GROWING TOGETHER

NORTHWESTERN AND THE CHICAGO BOTANIC GARDEN HAVE TEAMED UP TO EDUCATE GRADUATE STUDENTS IN PLANT BIOLOGY AND CONSERVATION — AND TO PROTECT ENDANGERED PLANTS AND ECOSYSTEMS FOR FUTURE GENERATIONS TO ENJOY.

by **Stephanie Russell**

Monarch butterflies take in nectar on a sawtooth sunflower on the Dixon Prairie at the Chicago Botanic Garden.

IN THE FIRST DAY OF CLASS last September, the newest crop of graduate students in the Northwestern–Chicago Botanic Garden Plant Biology and Conservation program headed down Lake Shore Drive for a field trip to Chicago's Montrose Harbor. "We looked at the active beach restoration that's taking place at Montrose," says master's student Wes Glisson, "to learn which species of plants had returned on their own and how well the planted ones were doing."

One of the plants they observed was Pitcher's thistle, a threatened native species with fuzzy leaves, creamy pink or cream flowers and a 6-foot taproot. The thistle grows along the beaches and grassland dunes of the western Great Lakes but is on the verge of extinction because of residential, condominium and marina development and recreational activities. Climate change is also an emerging threat to the species. The thistle had disappeared from Illinois beaches in the early 1900s but was reintroduced on Montrose Beach with seeds from Round Lake, Mich.

The good news is that Pitcher's thistle is making a comeback, thanks to the efforts of the Chicago Botanic Garden's Plants of Concern (a citizen scientist monitoring program) and countless volunteers, students and research scientists. Its growth and spread at the Montrose Beach dunes is a small victory for conservationists and the beach; the plant helps prevent beach erosion and colonizes the sand dunes to attract other native plants and pollinators and birds.

Conserving endangered plants and restoring them to sites where they once lived is a long-term challenge — and the type of work for which the Chicago Botanic Garden and Northwestern are educating a new generation of plant biologists and conservationists.

"BY 2050 WE EXPECT UP TO 30 PERCENT OF PLANT DIVERSITY IN THE WORLD COULD BE LOST."
— NYREE ZEREGA

ALL LIFE DEPENDS ON PLANTS

"Without plants we wouldn't be able to sustain most forms of life," explains Nyree Zerega, director of Northwestern's Graduate Program in Plant Biology and Conservation. "Plants supply oxygen, food, building materials and medicines."

Biologists believe that climate change puts plants in grave danger. "By 2050 we expect up to 30 percent of plant diversity in the world could be lost," says Zerega. "That is truly a global tragedy."

"The projection is that it's not only going to be hotter overall, but there could be intermittent cold snaps," says Greg Mueller, vice president of academic and scientific programs at the Chicago Botanic Garden. "And it's probably going to be wetter, with more heavy downpours interspersed with drier periods."

Which means that native plants could face a tougher time adjusting to new environmental conditions and invasives could literally have a field day, spreading profusely as conditions benefit their growth in the changing climate.

That is why conserving plants and restoration of plant habitat has been a major focus at the Chicago Botanic Garden for more than two decades. And why the Garden and Northwestern University partnered together in 2004 to help train scientists to understand and address the threats facing plants and ecosystems.

Today more than two dozen graduate students are enrolled in the Northwestern–Chicago Botanic Garden master's and doctoral programs in plant biology and conservation. Their research ranges from studying invasive plants to understanding how wetlands can help reduce nitrogen runoff from farm fertilizers to learning how to restore tallgrass prairie ecosystems to conservation of diversity in tropical tree crops.

Classes are held on the Evanston campus and at the Garden. Because of the interdisciplinary nature of conservation work, students get a strong grounding in ecology, genetics, evolution and sustainability, as well as take classes in anthropology, Earth and planetary sciences, biology, economics, environmental policy and culture and environmental engineering.

THE ROOTS OF THE NORTHWESTERN–CHICAGO BOTANIC GARDEN PARTNERSHIP

The Northwestern–Chicago Botanic Garden plant biology and conservation program owes its roots to a dinner party hosted by Morris Kaplan (EB35) and Dolores Kohl Kaplan at their Highland Park home in 2003. Dan Linzer, newly named dean of Northwestern's Weinberg College of Arts and Sciences, was seated near Barbara Carr, then president and CEO of the Garden.

