IES Newsletter

Volume 13, Number 3
May - June 1996

IES invites you ...

... to the **Perennial Garden**, where there is a new "Edible Annual Bed" in the sunken garden, and where — later in summer — a water garden and xeriscape bed will join other educational displays.

... to the **Fern Glen**, where it is often 10° cooler than elsewhere. Over 20 kinds of ferns are hiding their reproductive spores on the undersides of their leaves, so bring a magnifying glass: each species of fern produces a different shape spore. Also, a new sign details the relationships of the "Shrub Swamp".

... to the **Greenhouse**, to follow the new, self-guided "Economic Botany Trail" and learn about edible and medicinal plants.

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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Printing: Central Press, Millbrook, N.Y.

Why Are Catskill Mountain Forests Leaking Nitrate into Streams?

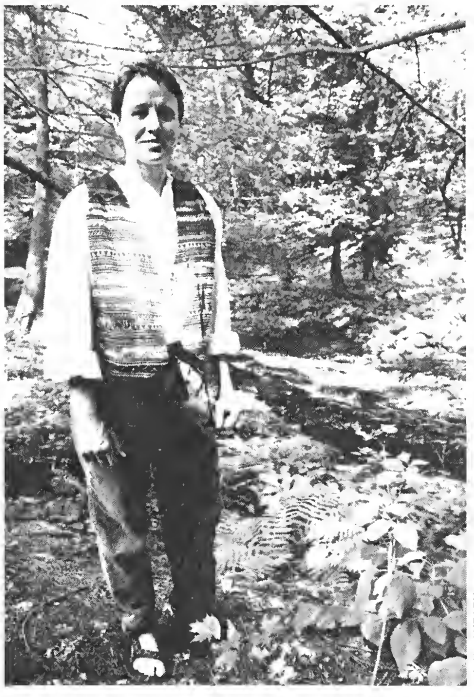
by Ann Botshon

Cold, sparkling Catskill Mountain streams supply most of the drinking water in New York City's reservoirs. This precious water is still of high quality, but it is worrisome that nitrate concentrations in the stream water have increased several-fold over the past 20-plus years.

This troubling change in stream water nitrate concentrations is behind the efforts of IES ecologists Gary Lovett and Kathleen Weathers, and Mary Arthur of the University of Kentucky, to understand the connections between the pattern of nitrogen deposition, the tree composition of the forest, and the chemistry of Catskill Mountain stream water. Complicating the puzzle is the fact that even though the streams show that the forest has been losing nitrate over time, there has not been a corresponding increase in the amount of nitrogen being deposited from the atmosphere over the last 20 years. Where is the nitrate coming from, then? Says Dr. Weathers, "We think the forest itself greatly influences the amount of nitrate found in streams."

Shedding Excess Nitrogen

Nitrate is a drinking water pollutant, although nitrate concentrations in Catskill streams are not yet high enough to warrant direct health concerns. Nitrogen, as nitrate as well as in other forms, reaches ecosystems in rain, snow, and clouds, and even as dry particles or gases. "The Catskill Mountains experience some of the highest rates of nitrogen deposition in the Northeast. These rates are influenced in part by air pollution from the New York-New Jersey urban corridor," says Dr. Weathers. "Some areas at the tops of mountains in the Catskills — 'hot spots' — receive up to four times more nitrogen than nearby low-elevation sites."



MOLLY AHEARN

Nitrogen is, of course, a nutrient as well as a pollutant, and historically researchers have believed that the more nitrogen added to a forest, the more the forest would grow (much like adding nitrogen fertilizer to your garden would cause a spurt in growth). "If forests really acted like a limitless sponge for nitrogen, we wouldn't expect increased nitrogen deposition through air pollution to result in increased nitrogen in stream water," Dr. Weathers points out, "because the plants and microbes would simply continue taking in all that was available and grow more."

