Improving the environmental health of the First State is the focus of the Delaware Experimental Program to Stimulate Competitive Research (EPSCoR), a National Science Foundation (NSF) initiative involving UD, Delaware State University, Delaware Technical & Community College, and Wesley College.

The Delaware partnership’s five-year, $15 million award, announced by NSF in November, is the second Research Infrastructure Improvement grant the four institutions have shared since 2005. The grant is coordinated by the Delaware EPSCoR Office located at UD.

“This new funding will do three things,” says Steve Borleske, Delaware EPSCoR director. “It will allow the state’s institutions to expand environmental research capacity and broaden educational opportunities. It will also allow us to collaborate with government agencies, industry, and nonprofit organizations to solve key state and regional environmental problems and to promote economic development.”

According to Donald Sparks, principal investigator and director of UD’s Center for Critical Zone Research, the research catalyzed by the new grant focuses on the state’s major goals of improving air and water quality, preserving its delicate coastal ecosystem, and promoting brownfield redevelopment.

Postdoctoral researcher Matthew Ginder-Vogel examines arsenic-contaminated soils at Brookhaven National Laboratory’s National Synchrotron Light Source. Photo courtesy of Marta Avila Perez
Exploring the Natural World

The five projects seeded by the program in March all “aim to improve Delaware’s environment through discovery research,” according to Sparks:

Developing a “Lab on a Chip”

Karl Booksh, professor of chemistry and biochemistry, and Raul Lobo, professor of chemical engineering, are developing a “lab on a chip” sensor platform to monitor air quality for volatile organic hydrocarbons (VOC) and ammonia vapor. The tool will enable continuous monitoring outside animal feed lots, power plants, and other settings where emissions may impact quality of life for workers or local residents.

Examining Air Particulates

Matthew Ginder-Vogel, postdoctoral researcher in plant and soil sciences, Don Sparks, and Murray Johnston, professor of chemistry and biochemistry, are working with William Ritter, chairperson of the Department of Bioresources Engineering, and Eric Benson, associate professor of bioresources engineering, to study a major environmental issue facing the animal industry and regulatory agencies in Delaware — airborne emissions of particulates from confined animal feeding operations, such as poultry houses.

(Continued on page 24)

Changing climate may make ‘super weed’ even more powerful

UD researchers have discovered a new reason why the tall, tasseled reed *Phragmites australis* is one of the most invasive plants in the United States.

They found that *Phragmites* delivers a one-two chemical knock-out punch to snuff out its victims, and the poison becomes even more toxic in the presence of the sun’s ultraviolet rays.

The study, published in the June issue of the journal *Plant Signaling & Behavior*, is believed to be the first to report the effects of UV-B radiation on plant allelopathy — the production of toxins by a plant to ward off encroachment by its neighbors.

The authors include Thimmaraju Rudrappa, a former UD postdoctoral researcher who is now a research scientist at DuPont; Harsh Bais, assistant professor of plant and soil sciences; Yong Seok Choi, postdoctoral researcher in chemical engineering; Delphis Levia and David R. Legates, both associate professors of geography; and Kelvin Lee, Gore Professor of Chemical Engineering and director of the Delaware Biotechnology Institute. The research was conducted in Bais’s lab at the institute and in Delaware wetlands.

“The toxin secreted by *Phragmites* is degraded by sunlight — ultraviolet rays — and causes severe deleterious effects on other native plants,” Bais says.

“Our research also addresses the growing questions of increased UV-B incidences because of global warming and its ultimate effect on plants. In this case, an invasive plant is accidentally utilizing the changed global conditions for its survival and invasion,” Bais notes.

Two years ago, Bais led a study funded by the NSF-Delaware EPSCoR program which revealed that *Phragmites* actively secretes gallic acid to kill off plants and take over new turf. Gallic acid, also known as 3,4,5-trihydroxybenzoic acid, is used to tan leather, make dyes, and formulate astringents, among other applications.

In this research, the scientists found that the gallic acid released by *Phragmites* is degraded by ultraviolet light to produce another toxin, mesoxalic acid, effectively hitting susceptible plants and seedlings with a double-whammy.

The mesoxalic acid triggers a similar “cellular death cascade” in victim plants as gallic acid does, Bais says, destroying the structural protein in the roots within minutes of exposure.

The team detected the biological concentrations of mesoxalic acid in Delaware wetlands, in stands of both exotic and native *Phragmites*. The study highlights the persistence of the photo-degraded phytotoxin, particularly potent in the exotic species of the plant, and its enhanced effects against the native species of *Phragmites*, which is becoming increasingly endangered in the U.S.

Walnut trees, pine trees, ferns, and sunflowers are among the plants that release harmful chemicals to prevent other plants from growing too close to them. However, *Phragmites* uses this strategy not so much to keep other plants away, but to aggressively conquer them and invade new territory, Bais says.

