streamer survey data collection process proved more efficient than that for the conventional survey and provided superior data quality despite minor disadvantages such as traffic control, traffic noise, and a need for larger crews.

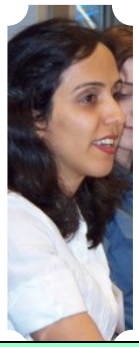
Eleven stratigraphic horizons were identified on the processed seismic sections and seven well-log cross sections and subsequently were correlated. These correlations follow previous interpretations in most parts of the study area; however locally, these horizons are not parallel and show erosional relief. Six lithofacies were identified in the cores: paleosols, lake, frequently flooded lake/abandoned channel, splay/levee, fluvial channel, and splay channel. Geophysical log patterns for these lithofacies were identified in the continuously cored borehole and one more borehole located near another seismic line and then correlated with the seismic data. A seismic facies classification was established using instantaneous amplitude and reflection length and related to these interpreted environments. Using this classification, seismic facies were defined that correspond to four of the lithofacies: fluvial channel seismic facies (very low to low continuity and variable amplitude), paleosol seismic facies (moderate to high continuity and moderate to high amplitude), splay/levee seismic facies (low continuity and low amplitude), and a frequently flooded lake/abandoned channel and splay/levee combined seismic facies (low to moderate continuity and low to moderate-high amplitude).

The analysis of seismic facies sections provides, for the first time, a two-dimensional basis for detailed understanding of the dimensions and distribution of lithofacies in the Potomac Formation. These results indicate that the sand bodies have average width, thickness, and width/thickness ratio of 173.4 m, 10.7 m, and 17.3, respectively. They are poorly connected, with only 27% of the sand bodies identified on the seismic lines exhibiting contact with other sand bodies. These sand-body dimensions suggest that the depositional system was characterized by an anastomosing fluvial style with winding channel sands encased in a section dominated by fine-grained overbank sediments. This system produced a complex, labyrinth-style heterogeneity of lithologies.

Based on the vertical trends in proportion of coarse-grained fluvial deposits interpreted from the seismic facies sections, the Potomac Formation is subdivided into three intervals, bounded by discontinuities, that may have sequence stratigraphic significance: in the lower part of the formation, a lowermost lowstand systems tract characterized by a 1:2 ratio of fluvial channel to paleosol; in the middle, a transgressive systems tract where this proportion decreases to 1:3; and an upper interval of early highstand systems tract deposits where the proportion of sand increases slightly to 1:2.5.

These results provide a refined geologic framework for the Potomac Formation and target areas for future evaluation of aquifer properties useful for groundwater models. The results also indicate that the two-dimensional lateral connectivity of the sand bodies of the Potomac Formation is limited to short distances, contrary to correlations in previous studies that have indicated connection of sands between wells at distances of at least 3 km. The results of this study highlight the importance of integrating multiple sources of geologic information for the interpretation of the stratigraphic architecture of non-marine sediments, and the value of roadway-based high-resolution land-streamer seismic data for the interpretation of near-surface (less than 300-m-depth) aquifer sand characteristics in developed areas.

DWRC Spotlight on Graduate Research



Below is the abstract from a recent journal article by finishing ***DWRC*** Fellow Maryam Akhavan. (Akhavan, M., P.T. Imhoff, S. Finsterie, and A.S. Andres. 2012. Vadose Zone Journal, Vol. 2.)

A second article is being written as she is in "writing mode," with the goal of obtaining her Ph.D. in December 2012.

