



Shown here and above is the Sewanee Utility District's land application system and lagoon (top photo). (Photos courtesy of Dennis George)

## Center Researchers Work with Sewanee Utility District to Determine Effectiveness of Land Application System

The Sewanee Utility District (SUD) Wastewater Treatment and Land Application Facility, near Sewanee, Tenn., has been the site of a recent project – funded by the SUD – in which Dennis George, environmental engineer and director of the Center for the Management, Utilization and Protection of Water Resources; Martha J.M. Wells, environmental chemist; and Divya Edison, graduate student, have been determining the effectiveness of its land application system.

The practice of land-applying treated wastewater is one of the methods that utilities throughout the United States use to manage wastewater through cost-effective, environmentally sound techniques.

"In this project, the SUD wanted us to determine which water quality parameters persisted in the discharge from its lagoons and should be removed by the land application system under proper operation and maintenance of the irrigation system," George said. "The selected parameter, if present in waters leaving the SUD land application site, may indicate that the soil-water-plant matrix is inadequately treating the lagoon effluent."

One of the steps in the project was to use statistical analysis to determine water quality parameters, like the ratio of nitrogen to phosphorus found in the water system, in the land application effluent that were significantly different from water quality parameters in surface waters entering and leaving the irrigation site. If water sources are high in nitrogen, phosphorus or micronutrients, algae can form, which can negatively affect the habitat of the aquatic life that inhabits that region.

"One of the things we recommended after analyzing our data," George said, "was to monitor the nitrogen-to-phosphorus ratios to limit algal productivity. Also, nitrate to nitrogen concentrations in the surface water leaving the land application system should be limited."

The SUD project ended with a complete report of the team's findings, but according to George, further investigation is needed to determine whether there are other issues with flow seeping through the lagoon dikes.

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# Industrial Management Class Offers Opportunities for Students, Industries

*Center Director George Leads Students in Real-Life Learning Applications That Guide Local Industries in Developing Environmental Best Practices*

Article by: Carey Vaughn

Through an industrial management class taught by environmental engineer and Center Director Dennis George, both students and industries are benefiting. The students get real-life work experience, and industries get guidance in environmental best practices for their companies.

"It is so exciting to see the recommendations that we make actually being used by companies in their day-to-day operations," George said.

George's graduate students Divya Edison and Carey Vaughn recently helped Cookeville Plating Company Inc. develop an Environmental Management System (EMS) manual to help the company increase its productivity and reduce pollution.

Since CPCI opened in 1972, the company has been committed to continual management of pollution prevention strategies and waste minimization, complying by all government regulations and guidelines. CPCI has maintained environmental excellence by implementing environmental guidelines for metal finishers and installing equipment and technology necessary for improved operation.

"The success of CPCI comes from family values and client satisfaction," Bryan Johnston, plant manager, said. "Our business plan is to produce quality products in a timely manner."

As part of the EMS, CPCI evaluated its facility and set additional environmental objectives and targets for the company to achieve. One target was the minimization of gas and electric usages at the facility.

The Tennessee 3-Star Industrial Assessment Center was contacted to perform an energy assessment to determine ways for CPCI to lower its utility consumption, thereby becoming more environmentally friendly. Led by Glenn Cunningham, director and mechanical engineering professor at Tennessee Tech University, the IAC performs energy assessments at manufacturing plants across Tennessee and portions of other states at no charge to the industry.

The criteria for acceptance for an industrial energy assessment are utility usages between \$100,000 and \$2,500,000; company employment of less than 500 people; gross annual sales below \$100,000,000; and no in-house staff available to perform an audit.

CPCI is a family-operated business owned by Charles and Barbara Johnston and operated by their son, Bryan Johnston, and their daughter, Kim Williams. CPCI, an existing electroplater operating both a chrome and nickel plating line, has continued to succeed as an electroplater by establishing goals for product quality and environmental excellence.



Front row (from left): Divya Edison, Dennis George, Dustin Boyette, Brian Traylor, Carey Vaughn, Bryan Johnston. Back Row (from left): Steve Stone, Glenn Cunningham, Jimmy Kitchens, Justin Tripp, Charles Johnston (Photo courtesy of Carey Vaughn)

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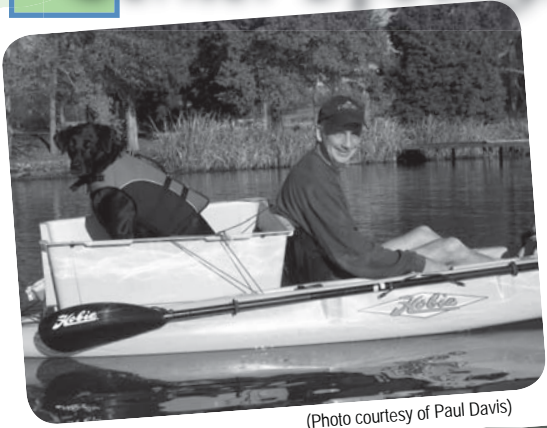
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## Center Spotlight: PAUL DAVIS