Funding for the project was provided by the University of Delaware Research Foundation.
Novel Imaging System for Intertidal Areas

Thomas McKenna, associate scientist-hydrogeologist at the Delaware Geological Survey, is working with Jack Puleo and Christopher Meehan, assistant professors in the Department of Civil and Environmental Engineering, to develop a ground-based imaging system for the coastal zone that extends beyond the visible light range, to thermal and infrared imagery.

Such a system could aid research on a number of Delaware environmental issues, including water quality, wetland loss, point and nonpoint source pollution, contaminated sites, habitat degradation, coastal erosion, oil spills, and deteriorating sewer and water infrastructure.

Assessing Beachface Flow

Through a combination of field experiments at Cape Henlopen, Delaware, and lab studies, Holly Michael, assistant professor of geological sciences, and William Ullman, professor of oceanography, are working to demonstrate the applicability of new and improved methodologies for studying fluid and particle flow through beachfaces on the time scale of tides and waves.

The research is expected to increase scientific understanding of the ecological benefits of sandy beaches, ultimately aiding beach managers in improving the health of coastal marine ecosystems.

Nanotechnology

John Rabolt, professor of materials science and engineering, is collaborating with John Xiao, professor of physics and astronomy, and Shouheng Sun of Brown University to develop a new class of environmental sensors.

The team is using new and established processing protocols to fabricate nanoparticles and nanofibers, displaying functional groups that interact with such environmental contaminants as arsenic, zinc, chromium, and nickel. These high surface area nanostuctures concentrate the toxic atoms/molecules, allowing small concentrations to be analyzed using spectroscopic techniques.

Report puts Delaware River Basin’s health in focus

A recent report published by the University of Delaware provides the most comprehensive scientific evaluation of the health of the 13,539-square-mile Delaware River Basin to date, thanks to a collaboration of land-grant institutions in the four states that share the watershed.

The State of the Delaware River Basin Report, the culmination of a three-year, $145,000 project funded by the Delaware River Basin Commission and the Partnership for the Delaware Estuary, was the product of a research consortium that included Cornell University in New York, Rutgers in New Jersey, the Pennsylvania State University, and UD.

The effort was coordinated by the Water Resources Agency in the Institute for Public Administration, College of Education and Public Policy.

“We have a tremendous resource that we need to keep healthy,” says Gerald Kauffman, Water Resources Agency director, who was one of the project’s principal investigators.

The longest undammed river east of the Mississippi, the Delaware River extends 300 miles from Cape Henlopen, Delaware, to the Catskills. The river is the world’s largest freshwater port yet also sustains reviving shad and striped bass fisheries. The basin also provides drinking water to 15 million people, including Philadelphia and New York, Kauffman notes.

In the 1950s, the Delaware River at Philadelphia was called “one of the most grossly polluted areas in the United States.” Since then, Kauffman says, environmental policies have sparked the resource’s comeback.

Among the Delaware River basin’s improvements:

- Water quality as measured by dissolved oxygen, phosphorus, lead, and zinc levels has improved in most tributaries since 1990.
- Watershed groups are removing dams that impede fish migration.
- Over 1,600 federal Superfund sites are being cleaned up.
- Blue crab landings are up, resulting in a $7-million economy.
- Bald eagles are back, with more than 50 nesting pairs.
- Forests cover more of the basin now than during the 1930s.
- More than 400 miles of rivers in the basin are included in the National Wild and Scenic Rivers Program.

However, a number of troublesome trends remain:

- The pesticides atrazine and metolachlor have been detected in 8 out of 10 basin streams.
- Fish-consumption advisories remain on 4,000 miles of streams.
- The red knot, a shorebird that gorges on Delaware Bay horseshoe crab eggs during its spring migration from the tip of South America to Canada, is closer to extinction.
- About 15% of habitat for brook trout, the state fish of New Jersey, New York, and Pennsylvania, has been extirpated.
- The Atlantic sturgeon is teetering on the brink of extinction. Only two fish per haul were caught in the Delaware in 2004 and none in 2005.
- Between 1996 and 2001, the Delaware Basin lost 18 square miles of agricultural land, 4 square miles of wetlands, and 48 square miles of forests, while gaining 70 square miles of urban/suburban land.

Download the report at www.ipa.udel.edu/publications/water.html.
UD a ‘hotbed’ for polar studies

With multiple research projects under way in both the Arctic and Antarctic, and world-class Inuit art collections at home, the University of Delaware is a veritable ‘hotbed’ for polar studies, as geography professor Frederick E. “Fritz” Nelson will tell you. And that’s thanks in large measure to William S. Carlson, an accomplished arctic explorer and Earth scientist who was UD’s president from 1946 to 1950.

