



**Water-Friendly Landscape Design:  
Wetlands, Subdivision Design,  
Rain Gardens, and More**

**2005 Delaware Water Policy Forum Highlights**

How can private citizens, city and state planners, subdivision and campus engineers, and groups of private and government agencies work together toward better water quality and supply in Delaware? Expert speakers addressed this topic at the fifth annual Delaware Water Forum *"Water-Friendly Landscape Design: A Prescription for Healthy Watersheds"*, attended by nearly 150 visitors from government, academia, and the commercial and private sectors on October 21, 2005 at the University of Delaware's (UD) Clayton Hall. Co-sponsors of the event included the Delaware Water Resources Center (DWRC), UD Institute for Public Administration (IPA) Water Resources Agency (WRA), Longwood Graduate Program in Public Horticulture, and the Delaware Department of Natural Resources and Environmental Control (DNREC).

*Please note:* Detailed Forum presenter biographies, talk abstracts, and slide presentations can be found on WRA's website at <http://www.wr.udel.edu/>. To request Forum proceedings, contact WRA Watershed Analyst **Martha Corrozi**, phone: (302) 831 – 4931 or email: [mcorrozi@udel.edu](mailto:mcorrozi@udel.edu).

After a welcome by IPA director **Jerome Lewis**, DWRC director **Tom Sims** described changes in Delaware during the Center's 40 years of existence. From 1960 to 2000, Delaware experienced a 75% increase in population, a 150% increase in housing units, and a 20% loss in farmland, creating a number



*"Wetland Willie" (Blackiston Wildlife Area); Frog and Delaware (Norman G. Wilder Wildlife Area, Petersburg); "Jack the Pig" (Pratt Farm near Blackiston). Photos: Tom Barthelmeh, DNREC*



of serious water-related problems that are growing today as development increases statewide. Over the past five years, 60 DWRC interns have researched many of the water resources challenges brought on by this changing landscape.

**Large-scale Delaware wetland and stream restoration projects** were the topic of featured lunch keynote speaker **Stephen N. Williams**, Ecological Restoration Coordinator of DNREC's Ecological Restoration and Protection Team in the Division of Soil and Water Conservation. The team was created in 2003 to bring together expertise and resources from various agencies for projects enhancing water quality, providing stream-bank protection, reducing erosion, and establishing wildlife habitat. DNREC's innovative **wetland restoration and construction** techniques began in the early 1990s in natural areas (above) and along agricultural field margins (page 2).

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2000 Pratt Farm geomorphic water management project  
Photo: Tom Barthelmeh

These areas are some of the demonstration/education sites now in excess of 200 acres throughout the State. Recent efforts have expanded to include restoration of tidal and freshwater wetlands, streams, man-made drainage channels (tax ditches), riparian corridors, and the connection of forest tracts. When 245 acres of wetlands were impacted by the creation of Delaware State Route 1, **DNREC** mitigated these at a ratio of 2:1 for forested wetlands and of 1:1 for those wetlands classified as scrub/shrub, emergent, or tidal. As of the 2003 opening of SR1's final Odessa portion, approximately 488 acres of wetlands with several additional adjacent acres of habitat had been created, and all were placed in perpetual conservation easements. For photos, see [http://www.deldot.gov/static/projects/sr1/photos\\_wetlands.shtml](http://www.deldot.gov/static/projects/sr1/photos_wetlands.shtml).

**The making of a wetland:** Construction methods to best mimic wetland characteristics are continually refined, emphasizing irregularly-shaped perimeters that include micro- and macro-topography. Trees ranging in diameter from one to six inches have been relocated into wetlands with a backhoe or hydraulic excavator. Coarse woody debris such as tree stumps has been added to provide habitat structure, a long-term carbon source, and basking/loafing areas for reptiles and waterfowl. Straw and horse manure have been added to provide an organic matter substrate for macro-invertebrates. The surrounding upland areas have been seeded with warm-season grasses to serve as stormwater buffers and filtering strips and to provide additional wildlife habitat. Projects are routinely planted with nursery stock to further promote ecological diversity. This practice provides opportunities, like at the recently-completed wetland project at Christ the Teacher Catholic School, for groups to learn about principles of ecology and the importance of environmental stewardship as they participate in planting events.

