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Editor's Note

As December comes to a close, many of us reflect on resolutions for the new year. Spending time with our families and improving our health typically top the list, with many of us also striving to live in a more environmentally-sensitive way. Our lifestyle choices affect the nitrogen cycle, resulting in a suite of ecological maladies such as acid rain, ozone depletion, and eutrophication of coastal estuaries. Making informed decisions about energy and food consumption is yet another way that humans can minimize their footprints on the Earth.

With the grounds blanketed in snow, and temperatures approaching the single digits, the IES greenhouse is an antidote to the winter blues. You can't escape to the tropics for the afternoon, but you can indulge in the exotic greenery maintained by David Bulkeley and his staff. The display of orchids, jasmine, and citrus trees will *almost* make you forget that your driveway will need shoveling for three more months. It is free to the public, and open daily from 9:00 am to 3:00 pm with a visitor's permit.

The *IES Newsletter* is published by the Institute of Ecosystem Studies, located at the Mary Flagler Cary Arboretum in Millbrook, New York.

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Excess Nitrogen in the Catskill Forest

Nitrogen is a critically important element for life on earth. It has long been considered the most limiting nutrient for production of agricultural crops and forests, but in recent decades human activities have doubled the availability of nitrogen. As a result, it is now in excess in many places. (See Primer on page 3.) The scientific community is keenly aware of the detrimental effects of nitrogen run-off and leaching from farm fields and feedlots. In these agricultural scenarios, nitrogen loading is concentrated at specific sites, and its effects are visible. Excess airborne nitrogen from fossil fuel combustion, on the other hand, spreads over large areas. Forests, known to be N-limited, were expected to retain this excess nitrogen and keep it out of nearby waters. However, the work of Drs. Gary M. Lovett and Kathleen C. Weathers and other scientists has shown that forests can lose nitrogen, especially in places where deposition rates are high.

Jake Griffin sampling stream water in the Catskills

Due to its proximity to the New York-New Jersey metropolitan region, our area receives high levels of nitrogen oxide air pollution. In collaboration with colleagues at other institutions, Lovett and Weathers are studying how watersheds in the Catskill Mountains and Hudson Valley process the large amounts of nitrogen added to the region's forests. Their research has revealed that "nitrogen saturation," the phenomenon in which forests lose nitrogen to surrounding water bodies, is present in some watersheds but not in others, and they are trying to understand why.

Many of us are familiar with the idea that excess farm fertilization leads to nitrogen-rich agricultural run-off. A similar situation occurs in natural areas that receive high atmospheric nitrogen inputs. When nitrogen inputs exceed an ecosystem's capacity to use or retain nitrogen, the system is nitrogen saturated. If you think of a forest watershed as a sponge, it can only absorb so much nitrogen before "leaking" it into ground and surface waters. Nitrogen losses from watersheds are a double-edged sword, reducing the fertility of forest soils and negatively impacting receiving waters.

Calcium and magnesium, nutrients that are vital for plant growth, are removed from forest soils when nitrogen is leached. When excess nitrogen is deposited into streams, the acidification creates an inhospitable environment for stream biota. Declines in young fish and invertebrates, which play essential roles in aquatic food chains, have been linked to increases in stream acidity. Forest nitrogen loss can also contribute to eutrophication in estuaries and coastal waters, causing dense algal blooms and aquatic vegetation.

Nitrate is the most mobile form of nitrogen in forest ecosystems. Through sampling forest streams in the Catskills, Lovett and Weathers have uncovered that despite similar nitrogen inputs, stream nitrate concentration varies greatly among the sites. Preliminary data suggest that the tree species composition of the watershed has a strong effect on nitrate release. This finding is significant for two reasons: watershed retention of nitrogen buffers water bodies from excess nitrogen inputs, and changes in forest composition due to exotic pests, climate change, or acid rain sensitivity could alter this species-sensitive ecosystem function.

Weathers and Lovett are currently exploring which watersheds are most efficient at retaining nitrogen inputs, and for how long. Using nitrogen tracers, which help determine the "fate" of nitrogen inputs, they are testing the nitrogen holding capacity of single-species plots. Initial findings show that forests dominated by sugar maple leak more nitrogen than oak or beech dominated forests.

The discovery that species have different nitrogen retention rates is important because forest pests, such as beech bark disease, can dramatically alter forest composition. Understanding what regulates nitrogen saturation in the Catskills, which provide 90% of New York City's drinking water, is of interest to ecologists, land managers, and policy makers.