(Photo courtesy of Paul Davis)

Since 1988, Paul Davis, a member of the Center's Advisory Board, has served as the director of TDEC's Division of Water Pollution Control – which, with its staff of more than 200 engineers, scientists and support personnel in nine offices across Tennessee, is involved in management and regulatory activities for protecting the state's surface waters. Davis' duties include water quality planning, monitoring, managing permits, compliance review, enforcement, mining regulation, oil and gas regulation, abandoned land reclamation, and emergency response. In that position, he also serves as technical secretary for the Tennessee Water Quality Control Board.

"The most important parts of my job, and my greatest challenges, are education and advocacy," Davis said. "In my 34 years with TDEC, I've come to understand that the single most important thing we can do for the environment is to educate ourselves and others about how – thinking a bit narrowly here – water works in nature, why we should protect it, and how this change here or now causes that effect there or then."

Davis' history in Water Pollution Control began in 1974 and includes five years as environmental engineer in the Knoxville office, two years as chief of Compliance Review in Nashville, five years as manager of the Permit Section and three years as deputy director.

*"I'm a person who's always liked water...Here I am with my pooch, Twinkle, on board one of my kayaks. I do all the paddling."*

*~ Paul Davis, Tennessee Department of Environment and Conservation (TDEC)*

Currently the president of the Tennessee Section of the American Water Resources Association (AWRA), Davis has also served (1989–1991) and continues to serve (August 2005 –present) on the Board of Directors of the Association of State and Interstate Water Pollution Control Administrators. He was the secretary-treasurer of the Kentucky-Tennessee Water Pollution Control Association from 1988 to 2003, and he won the S. Leary Jones Achievement Award in 2001. Davis was also named the Water Conservationist of the Year (1997) by the Tennessee Conservation League and the 2004 Government Engineer of the Year by the Nashville Chapter of the Tennessee Society of Professional Engineers. He has served on the Center's Advisory Board since 2004 and was the Commissioner's Designee for the Underground Storage Tank Board from 1997 to 2005. In 1993, Davis won the Arthur Sidney Bedell Award from the Water Environment Federation.

As a member of the Center's Advisory Board and as an AWRA officer, Davis says that his exposure to water professionals, particularly researchers, in Tennessee has been broadened.

"I've been fortunate to learn more about their work and the business of being a researcher," Davis said. "I have a clearer appreciation for the leading-edge science being done in Tennessee, and that's helping us to do a better job of protecting ourselves and our waters."

"And not just locally, much of what Tennessee researchers are working on has broad application."

## Biologist Mattingly Coordinates Scientific Advisory Committee to Guide the Development of Habitat Conservation Plans

### *HCPs are Being Assessed for Use in the Northern Cumberland Plateau to Help Conserve the Large Number of Federally Listed Species in that Area*

Biologist and Center faculty associate Hayden Mattingly is leading the Scientific Advisory Committee (SAC) charged with providing expert opinions and guidance on the species and land use activities that will potentially be covered in the Habitat Conservation Plans (HCPs) being considered for the northern Cumberland Plateau area.

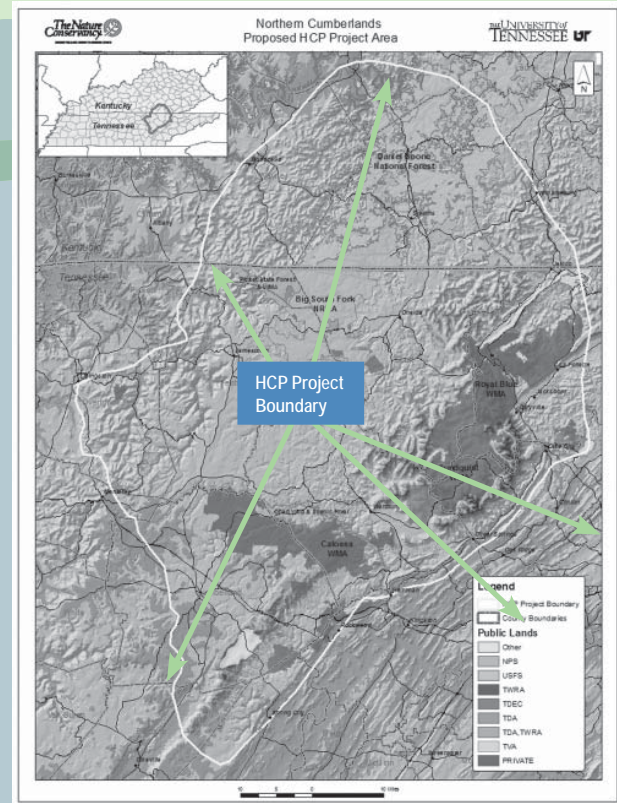
"We are currently developing two HCPs in the Cumberlands," Mattingly said, "one that covers development activities in the Crossville, Tenn., area and another that covers forestry practices in state wildlife management areas in Kentucky and Tennessee.

