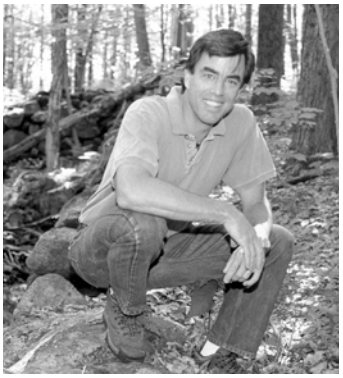
Looking Forward 2007

Highstead

From the Chairman



David Foster *is the Director of the Harvard Forest at Harvard University and the Chair of the Highstead Board. His research focuses on the history, ecology and conservation of landscapes shaped by natural and human processes.*

To the Members and Friends of Highstead

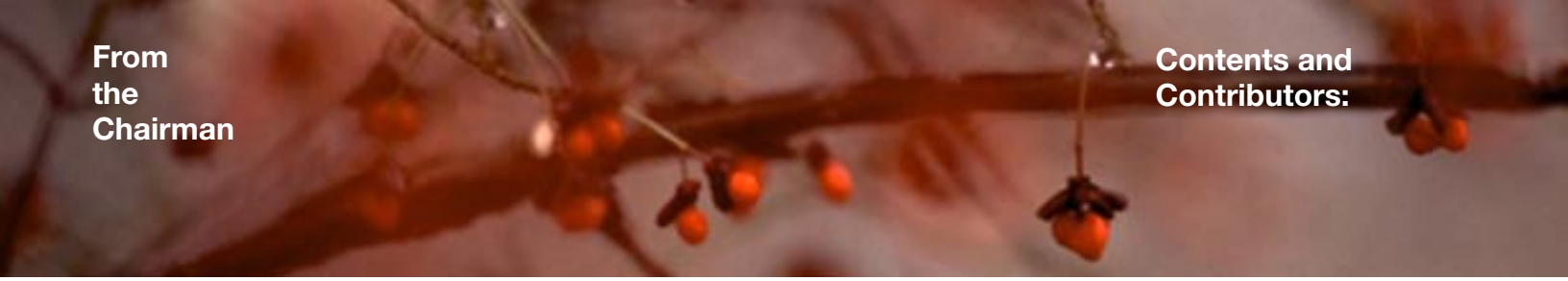
It has been a year of new activities, accomplishment, and transition at Highstead and we are pleased to provide an update on our educational, research and conservation efforts centered on the landscape of southern New England. Under Margaret Shea's direction and with the support of a growing staff, new collaborators and our undergraduate internship program we have much to report.

Highstead's Mission:

To inspire curiosity and build knowledge about plants and wooded landscapes in order to enhance life, preserve nature and advance sound stewardship practices.

Drawing from seven years of observations, Margaret has completed the first study in our Woodland Demonstration, an experiment that assesses the impact of the growing deer population on New England forests. Her article and accompanying photographs provide a striking picture of how rapidly deer are transforming the landscape by eliminating wildflowers, shrubs and tree saplings from our woods. This winter Margaret will write these results up for publication in a research journal. Unfortunately, however, this will be her final Highstead project as Margaret and her husband David are returning to their native Kentucky to pursue old and new endeavors. We have benefited from her two years of leadership and will miss her energy, passion for conservation and knowledge of the natural environment.

continues inside



To the Members and Friends of Highstead

continued from page 1

This spring we welcomed Ed Faison as Forest Ecologist, a position established to broaden our research and conservation efforts on natural landscapes. Ed and his wife Brooke are from northwestern Connecticut and he has a zoology degree from Connecticut College and graduate degrees in natural history and ecology from the University of Vermont and Harvard University. This summer Ed extended our forest ecology study to include the land of our conservation neighbors – the Town of Redding, Redding Land Trust, and The Nature Conservancy. As he reports here, this project expands Highstead's mission as we collaborate with other organizations to address topics with direct relevance to conservation and land management.

While launching new efforts we have maintained our strong commitment to the Highstead Arboretum. This Spring Kathleen Kitka began long-term management plans for all of our natural and managed landscapes and collections. Kathleen has completed draft documents for the Kalmia, Azalea, and Clethra collections as well as the Native Tree and Shrub Walk. By next spring we hope to have a comprehensive draft outlining the long-term directions for our entire landscape.