Rapid infiltration basin systems (RIBS) are used for the application of treated wastewater to soil for wastewater disposal. To ensure sufficient additional wastewater treatment, U.S. regulations require a minimum separation distance between the infiltration basin and groundwater. Analytical and numerical models that predict groundwater mounding beneath basins have assumed a uniform specified flux boundary condition across the basin. In many systems, however, the basins are only partially flooded, with overland flow and soil infiltration controlling the extent of basin inundation. The iTOUGH2 computer code was modified to describe the coupled surface–subsurface flow in RIBS. After testing the model with published laboratory and field data, simulations were used to estimate groundwater mounding beneath RIBS for four hydraulic loading rates and two flooding periods in two representative soils. Because of interest in nitrate ($NO3^-$) removal beneath RIBS, a simplified approach using a domain-average denitrification reduction factor, *F*s, was used to assess the impact of pore water saturation on denitrification. Simulations using the conventional specified flux boundary condition underpredicted groundwater mounding by as much as a factor of 25 in loamy sand and a factor of 6 in sand. The impact of the basin boundary condition on *F*s was less significant, with *F*s reduced by up to 50% if the specified flux boundary condition was used. Thus, ignoring overland flow underpredicts denitrification and groundwater mounding for the cases studied here. For a fixed amount of wastewater discharged during a weekly flooding–drying cycle, simulations indicate that longer flooding periods result in less groundwater mounding but a reduction in denitrification.

Sustainable UD water
WATERSHED ACTION TEAM FOR ECOLOGICAL RESTORATION

The UD WATER project (*Watershed Action Team for Ecological Restoration*) is a multi-disciplinary project intended to develop a watershed management plan for the Cool Run tributary of the White Clay Creek, a wild and scenic river whose tributaries flow through the University of Delaware campus. The UD WATER project team currently consists of faculty and professionals associated with the ***DWRC***, the UD Water Resources Agency, the Delaware Geological Survey, and the University's Stormwater Management and Grounds programs, and the City of Newark. In the Fall semester 2012 undergraduate internships are intended to be offered to work with the UD WATER team in both the Fall and Spring semesters of 2012-2013 to work as a team to develop and implement best management practices that protect water quality and restore ecosystems in the Cool Run watershed. The expected deadline for application is early October 2012. For more information, please check back to the websites: http://www.udel.edu/water/ and http://ag.udel.edu/dwrc/.

UD Graduate Program in Water Science and Policy

Information provided by Program Director & ***DWRC*** Advisory Panel Member Dr. Shreeram Inamdar

Global climate change, unsustainable population growth, and widespread pollution and degradation of our natural resources are threatening the quantity and quality of water resources worldwide. Addressing these challenges require solutions that are not only scientifically sound but are socially acceptable, economically viable, and environmentally sustainable. The new program in Water Science and Policy will train students to think broadly across disciplines and simultaneously possess a depth of knowledge to address important water issues.

By choosing to study Water Science and Policy at the University of Delaware students will be embarking on an exciting intellectual journey that will require synthesis of knowledge from a number of disciplines and perspectives, looking at how water intertwines with natural and human systems in order to meet the challenge of providing all of Earth's inhabitants with clean and adequate water supplies.

The graduate program in Water Science and Policy provides three degree options: 1) a PhD, with a water science concentration (36 credits total); 2) a PhD, with a water policy concentration (36 credits); and 3) a Master of Science, with thesis (30 credits).

The program is administrated by a Faculty Director in close coordination with the Program Committee. Faculty affiliated with the program are able to advise students and help shape the future direction of the program. The Program Committee and the affiliated faculty include representatives from the Colleges of Agriculture and Natural Resources, Arts & Sciences, Earth, Ocean & Environment, and Engineering.

Students are able to apply to the university-wide graduate program directly through a link provided on the university Graduate Admissions homepage. The students are required to meet the specific qualifications of the program to be admitted and awarded the degree in Water Science & Policy. The program students will be housed in the Colleges associated with their primary advisor and the degree will be awarded by the College of residence.

The graduate program in Water Science & Policy is synergistic with other programs on campus, and draws almost entirely upon existing courses. The graduate program in Water Science and Policy is well aligned with the strategic priorities at the University including an emphasis on environmental research and the University's Initiative for the Planet, all within the University's Path to Prominence.

Complete information can be found at http://www.udel.edu/watersciencepolicy.