But in recent years a number of ecologists have begun to think that as a result of chronic pollution, more nitrogen is being deposited on Catskill Mountain ecosystems than the forests and microbes can use. This suggests that any nitrogen in excess of what the ecosystems need will leak out into stream water. Quite simply, this theory implies that now the forests are saturated with nitrogen and dumping the excess. But Dr. Weathers and colleagues think something else is going on as well.

What Role Do Forests Play?

In addition to, and perhaps in conjunction with, air pollution, there is another possibility, one proposed by the IES ecologists, which draws on the fact that forest types differ at taking up and processing nitrogen — a model that implies that if the forest composition has changed over time, the nitrogen export patterns also may have changed. For example, the IES researchers have found that yellow birch and sugar maple trees may make more nitrate available for leaking into streams than do beech or hemlock. Their theory suggests that if there were an increase in birch and maple trees in Catskill forests, more nitrate would leach out from the soils and into the water.

continued on page 2

Complex Forest Dynamics Link Acorns, Deer Ticks, Gypsy Moths

by Ann Botshon

A bumper year for acorns may result in a bad season for Lyme disease two years later. It may also mean a population explosion of gypsy moths in some future year.

Such intriguing links are among the findings of a long-term IES study of ecological relationships in oak forests of the eastern United States. Institute of Ecosystem Studies scientists Richard S. Ostfeld and Clive G. Jones, together with colleague Jerry O. Wolff of Oregon State University, described the interplay of a host of characters in the oak forest drama in the May 1996 issue of the journal BioScience.

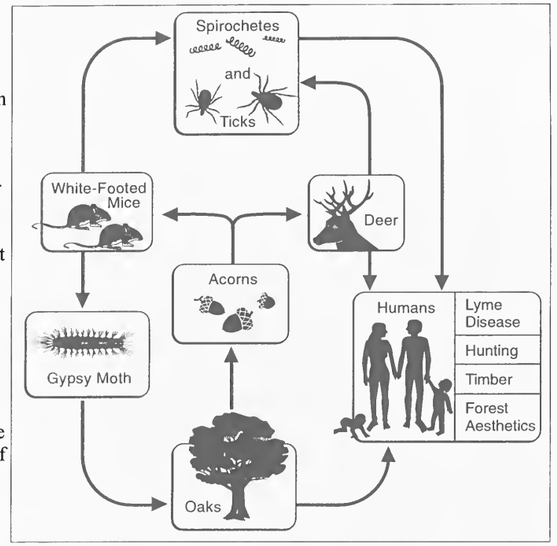
In those acorn-rich years when deer gather in the oak forest to feed, large numbers of adult deer ticks drop from their hosts onto the forest floor and lay their eggs in leaf litter there. Thus, in the summer following a heavy acorn crop, there is an outbreak of larval ticks (the stage that hatches from eggs) in oak forests.

Meanwhile, an autumn's abundance of acorns also encourages growth of populations of white-footed mice. In a peak acorn year, mice get fat, survive the winter well, and actually breed in the dead of winter (something that does not occur when acorns are absent or only few in number). The result is that mouse populations get a head start and also reach a peak the summer following a peak acorn year.

"In other words," says Dr. Ostfeld, "just at the time that legions of larval ticks are hatching from eggs and crawling about in the forest, they encounter enormous numbers of the preferred host animal, the white-footed mouse." The larval ticks take a blood meal from the mice, but it is not until another spring arrives that the ticks — now in the nymph stage — attach to humans or other mammals. After a blood meal on that host, the nymphs molt into adult ticks.

It is the mice that are responsible for infecting feeding larval ticks with the Lyme disease bacterium, since, of all the animals ticks may feed on, only mice carry large populations of these microorganisms in their blood. Without mice, the ticks would be a nuisance but would not cause Lyme disease.

The IES ecologists are working now to ascertain if bumper years for acorns are followed two years later by unusually large numbers of nymphal ticks or an unusually high incidence of the Lyme disease bacterium in the ticks, or both. The year 1994 brought an extremely healthy acorn crop; Dr. Jones and Dr. Ostfeld expect large numbers of ticks this summer.



The relationships between humans and oak forests, and between them and the organisms that affect Lyme disease and gypsy moth outbreaks. Drawing by Sharon Machida Okada.