Carlson established the University’s geography program, which included “Problems in Polar Research” as one of its first seminars. Ever since that seminar, which was taught by Carlson himself, UD has been active in cold-regions research, says Nelson, who directs UD’s Permafrost Group and is a member of the Intergovernmental Panel on Climate Change, which shared the 2007 Nobel Peace Prize.

In 2008, the University launched the William S. Carlson International Polar Year Events in recognition of the late Carlson, the world’s fourth International Polar Year, and UD’s significant polar research. The 15-month series covered polar science, social science, material culture studies, and photography through public lectures, seminars, films, and art exhibits at the University Museums. A polar course also was offered at UD’s Academy of Lifelong Learning.

Organized by a University committee led by Nelson and Lesa Griffiths, associate provost for international programs, and co-sponsored by the American Geographical Society (AGS), the series collectively attracted thousands at events and via Webcasts, simulcasts into UD Second Life, and an interactive Web site at www.udel.edu/research/polar/, which includes an overview of UD polar research activities.

The series kicked off with the signing of the AGS Fliers’ and Explorers’ Globe, containing the signatures of over 75 famed explorers, from Robert Peary to Neil Armstrong. On an appropriately icy evening, U.S. Coast Guard Capt. Lawson Brigham added his name, as the first to navigate the ocean’s polar extremes, from Antarctica’s Ross Ice Shelf to the North Pole.

As Brigham spoke at the Roselle Center for the Arts, pictures of the icebreaker Polar Sea barreling its way through five-foot-thick ice at the North Pole were projected, along with polar bears that he had been told wouldn’t venture that far north, and a whale that pushed its head through the ice to take a look at the crew.

The series culminated with an AGS awards ceremony honoring the past and looking to the future of polar research. Gold medals were awarded to the late Matthew Henson, the African-American explorer who assisted Robert Peary on the 1909 expedition to the North Pole, and Peter Smith, leader of the Phoenix Mars Mission, which in 2008 confirmed the existence of water-ice in the soil of the Martian Arctic.

UD’s polar explorers work in the Dry Valleys of Antarctica to drifting ice packs in the Arctic Ocean. The Arctic Research Consortium of the United States (ARCUS) recently published a special insert on UD’s polar studies in “Witness the Arctic” available online at www.arcus.org/.

Hole in the ice — watch your step!

Scientists from UD’s Bartol Research Institute are helping to build the world’s largest neutrino telescope, aptly named “IceCube,” deep in the ice near the South Pole. Neutrinos are elusive, high-energy particles that can travel millions of miles through space, passing right through planets.

The telescope’s optical detectors are suspended like beads on a necklace in mile-and-a-half deep holes like this one in the Antarctic ice. It takes a special 5-million-watt hot-water drill two days and 4,800 gallons of jet fuel to melt one hole.

Once frozen in the ice, each detector is sensitive enough to detect a single photon of light, which may be generated if a neutrino slams into an ice molecule as it passes through the ice.

The detectors are designed to capture the flash of light, stamp it with a precise time code, and relay the information to the IceCube Lab, where the particle’s path can be reconstructed and scientists can trace its origins, perhaps to an exploding star or black hole. Learn more at www.expeditions.udel.edu/antarctica/.
Novel airship joins UD’s research fleet

The University of Delaware has one of the most advanced coastal research vessels in the world — the 146-foot Hugh R. Sharp.

Now, thanks to a generous donation from UD alumna Rachel Jewett Ledbetter, who graduated in 1944 with a degree in chemistry, the University has added another remarkable “floating classroom” to its research fleet: an airship.

Believed to be the first of its kind in a university setting, the Low-altitude Environmental Analysis Dirigible (L.E.A.D.) is a novel environmental research and monitoring platform for a myriad of studies.

The airship, dedicated in May, is expected to impact thousands of students across four colleges and more than 50 courses at UD, facilitating undergraduate inquiry in disciplines ranging from geography to civil and environmental engineering, urban planning, and agricultural and natural resources, among others.

The brainchild of Michael A. O’Neal, assistant professor of geography, the 60-foot long airship operates via remote control at altitudes of up to 500 meters with instrument payloads of up to 100 pounds. It has an interchangeable payload design, enabling it to be equipped with a variety of imaging instrumentation, including a laser scanner and visible, ultra-violet, and infrared cameras.

“Much of what we do in classroom settings attempts to utilize data made publicly available by other institutions or agencies,” O’Neal says. “LEAD transforms learning in the classroom by not restricting students to such data, but instead allowing them to choose the type, extent, and resolution of data collected for their particular need — an unprecedented goal for any university.”

Depending on the instrumentation used, researchers have the capability to capture data and analyze land-use and land-cover change, transmitting answers to black duck decline

Once the most abundant ducks in eastern North America, black ducks have declined to as few as 188,000 on traditional wintering grounds.