DWRC Spotlight on Undergraduate Internships

(Photos by M. Pautler)

Long-time ***DWRC*** faculty advisor Dr. Janet Johnson (top photo, center), UD Department of Political Science and International Relations, shared the following about one of her 2010-11 interns, "Kate Miller (top photo, left/bottom photo, right) wrote an excellent paper about the impact of recent Supreme Court decisions on the reach of the Clean Water Act. She also did an analysis of its potential impact on watershed protection on watersheds in Delaware using GIS." Ms. Miller's paper is titled "The Impacts of Redefining "Navigable Waters' under the Clean Water Act." During the same time period, Dr. Johnson also advised Aidan Galasso (top photo, right) who wrote on "Politics and Marcellus Shale Development in Pennsylvania." For available text and maps on these timely issues, please contact Dr. Johnson at jbj@udel.edu.

2011-12 ***DWRC*** intern Nicholas Spalt summarized his internship, "Hydraulic Properties of the Columbia Aquifer," directed by A. Scott Andres of the Delaware Geological Survey (DGS) with the help of environmental scientists Daniel Fluman and Shawn Kauffman: "The Southern Solid Waste Management Center (SSWMC) is comprised of two landfill cells, with a third on the way. The facility, operated by the Delaware Solid Waste Authority (DSWA), is a primary collection point for solid waste in Sussex County, Delaware. I studied the hydraulic properties of the unconfined Columbia aquifer in the direct area of the management center. Determining local groundwater flow, sediment characteristics, and other hydraulic properties are important in determining how a contaminant would react in the event of a landfill leak. In addition to quantifying these aspects of the Columbia aquifer, I attempted to create a systematic hydraulic conductivity calculator using the DGS's lithologic database. The DGS is building an electronic record of all of the borehole data in the state. Included in these records are sediment types and their respective thicknesses. One could possibly use sediment grain size as a proxy for hydraulic conductivity for the whole database or selected areas." For more information on these and related topics, please visit http://www.dgs.udel.edu.

*(Pictured, in a photo courtesy of UD staff, are [left to right] Shawn Kauffman [DSWA], Kristen Barbour [UD undergraduate], A. Scott Andres [DGS], and Nicholas Spalt [**DWRC** intern])*

From Martha Narvaez, UD Water Resources Agency and ***DWRC*** Advisory Panel Member

The University of Delaware, Water Resources Agency and the Delaware Department of Natural Resources and Environmental Control (DNREC) are excited to announce a new website to help you learn about the Delaware watersheds in which you live and work:

It is our hope that this website will be a valuable resource for professionals, students, and the general public. Our organizations believe that by learning about what's going on in your watershed you'll be inspired to help protect, preserve, and enhance the quality of Delaware's water resources.

We encourage you to contact us (via the website) if you have any comments, news, data, and water-related events and publications to ensure that the website continues to be a dynamic online library resource for Delaware's watersheds. Enjoy the site: http://delawarewatersheds.org.

RECENT POSITIONS FILLED *(pictured top to bottom):*

Former ***DWRC*** Graduate Fellow Jennifer (Jennings) Volk has recently taken a position with the UD's Cooperative Extension as Extension Specialist, Environmental Quality.
http://ag.udel.edu/extension

David Wunsch has been named Director of the Delaware Geological Society (DGS) and State Geologist.
http://www.dgs.udel.edu/

Kathleen Stiller leads the DNREC's newly organized Division of Water Management Section.
http://www.dnrec.delaware.gov/wr/Pages/DivisionManagement.aspx.

~~ On Protect Your Groundwater Day, **September 11, 2012**, the National Ground Water Association (NGWA) urges you to ACT (acknowledge, consider, take action). Find out more by visiting http://www.ngwa.org/Events-Education/groundwater-day/Pages/default.aspx.

~~ This year marks the 40th anniversary of the Clean Water Act. To commemorate the legislation's four decades of helping to protect our nation's water resources, EPA invites you to submit a 15-second video containing only original content that describes the important role water plays in your life. Each video should include the phrase "Water is worth it because…," but the rest is up to your creativity. Video submissions must be received by **September 14, 2012**. To learn more and register, visit http://water.epa.gov/action/cleanwater40c/video-project.cfm.