Looking ahead, we have much to do as we continue to expand in personnel, programs and capacity. Our first step is to hire a new director who will bring strengths in conservation, education, and ecology to help guide our growing activities. Our success with the internship program has convinced us to develop a permanent program of research and training for undergraduates. This coming summer we anticipate supporting three or more students in ecology, conservation and collections-based activities. Meanwhile, to broaden our scope and complement exciting developments in forest conservation across southern New England, we are developing a new staff position in regional conservation. Finally, we are framing plans to expand our infrastructure, web page, and outreach programs to support this new level of activity. Our staff and new director will have many engaging projects to pursue as Highstead looks to the future.

I would like to end with a word of thanks to Margaret for guiding Highstead through a prosperous period of expanding programs, outreach and research. We wish her well in her new endeavors.

With my best wishes,

David R. Foster
Chairman, Highstead Board

Highstead

Insights into the impacts of high deer densities on the forests of southern New England

Margaret Shea *served as director of the Highstead Arboretum from 2004 to 2006. She is currently working with David Foster and members of the Highstead staff to complete the analyses and publish the results from the first decade of the Woodland Demonstration.*

White-tailed deer are ubiquitous across Fairfield County, Connecticut and historical evidence suggests that the modern population of this large herbivore is approximately five to ten times greater than that at the time of European settlement.

Homeowners throughout the region witness deer browsing on flowering herbs and shrubs as well as vegetable gardens, and the regional population is becoming aware of associated health risks posed by Lyme disease and automobile accidents. Even anecdotal evidence of the horizontal browse lines on trees along woodland and wetland edges indicate that deer are affecting plants throughout our natural plant communities. The question looms as to the extent of deer impacts on our forest ecosystems and the ways in which our management may mitigate or exacerbate these effects.

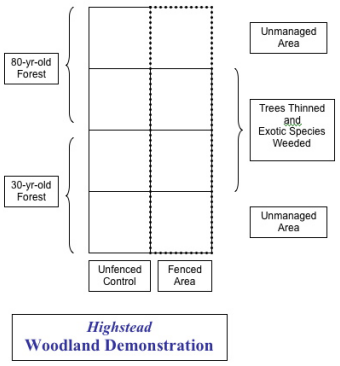
In 1998, Highstead initiated a long-term experiment to quantify the impacts of deer on woodland plants and ecosystems. The study, which we call the Woodland Demonstration, is situated near our interpretive trails so that it can provide a convenient demonstration for our visitors and for landowners throughout the region. The experimental design is simple. An eight-foot tall fence was erected to exclude deer from one acre of moist upland forest, whereas an adjacent, unfenced area serves as a control area that deer can freely browse. To make the demonstration realistic and useful to landowners, in half of the fenced and unfenced woodland areas we employed common management practices, including selective tree harvesting and weeding of exotic plant species.

The unfenced woodland showing an absence of understory herbs, shrubs or tree seedlings, a lawn-like cover of grass and sedge, and an abrupt "browse line" in the distribution of tree leaves.

The adjacent fenced and managed woodland in 2005 seven years after the experiment began. Rapid recovery from deer browsing has led to a proliferation of the native understory and much greater structural diversity in the forest.

In Less than a Decade – A Transformed Forest

Eight years later photographs from these adjoining areas provide evidence of the dramatic changes in these woodlands following the exclusion of deer. In a relatively short period of time trees, shrubs and herbs have regenerated within the fenced area and are filling out the forest understory. These plants provide many benefits beyond the diverse and often colorful appearance of their foliage and flowers. For understory nesting birds like veery (*Catharus fuscescens*), worm-eating warbler (*Helmitheros vermivorus*), and hooded warbler (*Wilsonia citrina*) and small mammals including white-footed mouse (*Peromyscus leucopus*), eastern chipmunk (*Tamias striatus*), and woodland vole (*Microtus pinetorum*), the plants provide protective cover, food, and nesting sites. In turn, these small animals support larger forest predators such as coopers hawk (*Accipiter cooperii*) and fisher (*Martes pennanti*), which add complexity and stability to the forest food web. For the forest itself, the new cohort of seedlings and saplings that have established with the removal of deer represent the next generation of overstory trees, without which the forest cover will gradually decline. And for the region as a whole, these protected forest areas help to restore the diverse range of species that grow naturally in our landscape. Results from the study confirm that the large deer herd in southern Connecticut is changing the forest structure and composition and altering its response to active management.



Map showing the experimental design of the Woodland Demonstration. Half of the area was fenced to exclude deer while the other half was left as an unfenced control. In part of each of these two areas trees were thinned and exotic plant species were removed by weeding. The size of the entire area is 2 acres.