Acorns Now, Gypsy Moths Later

White-footed mice also have a beneficial effect on the oak forests, in an indirect connection that involves the gypsy moth. Mice are voracious consumers of gypsy moth pupae (the insect's cocoon stage). So, when mice are abundant and gypsy moth populations are low, the mice may prevent gypsy moth outbreaks. (In contrast, most other natural enemies of gypsy moths are not abundant when gypsy moths are at low density.)

But two to three years after a heavy acorn crop, white-footed mouse populations typically "crash". That allows many gypsy moth pupae to survive, so that the moth population can start to escalate to outbreak levels. The caterpillars strip the oak trees of their leaves, often over thousands of acres of forest. When this happens a number of years in a row, it can kill trees. Such outbreaks occur every ten years or so.

Speaking of the recent findings, Dr. Jones observes, "It is often such indirect connections that can have a big influence on the structure and function of ecological communities."

The surprisingly complex web of interconnections revealed in these oak forest studies indicates that particular species cannot be managed in isolation from other interacting species. For example, one strategy for improving the timber harvest might be to keep the number of gypsy moths low by keeping the number of mice high (e.g., by deliberately providing food for mice in the year after a peak acorn crop). But since mice also carry deer ticks, such an approach could have the unwanted consequence of increasing the risk of tick bites and the occurrence of Lyme disease in people.

This study points to the compelling need to explore the complex ecological connections that affect the health of both humans and forests. "Typically, community ecology has focused on understanding the direct effects of one species on one or a very few other species," says Dr. Ostfeld. "The new work emphasizes the importance of viewing such 'pairwise' interactions within the context of the overall ecosystem."

Catskill Mountain Forests, *from page 1*

There is, in fact, historical evidence that beech bark disease moved through the Catskills between 1940 and 1960, leaving many beech dead and dying, and perhaps resulting in a forest species shift. Drs. Lovett, Weathers and Arthur are working to see if the increase in nitrate in Catskill stream water over time can be linked to a decline in the number of beech.

The researchers also are studying the connection between forest type and the concentration of nitrate in different places in the Catskills. They have established that there are large differences in nitrate concentration among Catskill streams. Now they are working to link that information to differences in forest type in the watersheds' ecosystems.

The Institute's pursuit of the connection between air quality, water quality, and forest dynamics and health is no obscure academic exercise, but a study that will be of great interest to managers of Catskill Mountain watersheds, to people interested in clean air, and to Catskill residents whose welfare depends on the functioning ecosystem. "And, especially," says Dr. Weathers, "to those millions of people who turn on their taps daily to receive a Catskill Mountain gift: clean, forest-filtered water."

Student Evolution at IES

It has been only two years, and research assistant Pamela Templer is about to move on to her fourth incarnation as an IES researcher: this fall, she will begin her doctoral studies in a joint graduate program between Cornell University and the Institute of Ecosystem Studies.

Ms. Templer's IES story began in summer 1994, when, as a student at the University of California at Santa Cruz, she was one of 10 students accepted to that year's IES Research Experiences for Undergraduates (REU) program[1]. She spent three months at the Institute, working with mentor scientist Dr. Richard Pouyat on the IES Urban-to-Rural-Gradient program and studying nitrogen and ammonium uptake in red oak (*Quercus rubra*) and Norway maple (*Acer platanoides*) seedlings. The following summer she returned to the Institute as a Polgar Fellow[2]. This time, she studied the biogeochemistry of marshes at Tivoli Bays, a Hudson River marsh north of Red Hook, with IES aquatic ecologists Drs. Stuart Findlay and Cathleen Wigand. Her project was a comparison of nutrient cycling (the transfer of chemical elements such as nitrogen and carbon between living and non-living parts of the environment) in the native wetland plants *Phragmites* and cattail with that in non-native purple loosestrife.