For a Primer on Human Inputs to the Nitrogen Cycle, *see page 3*

SEEDS: Out of the Nursery and into the Field

As the first young scientists influenced and aided by SEEDS (Strategies for Ecology Education, Development and Sustainability) complete their graduate studies in ecology, the program continues to grow in impressive ways. After six years of nurturing at IES, SEEDS is ready to be housed fully within the Ecological Society of America's new Department of Education as one of its major initiatives.

Melissa Jurgensen-Armstrong

(R-L) Brandi McClain (Alcorn State University), Melody Sipp (Rust College), Shameca Wilson (Rust College), Yoby Allen (Alcorn State University), Sundra King (Rust College), and Doris Wilson (Rust College) on a SEEDS field trip to the Great Smoky Mountain National Park

Funded by The Andrew W. Mellon Foundation, SEEDS started as a collaboration between the United Negro College Fund (UNCF), the Ecological Society of America (ESA), and the Institute of Ecosystem Studies (IES) to increase the number of African American undergraduates pursuing scholarship in ecology. Leadership roles were assumed by Dr. Alan R. Berkowitz, Head of Education at IES, and Mr. Daniel Durret, the Director of the UNCF's Department of Environmental Education Programs. The program took on the challenge of minority recruitment in two areas – developing infrastructure for ecology at Historically Black Colleges and Universities (HBCUs), and making the field of ecology more accessible to diverse populations.

Dr. Berkowitz has a passion for building diversity in the field of ecology. In his own words, "More and more, ecology is being called upon to link with and embrace the social sciences and the human dimensions of ecosystems. How can we do this when our ranks are overwhelmingly dominated by people from just one segment of the American family? We need the fullest of palettes to paint a vivid and compelling environmental future for our land and people. This is, perhaps, the greatest challenge we face in ecology today." In 1996, while serving as the Vice President for Education and Human Resources of the ESA, Berkowitz turned his passion into action by joining forces with other ecologists and educators to create SEEDS.

The path to racial equity in the sciences has been a steep one. Throughout this century racism has directly hampered minority advancement in science. In 1962, Southern University entomologist Dr. Leon R. Roddy expressed his concerns about minority science recruitment in *Ebony Magazine*, pointing out that many schools serving African Americans were not adequately prepared to teach science due to a lack of infrastructure. For students to achieve in the sciences, he asserted, they needed stimulating coursework, mentors they could relate to, and confidence in the career possibilities that await them.

America's HBCUs have strengthened their science programs significantly in the last forty years. Minority students attending HBCUs are more likely to pursue advanced degrees in the sciences than students attending majority institutions. However, the biology curriculum at many HBCUs focuses on medical sciences, with few options for pursuing ecological and environmental career paths. This lack of ecological coursework, coupled with family expectations and students' desire to give back to their communities in familiar ways, results in many talented science students at HBCUs choosing human health related careers. As a result, African Americans make up a smaller portion of the environmental science workforce than in any science. For instance, they comprise less than 0.5% of the 7600 members in the Ecological Society of America, our nation's largest ecological professional association.

The absence of diversity in the ecological and environmental sciences is especially sobering in light of the environmental burdens faced by minorities in the U.S. The effects of polluted air and water, a lack of green space, and toxic contamination from chemical plants disproportionately affect minority groups. Rising asthma rates and decreasing access to potable water are mounting concerns. Now, more than ever, minority leaders are needed to help forge solutions to these injustices. In the words of Dr. Mike John of Bethune-Cookman College, educators need to "remove the mind-set of apathy brought on by years of minority disenfranchisement from the environmental movement and replace it with the ecological awareness that would make students see the necessity of taking ecology in the first place."

SEEDS set out to develop undergraduate ecology courses and leadership at HBCUs by building capacity in unique ways at each of the 14 participating schools. Curriculum development, teaching workshops for faculty, and student opportunities in ecology were at the heart of the program. By focusing on individuals and their institutions, the SEEDS program helped schools build the infrastructure needed to sustain minority recruitment in the ecological sciences. Dr. Charles Nilon, a professor at the University of Missouri and chair of the SEEDS Advisory Board, felt this "flexibility allowed schools to come up with strategies that were tailored to meet their needs."

The success of the SEEDS program is reflected in three ways: students pursuing ecology careers, enhanced ecological infrastructure at participating schools, and organizational changes within ESA. Enrollment in ecology courses at SEEDS schools has increased by over 80%, and 36 students are now enrolled in ecology-based degree programs. Students who had never been exposed to the subject were given a foundation to pursue advanced ecological scholarship. In the words of one SEEDS student, "Without SEEDS involvement in my undergraduate experience, the (ecological) experiences and opportunities that I have been exposed to would be nonexistent."

