Construction on three separate projects in Phase IV of the Duke University Wetland Center's Stream and Wetland Assessment Management Park has been completed.

In Spring 2009, DUWC undertook nearly 18 months of construction at the site in a section of Duke Forest near University's West Campus. The Phase 4 site lies along NC Highway 751 just south of the intersection with Duke University Road. The project's goal is to improve stream flow, hydrologic water retention, and sediment prevention. Phase IV will improve water quality and stream habitat across 210 acres of watershed in Durham County.

The restoration of an unnamed tributary of Upper Sandy Creek was done in two installments. Work began in an area north of NC-751 known as Phase IVa, while work on Phase IVb south of the highway began several months later. The creek-deeply incised, eroded, and clogged with sediment-was recontoured, with the channel being reconnected to its floodplain in the surrounding bottomland hardwood forest. Trees removed for the new channel were used as root wads, cover logs, log vanes, and floodplain habitat.

The Phase 4 stream/wetland complex is connected with SWAMP's three earlier phases built between 2004 and 2007: (1) a stream/wetland restoration on another segment of Sandy Creek, (2) a dam and stormwater impoundment, and (3) a natural channel design surrounded by six stormwater wetland cells.

The Durham Soil and Water Conservation District is the project's sponsor and cooperative agency, with funding coming from the North Carolina Division of Water Quality.

The Conservation District is also a partner in the third construction initiative at Phase IV with funding from the NC Clean Water Management Trust Fund's innovative stormwater projects initiative. DUWC's project incorporates a technique known as "anabranching" into the Phase IVa restoration site, where a specially built system of weirs diverts water from the main channel during high-flow storm events, allowing it to flow back over the riparian floodplain in multiple channels.

With Phase IV construction completed, the area is now being used for a number of research projects. Prime among them is the study of the effectiveness of a restoration technique known as anabranching. In traditional stream and wetland restorations, overbank events have often occurred less frequently than might have been the case in natural undegraded systems. In the DUWC anabranching project, small weir structures in the Phase IVa channel will make it possible for researchers to vary both the amount and periodicity of floodplain connectivity to a greater degree than had been previously possible, allowing more contact between the stream and its riparian wetland floodplain. The IVa anabranching site will allow Duke researchers to collect comparative data on the two restoration techniques.
It's hard to believe that it all started so long ago, but it was back in 1998 that I first started thinking about the possibility of restoring wetlands on the Duke University campus. Site surveys done by our ecology class showed that stormwater-laden with pollutants and sediment was pouring out of the City of Durham and the Duke Campus and flowing directly into the reservoir at Jordan Lake, a local drinking water source. The streams and wetlands on and around campus were badly degraded, and at first blush the situation looked hopeless. Still, the University administration agreed to let us develop restoration plans for Duke lands. But where could we find the money to put the plans into action?

Fortunately, in 1996, the State of North Carolina founded the Clean Water Management Trust Fund (CWMTF), a program intended to help reduce pollution, restore streams and wetlands, and purchase land to preserve and sustain our state's environment. Duke applied for and received CWMTF funding, over $750,000 that allowed us to move the project forward. Phase I was a stream and riparian wetland restoration on Sandy Creek near Duke's West Campus. In Phase II, we built a stormwater reservoir and wetland downstream of Phase I. The project became known as the Stream and Wetland Assessment and Management Park-in short, SWAMP. The University dedicated the facility in 2007.

SWAMP had been conceived as not just a means to improved water quality, but as an outdoor laboratory and educational resource. Fittingly, many Nicholas School graduate students taking the wetland restoration courses during these years contributed to the design process and helped focus our efforts, and the students remained active participants as we added Phases III and IV.

Phase III, a treatment wetland built with $160,000 in support from the NC Department of Water Quality, was designed to aid in nutrient removal from the Duke campus. In addition to restoration, we were fortunate to obtain over $350,000 in funds from EPA's 319 program to assess the effects of each additional phase on downstream water quality. In Phase IV, we were able to restore more of Sandy Creek and wetland area connected to a significant portion of Durham County's watershed.

New funds from the CWMTF recently funded our new research effort called anabranching, the creation of a system where streams under high-flow conditions flow back over the riparian floodplain in multiple channels. Work is now underway comparing traditional restoration techniques with anabranching to see which is more efficient to remove sediments and nutrients.

