

# Ecologists Grapple With Heterogeneity

by Dr. Alan R. Berkowitz

During the week of April 28<sup>th</sup>, the Institute held its tenth biennial Cary Conference. Once again, a distinguished and diverse group of scientists assembled to grapple with a frontier issue in ecology – in this case, “Ecosystem Function in Heterogeneous Landscapes”. Organized by Institute scientists Drs. Gary M. Lovett, Clive G. Jones and Kathleen C. Weathers, and Dr. Monica Turner of the University of Wisconsin, the conference focused on how ecologists should deal with spatial heterogeneity.

Defined as “consisting of dissimilar elements or parts,” heterogeneity is important to consider when an ecosystem is not reflected by the sum of its parts. Understanding the causes and consequences of heterogeneity, i.e. how disparate parts of the landscape interact, is important to maintaining biodiversity and ecosystem services. Historically, many ecologists have viewed the landscape in black and white, with distinct patches of functional (forest) and non-functional (roadway) habitat. Heterogeneity provokes ecologists to view the landscape in shades of gray, with patches having varying levels of functionality.

In attempting to explain the conference to my mother (a test of understanding first posed to me by IES Director Dr. Gene E. Likens), I drew upon parallels to landscape painting:

You’ve been asked to paint a landscape, and are given what appears to be a generous canvas, a full palette, and a collection of brushes. What do you paint? Some topography – hills or mountains, valleys – and perhaps an assortment of fields and forests, a stream with a thicket of willows along it, a country road lined by trees. A few houses, or a single farmstead with some ramshackle barns. Maybe even a few people, working the land or just passing through.

Thinking as a landscape ecologist, we note that you’ve created a heterogeneous landscape with a number of elements in particular proportions (together these are the landscape’s composition) and in a particular pattern (the landscape’s configuration). The “truth” of your painting is tested, in some measure, by whether others think you’ve captured the essence of the landscape you’re depicting, a process similar to the way scientists’ renderings are evaluated. Are the key elements included, with the crucial patterns and in the right proportions?

This “painting” can be thought of as the starting point of the Cary Conference. From there, we ask three questions that pose exciting but vexing challenges to the landscape ecologist: (1) What caused the landscape to have the patterns – the composition and configuration - we painted or described? (2) What, if anything, does the pattern



Georgia O'Keefe Museum, Tucson, Arizona



Donna Reed Collection, New York, New York

Above: Georgia O'Keefe's "Evening Star No. VI" (1917)  
Below: Frederick Church's "Secluded Sunset" (1860)

mean for landscape functions we care about? (3) What if you had to depict even bigger portions of the landscape than painters and ecologists had traditionally grappled with?

The Cary Conference made significant strides in addressing each of these three questions. I will summarize a few findings for each question and close with final thoughts on the shared metaphors of landscape painting and ecosystem science.

What causes landscape heterogeneity? The physical environment, the biological environment, and disturbances can all give rise to spatial heterogeneity. Disturbance type and scale exert different effects. While small-scale disturbance tends to create and maintain heterogeneity, large disturbances can lead to homogeneity at the patch and landscape level. One of the most intriguing questions to arise from the conference asked, “Is the heterogeneity caused by humans different from natural forms?” Because it tends to create more niches and higher levels of species diversity, evidence suggests that natural heterogeneity increases ecosystem resilience.

What is the functional significance of landscape heterogeneity? Thinking back to the pastoral landscape we “painted” for my mother, we might consider traditional functions: food delivery, clear water and fresh air, or the impact of the landscape on the Earth’s atmosphere. But did we include functions more recently incorporated in the ecological lexicon, such as the maintenance of biodiversity, resilience in the face of disturbance, or the provision of recreation-based ecosystem services?

Volume 20, Number 3  
May - June 2003

## Editor's Note

Through a stroke of good fortune, my office window faces the Gifford Garden. The efforts of the IES gardening staff, combined with a rainy May, have culminated in a stunning display of flowers and greenery. I encourage staff members and visitors to take advantage of this botanical oasis on our campus!

Summer is almost upon us, and with it comes the rewards of the field season and an influx of new faces. Research Experiences for Undergraduates students, seasonal research assistants, interns, and visiting scientists contribute to the summer community at the Institute.

This issue of the IES Newsletter features an article by Dr. Alan R. Berkowitz, Head of the Education Program. In it he sheds some light upon the theme of this year's Cary Conference X, why does ecosystem heterogeneity matter? The article demystifies a complex word and illustrates a new way of looking at the landscape.

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.