Increasing the Diversity of Native Plant Species

Results from the Woodland Demonstration also suggest that in forests with high deer densities and abundant invasive exotic plants the diversity of native plants will increase most rapidly when management deals with both deer and invasive plants simultaneously. For example, we witnessed no change in the number of native plant species in either the unfenced woodland where invasive exotic plants were weeded or in the fenced young woodland where deer were excluded but exotic species were allowed to remain. (There was however, an increase in the overall cover of vegetation.) In contrast, in the adjacent fenced woodland from which both deer and invasive exotic plants were removed, the number and diversity of native plant species doubled.

Conclusion

Although these results are striking, the impact of deer on individual forests will vary with the site conditions, history, and type of management. In general, a reduction of deer densities will increase the abundance and diversity of herbs, shrubs and trees in most southern New England forests that support large deer herds. Fortunately deer have only been at high densities in this region for a few decades, so many natural areas retain a large number of native plants either as seeds in the soil or as inconspicuous low individuals that sprout annually but are browsed close to the ground. Consequently, if efforts are successful at lowering the deer density, it is possible that the diversity and continued regeneration of our forests will be retained.

Highstead

Expanding our studies and collaborations on New England forests and the factors controlling the distribution of exotic plant species

Ed Faison *is an ecologist at Highstead and graduated from Connecticut College with a degree in zoology. He received a MS degree from the Field Naturalist Program at the University of Vermont and a MFS from Harvard University where he studied the impact of the newly arriving moose population on the forests of Massachusetts.*

The summer of 2006 marked an important landmark for Highstead as we extended our ecological research program for the first time beyond our own boundaries and into the forested landscape on adjacent conservation lands. This collaborative foray onto Redding Land Trust, Town of Redding, and Nature Conservancy lands exemplifies two missions at Highstead: (1) to establish a research program that addresses questions at a range of geographical scales from our own land base to the broader ecological region of Southern New England and (2) to develop partnerships with local, regional and national groups engaged in research, land protection and conservation activity.

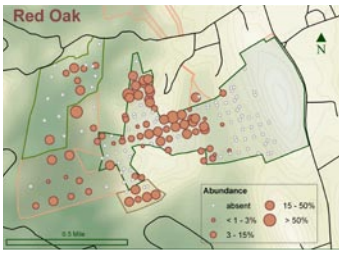
Continuing research initiated in 2004 by Harvard University scientist Dr. Betsy Von Holle, undergraduate interns Lisa Schauer and Dana Graef assisted me in this forest research project. We sampled 17 plots across Highstead's swamp, upland oak and scattered fencerow woodlands and established 45 plots on adjoining conservation lands to explore a greater diversity of forest types, conditions and histories. In total we now have 167 permanently marked plots in which every tree diameter is measured, all herbs, shrubs and trees have been identified and quantified and the local environment and soils have been analyzed. The plots are 20 x 20 m in size and are distributed and located by GPS (Geographical Positioning System) on a regular surveyed grid. All plant identifications are confirmed with the assistance of Connecticut botanical expert Bill Moorehead, and at least one collection of every species is added to the Highstead Herbarium. Collectively, these data will provide a useful infrastructure for our ongoing studies of forest environments and wildlife and will yield valuable information for our neighboring collaborators as they seek to monitor long-term changes on their properties.

Like most of Highstead's upland oak forest to the west, the swamp forest was apparently never cleared for agriculture by colonial farmers or the previous owners. However, due to the wet soil conditions the swamp is dominated by red maple (*Acer rubrum*) and spicebush (*Lindera benzoin*), similar to the woodland on the moist drumlin slopes to the east, which was cleared for pasture and reforested in the 20th century. The swamp is distinguished from this younger drumlin woodland by an abundance of yellow birch (*Betula alleghaniensis*), sweet pepperbush (*Clethra alnifolia*) and skunk cabbage (*Symplocarpus foetidus*) and by a near absence of invasive exotic species.