**Stream restoration:** **DNREC's** first stream restoration project was in 2001 (Mill Creek, Delaware Park.)

*Mill Creek:*

*New meander bend bank erosion control with brush layering and root wads*  
Courtesy **DNREC NonPoint Source Program**



Since then, a number of projects have taken place, the most recent being the 5,000-foot Pike Creek project at Three Little Bakers Golf Course. This stream restoration project, the largest ever implemented in Delaware, incorporates a host of restoration techniques reducing flows and erosion:

*Rock toes and rebuilt banks at Three Little Bakers*  
Photo: Stephen Williams, **DNREC**



- \* rock and log "toes" at the base of banks which are embedded with layers or mats of materials such as live branches and tree root "wads" for stability, and
- \* engineered bends or "meanders", "J's" or "V" vanes made of rocks or logs, riffle and pool sequences, and random boulder placement, all to slow stream flows.

**Two public landscaping programs** with aesthetic as well as water quality / quantity benefits were described. **Susan Barton** of the **UD** Dept. of Plant and Soil Sciences showed how **DELDOt's Enhancing Delaware Highways** project can prevent mowed-slope erosion by instead planting durable, low-maintenance and attractive roadside native vegetation. Researching and promoting the benefits of tree canopies and pervious green surfaces for better water quality and stormwater management are the goals of the **Wilmington Greening Program**, presented by **Gary Schwetz**, director of Programs for the Delaware Center for Horticulture and former fellow of the Longwood Graduate Program.

**Water-friendly Subdivision Design:** Opening forum keynote speaker **Jack Clausen**, an associate professor of natural resources management and engineering at the University of Connecticut, spoke on how community planners and land use decision-makers can develop subdivision designs to best preserve watershed health. He described the example of coordinated efforts of a large team of participants in a Section 319 National Monitoring Project supported by **USEPA** through the Connecticut

Department of Environmental Protection. In response to poor water quality due to nutrients and bacteria levels in Connecticut's Jordan Cove and Long Island Sound, local planners wished to learn what water quantity and quality benefits could be derived from pollution prevention Best Management Practices (BMPs).

A **10-year study** was undertaken comparing the water and pollution flows exported from a water-friendly BMP-designed urban subdivision, and from a subdivision with traditional design, in relation to an existing (control) subdivision. The results were astonishing. **The traditionally-designed subdivision had over 800 times the stormwater volume**, 18 times the water flow rate, and increases ranging from **19 to 144 times the pollutant runoff amounts** of nitrate/nitrite (N), ammonia, total nitrogen, total phosphorus (P), total suspended solids, and total copper, lead and zinc **relative to the control watershed. The "BMP" subdivision** was re-zoned and designed to use shared driveways with pervious pavers, no curbs or sidewalks, narrower roads, a water retention cul-de-sac island, grassed swales and landscaping, and individual property roof runoff rain gardens. Fertilizer and runoff from grassy swales did cause a 146% increase in the small amount of total P exported. In comparison, it **had 75% less stormwater, ammonia, lead and zinc runoff volumes, a 43% decrease in total N**, and no other changes compared to the control watershed.

**Rain Gardens – Landscaping with an “underlying” purpose**

Rain gardens, technically named **“bioretention areas”**, combine the aesthetics of a garden with the functions of a stormwater management facility. Positioned in low-lying areas, they are constructed of underlying sand and then soil topped with organic mulch in a 4.5 - 5 foot-deep pit. The garden’s surface is several inches below surrounding areas so that storm runoff is captured. After storms, the garden gradually drains over a few days,

- filtering excess fertilizers and pollutants,
- preventing downhill topsoil erosion that muddies nearby streams,
- conveying groundwater to the nearest stream,
- supporting deeply rooted shrubs / trees, and
- providing a beautiful habitat for wildlife.