"We are two years into what might be a five-year effort for one or both HCPs."

According to the Cumberlands Habitat Conservation Plan Web site ([www.cumberlandhcp.org](http://www.cumberlandhcp.org)), an HCP is a "means to integrate the use and conservation of natural resources associated with threatened and/or endangered species." The HCP will be a partner between resource users and the Fish and Wildlife Service to ensure that resources are used in a manner providing the least impact to threatened and/or endangered species. Private land owners, government municipalities, state agencies, corporations and non-profit organizations can all be holders of HCPs.

Since the Cumberland Mountains and Plateau areas in northern Tennessee and southern Kentucky are rich in cultural and environmental resources – and since more demands are being placed on those resources through tourism and growth – a natural opportunity to establish an HCP is evident.

The region being considered for the HCP is shown in the photo above. One of the first steps in developing the HCP concept is to identify potential participants. After that, the HCP that "meets the needs of the future holder of that HCP" will be completed.



(Photo from the Cumberlands Habitat Conservation Plan Web site, [www.cumberlandhcp.org](http://www.cumberlandhcp.org))

Private interests and land owners can benefit from an HCP process by being guaranteed a right to use available resources as long as measures are taken to mitigate impact to endangered species. An HCP also provides land owners and private interests more of a control over finding "positive solutions to endangered species protection issues, and in some cases, environmental permitting is streamlined."

Communities and conservationists can benefit from an HCP as well. An HCP provides an outlet for cooperative relationships among members of the community, so the focus can be on ensuring that wildlife and biodiversity are conserved now and for future generations.

"Multispecies habitat conservation planning on this scale is unprecedented in the Cumberlands region," Mattingly said. "This has its challenges and, hopefully, its rewards."

As coordinator of the SAC, Mattingly is a liaison with government agencies on the specific scientific issues related to HCP development. He also oversees the "development of biological goals and objectives for the species likely to be covered by the water focus of the HCP."



Left photo: (from left) Center-supported graduate student Michelle Casto-Yerty, Center technician Rob Bisch, and TWRA biologist (and former Center student) George Scholten remove sturgeon from a gill net pulled from the Mississippi River. Right photo: Casto-Yerty releases an endangered pallid sturgeon that was incidentally captured in commercial fishing gear. (Photos courtesy of Phil Bettoli)

## Biologist Bettoli and Research Team Study Habitat and Movements of One of the Rarest Fish in North America: *the Endangered Pallid Sturgeon*

Pallid sturgeon have a couple of major concerns. One, they're endangered. Two, they're sometimes caught by mistake by fishers hoping to find the commercially valuable shovelnose sturgeon, whose eggs are processed into caviar (wholesale value listed as \$220/kg).

"Higher prices increase fishing pressure on shovelnose sturgeon," biologist and Center associate Phil Bettoli said, "and that increases the likelihood of endangered pallid sturgeon encountering commercial fishing gear."

While data have been gathered on how often other non-target fish like the paddlefish *Polyodon spathula* are caught with commercial fishing gear – a term called "bycatch" – nothing had been gathered on the endangered pallids, that is, until Bettoli and his team began their work in a project funded by the Tennessee Wildlife Resources Agency (TWRA). During the commercial fishing season in 2007, Bettoli's group accompanied commercial fishers targeting shovelnose sturgeon in the Mississippi River. The catches were monitored to see how many pallid sturgeon were incidentally captured in the fishermen's attempts to gather shovelnose sturgeon.

Through this project, Bettoli and his team are also hoping to track the movements of pallid sturgeon among the reaches of the lower and middle Mississippi River to learn about their habitat and how they live.

"A multiagency effort just began to monitor movements of these fish in the lower Mississippi River below the mouth of the Ohio River," Bettoli said.