PROFILE REBECCA TONIETTO

The Buzz on Rooftop Gardens

Rebecca Tonietto (G09) has spent the past two summers chasing bees on rooftops and in parks throughout Chicago. Working jointly with the Chicago Botanic Garden and Northwestern, she is conducting the first bee study on green roofs in North America. Her study also examines prairies and parks throughout the Chicago area. So far, her evidence indicates that bees can exist and even thrive in human-dominated landscapes if the habitat is right.

Chicago leads the nation in green roofs, with 4 million square feet as of a year ago. The number keeps going up rapidly, partially thanks to programs introduced by Mayor Richard M. Daley that waive consulting fees and expedite building permits for green buildings.

Tonietto's urban study sites include the top of Optima Views condo in Evanston, the roof gardens at the Chicago Botanic Garden's new science center, Peggy Notebaert Nature Museum in Lincoln Park, the CTA headquarters and the green roof at the Joffrey Tower in Chicago. Green roofs, prairie restoration areas and landscaped native prairie plantings within traditional parks, all features of Chicagoland's urban green spaces, have proven to make successful habitats, unlike the standard lawn that covers many parks.

Rebecca Tonietto nets a bee.

PRINCIPAL PHOTOGRAPHY BY ROBIN CARLSON/CHICAGO BOTANIC GARDEN

A bumblebee lives the high life on a rooftop garden.

"One in three bites of food you eat is thanks to bee pollination," says Tonietto. "Virtually any grown food that is not a grain relies on bees." According to the USDA, bee pollination is currently a $15 billion industry. Both rural and urban areas have seen a steep decline in bee populations. "Previously ubiquitous species, you just can't find them now," says Tonietto. "Native prairie and native plants are needed, otherwise pollinators simply don't exist."

Contrary to the hives one might expect, most bee species live solitarily, in holes in the ground — and will continue to do so even if that "ground" is 15 stories in the air.

Despite the decline of the overall population, Tonietto collected a native Midwestern bee never seen in Illinois before, as well as the first find in the Midwest of a European bee that recently spread across New York City's community gardens. She also logged three other first records for Illinois.

Tonietto, a doctoral student in the Northwestern–Chicago Botanic Garden plant biology and conservation program, came to her current project in a roundabout way. After graduating with a degree in biology from Kalamazoo College, where she did a thesis investigation of aquatic insect responses to large predators in ponds, she switched to dryland insects "to avoid the mosquitoes" and got "hooked on bees" as a research assistant at Princeton. The same pursuit brought Tonietto to the Chicago Botanic Garden. When Northwestern started a partnership degree program with the Garden in 2005, Tonietto applied. Having finished her master's, she was one of the first two doctoral students to enter the program in 2009.

"The study is a way to show green space utilized by native species of bees. The city's not uninhabitable, and it gives them options for places to be. Urban green space that's not turf grass is exciting." As for the apparent downsides of her job, she's been "stung in the past, but never on this project." — *Kent Cubbage*

"Barbara explained how she wanted to transform the Garden into a research garden that contributes to conserving plant species that are rapidly disappearing around the world," says Linzer. "My reaction was that, in order to develop that kind of strength as a research institution that would also train the next generation of scientists in this area, you would have to create a partnership with a university."

The two exchanged business cards. Linzer recalls that Carr later told him she expected that their conversation would go no further.

Joe Gawronski-Salerno (G08) and Chicago Botanic Garden scientist and Northwestern adjunct professor Louise Egerton-Warburton take soil samples among goldenrod under a bur oak tree at the Garden.

But Linzer called Carr to follow up and invited her and some of her leadership team to Northwestern to discuss the creation of a new program in plant biology and conservation.

Linzer saw the program with the Garden "as a great opportunity for Northwestern to team up with a world-class institution that would add distinction to a University academic program." A joint program would also enable the University to offer students classes in conservation biology and ecology, which had been lacking since the ecology and evolutionary biology department was phased out in 1988.