# The Greenhouse: Supporting Research & Eco-exploration!

This year marks the 30th anniversary of the Institute's greenhouse complex. Constructed in 1973, its original mission was to propagate a collection of woody plants, trees, shrubs, and perennials from the Temperate regions of the world. In the 1970s, as part of a seed exchange program, the greenhouse distributed over 6,000 seeds annually to hundreds of botanical gardens and arboreta.

Over the years, the facility has evolved to meet the needs of an ecological research institution. In addition to housing an extensive collection of tropical plants, the greenhouse is home to scientific research experiments, ecology field programs, and continuing education classes. The facilities also help generate plant material for the Fern Glen and the Gifford Garden.

Recently, I sat down with Greenhouse manager David Bulkeley and technician Becky Curtis to discuss the role the greenhouse plays at the Institute.

How has the role of the facility changed over time?

DB: When I began working here in 1976, the greenhouse was very involved in collecting and distributing seeds. We were part of the Sino-American Botanical Exchange, along with The New York Botanical Garden, U.S. National Arboretum, and The Arnold Arboretum. Greenhouse horticulturist Bob Hebb went to Russia several times to gather woody plant seeds. The hardy cyclamen in the greenhouse is a living legacy of one of these excursions.

Historically, many of the plants in the greenhouse were started from seed. Mature plants were either kept in the collection, planted on the grounds, or given to partner arboreta. In the early days, we had a 15-acre nursery facility. Many trees on the campus originated from this nursery. The Institute has one of the most complete birch collections in the Northeast, most of which were propagated in the greenhouse. You can find them on the grounds, where Cary Drive intersects Lovelace Drive.

What are the major plant collections in the greenhouse?

DB: Our larger collections include scented geraniums, orchids, staghorn ferns, coleus, herbs, citrus, and cactus. The staghorn ferns are over 25 years old. We received over 70 coleus plants as a donation from Mr. Noel Montgomery; grouped together they make a striking display.



*Greenhouse Manager David Bulkeley and Greenhouse Technician Becky Curtis in front of the staghorn ferns.*

BC: We encourage people to interact with the herb and the scented geranium collections. Instead of saying "hands-off," our signs invite visitors to touch and smell the plants.

What educational programs utilize the greenhouse?

DB: Mary Ford holds the Plant Power Program here. During the school year, over 890 school children come through the greenhouse. Geared toward grades K-8, Plant Power teaches students about plant growth and function through hands-on activities.

BC: Plant Power is very interactive. Dan Novak and Libby Lowe, the AmeriCorps educators, set up an experiment so students can see research in progress. The kids are always excited about taking measurements. They have a tropical treasure hunt where they search the greenhouse for plants with different leaves, roots, and textures.

DB: The IES Continuing Education Program holds a number of classes in the greenhouse. Plant Propagation, Container Gardening, and Watercolors in the Greenhouse all take place here.

Does the greenhouse support research?

DB: A number of staff scientists, research assistants, and Research Experiences for Undergraduates (REU) students have performed research at the greenhouse. Dr. Clive G. Jones conducted extensive research on plant chemical defenses, at one time he had thousands of experimental cottonwood trees at the facility.

BC: When I began working the cottonwood trees were six feet tall and in one gallon pots. In the summer months, tending to them was a full

time job. There were so many that by the time you finished watering them all, the plants you started with were dry again! DB: Over the years we have hosted hundreds of projects, from "Seedling Response to Root Stress," to "Do Air Pollutants Alter Plant Resistance to Pests." Currently, Dr. Valerie T. Eviner uses the greenhouse to support her research on plant species interactions. She will have an REU student working on plants here this summer.

The rearing building and the cold storage room, both part of the greenhouse complex, also support research. The cold storage room archives water and soil samples. Several staff scientists use laboratory space in the rearing building.

Are plants reared in the greenhouse planted on the grounds?

BC: Many of the annuals for the Gifford Garden are propagated in the greenhouse. A number of the non-hardy display plants overwinter in the facility. The lath house

is used to store plants for the gardens and the plant sale. The gardening staff does the work, we maintain the facility.

DB: Janet Leete, Judy Sullivan's assistant in the Fern Glen, uses the greenhouse fern cases to propagate ferns from spores.

What plant collections is the public most receptive to?

BC: Visitors love the tropical plants, especially anything flowering. The Cadwallader Area, in the second greenhouse, is a popular spot for reflection and relaxation. There is a bench, nestled near a rabbit's foot fern and a large fiddle-leaf fig, that faces our goldfish pond.