When the pallid sturgeon were first classified as endangered, most of the habitat and other information came from the upper Missouri River. But lately, informa-

tion is showing that the Mississippi River also has substantial numbers of wild fish. Since 1997, more than 200 pallid sturgeon have been collected at more than 60 locations in that river. In 2003, the Missouri Department of Conservation began a project using ultrasonic telemetry measurements in the middle Mississippi River to locate sturgeon spawning areas. More than 20 pallid sturgeon have been located near Cape Girardeau, Missouri, and surgically implanted with sonic transmitters.

According to Bettoli, "all of these fish have moved downriver outside of the project area into the lower Mississippi River. Pallid sturgeon have also been tagged recently by federal biologists in Louisiana, and those fish may move upriver into the Tennessee portion of the Mississippi River."

In Summer 2007, Bettoli and Center student Michelle Casto-Yerty will attach ultrasonic receivers to the supports of bridges spanning the Mississippi River. These underwater receivers will "listen" for the unique signal that tagged fish emit if they swim past the bridges. The underwater receivers will automatically log the passing of any tagged fish for up to a year.

"Obstacles to manually tracking fish in the Mississippi River include the immensity of the search area," Bettoli said. "Therefore, an array of stationary receivers will be deployed on bridge abutments at strategic locations below the mouth of the Ohio River."

### Statistics on Pallid Sturgeon

- Described as one of the rarest fish in North America
- Listed as an endangered species in 1990
- Has a historical range of more than 3,500 miles in the Missouri and Mississippi rivers
- Has been collected at more than 60 locations in the Mississippi River since 1997

Bettoli says that data from these stationary receivers will provide information on the seasonal and migratory movements of pallid sturgeon. That data will be used to focus manual field-tracking efforts to determine potential sturgeon spawning areas and other ways they use their habitat.

## Center Sponsors Douglas Alsdorf Presentation on Measuring the Amazon from Space and Modeling Its Flow

The Center recently sponsored a presentation by Douglas Alsdorf, a faculty member of the School of Earth Sciences at Ohio State University, titled "Measuring the Amazon from Space and Modeling Its Flow" as part of the Tennessee Tech Graduate Seminar Civil and Environmental Engineering Series. TTU Provost Marvin Barker and many other faculty and students attended the well-received event.

Alsdorf and his research team are internationally known for their work with the Amazon and other tropical, low relief wetlands.

"Doug's presentation of his team's cutting-edge research on satellite-based surface water measurement was very exciting," said Faisal Hossain, Graduate Seminar Series coordinator, civil and environmental engineering assistant professor, and collaborator with Alsdorf. "Collaborating with OSU helps leverage TTU's own expertise on satellite-based precipitation flood modeling know-how, which has evolved with Water Center support, for countries lacking in ground-based infrastructure."

Alsdorf and his team, including scientists, engineers and policy researchers, study the enormous amounts of water flowing through wetland systems and how that water relates to flooding, ecology and global change. Their key research methods use space-borne measurements of water surface elevations, and their work is leading toward a new satellite mission concept.

Temporary changes in flood water heights are more complex than typically assumed, according to Alsdorf and his team. And the water flows are not easily prescribed by discharge down the main channel and floodplain topography alone. Alsdorf's international team is suggesting the Water and Terrestrial Elevation Recovery Hydrosphere Mapper (WATER HM) satellite as a method

of mapping the ever-changing distribution of the world's water.

Alsdorf and his team's work is demonstrating that "water storage on the Amazon floodplain may be 40 percent less than previously assumed, which suggests a significant imbalance between rainfall measurements and main-channel discharge."

"Previously, my work with interferometric and intensity data gathered from synthetic aperture radar (SAR) included investigations of floodplain sediment storage mechanisms, geomorphic impacts of large flood events, glacier response to volcanism, and measurements of seismic displacements along faults," Alsdorf said.

Alsdorf has demonstrated that interferometric processing of SAR data reveals centimeter-scale changes in water levels beneath flooded vegetation. Hydrologic modeling of these changes yields new insights regarding the flow of water across floodplains.

Alsdorf is an alumnus of The Ohio State University and earned his Ph.D. from Cornell University.

"I am very excited to be working with TTU on cooperative issues regarding lowland regions that are regularly impacted by floods," Alsdorf said. "For example, in one aspect of a project, we are working together on remote sensing of floods in Bangladesh.

"This is a wonderful connection to build between Ohio State and TTU."

Hossain agrees.

"Working with such a globally recognized expert like Doug helps TTU students and faculty gain a truly broad perspective of the currently open science issues on satellite-based water measurement that the scientific community is in hot pursuit of," Hossain said. "Thanks to the Water Center's patronage, we manage to keep ourselves up-to-date with the state of the art."