In 2004 the two institutions created a new graduate program — the nation's first master's degree in plant biology and conservation. The inaugural class entered in 2005, and the collaboration led to a doctoral program in 2009, also the first of its kind in the United States. While such partnerships exist between other universities and botanic gardens in the United States, notes Zerega, "this program is unique in its strong focus on plant, as opposed to animal, conservation. And although many people may not realize this, Chicago is a very active place for conservation and restoration research, providing tremendous opportunities for students."

THE RICE PLANT CONSERVATION SCIENCE CENTER

Northwestern and the Garden decided that offering a doctorate in plant biology and conservation was the next logical step as the first graduates of the master's program enjoyed success in pursuing careers in the field — going on to work for places such as the Environmental Protection Agency and the Illinois Department of Natural Resources, or to enter top-notch doctoral programs at other institutions.

With the growth of the master's program and the addition of doctoral students, there was a great need for more lab facilities. Fortunately, the Garden opened the Daniel F. and Ada L. Rice Plant Conservation Science Center in September 2009, just in time to house the incoming master's students and the first cohort of doctoral students. The 38,000-square-foot, state-of-the-art green building features nine laboratories, a herbarium, a seed bank, a 16,000-square-foot rooftop demonstration garden and an interactive visitors gallery, where guests observe scientists at work in the labs.

The Garden's staff of 31 full-time scientists and research assistants is able to provide mentorship on research addressing plant conservation problems caused by climate change, habitat loss and fragmentation, invasive species and pollution.

BANKING ON SEEDS FOR THE FUTURE

One of the most important conservation projects under way at the Garden is the Dixon National Tallgrass Prairie Seed Bank and laboratory housed at the Rice Center. The seed bank is part of Seeds of Success, a national coalition of efforts to collect, bank and preserve seeds for current and future conservation work in North America. Coordinated by the Bureau of Land Management, Seeds of Success intends to collect 14,000 native plant species in the United States.

The Garden's focus in that effort is the tallgrass prairie region from the Midwest to the Great Plains, explains Mueller. Habitat fragmentation has reduced the tallgrass prairie to less than 0.01 percent of its former range, making it one of the most endangered ecosystems in the world.

Between 2003 and 2010, Garden scientists, students and volunteers collected seeds from native species across the Midwest, a flora of 1,500 that includes more than 800 tallgrass prairie species. Back at the science center, volunteers document, clean and dry the seeds and place them in a walk-in deep freezer where they can be stored for up to 200 years. Eventually the Garden plans to bank 100 million seeds that will help future generations preserve plant biodiversity and restore natural areas in the upper Midwest.

"We want to germinate the seeds, so we need to know more about seed biology," says Mueller. "And then we want to use the seeds in restoration projects. That means that we have to do much more than just grow them. We'll need to know how seeds will do in different places and in changing climates. We're doing a lot of research to understand the genetic diversity of plants and to see how far away from a seed source a plant will effectively grow."

Pitcher's thistle

Plants and Plans

The Chicago Botanic Garden announced a 10-year strategic plan last spring, but president and CEO Sophia Siskel (KSM99) has a longer-range plan in mind for the Garden's future.

"Here at the Chicago Botanic Garden, we see ourselves as stewards," she says. "We're responsible for stewarding an organization that will be here 500 years from now." She compares it to the Garden of Padova in Italy, which was founded in 1545 and is still in operation. By that yardstick the 39-year-old Chicago Botanic Garden is still just a sapling.

Siskel hopes to keep the Garden growing, increase its educational programs and enable its research scientists to save hundreds of native plants in the Midwest for generations to come. The $250 million master plan she announced last April calls for the creation of a new entrance to the Garden, a children's learning campus, rebuilt greenhouses, reconfigured parking and a miles-long extension to the Cook County Forest Preserve bike-walking path.

Since being named the Chicago Botanic Garden president and CEO in 2007, Siskel has managed a $27 million budget and 500 employees and has presided over the building of the state-of-the-art, $50.9 million Daniel F. and Ada L. Rice Plant Conservation Science Center, expanding the Garden's research and science education programs and putting it at the forefront of plant conservation science.