Ecological Research at Highstead

Identifying the Factors Controlling Exotic Invasive Species

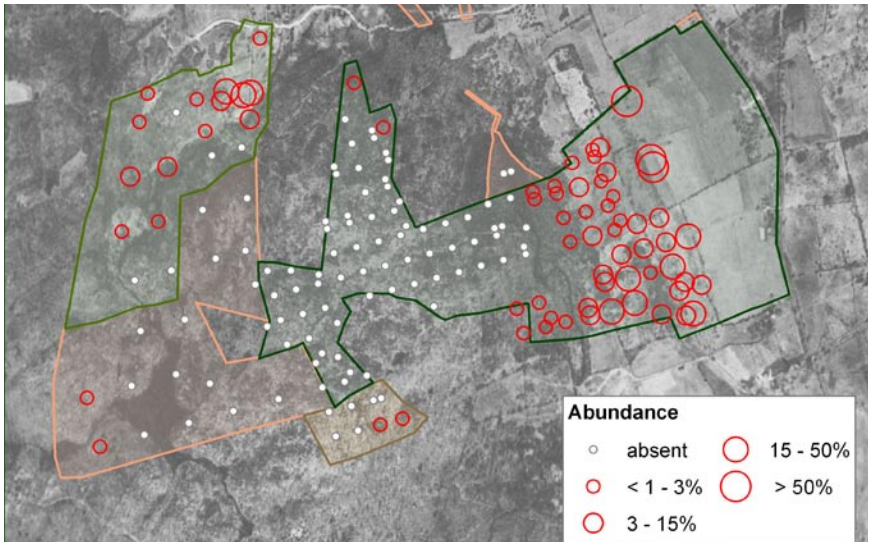
As mentioned in the spring 2006 newsletter, one of the challenges of interpreting exotic species distributions at Highstead is that the major factors that control plant distributions such as soil type and land use history are confounded with one another in this landscape. For example, the drumlin forests east of the swamp, which support abundant exotic species, were previously cleared for agriculture and have moist, fine-grained soils. In contrast, the oak forests, which lack invasive species, were never cleared for farming but occupy thin, rocky soils. Consequently, it is difficult to interpret whether past land use, soil conditions, or both are responsible for controlling the distribution of invasive species.



Red Oak

In contrast to the introduced species, native red oak is abundant across the rugged hilly terrain of Highstead and adjoining lands on sites that were never cleared for agriculture.

Fortuitously, the adjacent lands owned by The Nature Conservancy, Redding Land Trust and Town of Redding extend the breadth of forest types, soil conditions, and land use histories and allow us to disentangle some of these factors. We interpreted the land use history of these adjoining forests from various sources: 1934 aerial photos, old maps, tree ages, and artifacts such as stone walls. Soils were determined from Connecticut soil survey maps and by careful examination of pits that we dug two feet or more into the ground. Through these historical investigations we learned that the abutting properties included forests on dry, rocky soils that had been cleared in the 19th C for farming as well as forests on moist, fine-grained soils that had remained forested since European settlement. Our results from the summer field work are still being analyzed; however, preliminary observations show that exotic species like Japanese barberry (*Berberis thunbergii*) are abundant across a range of soil types but almost exclusively occur in areas that were formerly cleared for farming. Thus historical land use rather than soils appears to be the major factor explaining the distribution of at least some of our most troublesome exotic plants.



Japanese Barberry

The distribution of Japanese barberry, an exotic species, in relationship to the land use history of the Highstead region (see map on opposing page for owenership details). The dots represent the 167 plots surveyed in modern forests on Highstead, TNC, Redding Land Trust and Town of Redding land with red indicating the presence of barberry and white indicating sampled plots where it was absent. Highstead lands are outlined in bold whereas collaborators' lands are outlined in other colors.

The aerial photograph dates from 1934 when the lower slopes of the drumlin (the easternmost part of Highstead) were still in open field. Thus, the map indicates that the barberry is currently found in young forests like the red maple stands east of the swamp. Barberry is absent from almost all of the oak forests at Highstead as these were never cleared for agriculture. The red dots at the extreme northwest and west of the photo are barberry in young oak forests on TNC lands that were cleared for agriculture and established in the late 19th or early 20th C.