To-date nearly $4.7 million has been spent on building SWAMP and on research at the site, with Duke University contributing $2.5 million. This effort has turned into a real town-and-gown effort, as the Durham County Soil and Water Conservation District, with both county and city approval, has become an active collaborator and co-sponsor for the project.

The future looks bright for SWAMP. Masters and Ph.D. students continue to work on projects that range from turtle, bird and amphibian studies to greenhouse gas losses after restoration. Training classes and tours of the multiple projects at SWAMP are part of our outreach efforts. Many Duke departments from Engineering to Art have held classes at SWAMP. An array of boardwalks, a bird Blind, and trails have been constructed, and a permanent set of educational signs have been added to the trails.

However, SWAMP's greatest long-term contribution may be its successes in nutrient and sediment removal and increased biodiversity. Our recent estimates suggest that nearly 500 metric tons of sediment that would normally flow annually into Jordan Lake are now being retained, mostly in the wetlands. We are reducing nitrate-nitrogen levels in the water by 64% and phosphorus by 28% during storm events. We have observed a threefold increase in the number of macroinvertebrates in the restored streams. Over 100 plant species have been identified, and the number of bird species has almost doubled to nearly 100. Biodiversity at the site has increased dramatically, especially for wetland species.

One can never be sure what the future will bring, but SWAMP will certainly be making a difference in Durham's regional water quality thanks to the efforts of many people and agencies.

—Curtis J. Richardson
Director, Duke University Wetland Center
In 2009, the deeply incised and silted tributary of Sandy Creek in Phase IVa of the Stream and Wetland Assessment Management Park (left) was recontoured and the creek reconnected with its surrounding floodplain (right).

Photos by Mengchi Ho (L) and Neal Flanagan (R)

Left: By early autumn 2011, the Phase IVa restoration site was being repopulated by wetland plants. One of the anabranching weirs can be seen towards the back of the depression by the treeline. Right: One of the anabranching weir gates.

Photos by Mengchi Ho

A complex of boardwalks and signs, a joint project of DUWC and the Durham County Soil and Water Management District with support from the NC Clean Water Management Trust Fund, was completed in November 2011.

Photos by Mengchi Ho
our students at Duke University's Nicholas School of the Environment traveled to Costa Rica during the summer of 2010 to conduct research investigating the health of a 32-acre red and black mangrove forest.

The study was part of the new client-centered group masters project initiative being offered at the Nicholas School.

Derek Fedak, Nina Rodriguez, Adam Spitzig and Marie Windstein spent seven weeks immersed in research and planning at the Flamingo Beach Resort and Spa in the Guanacaste region of northwestern Costa Rica.

Red and black mangroves comprise two of the four mangrove plant families found along the Costa Rican coast. Mangrove forests are an ecosystem valued for the complex and often underappreciated habitat they provide for developing marine and estuarine species, says the students' advisor, Curt Richardson, director of the Duke University Wetland Center and professor of resource ecology. Mangroves also are credited with protecting coastal areas from erosion and other wave action.

The four Nicholas School students worked toward two objectives: conducting a general ecological assessment of a mangrove forest adjacent to the Flamingo Beach Resort, and securing a Costa Rican government-issued Certification in Sustainable Tourism for the resort. Documenting that the mangroves were largely unpolluted was critical to help validate the resort's low impact on the surrounding environment.

Rodriguez's parents Pam and Carlos Rodriguez own the resort and provided a grant that covered the project's costs, including transportation, room and board, and a stipend.

The Rodriguezes also wanted to explore the option of creating an educational boardwalk through the mangroves to help locals and visitors learn more about the importance of mangrove systems.

While Spitzig and Rodriguez tackled the ecocertification paperwork, Fedak and Windstein spent many muddy days in the forest mapping the mangrove system, measuring geochemistry and water quality levels and monitoring vegetation and wildlife.

The team tried to engage the community in their work as much as possible, Fedak said. They organized a community clean-up, amassing more than 60 bags of trash around the forest's edges. He and Windstein also gave a lecture on their research to local middle and high school students, who were so interested in learning about the mangrove system that they offered to conduct additional field projects on the mangroves once the Duke team's work concluded.

"It's reassuring to know we left the mangroves in their hands," said Fedak.