After Ms. Templer graduated from the University of California with a bachelor's degree in biology and environmental studies, she was hired as an IES research assistant, working with Dr. Findlay and post-doctoral associate Dr. Cathleen Wigand. She is continuing her Polgar Fellowship project, and also is doing nutrient analyses in underwater plant stands with *Vallisneria* (wild celery) and *Potamogeton* (clasping pondweed)— two species common in the Hudson River.

During a typical day of field work, Ms. Templer sets "peepers" to collect pore water in the sediments of Tivoli Bays. Peepers are small, rectangular samplers that are sunk to a depth of 20 centimeters (8 inches), which is the root zone of the study plants. Holes in the peepers' sides are covered by very fine membrane that allows chemicals to pass through. After they equilibrate in the sediments for a week, Ms. Templer brings them to the laboratory where she extracts the water with a syringe and injects it into a device called an autoanalyzer, which measures ammonium, nitrate and phosphate.

MOLLY AHEARN

Pamela Templer extracts pore water from a sampling device called a peeper.

Results of Ms. Templer's work last summer showed a significant difference in the pore water nutrient levels between native species and purple loosestrife, with the lowest nutrient levels in sediments where loosestrife is growing. The ability to grow with reduced nutrients could give this invasive plant a competitive advantage. This summer, Dr. Findlay is expanding his research to include three more marshes in the Hudson River — Piermont Marsh just south of the Tappan Zee Bridge, Constitution Marsh in Cold Spring, and Stockport Flats in Columbia County — as well as some in the Connecticut River, so Ms. Templer will be setting peepers in sediments at these sites as well.

With Dr. Wigand, she is doing similar pore water nutrient analyses with submerged plants. The aim here is to compare sediments from vegetated and non-vegetated areas, as well as from different sites within vegetated areas. While many aspects of the Hudson River have been thoroughly studied, no one has yet looked at nutrients in the sediments. Data from this study will help complete the picture of the whole ecosystem.

The end of summer will bring the end of Ms. Templer's work as an IES research assistant and the beginning of her five-year career as a graduate student. She has been accepted by Cornell University's Section of Ecology and Systematics as one of the first students in a new program, Human Accelerated Environmental Change, developed by Cornell and IES and funded by the National Science Foundation. After two years of course work, she will do doctoral research related to a human-induced environmental change — one topic she is considering is land-use effects on plant communities and nutrient cycling. The co-chairs of her doctoral committee are Dr. Findlay, at IES, and Dr. Todd Dawson, a Cornell University plant ecologist.

Pamela Templer's evolution through the Institute is not an exception. A recent tracking of former IES REU students found 14 Ph.D. candidates, five masters degree students and a number of others already working in research and education related to science and the environment. IES laboratory assistants also frequently move on to graduate programs; Ms. Erika Latty, for example, a doctoral student whose work was described in the story on Dr. Charles Canham's Adirondack Mountain project in the March-April 1996 issue of the newsletter, was a research assistant for three years before entering the same Cornell/IES program that Ms. Templer is beginning. The nurturing and encouragement of young scientists is one way in which the Institute is accomplishing its educational mission.

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1. *Developed by the National Science Foundation (NSF), a federal agency, the REU program's purpose is to improve science education in the U.S. and to help assure an adequate supply of scientists, mathematicians and engineers for the future. Many institutions compete for annual NSF funds to support REU students, and consistently IES has been among the recipients. The 1996 REU program at the Institute will be featured in the next issue of the IES NEWSLETTER.*
2. *The Polgar Fellowship Program, sponsored by the Hudson River Foundation and the Hudson River National Estuarine Research Reserve, enables students to do research related to Hudson River ecosystems. The Institute participates in the program, both by providing advisors and facilities for research projects and by serving as the site for the final symposium where students present their results.*

Calendar

CONTINUING EDUCATION

For **summer semester** catalogues and program information, call the Continuing Education office at 914/677-9643. Upcoming programs are:

Landscape Design

Aug. 3: **Landscape Design for the Small Residential Site**
Aug. 3: **Perspective: A Crash Course**
Aug. 10 & 11: **Transit and Level Use for Landscape Construction - Extended**
Aug. 17: **Quick Sketching for Landscape Design**