DB: People are drawn to unique plants. The Venus fly traps are always a hit. When the New York Times covered the blooming of our century plant in 2001, thousands of visitors came to see it.

How does the greenhouse advance ecological messages?

DB: In addition to working with IES education and research programs, we promote integrated pest management (IPM). For over twelve years we've used predator insects to manage our botanical pests. Prior to implementing IPM, we sprayed about 450 gallons of insecticide annually. The tropical unit was routinely filled with poison gas to control mealy bugs. Our greenhouse is virtually pesticide free, and the plants are doing better than ever.

We want to encourage IPM through example. Initially, it was a learning experience. We had to stop spraying completely; toxins in the plants

## Greenhouse, continued from page 2

would build up in the pest insects and poison the beneficial insects. Right now we have a suite of beneficial insects controlling pests- *Cryptolaemus montrouzieri* for mealy bugs, *Phytoseiulus Persimilis* for red spiders, *Chrysopa carnea* for white flies and aphids, and *Lindorus lophanthæ* for scale. Having seen the greenhouse before and after IPM, I can attest that it is very effective. Our ability to provide a 99% pesticide-free classroom to educational programs is something we take pride in.

Future goals for the greenhouse?

DB: Our main goal is to continue maintaining the collections in an environmentally friendly and cost-effective way. We are always scanning the literature for suitable botanical additions. Becky has developed an educational Economic Botany Tour, detailing greenhouse plants that are utilized by humans- things like kiwi, rubber trees, and basil. We would like to integrate this more into the visitor experience.

Something the public should know?

DB: With the exception of Thanksgiving, Christmas, and New Year's Day, the greenhouse is open seven days a week from 8am-3pm. We have over 1,300 species of plants, you are sure to learn something new, and admission is free. Be sure to pick up a visitor permit at the Gifford House. □

## Encouraging Tomorrow's Ecologists



R-L: Victoria Dao, Dr. Gene E. Likens, and Kimberly Pennington

This year the Institute awarded the "Best Project in Environmental Science and Ecology" to Victoria Dao and Kimberly Pennington for their project, "Which fertilizer will make plants grow the tallest?" The 5th grade students at Myers Corners Elementary School in Wappingers Falls worked as a team on the project. The Institute has been judging the ecological and environmental projects at the Dutchess County Science Fair annually since 1991.

In addition to awarding a "Best Project" prize, this May the Institute hosted the first annual Young Environmental Scientists' Conference. Created to encourage ecological inquiry in young scientists, the conference was open to students who presented ecological or environmental projects in the Dutchess County Science Fair. Seventeen students shared their findings with a receptive audience of IES staff members.

The conference gave the young scientists an opportunity to interact with ecologists, who provided input on the projects, and learn more about the innovative research happening at the IES. The inaugural event was a great success and the Institute looks forward to hosting it next year.

## Heterogeneity, continued from page 1

When the landscape is altered in a way that increases homogeneity, these essential functions can be lost or compromised. The decline of the spotted owl as a result of clear-cutting illustrates this phenomenon. Conference attendees focused attention on determining the importance of composition versus configuration. Spatial heterogeneity influences ecosystem function across a broad range of scales, from fire legacies in western forests to thermal patterns in the ocean. A few large questions that arose include:

–How do we "paint" western forests for fire management? If we think of forest's as uniform landscape elements, we lose the essential differences among forests. As a result, we sow the seeds of management disaster.

–To balance accurately our global accounting of carbon, which governs our understanding of global warming, is it enough to add up the contributions from each biome or continent, or do we also need to capture how pieces of the landscape interact?

–When managing streams, are we equipped to incorporate the entire landscape – with its network of hillslopes, intermittent rivulets, rills and tributaries – as part of the stream?

–In developing a land management scheme for a region, even if the only goal were to

preserve biodiversity, what would the mix of elements and their pattern need to be?

The influence of scale.

After toiling away at our landscape painting, imagine our chagrin when our mentor comments, "that's quaint, but I want a painting that encompasses 10 times more area." This is the challenge ecologists now embrace, and is related to the increasing scope of human impacts on the environment. So, do we include more of the same things –fields and forests and streams and farmsteads- or include new elements in new patterns? What details do we include and what do we drop? Just as a landscape painter cannot include every blade of grass when depicting a meadow, ecologists taking on larger areas need to decide how to simplify or aggregate.

Can we learn from painters?

Consider the evolution of landscape paintings from the 1800's to the 1900's (see images). The artists are striving to strike that perilous balance between realism and simplicity, between detail and essence. As ecologists grapple with the three challenges I've described above, can artists help us identify what – in this case, in terms of spatial heterogeneity – we can omit?