Though already respected as a teaching and plant science research center, the Garden is now becoming the nation's leading center for training the next generation of scientists, restoration ecologists, land managers and policymakers, thanks to the creation of the joint plant biology and conservation master's and doctoral programs with Northwestern University in 2005 and 2009, respectively.

Siskel credits Northwestern University provost Dan Linzer (then dean of the Weinberg College of Arts and Sciences) and her predecessor, former Garden president and CEO Barbara Carr, for their vision in developing the joint program.

"The partnership speaks volumes about our Midwestern sensibility, the way this relationship has grown and flourished," she notes. "What's so nice about the Chicago Botanic Garden–Northwestern partnership is that it not only benefits our institutions beautifully, it benefits the world. These botanists and conservation biologists could not get this training anywhere else."

When she first took the helm, Siskel was charged with building the Garden's reputation as a leader in hard science, not just as a place with pretty flowers.

"We were struggling as an institution with the concept that people thought the Garden was just another pretty place," explains Siskel. "Then we invested in plant science, and it's wonderful. Now we say, 'Yes, we're a really pretty place, but we're also a smart, important place.' We can be both."

Siskel worked as vice president of exhibitions and education at Chicago's Field Museum and as an assistant curator at the Museum of Contemporary Art before joining the Garden as vice president of visitor programs and operations in 2006.

A committed gardener herself, Siskel is passionate in her belief in the transformative nature of plants.

"The world will go on without us," she concludes. "But for us to exist on Earth happily, we need to save the Earth's plants. All life depends on plants, not just to satisfy basic needs but for beauty, for joy, for inspiration, for our health, for bringing our families together, for work, for jobs.

"For it is with this connection to nature that we can bring out the best in ourselves." — *S.R.*

Sophia Siskel, Chicago Botanic Garden president and CEO, at the Garden's Evening Island

"Incubators allow us to grow plants under different temperatures and light conditions and even in different humidities and CO_2 levels," continues Mueller. "But plants don't grow in isolation; they grow in competition with other plants. We can set up different growing conditions based on climate change predictions in these incubators, so we can see how plants respond to different scenarios. That info gets fed into a new geographic information system, so you have all these data layers. We can shift the climate model and say, 'OK. Where is that climate going to be 50 years from now?' So with Pitcher's thistle, we see it up in Michigan but not in the same soil."

PRAIRIE RESTORATION AND RESEARCH

While scientists build the seed bank, outside the building's doors lies a living plant museum where graduate students and the public alike can observe many plants native to the Midwest.

The Chicago Botanic Garden, which opened 39 years ago in Glencoe, Ill., just north of the Skokie Lagoons, encompasses 385 acres of formal gardens, native woodlands, wetlands, lakes and the Dixon Prairie, a 15-acre re-creation of six distinct prairie ecosystems that once existed in Illinois.

On a late summer day on the Dixon Prairie, native prairie grasses, goldenrod, compass plant and butterfly weed dance in the breeze.

Graduate student Kate Gallagher is studying three warm-season prairie grasses — big bluestem, sideoats grama grass and Indian grass — for her master's project on the role of seed origin in prairie restoration success at several sites in Minnesota. These perennial, long-lived prairie plants are dominant components of the prairie ecosystem and are widely used in restoration projects.

"All three of these species are present in the Dixon Prairie," says Gallagher. "So when I needed to know how to clean the seeds and how to overwinter and plant them, I could just walk across the hall at the Rice science center to ask the experts.

"The Dixon Prairie is a beautiful re-creation," she continues, "with hundreds of diverse plant species supporting a huge variety of insects, birds and mammals. It's such a success. I want to know why. Walking through the prairie is a reminder of what all the numbers I stare at all day mean. They represent the answer to my question: Does seed source matter?"

Much of the research that Northwestern graduate students undertake deals with the hard science of what's happening in the habitat — below ground, in the soil and in waterways. And that means mucking about wetlands, through thick woodlands and overgrown fields.