Faisal Hossain (left) and Douglas Alsdorf (Photo by Amy Knox)

# wetlands

## Meeting on Wetland Issues Focuses on Delineation, Assessments and Mitigation



Participants of the workshop included government agency representatives and consultants. (Photo by Amy Knox)

Along with the Tennessee Department of Environment and Conservation, the U.S. Army Corps of Engineers, and Tennessee Tech, the Center recently co-sponsored a meeting on wetland issues, inviting professionals including consultants and representatives from government agencies from across the state, to discuss topics of concern about these important features of our natural environment.

During the three-day workshop, May 14-16, participants were engulfed in presentations that allowed them to learn about how wetlands are assessed and delineated, the basics of wetland hydrology, and more. Research specialist Ken Morgan and biologist Tom Roberts coordinated bringing the workshop to campus.

"Environmental regulations and policies related to wetlands are complex, change periodically and differ somewhat between state and federal agencies," Roberts said. "As a result, consultants, municipalities and the general public often find the wetland permitting process confusing and frustrating.

"To my knowledge, this was the first workshop ever held in Tennessee that was devoted solely to clarifying some of those issues and improving the process. Based on attendance, audience participation and comments I heard, I believe it achieved those goals, and in fact, I thought it was one of the most successful workshops I have ever attended."

More than 100 people took part in this informative meeting, which allowed participants an opportunity

to network with contacts who are working in similar fields.

"The workshop provided a forum for open communication between agency personnel and members of the public who deal with wetland regulations," Kim Pilarski, a presenter from the TVA, said. "There are multiple agencies involved with wetland permitting issues, so this workshop was especially useful because members of the regulated public were able to hear the specifics of what agencies do and also learn about new developments in wetland assessment."

According to Roberts, several attendees suggested holding a meeting like this each year.

"I doubt we will do that," Roberts said, "but scheduling one every two to four years probably would be a good idea."

### What is a Wetland ?

**wet-land** According to *Webster's Dictionary*, a wetland is "a land or areas that are covered often intermittently with shallow water or have soil saturated with moisture."

# wetlands delineation mitigation

## Microbiologist Berk Prepares to Host Australian Researcher Through “Backing Australia’s Ability” Program

Microbiologist Sharon Berk is planning to host a six-week visit this summer from faculty researcher Michelle Critchley through the Australian government’s “Backing Australia’s Ability” program, which allows researchers to interact with and inform each other to build strong international collaborative teams for future proposals and research.

“I’m excited to have the opportunity to work with a bright young researcher whose work helps complete the big picture of our studies,” Berk said.

According to Berk, Critchley’s specialization in molecular biology will complement her own expertise in protozoology. Through this partnership, Berk says that both researchers will be able to learn about each other’s work.

Critchley was one of 64 Australian scientists awarded grants to participate in collaborative research opportunities worldwide.

The funding was provided through a multi-million dollar program awarded to the Australian Academy of Science over three years.

Other host institutions were in China, Japan, Korea, Taiwan and Europe. Participating faculty will delve into a wide array of projects ranging from research in coral larvae to Type 2 diabetes.



Sharon Berk (Photo by TTU Photo Services)

### In Other News

In other news, Berk recently received a grant totaling approximately \$400,000 from the U.S. Department of Agriculture to continue her timely work in the ecology of microbes associated with food-borne illnesses. According to the Centers of Disease Control and Prevention Web site ([www.cdc.gov/ncidod/dbmd/diseaseinfo](http://www.cdc.gov/ncidod/dbmd/diseaseinfo)), two outbreaks of food-borne illness in Fall 2006 sickened nearly 400 people in at least 33 states, killing at least three people.

Berk and her team’s research deals specifically with *Escherichia coli* O157:H7 and *Salmonella enterica*, the most common bacteria involved in food-borne outbreaks. They are looking at how protozoa, which are prevalent in nature, can potentially release living bacteria in expelled food vacuoles. Their original research examined the protozoa *Tetrahymena*, which live in water, and found that when they fed on *S. enterica*, the bacteria was not digested and was, instead, encased in a protective vacuole and expelled into the environment. In this form, the bacteria seemed to be stronger and more impervious to the chemical used in sanitizing food-processing equipment and food.

More recently, Berk and her team are looking at protozoa that come directly from produce, rather than the soil, to see if these protozoa release vesicles containing *E. coli* O157:H7, *S. enterica* and *Listeria monocytogenes* bacteria. Berk says that, so far, they are seeing that *Tetrahymena* from produce release vesicles filled with *E. coli* O157:H7. *Glaucoma* expels vesicles with all three bacteria strains intact, and *C. steinii* do not produce vesicles with any bacterial strains.

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