During the 2010-2011 school year, the team used the data they collected during the summer to analyze vegetation health, water and soil quality, and bird species richness. They also identified threats to the forest's health and recommended ways to preserve the mangroves by improving water quality, reducing physical and chemical disturbances, and continuing to engage the community. Richardson says an important aspect of the project was "showing that in fact this is a wonderful mangrove, that it's ecologically very rich in diversity, and that it's an excellent resource for the bay community."

All team members graduated in May 2011. Fedak received the Master of Environmental (MEM) degree in Ecosystem Science and Conservation. Windstein's MEM degree is in Global Environmental Change. Spitzig has MEM and Juris Doctor degrees, with an MEM concentration in Ecosystem Science and Conservation. Rodriguez received her undergraduate degree in Environmental Sciences and Policy, earning independent study credits for her part in the project.

For more information on the Nicholas School's client-centered group masters project initiative, visit online at http://www.nicholas.duke.edu/people/students/advising/groupmp/client-centered

Left: Nicholas School students Derek Federer and Marie Windstein talk about their mangrove research with students at the La Paz School as part of the project's community involvement.
Right: Marie Windstein paddles through the Flamingo Mangroves as she collects data for the vegetation survey.
Among the many functions and values imparted by the Duke University Wetland Center's (DUWC) Stream and Wetland Assessment and Management Park (SWAMP), none is more broadly appreciated by Durham residents and the Duke community than its aesthetics. Every day hundreds of walkers, joggers and nature-lovers visit SWAMP via the popular Al Buehler Trail, which features newly added boardwalks and a blind for convenient nature observation. However, the SWAMP is not just a boon for bird watchers but also for the communities of birds themselves, according to a study by the DUWC.

Bird identification experts Scott Winton and Randy Neighbarger of the DUWC have arisen at dawn to brave frigid winter mornings or summer chiggers and poison ivy to stand quietly at the edges of streams, watching and listening for signs of bird life. Binoculars are an important tool, but more valuable is an extensive knowledge of local bird calls. In a forested setting such as SWAMP where leaves and branches obscure vision, most of the bird identification is done by ear.

Each morning the pair recorded bird observations for ten minutes at seven different streams. Some streams are located within SWAMP and are in various stages of regeneration following disturbance caused by heavy machinery during separate phases of restoration, completed from 2004 to 2010. Others are reference streams that have not been restored, but are contiguous with or adjacent to SWAMP. Counts were repeated for four mornings each summer and winter of the two-year study to generate a robust set of data.

Comparison of 10-minute point count results from sections of stream within SWAMP to those of nearby urban streams that have not undergone restoration indicate that the breeding bird communities in SWAMP are significantly more species rich than reference streams. The data also show that winter communities in SWAMP may have twice the bird density compared to those of nearby non-restored urban streams.

Restored streams of SWAMP are also home to many wetland-associated species, such as Green Heron, Acadian Flycatcher, Louisiana Waterthrush and Red-shouldered Hawk, which are not commonly found in urban stream systems. These birds are harbingers of success. In some ways the ultimate judges of the effectiveness of a restoration project are the feathered inhabitants who call it home.

Wetland birds contribute aesthetic value to any wetland restoration. But they may also correlate with other factors, such as hydrology, water quality and vegetation, which are more typically used as barometers of success in restoration studies. Regardless, the data indicate that, from the birds’ perspective, restoration of urban streams in SWAMP is a success.

Winton, a doctoral student, presented preliminary results from the study at the Society of Wetland Scientists South Atlantic Chapter annual meeting at the United States Geological Society headquarters in Reston, VA last spring.* He is currently conducting a field study on emission of trace greenhouse gases from a constructed mitigation wetland in Virginia.

DUWC is also compiling a complete checklist of bird species reported at SWAMP. To date, observers have reported approximately 100 species. The checklist can be found online at www.nicholas.duke.edu/wetland/swampbird.html. SWAMP is listed as a birding hotspot on the citizen science website eBird.org.