Rachel Gross (G08), a graduate of the master's program, researched the impact of prescribed fire on the soil of tallgrass prairies. "Fire is an agent of ecosystem change that has played a critical role in shaping present-day tallgrass prairie," she explains. "I looked at six prairies in the Chicagoland area that had different fire frequency management histories." After taking soil samples at the sites and checking nutrient levels and microbial diversity, Gross discovered that nitrogen levels were lower in sites that had regular burns and that grasses of the tallgrass prairies do better where there's less nitrogen available in the soil.

Master's program graduate Glen Madeja believes that the horticultural industry should create a labeling program for invasive plants.

Paul Hartzog, a current doctoral student, is conducting research on the restoration of degraded wetlands at sites in Wisconsin and Illinois, including Illinois Beach State Park in Zion. His work focuses on denitrification, the microbial process that converts inorganic forms of nitrogen (used in fertilizer) to harmless gaseous nitrogen that is released into the atmosphere.

"Fertilizer use and runoff in the Mississippi River system is the biggest contributor to dead zones and algae blooms in the Gulf of Mexico," notes Hartzog. "Wetlands are really good at supporting denitrification. I'm trying to determine which factors will help predict which wetlands are better at denitrification."

INVESTIGATING INVASIVES

Several graduate students are tackling the burgeoning problem of invasive plants in Midwestern habitats.

Doctoral student Lauren Umek (G07) has been researching a particularly thorny issue: the ecological impact of European buckthorn invasion on Midwestern woodlands and the tallgrass prairie as well as habitat restoration techniques.

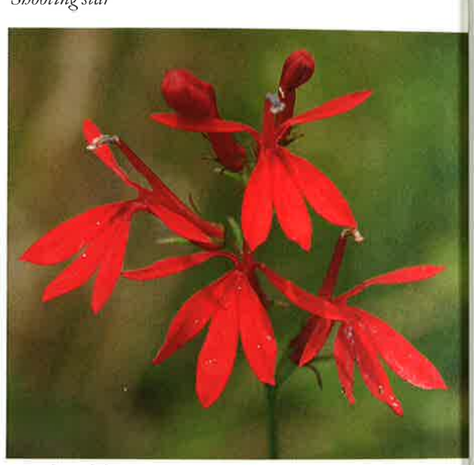
"Buckthorn was brought over from Europe as a horticultural hedge around the early 1800s," says Umek. "This invasive has become the most common woody plant in the Chicago area. You can chop it down, but it often comes back. And once it invades an area, we're finding that it makes a lot of changes to the ecosystem; restoration has mixed success."

One of Umek's research sites is in an old horse pasture on the Whippoorwill Farm Preserve in Mettawa, Ill., just west of Lake Forest. It was full of buckthorn. "The one

COVER STORY

Wild bergamot and yellow coneflower thrive on the Chicago Botanic Garden's Dixon Prairie, a 15-acre re-creation of six prairie ecosystems that once existed in Illinois.

Shooting star



Royal catchfly

Bottle gentian

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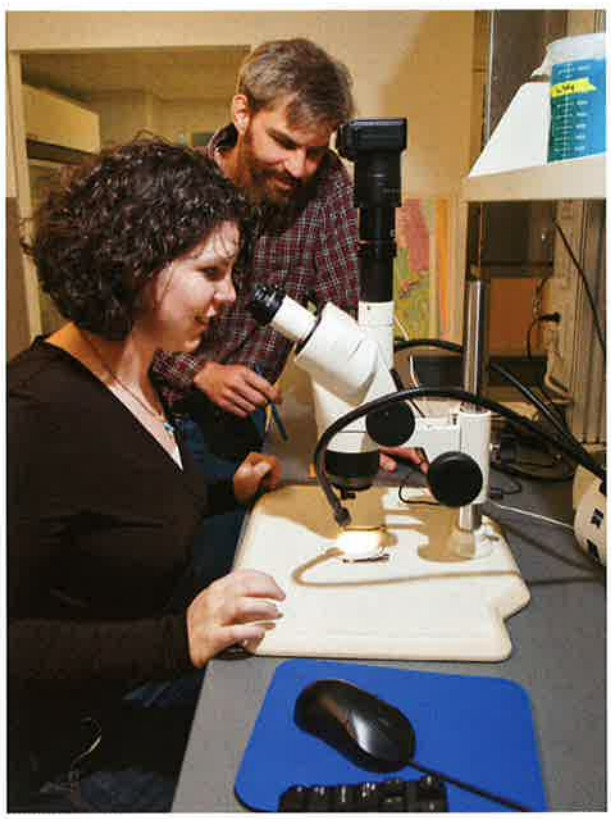
method that seems to be working so far, and where the native plants are starting to come back," she says, "is where we cut down the buckthorn, then rototilled mulch into the soil, so we're changing the soil and disturbing mini-buckthorn seedlings."