In his summary, IES scientist Dr. David L. Strayer posed this question directly. At first

glance, some of his answers were obvious. We can ignore spatial variability when the difference between elements is slight (e.g., two types of quite similar meadow) or when there are not clear mechanisms connecting the patches. Others answers were more subtle or profound – in some cases even stark variations in landscape structures might have no significance to the function of interest, or it might not be efficient to include variability even if it were interesting.

Scientists, as painters, work with the limited resources of time and money. Just as it might not be worth painting every blade of grass in a field, scientists might omit certain details. Dr. Strayer also pointed out that as our canvas gets bigger and our ability to measure functions expands (e.g., water or air fluxes from whole water- or air-sheds) variation will eventually be subsumed by our measurements and we can ignore it.

In writing about the last Cary Conference, I drew the analogy between models and poems. Here, I've waxed philosophically about ecology and painting. Perhaps the synthesis will come when these approaches are combined. Then I will need to contemplate a new art form, one where multidimensional landscape paintings or sculptures change in animated beauty. □

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# Newsletter

Volume 20, Number 3  
May - June 2003

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## Calendar

### CONTINUING EDUCATION

The Continuing Education Program is now accepting summer registrations. For information, or to request a brochure, call 845-677-9643 or visit [www.ecostudies.org/education/continuing.html](http://www.ecostudies.org/education/continuing.html).

Summer semester programs include:

#### Gardening

June 14 (1 Sat.) Managing Soils  
June 29 (1 Sun.) Fern Identification & Propagation  
July 12 (1 Sat.) Old Garden Roses  
July 20 (1 Sun.) Perennial Garden Maintenance

#### Natural Science Illustration

July 19 (1 Sat.) Outdoor Graphite Drawing  
July 20 (1 Sun.) Color Theory for Nature Art  
July 22 (1 Tues., 1 Wed., 1 Thurs.) Watercolors in The Garden

#### Landscape Design

July 13 (1 Sun.) Transit and Level Use for Landscape Construction

#### Biology and Ecology

June 15 (1 Sun.) The Medicine Garden: Creating Sacred Space for Healing, Celebration, and Tranquility.

#### Excursion

June 21 (1 Sat.) Hudson River Cruise

### SATURDAY ECOLOGY PROGRAMS

Come to free public programs. Children age 6 and up are welcome with an accompanying adult. Pre-registration isn't necessary. Programs are from 1 - 3 p.m. and begin at the Gifford House Visitor and Education Center. If you have questions, call 845-677-7600 ext. 317.

July 12: Ecological Gardening: The Management Of Gardens & Grounds at IES. Join Brad Roeller, Manager of Grounds & Display Gardens at IES, for a walk through the gardens and a discussion of the low-impact methods used to maintain them.

### 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).

What Will Your Kids Learn This Summer?  
Hurry... Only a few openings are left!  
SUMMER 2003

### IES ECOLOGY DAY CAMP

The 2003 Summer IES Ecology Day Camp consists of eight one-week sessions for children entering grades 2-4 and 5-7, and will run from the week of June 30th through the week August 18th. Students will explore our 2,000 acre property through ecology experiments, hiking, observation, and nature art projects. They will have the opportunity to learn from the IES scientists and the education staff. For more information or to register by phone, please call the Education Office from 9:00 a.m. to 4:00 p.m. at 845-677-7600 ext. 316.

### THE ECOLOGY SHOP

New in The Ecology Shop: quality children's gardening tools from Brio; new board games that teach children of all ages about nature; Dover nature-themed coloring books; New York made vegetable wax candles; and much more! Stop in for a visit.  
Senior Citizens Days: 10% off on Wednesdays.

### HOURS

Summer Hours: April 1 - September 30

Public attractions: Mon.-Sat., 9-6, Sun. 1-6; closed public holidays. The greenhouse closes at 3:30 daily.

The Ecology Shop: Mon.-Fri., 11-5, Sat. 9-5, Sun. 1-5. (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.*

### IES SEMINARS

Free scientific seminars are held at 11 a.m. on Fridays in the auditorium from September until early May. The fall schedule will be available in August.

### 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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... for education, general information and  
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... IES website: [www.ecostudies.org](http://www.ecostudies.org)

For information on current IES public events and attractions, visit: [www.ecostudies.org/this\\_week\\_at\\_ies.html](http://www.ecostudies.org/this_week_at_ies.html)  
For garden tips, visit: [www.ecostudies.org/gardens.html](http://www.ecostudies.org/gardens.html).