**Rain Gardens in Public Projects:** Three Forum presenters showed how bioretention facilities are used for watershed-sustainable campuses in a panel moderated by **Gerald Kauffman** of the **WRA: Tom Taylor**, Chief Landscape Engineer, **UD** Facilities Planning and Construction; Dr. **Robert Traver**,



**Left:** Bio-retention area near UD Dickinson Dorms at Apple Road bridge, Newark. Photo: Tom Taylor



**Left:** Bio-infiltration area, Villanova University West Campus Dorms. Photo: Robert Traver

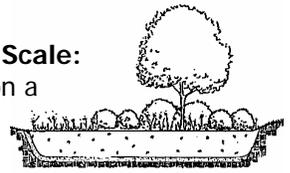
**Right:** Water Resources Agency Rain Garden at the University of Delaware Thompson Dorm. Photo: Elaine Grehl



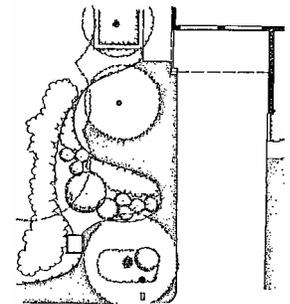
Associate Professor of Civil and Environmental Engineering, Villanova University, and **Elaine Grehl**, **UD** Water Resources Agency Graduate Research Assistant and former fellow of the Longwood Graduate Program.

**Rain Gardens on a Smaller Scale:**

Also speaking with Ms. Grehl on a panel moderated by **Robert Lyons** of the Longwood



Graduate Program were Delaware Nature Society’s **John Harrod** and **Marianne Cinaglia**, past president of the Naamans Creek Watershed Association. Both described how owners of homes and small properties can make significant water conservation impacts in small spaces, such as a 10’ by 30’ plot. “Delaware’s First Rain Garden” (see diagram and photo) was built in 1998 in a low spot next to Ms. Cinaglia’s driveway in north Wilmington. Reach Marianne at [mcinaglia@aol.com](mailto:mcinaglia@aol.com) or (302) 475-3037 for details.



**Above:** Raingarden plan. Delaware low-maintenance native plants: winterberry holly, seviceberry, hummingbird clethra, Virginia sweetspire, daylilies, hosta. **Left:** A backhoe digs the pit for a foot of sand topped with 4.5 feet of planting soil.

Images courtesy Marianne Cinaglia and Russ McKinney, NCWA.

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## Fate and Transport of Arsenic in Delaware Soils: Impacts on Water Quality

Jennifer Seiter, *DWRC* 2003-2006 fellow

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*Photo by Danielle Quigley*



Drinking water safety, the growing demand for potable water supplies, and soil quality are critical and closely related water resource issues in Delaware today. One area of emerging concern is the potential for soil arsenic contamination -- and the possible movement of arsenic from soils to drinking waters. For example, *USEPA* recently lowered the maximum contaminant level for arsenic in drinking waters from 50 ppb to 10 ppb because of human health concerns. The State of Delaware is now evaluating the best approach to identify and manage arsenic contaminated soils. Sources of arsenic in Delaware soils include old tanneries, pesticides, fertilizers, and poultry manure (some of the arsenic added to poultry feed to control avian coccidiosis disease and enhance broiler growth can end up in manures).

*DWRC* Graduate Fellow Jennifer Seiter, advised by Dr. Donald Sparks of the *UD* Department of Plant and Soil Sciences, is studying the forms and fate of arsenic in Delaware soils impacted by industrial and agricultural inputs of arsenic. Jennifer's research is funded by the *DWRC* and the Delaware Department of Natural Resources and Environmental Control (*DNREC*). Her goal is to gain a more complete understanding of soil arsenic through macroscopic studies that help determine how chemical factors (pH, organic matter, texture, phosphate) influence arsenic binding and release in soils. Microscopic studies focus on using advanced spectroscopic methods to identify the specific chemical forms of arsenic in poultry manures and soils. Together, these studies will help to develop management strategies that prevent arsenic pollution of Delaware's soils and waters. Jen states that "When starting my Ph.D., it was important to me that I work on a project with direct application to soil and environmental quality. My research with Dr. Sparks should be beneficial to the scientific community, state agencies, policymakers, and the public".