Glen Madeja (WCAS77, KSM82, G10), who earned his master's degree in the Northwestern–Chicago Botanic Garden graduate program last year, conducted five years of research on the ornamental grass miscanthus. There's increasing consensus among plant biologists that the grass should be considered an invasive because it has invaded and been naturalized in native plant communities in many areas of the United States.

"Miscanthus grows well in the southeastern United States," says Madeja, who lives — and gardens — in Evanston. "Our climate in the Midwest is getting warmer, so there's the potential for miscanthus to take off here. The city of Chicago is now thinking about putting miscanthus on its invasive list."

"GARDENERS ARE CARERS. IF YOU CAN PUT THE ISSUE OF INVASIVE PLANTS OUT IN FRONT OF GARDENERS, THEY WILL RESPOND."
— GLEN MADEJA



Master's student Kate Gallagher looks at a pollinator in the population biology lab at the Garden's new Rice Plant Conservation Science Center as Garden scientist and Northwestern adjunct professor Stuart Wagenius observes.

But the plant is sold in garden centers everywhere — with no indication of its invasive habit.

"The conclusion of my thesis was that the horticultural industry needs a labeling program," says Madeja, a Kellogg School of Management graduate who spent 25 years in the business world before enrolling in the plant biology and conservation program. "You have to educate the consumer at the point of purchase."

He is now considering the launch of a pilot program to label invasive plants sold in stores to help consumers better understand the environmental risks of placing such plants in their gardens.

In the meantime, Madeja is restoring the gardens of Frances Willard's "Rest Cottage" in Evanston, where he serves as head landscaper. He says he's optimistic that as gardeners become more educated about invasives, they'll avoid planting them.

"Gardeners are carers," he says. "If you can put the issue of invasive plants out in front of gardeners, they will respond."

GROWING GRANTS AND HONORS

Last year graduate students Rebecca Tonietto (G09) (see "The Buzz on Rooftop Gardens," page 21) and Kate Gallagher each received the highly sought after Garden Club of America Restoration Ecology Research Award. Only three were awarded in the country.

Tonietto was awarded $8,000 for her research on the effects of prairie restoration methods on native bee populations. Gallagher received the same amount for her study on the role of seed source in plant performance in prairie restorations.

Lauren Umek was honored with the 2010 Conservation and Native Landscaping Award from the U.S. Environmental Protection Agency and Chicago Wilderness for her prairie restoration work in the buckthorn thicket at Whippoorwill Farm.

These awards may be one of the best indicators yet of the growing demand for the type of hard science research that the Northwestern-Chicago Botanic Garden plant biologists and conservationists do.

Of course, the creation of a new academic program is not without its growing pains.

"I was the first person to graduate from the master's program," says doctoral student Umek. "There were a lot of tweaks that needed to be made to the program. Initially I wasn't sure that I wanted to come back for a PhD."

But the opportunity in the program for practical field application of conservation science convinced her to go for it.

"The Northwestern-Chicago Botanic Garden program is one of the few where application in the field is essential to the work," she said. "How we use our knowledge to conserve plants into the future is what's so valuable."

Some students appreciate being in on the ground floor of the startup program.

"Our professors are keen on asking for our input on classes," says doctoral student Hartzog. "It's great to be part of a new program, provide constructive criticism and actually have an impact as a student."

Stephanie Russell is editor of Northwestern *magazine.*

Tell us what you think. E-mail comments or questions to the editors at letters@northwestern.edu.