When the program began, only six ecology courses were offered at the participating schools. Today, there are over 75 classes that focus on ecology and five of the schools now have ecology majors or minors: Alcorn State University, Bethune-Cookman College, Florida Memorial College, Howard University

continued on page 3

Nobel Laureate Speaks at IES

(R-L) Dr Gene E. Likens and Dr. F. Sherwood Rowland. Dr. Rowland, winner of the Nobel Prize in chemistry for work on the formation and decomposition of ozone in 1995, presented a seminar on smog at IES. He and his research partner, Dr. Mario J. Molina, were the first scientists to determine that CFC's were depleting the Earth's atmospheric ozone layer. Their work formed the backbone of the Montreal Protocol, the first international agreement aimed at controlling environmental damage. Increased UV-B radiation, a result of depleted protective ozone, can cause skin cancer, cataracts, sunburns, and immuno-supression. Dr. Likens, a long-time colleague of Dr. Rowland, hosted him during his visit.

SEEDS, *from page 2*

and Tuskegee University. Ecology Clubs have been established at all ten of the current SEEDS schools, and over 30 faculty members have engaged in professional development activities through IES and ESA.

Though SEEDS is in its infancy, the program has motivated several significant changes within ESA. Its annual meetings cover a broader array of topics, including the never-before covered issue of environmental justice. A more diverse group of ecologists are serving as ESA mentors, authors, committee members and presenters; and the Society's education programs are expanding to reach out to more minority students. Since SEEDS' inception, ESA has grown in its commitment and leadership in education, now housing an Education Department for which SEEDS will be a major activity in the years to come.

Many of the changes within ESA are attributed to Berkowitz's leadership. In the words of ESA Executive Director Katherine S. McCarter, "Alan's dedication to diversity in the field of ecology was the inspiration behind the SEEDS program. Without his vision and his commitment to the recruitment of minority students, the SEEDS program would not have developed into the successful program it has become. He was responsible for sensing the need for ESA's involvement and for providing the leadership to establish the program. With his nurturing, SEEDS has become a vital and important part of ESA's mission and a key focus for its education programs."

Minority recruitment in the sciences relies on the slow and sustained growth of ecological course offerings, faculty mentors, feasible career opportunities and a welcoming scientific community. SEEDS is committed to meeting these needs. Over the past six years the program has seen tremendous growth, and is now poised to expand on its strong base by reaching out to members of other groups still under-represented in ecology, such as Hispanics and Native Americans. William Robertson, of The Andrew W. Mellon Foundation, views SEEDS as "a successful program that has a bright future ahead of it." ●

Human Impacts to the Nitrogen Cycle: A Primer

As the fourth most common chemical element in plant and animal tissue, nitrogen is an essential building block of amino acids, proteins, and genetic material. Prior to the last century, available nitrogen was scarce and its availability regulated the productivity of many ecosystems. Our growing dependence on nitrogen fertilizer, fossil fuel combustion, and the large-scale planting of nitrogen-fixing crops has resulted in an excess supply of this once-limited resource.

Approximately 78% of our planet's lower atmosphere is made of nitrogen gas (N_2) that is not bio-available due to its unique chemistry. Most plants and animals can only utilize nitrogen when it is found as fixed nitrogen. Nitrogen fixation occurs when atmospheric nitrogen is pulled from the atmosphere and bound to hydrogen or oxygen. Prior to human alterations, most fixed nitrogen came from naturally occurring nitrogen-fixing organisms and lightning.

In a global budget, nitrogen is measured in teragrams (Tg); one Tg is equal to a million metric tons of nitrogen. The rate of natural nitrogen fixation, prior to anthropogenic inputs, was 140 Tg annually. Human modifications have doubled the availability of fixed nitrogen to 280 Tg a year. Industrially-fixed nitrogen fertilizer (80 Tg/yr) is the largest input, with nitrogen-fixing crops (40 Tg/yr) and fossil fuel combustion (20 Tg/yr) also contributing significantly.

During WWI, while working for Germany's weaponry program, chemist Fritz Haber discovered how to converted atmospheric nitrogen (N_2) to fixed nitrogen (NH_3). His Haber-Bosch ammonia synthesis, used to make fertilizer from atmospheric nitrogen, revolutionized farming techniques and paved the way for the Green Revolution.

Legume crops, such as alfalfa, fix atmospheric nitrogen through a bacterium called *Rhizobium* that attaches itself to plant roots. This fixed nitrogen remains in the soil after the legumes are harvested, where it is assimilated by other plants or released in run-off. Fixed nitrogen is now a by-product of the large-scale cultivation of legumes for livestock feed.