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### DWRC Water News You Can Use

*DWRC* Water E-News features timely *DWRC* news, plus water resources jobs, project funding, upcoming water conferences and events. Visit <http://aq.udel.edu/dwrc/news.html>.

National Institute for Water Resources (*NIWR*) – *USGS* \$250,000 National Competitive Grants: [https://niwr.org/competitive\\_grants/2006RF\\_P104G](https://niwr.org/competitive_grants/2006RF_P104G) contains RFP and application information. Apply by Feb. 10, 2006. Local contact for this RFP is Dr. Tom Sims, Director, *DWRC*, (302-831-6757; fax 302-831-6758; [jtsims@udel.edu](mailto:jtsims@udel.edu)).

Feb. 14, 2006: Meeting, DE chapter American Water Resources Association, DE Geological Survey, Newark. <http://deawra.org/Meetings/meetings.php>.

Apply by Mar. 1, 2006 for *NIWR* \$15,000 graduate fellowships in water science and technology. Visit <http://www.nwri-usa.org> or call 714-378-3278.

*DWRC's* 2006-2007 \$3500 undergraduate internship program spring applications are due Friday, March 24, 2006. <http://aq.udel.edu/dwrc/jobs.html>.



Left: At the Forum: *DWRC* fellow Liping Zhang discusses her water virus removal research with Roy Simonson, Director of Water and Waste Water, City of Newark. Photo: Amy Boyd

### The *DWRC* welcomes David Legates, William Rohrer, and Denise Seliskar

State climatologist David Legates ([legates@udel.edu](mailto:legates@udel.edu) 302-831-4920), Delaware Department of Agriculture Nutrient Management Program Administrator William Rohrer ([William.Rohrer@state.de.us](mailto:William.Rohrer@state.de.us), 800-282-8685 in DE only), and UD College of Marine Studies research scientist and Halophyte Biotechnology Center co-director Denise Seliskar ([seliskar@udel.edu](mailto:seliskar@udel.edu), 302-645-4366), will now represent these organizations on the *DWRC* Advisory Panel.

**2005-2006  
DWRC  
Undergraduate  
Internships  
News**

*Photos by Danielle Quigley*

**Spotlight on Three  
Projects: Spring  
Internship Winners**

For all ten spring internship projects for 2005-2006, visit:

<http://ag.udel.edu/dwrc/jobs/2005-6Interns/SummerInterns2005-2006.pdf>



**Left:** Kayti Tigani collecting native sea (eel-) grass from the Indian River Bay.  
**Center:** Zostera cultures growing successfully in the lab. Photos center and below: Jack Gallagher



**Below:** Kayti experiments with growing media.



***Coastal Bay Water Quality Restoration***

Eelgrass, a type of seagrass, grows in beds in shallow bays such as Delaware's Inland Bays. It provides a primary source of food and shelter to an abundance of marine life, including economically important finfish and shellfish, such as the bay scallop. Because they filter nutrients and stabilize sediments, eelgrass beds are vital to coastal water quality, yet their size and numbers have declined along the mainland due to development, high nutrient levels, and increased water turbidity. Finding ways to mass-produce eelgrass for large-scale bay water quality restoration projects is the goal of a **DWRC** undergraduate internship co-sponsored by the **DWRC** and **UD** College of Marine Studies (**CMS**). Working with **UD CMS** advisor Jack Gallagher at the **UD** Halophyte Biotechnology Laboratory in Lewes, **DWRC** intern **Katherine Tigani** collected specimens in the field and followed up with lab experiments to determine the media best suited for micro-propagation of eelgrass tissue cultures. A recent graduate of **UD's** Plant Science and Landscape Horticulture program with a plant biology minor, Kayti said "This **DWRC** internship has been an amazing experience. Not only has it led to some exciting results in the lab, but the project has developed into a thesis for my Masters degree at the College of Marine Studies. Through the internship I was able to gain valuable contacts in the field and have now arranged to begin field collections along both coasts of the US."