Kurt Anderson, a master’s degree student in the College of Agriculture and Natural Resources who is a biologist at Ducks Unlimited in Delaware and New Jersey, is working with wildlife biologists there and at several federal and state fish and wildlife agencies to find out why.

“We know a little bit about the fall migration of black ducks thanks to banding efforts and harvest data, but we know even less about the timing of spring migration, their migration routes, and habitat use patterns on stopovers,” says Anderson.

Anderson is outfitting female black ducks with satellite transmitters to learn more about the conditions they encounter during spring migration, which is critical to their reproductive success. The ducks are trapped, measured, weighed, given federal leg bands for traditional tracking purposes, and then outfitted with a harness and solar-powered satellite transmitter, almost like a little backpack.

Mature hens with a body weight of over 1,000 grams are selected, with the harness and transmitter adding only 38 grams. After second year (ASY) females are selected, Anderson says, because of their importance in population dynamics and familiarity with migration routes. Waterfowl will often return to the same location they were born to reproduce, sometimes even to their same nests.

During the past two winters, 68 black ducks have been outfitted with satellite transmitters through the collaboration of UD, Ducks Unlimited, the U.S. Fish and Wildlife Service, and state fish and wildlife agencies in Delaware, New Jersey, New York, Ohio, and Virginia. You can follow the ducks on the Ducks Unlimited Web site at www.ducks.org/Conservation/BlackDuckStudy/3415/FollowtheDucks.html.

“This project has been a unique collaboration of state, federal, and private partners,” Anderson says. “We hope to offer further insight into the reasons behind the decline and provide habitat recommendations for wildlife managers throughout the black duck’s entire range.”
geomorphology, climate variability, coastal processes, landfill chemistry, and a variety of other environmental phenomena.

“The blimp will offer us a wonderful opportunity to fly over large sections of the coast every six months or so and note changes, at a much lower cost than renting a small plane each time,” says Jack Puleo, assistant professor of civil and environmental engineering.

One of Puleo’s interests lies in using LIDAR (Light Detection and Ranging) equipment to generate topographic maps of Delaware’s coastline so that he can assess dune height variability and beach erosion.

Research using the airship is already under way with funding from Kent County and the University of Delaware Research Foundation. In addition to the purchase of the airship itself, enabled by Mrs. Ledbetter’s donation, the colleges of Arts and Sciences; Earth, Ocean, and Environment; and Engineering provided funds for accessories, including the 20-foot trailer used to transport the airship when deflated.

Rachel Jewett Ledbetter christens UD’s airship. Note the wording on the gondola, with the airship dedicated to the memory of her grandfather, Thomas Tustin Cloward, a proud Delawarean who once worked for the Pennsylvania Railroad. Looking on are UD President Patrick Harker, left, and professors Jack Puleo and Michael O’Neal who led efforts to develop the novel research facility.

UD and Xiamen University establish joint coastal institute

The logo of the new Joint Institute for Coastal Research and Management (Joint-CRM) symbolizes a key objective of the world-class collaboration established by the University of Delaware and China’s Xiamen University (XMU) last summer.

The converging water drops signify the institute’s goal to attract scientists from around the globe to work together to meet common goals in ocean and environmental science.

In its first year of operation, the institute, believed to be the first alliance of its kind established in the field of marine science between China and the United States, has fostered numerous faculty exchanges between its lead partners — UD’s College of Earth, Ocean, and Environment and Xiamen University’s College of Oceanography and Environmental Science. An international workshop on ocean climate change was held in December, a collaborative Web site (joint-crm.org) has been launched, and peer-reviewed journal articles have been written, co-authored by scientists from each institution.

Known as China’s “cradle of marine sciences,” Xiamen University was the first Chinese university to initiate a program in marine science studies. The institution has a reputation for excellence in oceanography and the environment, chemistry, and chemical engineering, as well as the life sciences and the social sciences. The university has 34,000 students and 4,600 faculty and staff.

Similarly, UD’s College of Earth, Ocean, and Environment is a pre-eminent institution for marine and environmental research and policy in the United States. It is home to the Delaware Geological Survey, the Delaware Sea Grant College Program, and the Scientific Committee on Oceanographic Research (SCOR), among other major programs, and operates the 146-foot Hugh R. Sharp, one of the world’s most advanced coastal research vessels, as part of the University-National Oceanographic Laboratory System fleet.

“The past year is only the beginning,” say Deans Targett and Dai in their joint message in the institute’s first anniversary newsletter. “Joint-CRM will continue our efforts to build the best global platforms for scientists, staff, and students from both UD, XMU, and beyond to explore the coastal oceans. We will make our expertise sharable, our collaborations efficient, and our friendships lasting.”

UD President Patrick Harker (left) and Xiamen University President Chongshi Zhu sign a Memorandum of Understanding between the two universities on June 27, 2008.