Fossil fuel combustion releases atmospheric and fuel-bound nitrogen into the air as nitrogen oxides. These emissions contribute to atmospheric levels of nitric oxide, a precursor to both smog and acid rain.

Effects of excess nitrogen pollution include algal blooms in estuaries and coastal waters, soil and stream acidification, and the loss of nutrients such as calcium and potassium from the soil. ●

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Newsletter

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Calendar

CONTINUING EDUCATION

The Continuing Education Progrram is now accepting winter registrations. For information, or to request a brochure, call 845-677-9643 or visit www.ecostudies.org/education/continuing.html.
Winter semester programs include:

Gardening

January 9(1 Thurs.): **Some Winter Bloomers**
January 18(3 Sat.): **Plant Propagation**
January 23(1 Thurs.): **The White Garden**
January 29(6 Wed. & 2 Sat.): **Introduction to Ecology**

Natural Science Illustration

January 11(4 Sat): **Water Colors in the Greenhouse**
January 17(1 Fri.,1 Sat.,1 Sun.): **Drawing in the Greehouse with Contes and Pastels**

Landscape Design

January 18(4 Sat.): **Principles of Landscape Design**

Workshop

January 25 (2 Sat.): **The Gardener/Garden Designer as Writer**

SATURDAY ECOLOGY PROGRAMS

Come to **free public programs.** Children age 6 and up are welcome with an accompanying adult. Pre-registration isn't necessary. If you have questions, call 845-677-7600 ext. 317 for information on upcoming programs: Programs are from 1 - 3 p.m. and begin at the Gifford House Visitor and Education Center. [Dress according to the weather for the outdoor programs.]
January 25 **Track animals, find tiny winter homes, differentiate between death and dormancy and admire the intricacies of the snow while exploring the wonderful and ecologically rich world of winter. The exploration will be led by Dan Novak, an IES Ecology Education Fellow.**

GREENHOUSE

The Greenhouse is a year-round tropical plant paradise and a site for controlled environmental research. The green house is open daily until 3:30 p.m. with a free permit (see HOURS).

IES SEMINARS

Free scientific seminars are held at 11 a.m. on Fridays in the auditorium from September until early May.
Jan. 24: **Mycorrhizal response to perturbation.** Dr. Amy Tuininga, Fordham.
A schedule for the winter-spring scientific seminar series is available by calling 845-677-7600 ext. 321, or find it on the IES Website (www.ecostudies.org) after January 15.

2003 SPRING ECOLOGY DAY CAMP

The Staff of IES Programs for Youth and Educators is pleased to announce the 2003 Spring Camp. The 2003 Spring Camp is designed for 1st - 3rd graders, and will run April 14 -17 (Mon.-Thurs. of Millbrook's spring break) from 9 a.m. to 3 p.m., with a 4 p.m. late pick-up option. We'll spend as much time outside as the weather allows, exploring, doing scientific experiments, and using games and crafts to learn about the ecology of our region. Call or e-mail Susan Eberth at (845)677-7600 ext. 316 or EberthS@ecostudies.org for more information or to register.

THE ECOLOGY SHOP

New items in the shop! Peruvian gourd boxes and ornaments, nature cookie cutters, tagua nut ornaments, Aurora recycled glass suncatchers, assorted wooden puzzles and toys, and many wonderful plants.
Senior Citizens Days: 10% off on Wednesdays.

HOURS

Winter Hours: October 1 - March 30
Internal roadways and trails closed when snow covered.

Public attractions: Mon.-Sat., 9-4, Sun. 1-4; closed public holidays. The greenhouse closes at 3:30 daily.
The Ecology Shop: Mon.-Fri., 11-4, Sat. 9-4, Sun. 1-4.
(Please note: The shop is closed Mon.-Sat. from 1-1:30.)

Free permits are required and are available at the Gifford House Visitor and Education Center until one hour before closing time.

MEMBERSHIP

Join the Institute of Ecosystem Studies. Benefits include subscription to the IES Newsletter, member's rate for courses and excursions, a 10% discount on IES Ecology Shop purchases, and participation in a reciprocal admissions program. Individual membership: $40; family membership: $50. Call the Development Office at 845-677-7600 ext. 120.

The Institute's Aldo Leopold Society

In addition to receiving the benefits listed above, members of The Aldo Leopold Society are invited guests at spring and fall IES science updates. Call the Development Office at 845-677-7600 ext. 120.

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... IES website: www.ecostudies.org

For information on current IES public events and attractions, visit: www.ecostudies.org/welcome/ThisWeek.html.
For garden tips, visit: www.ecostudies.org/welcome/gardens.html.