Says Gallagher, "Kayti's progress in tissue culturing local eelgrass during her internship has set the stage for her to make two major breakthroughs in sea grass tissue culture during her graduate work at Delaware. The first is the creation of a method for economically mass-producing eelgrass from local ecotypes. The second will be the development of a protocol to produce variants of remnant local strains to increase diversity in the seagrass beds."



***Water Report Card for the Delaware River Basin***

**Christi Desisto**, a UD senior civil and environmental engineering major, has been conducting research to develop a series of watershed indicators for a Delaware River Basin Commission (**DRBC**) State of the Basin Report. Christi is collaborating with the **DWRC**, UD Water Resources Agency (**WRA**), and the water resources research centers at Cornell University, Penn State University, and Rutgers University. The project aims to assess the health of the 13,000 square mile river basin which has headwaters in New York and flows through Delaware, New Jersey, and Pennsylvania before joining the Atlantic Ocean. Christi is evaluating such indicators as forested area, impervious cover, stream flow, water quality, and oyster and bald eagle populations as the basis for an overall State of the Basin report which will be jointly issued by the 4 universities, the **DWRC**, the **DRBC**, and the Delaware Estuary program. This work was commissioned as part of the **DRBC** basin plan which was approved by the four governors of the states in 2004.

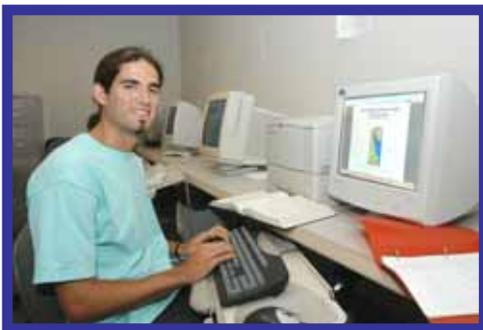
*Christi DeSisto at the UD Water Resources Agency Raingarden*

Her advisor, **WRA** Director of Watershed Policy Gerald Kauffman, states that "Christi is working on a scientifically rigorous and stimulating collaborative research project with our fellow land grant universities to diagnose the health of the Delaware River and its tributaries. Her project is designed to determine the extent of the river's recent recovery and how far it needs to go to meet Federal fishing and swimming goals". **(cont. next page)**

*(Spotlight on 3 interns, continued from p. 5)*

### ***Landowners' views of water quality laws***

How restrictive do Delawareans maintaining their land for natural or agricultural uses find the regulations that govern their water use? UD College of Agriculture and Natural Resources student **Matthew Lee** has consulted statutes and published sources and made phone contacts with the goal of determining types of land uses affected by eight water quality policies and learning how these restrain land use decisions. One of the projects' many challenges was identifying a population to study. Sussex County landowners with more than five acres and greater chance of awareness of policies were chosen as the target population, and 233 were painstakingly identified. "Several drafts of a survey instrument were then created and critiqued," explains Joshua Duke, the project's advisor with Rhonda Aull Hyde, both of the **UD** Department of Food and Resource Economics. "We also received reaction from other faculty and pretest subjects in our survey design. The final instrument and survey protocol was approved by **UD's** human subjects review board and administered during November and December."



*DWRC intern  
Matthew Lee  
researching  
landowner  
perceptions*

Matt's survey received a relatively high return rate of 30% for the first mailing. The results of the survey will show: (1) the landowners' level of familiarity with the 8 policies; (2) their beliefs about which of the policies apply to their land; and (3) the relative, perceived restrictiveness of the applicable policies.

How do these views square with those of the policymakers involved in creating these regulations? Matt also collected data from DNREC and DDA policymakers that provide an "official" perspective on (1) the number of landowners likely affected by each policy; and (2) the relative restrictiveness of the policies. Comparing the results of these two surveys will show the extent of agreement among landowners and policymakers in the coverage and restrictiveness of water quality policies.