* R. Scott Winton, Randy L. Neighbarger, and Curtis J. Richardson. The effects of urban stream and riparian restoration on summer and winter avian populations. Society of Wetland Scientists Regional Meeting, Reston, VA, March 8, 2011.
Duke and Durham County Host Wetland Education Workshop

On June 23, 2011, the Duke University Wetland Center and the Durham County Soil and Water Conservation District (DCSWCD) hosted a workshop featuring the wetland curriculum WOW! The Wonders of Wetlands developed by Environmental Concern, Inc., a non-profit organization based in St. Michaels, MD. The workshop, intended primarily for K-12 educators, docents, and public outreach workers, focuses on multidisciplinary activities in lesson plan format, extensive background information on wetlands, ideas for student action projects, and a wetland resource guide.

Environmental Concern workshop facilitators Kaitlin Frase and Susan Sanger led the participants in classroom activities in Duke's Levine Science Research Center and in hands-on outdoor activities at DUWC's Stream and Wetland Assessment Management Park.

The workshop was a component of DUWC and DCSWCD's Innovative Stormwater Project funded by the North Carolina Clean Water Management Trust Fund. Wetland Center members Dr. Neal Flanagan and Dr. Randy Neighbarger and Durham County representatives Lisa Marochak and Jennifer Brooks represented the host organizations.

More information on the Environmental Concern education program can be found at their website, www.wetland.org.

2010-2011 Publications by Duke University Wetland Center Researchers


2010-2011 Conference and Workshop Presentations by Duke University Wetland Center Researchers

Curtis J. Richardson


Is phosphorus the ultimate limiting factor for microbial communities? Society of Wetland Scientists Annual Meeting, Prague, Czech Republic, July 3-8, 2011.

Plant community shifts and successional trends in a restored urban wetland stream complex. Society of Wetland Scientists Annual Meeting, Prague, Czech Republic, July 3-8, 2011.

The restoration of Iraq's marshes. Invited Seminar Presentation, South Dakota School of Mines and Technology, Rapid City, SD. September 15, 2011.

Jonathan Bills
The impact of urban stream restoration on water quality and greenhouse gas emissions in an urban watershed. Society of Wetland Scientists Regional Meeting, Reston, VA, March 8, 2011.

Neal E. Flanagan


Wyatt Hartman
Distribution and dynamics of microbial polyphosphate accumulation in wetland soils compared to terrestrial and aquatic ecosystems: a 31P NMR study. Society of Wetland Scientists Regional Meeting, Reston, VA, March 8, 2011.

Mengchi Ho

Vegetation dynamics and succession outlook in a restored urban wetland complex. Society of Wetland Scientists Regional Meeting, Reston, VA, March 8, 2011.

Amani McHugh
Assessing college campus water management. Society of Wetland Scientists Regional Meeting, Reston, VA, March 8, 2011.

Scott Winton
The effects of urban stream and riparian restoration on summer and winter avian populations. Society of Wetland Scientists Regional Meeting, Reston, VA, March 8, 2011.

Poster Presentation: The effects of urban stream and riparian restoration on summer and winter bird populations. Society of Wetland Scientists Annual Meeting, Prague, Czech Republic, July 3-8, 2011.

Wyatt Hartman received his Ph.D. at the Nicholas School graduation ceremony on May 14, 2011. Hartman earned his degree with the dissertation "Microbial Phosphorus Cycling and Community Assembly in Wetland Soils and Beyond." During his time at Duke, Hartman was awarded the Nicholas School Dean's Award for Outstanding Graduate Student Paper. The article*, based on research related to Hartman's dissertation topic, appeared in The Proceedings of the National Academy of Sciences. During Fall semester 2011, Hartman is teaching the Nicholas School's graduate course


Photo left. A gowned Wyatt Hartman poses with DUWC Director Curtis Richardson during Duke’s 2011 commencement exercises.
The Graduate and Professional Student Council Campout is a regular tradition at Duke. During a fall weekend, graduate students queue for the chance to purchase tickets to Duke basketball games, literally camping out in tents for 2 nights to hold their place in line.

On September 17, a group of Campout grad students took a break from their tents to perform volunteer service at the Wetland Center's Stream and Wetland Assessment Management Park (SWAMP).

Led by DUWC Ph.D. student Scott Winton and Research Associate Dr. Mengchi Ho, the students learned about invasive plant species that crowd out desirable natives, and they worked to eradicate some of the nuisance plants near the new SWAMP boardwalks and birdblind.

The Campout group is one of a number of university and community volunteer organizations that have supported the SWAMP project.

Photo by Mengchi Ho

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