~~ National Public Lands Day (NPLD) – the nation's largest, single-day volunteer event for public lands (http://www.publiclandsday.org/) – and World Water Monitoring Challenge (WWMC) are partnering for the fourth consecutive year. Ninety free WWMC test kits will be available to individuals organizing an NPLD event on **September 29, 2012**. Those who would like to receive a free test kit may either request one from NPLD or register with WWMC *and* indicate affiliation with "National Public Lands Day 2012." Kits will be shipped between July and September as long as supplies last. Please direct questions to wwmc@wef.org.

DWRC Notices and Calendar

The Northeastern Branch ASA-CSSA-SSSA is sponsoring a tour of commercial vegetable and fruit producers and processors in Delaware. This bus tour is being organized and hosted by Drs. Gordon Johnson and Richard Taylor, and Karen Gartley, all of the UD's Cooperative Extension and Department of Plant and Soil Sciences. The tour will be held on **Tuesday, August 7, 2012**, from 7 AM – 6:30 PM and will include lunch. For further details, including the cost and to register, contact Karen Gartley at kgartley@udel.edu or 302-831-1392. Seating is limited so please register soon.

UPCOMING MEETINGS

Sep. 25, 2012 – White Clay Wild and Scenic Watershed Symposium will be held at the Stroud Water Research Center in Avondale, PA from 9 AM – 4:30 PM. Click here for registration and call for posters. **Deadline: Sep. 18**.

Oct. 15-18, 2012 – The 28th International Conference on Soils, Sediments, Water and Energy will be held in Amherst, MA. Visit http://www.UMassSoils.com.

Oct. 21-24, 2012 – ASA-CSSA-SSSA International Annual Meetings. The meeting, "Visions for a Sustainable Planet," will be held in Cincinnati, OH. Visit https://www.acsmeetings.org/.

Jan. 27-30, 2013 – The Delaware Estuary Science and Environmental Summit, "Weathering Change – Shifting Environments, Shifting Policies, Shifting Needs" will be held in Cape May, NJ. This theme seeks to create more effective partnerships and sharing information among scientists, outreach specialists, resource managers, and others with an interest in the prosperity of the Delaware Estuary. Speakers and poster presenters must complete this form no later than **August 1, 2012**. Visit http://www.delawareestuary.org/news_pde_science_conference.asp.

The American Geosciences Institute's Earth Science Week, October 14-20, 2012, will have the theme "Discovering Careers in the Earth Sciences." Learn more at http://www.earthsciweek.org/.

The next National Climate Assessment is scheduled to be completed in 2013. To learn more visit http://www.globalchange.gov/what-we-do/assessment.

UD graduate students Shannon Carter *(left photo)* and Matt Siebecker *(right photo)* engage visitors to the ***DWRC*** booth at the UD College of Agriculture and Natural Resources' annual Ag Day in April 2012. *(Photos by Q. Diaz)*

Delaware Water Resources Center Advisory Panel

The Delaware Water Resources Center

The Delaware Water Resources Center (*DWRC*), established in 1965, is part of a network of 54 Water Resources Research Institutes throughout the nation. The *DWRC* receives funding through Section 104 of the Water Resources Research Act of 1984. The US Geological Survey administers the provisions of the Act and provides oversight of the nation's Water Resources Centers. The primary goals of the *DWRC* are: to support research that will provide solutions to Delaware's priority water problems, to promote the training and education of future water scientists, engineers, and policymakers, and to disseminate research results to water managers and the public. For more information, visit our website: http://ag.udel.edu/dwrc/

Steven Abbott
USDA Natural Resources Conservation Service

Scott Andres
Delaware Geological Survey

Judith Denver
US Geological Survey

Mingxin Guo
Delaware State University

Paul Imhoff
UD Civil & Environmental Engineering

Shreeram Inamdar
UD Plant and Soil Sciences

Andrew Manus
The Nature Conservancy

Martha Narvaez
UD IPA Water Resources Agency

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WATER NEWS
FALL – WINTER 2011 and SPRING – SUMMER 2012
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