### **Seven Fall *DWRC* Internship Winners for 2005 - 2006**

Seven undergraduate students were selected in October for the first fall offering of Delaware Water Resources Center (**DWRC**) internships for fall 2005 through February 2006. Applicants from the University of Delaware and Delaware State University teamed with faculty advisors to propose projects earning the students up to \$3500. The new internships bring to 60 the number of undergraduate projects funded by the **DWRC** to date in collaboration with ten co-sponsors: the Delaware State University (**DSU**), University of Delaware's (**UD's**) College of Arts and Sciences (**CA&S**), College of Agriculture and Natural Resources (**CANR**), College of Engineering (**CENG**), College of Marine Studies (**CMS**), Institute of Soil and Environmental Quality (**ISEQ**), Department of Plant and Soil Sciences (**PLSC**), and Water Resources Agency (**WRA**), and also the Delaware Geological Survey (**DGS**) and Delaware Division of Natural Resources and Environmental Control (**DNREC**).

UD third-year Landscape Horticulture and Wildlife Conservation double major **Leslie Carter** (*below*) will educate the public about water quality and property value improvements through environmental landscaping in "Rain Gardens" under the advisement of Dr. Susan Barton of the UD Department of Plant and Soil Sciences. Leslie is continuing rain garden studies she began as a UD Undergraduate Research Science and Engineering Scholar. Her goals for this **DWRC / PLSC**-sponsored internship project are to publish a rain gardens article in a Cooperative Extension periodical, to create a rain gardens page for the Cooperative Extension web site, and to create interpretive signage or brochures for the rain garden located at the UD Water Resources Agency.

**Leslie Howe**, a Delaware State University second-year Pre-Veterinary Science major, will be researching aspects of "Nutrient Release from Mineralization of Poultry Litter under

*Simulated Field Conditions*" for her **DWRC / DSU** co-sponsored project. Her internship advisors are Dr. Mingxin Guo and Dr. Maria Labreuveux of DSU's Department of Agriculture and Natural Resources. Leslie will study the rate of mineralization,



immobilization, and plant availability of nitrogen (N) and phosphorus (P) in land-applied poultry litter. Her investigation will make possible the creation of more appropriate rates of crop fertilization using poultry litter, in order to improve water quality and agricultural sustainability on the Delmarva Peninsula.

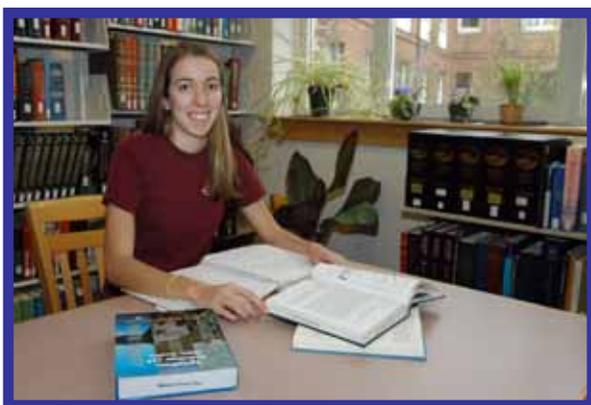
Dr. Delphis F. Levia of the UD Department of Geography will serve as advisor for a **DWRC / UD CA&S** co-sponsored internship research project "*Winter transpiration rates of Pinus strobus L. (eastern white pine) in relation to meteorological conditions*", undertaken by UD fourth-year Environmental Science major **Lydia Leclair**. Knowledge of water consumption and transpiration rates by forests is important for watershed management but is largely lacking with respect to short-term changes in winter weather conditions. Lydia will measure transpiration rates for a select number of trees in the Fair Hill (MD) Natural Resources Management Area and collect corresponding meteorological data recorded by a Delaware Environmental Observing System (**DEOS**) station in close proximity to the site.

**Jimit Modi (right)**, a UD second-year Chemistry / Environmental Engineering double major, will be working with advisor Dr. Herbert E. Allen of the UD Department of Civil and Environmental Engineering on his **DWRC/CENG** co-sponsored internship project, "*Kinetics Model for Soil*". Jimit will investigate and quantify the behavior of trace metals in the soil environment in order to create a predictive model. Some trace metals are essential for plant growth, but others can have negative effects on soil micro-organisms, invertebrates, and water quality. This research will lead to a greater understanding of trace metal fates and consequent environmental impacts.