Gardening

July 6: **Container Gardening**
July 13: **A Natural Way to Attractive Lawns and Gardens: A Professional Horticulturist Shares His Secrets**
July 20: **Color Relationships in Illustration and the Garden**
July 20: **Pinching, Deadheading, Staking and More - Extended**
July 21: **Summer Wild Plant Identification**
July 27: **Designing a Perennial Border for All Seasons**
Aug. 3 & 10: **Fundamentals of Gardening**
Aug. 10 &/or 17: **Annuals on Slides and at The New York Botanical Garden**

Biology and Earth Science Courses

Aug. 3 & 4: **Field Identification of Grasses**
Aug. 4: **The Spineless Inhabitants of Flowing Water**

Natural Craft Course

Aug. 24: **Black Ash Splint Basket**

Excursions and Tours

July 20: **Duck Hill and the Hammond Museum Japanese Stroll Garden**
July 21: **Ecology and Behavior of Raptors**
July 27: **Noah's Garden: An Ecological Model for Transforming the Suburban Landscape**
Aug. 11: **Wave Hill and The Cloisters**

IES SEMINARS

From mid-September through mid-May, **scientific seminars** are held each Friday at 3:30 p.m. at the IES Auditorium. Seminars are free, and the public is invited to attend.

SUNDAY ECOLOGY PROGRAMS

Free public programs are held on the first and third Sunday of the month, except over holiday weekends. Call 914/677-5359 to confirm the day's topic or, in case of poor weather, to learn the status of the day's program. The following programs begin at 2 p.m. at the Gifford House:

July 21: *Call to see if a program has been scheduled for this date*
Aug. 4: **Deer Impacts on Forest Vegetation**, a walk led by Mr. Ray Winchcombe
Aug. 18: **Weather Monitoring at IES**, a program led by Ms. Vicky Kelly

* *We strongly recommend that participants wear long pants tucked into socks and sturdy waterproof footwear for all outdoor programs.*

VOLUNTEER OPPORTUNITIES

We're hoping to find a few people who enjoy gardening and would like to volunteer a few hours a week in the IES display gardens ... it's a great learning experience! Volunteers also are needed for visitor reception and for work in the Gift and Plant Shop. For information on benefits and responsibilities, call Ms. Su Marcy at 914/677-5359.

GREENHOUSE

The IES greenhouse, a year-round tropical plant paradise and a site for controlled environmental research, is open until 3:30 p.m. daily except public holidays. Admission is by free permit (see "HOURS").

IES GIFT AND PLANT SHOP

New in the Shop ... bark birdhouses ... the latest edition of *50 Hikes in the Hudson Valley* ... **for children** ... kaleidoscope-on-a-rope ... garbage garden (a kit for using composted kitchen waste to make a kid's garden) ... **and in the Plant Shop** ... "Toad Stools": plant fertilizer garden ornaments
Senior Citizens Days: 10% off on Wednesdays

•• **Gift Certificates** are available ••

HOURS

Summer hours: May 1 - September 30
Closed on public holidays.

Public attractions are open Mon. - Sat. 9 a.m.-6 p.m. & Sun. 1-6 p.m., with a free permit*. (Note: The Greenhouse closes daily at 3:30 p.m.)
The **IES Gift and Plant Shop** is open Mon.- Fri. 11a.m.-5 p.m., Sat. 9 a.m.-5 p.m. & Sun. 1-5 p.m. (The shop is closed weekdays from 1-1:30 p.m.)

* *Free permits are required for visitors and are available at the Gift Shop daily until 5 p.m.*

MEMBERSHIP

Join the Institute of Ecosystem Studies. Benefits include a member's rate for courses & excursions, a 10% discount on Gift Shop purchases, a free subscription to the newsletter and participation in a reciprocal admissions program. Individual membership: $30; family membership: $40. Call Ms. Janice Claiborne at 914/677-5343.

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 Ms. Jan Mittan at 914/677-5343.

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Newsletter

Volume 13, Number 3
May - June 1996

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