Dr. Diane Herson of the UD Department of Biology will advise another **DWRC/CA&S** co-sponsored project titled "*Detection of Salmonella in Biosolids using a Combination of Cultural, Molecular and Immunological Methods*". Until recently, there were no **USEPA**-approved tests for the detection of the *Salmonella* pathogen in waste water treatment. Third-year UD Biology major **Samantha Smith** will compare the effectiveness of a combination of techniques versus the new method proposed by the EPA to detect and count these pathogens in treated biosolids. Accurate assessment of *Salmonella* presence will help determine the suitability of biosolids for land application in compliance with federal monitoring requirements protecting public health and the environment.

Locating suitable brackish aquifers to irrigate crops of seashore mallows as potential sources of biodiesel fuel is the goal of **Maia Tatinclaux's (below)** project "*Location and Evaluation of Coastal and Inland Brackish Aquifers for the Support of Halophyte (Kosteletzkya) Oil Production for Biodiesel Fuel Conversion*". She hopes to determine economic feasibility of inland biodiesel production sites in areas of salinized soils as alternative to current oil refineries which are concentrated on the Gulf and Mid-Atlantic coasts and are susceptible to natural disaster. Maia will be building on her experiments with the halophyte *Kosteletzkya virginica* during summer 2005 as a National Science Foundation Research Experiences for Undergraduates (**NSF REU**) intern at the UD College of Marine Studies. Now a fourth-year UD natural resource management major, she will be advised by Dr. Jack Gallagher and Dr. Denise Seliskar of the UD College of Marine Studies Halophyte Biotechnology Laboratory, Lewes, Delaware, for her **DWRC/CMS** co-sponsored internship.



"*Diversity, function, and benefits of specialized plants in poorly drained environments*" is the title of **Michael Zuk's** internship, co-sponsored by **DWRC/PLSC** under the advisement of Dr. John Frett of the UD Department of Plant and Soil Sciences. A third-year UD plant science major with an Associate of Arts and Sciences in Biotechnology degree from Delaware Technical and Community College, Michael will inventory specialized plants that can improve soil drainage in areas of increased land development and impervious cover, thereby reducing pollutant runoff affecting water supply and quality. He further aims to develop educational literature and signage for the UD Botanic Gardens explaining these plants' ability to stabilize streambeds, filter nutrients, and prevent erosion in riparian corridors, rain gardens, and retention ponds.

***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 U.S. 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 further information, visit our website:

**<http://ag.udel.edu/dwrc/>**

***Delaware Water  
Resources Center  
Advisory Panel***

**Scott Andres**

*Delaware Geological Survey*

**Martha Corrozi**

*AWRA Delaware Chapter  
UD IPA Water Resources Agency*

**Steven K. Dentel**

*UD Dept. of Civil &  
Environmental Engineering*

**Judith Denver**

*U.S. Geological Survey*

**Kevin Donnelly**

*DNREC  
Division of Water Resources*

**Jen Gochenaur**

*Delaware Nature Society*

**Maria Labreveux**

*Delaware State University*

***Delaware Water  
Resources Center  
Advisory Panel***

**David Legates**

*UD Dept. of Geography*

**Edward Lewandowski**

*Center for the Inland Bays*

**Ken Lomax**

*UD Dept. of  
Bioresources Engineering*

**Paul Petrichenko**

*USDA Natural Resources &  
Conservation Service*

**William Rohrer**

*DE Nutrient Mgmt Commission*

**Bill Saylor**

*UD Dept. of  
Animal and Food Sciences*

**Denise Seliskar**

*UD College of Marine Studies*

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***WATER NEWS – FALL 2005 - WINTER 2006***

Delaware Water Resources Center  
College of Agriculture and Natural Resources  
University of Delaware  
113 Townsend Hall  
Newark, DE 19716-2103

**<http://ag.udel.edu/dwrc/>**

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