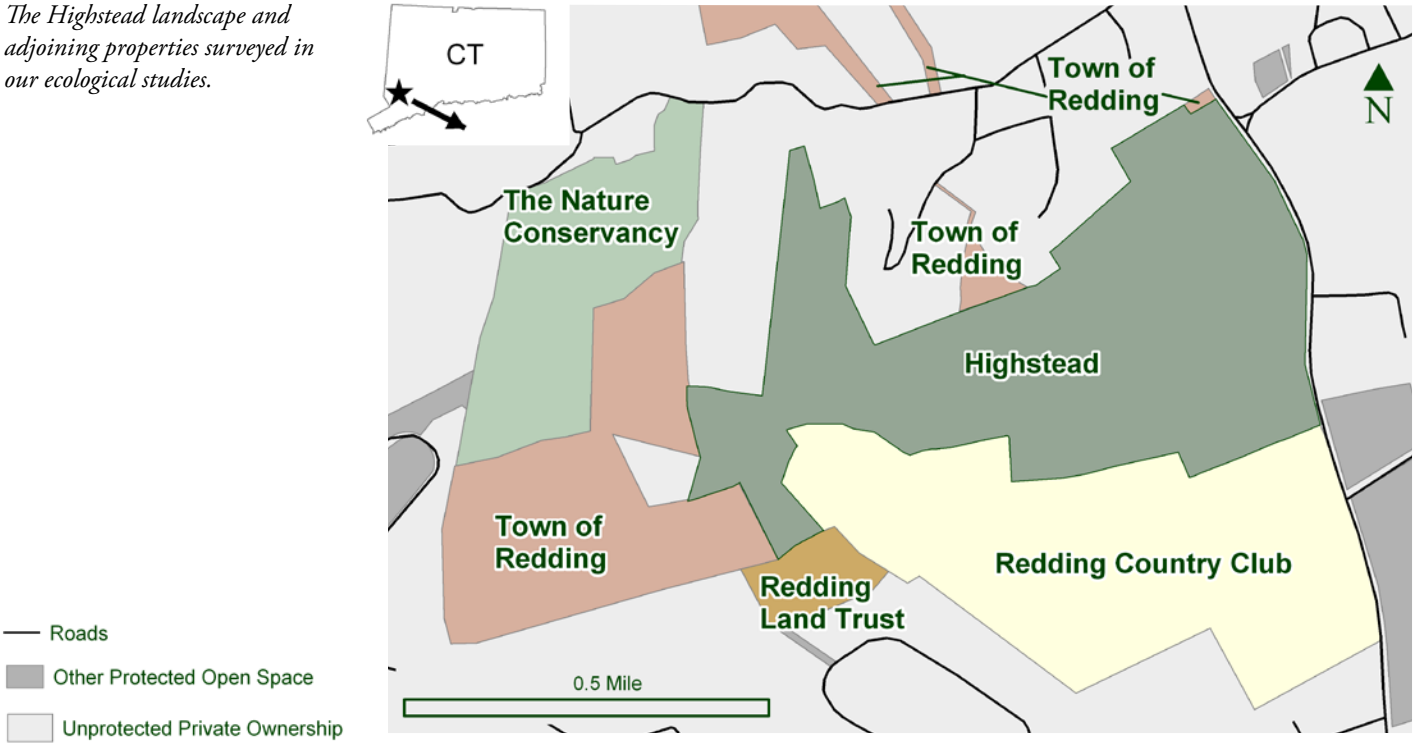
Tree Rings – A Detailed Record of Tree Growth and Forest History

In our research many details on forest history were derived from tree ring records obtained by coring to the center of the largest trees and extracting a thin dowel of wood. Trees of the temperate forest produce annual growth rings in their wood that correspond to the alternate growing and dormant seasons. Each spring and summer, trees produce water-conducting cells for growth and reproduction; in many species these appear as light-colored wood in cross-section. In the fall, trees change their strategy from water conduction to structural support and produce thicker-walled cells that appear as darker bands. In deciduous species, production of this dark "late wood" ceases when the tree becomes dormant in the winter. The following spring the new light wood contrasts sharply with the dark band from the previous fall. Under a microscope, we count and measure the thickness of these annual rings in order to assign an age to the tree and to identify periods of changing growth rate. Preliminary examination of Highstead cores shows that the oldest trees exceed 130 years and occur at the far western part of the property on sites that have been continuously forested since European settlement. On broad areas that were cleared for agriculture and subsequently reforested in the late 19th and 20th C, we find younger forests. At Highstead, the youngest stands on the flanks of the drumlin are only about 30 years old.

Conclusion

The 167 permanent vegetation plots that we have established across Highstead and surrounding conservation lands provide new insights into the relationship between land use history, forest age and variation, and the current distribution of exotic plant species. The value of this rich dataset will continue to grow over time. Forests are continuing to change as they mature and are influenced by environmental change, herbivores including deer, and a range of human and natural disturbances. Future re-sampling of these plots in this diverse range of forests will yield quantitative data on these changes. The information will also be an invaluable resource for future studies by us and our collaborators as we investigate many other aspects of these forest ecosystems.

The Highstead landscape and adjoining properties surveyed in our ecological studies.



Summer Undergraduate Internship Program Established

Highstead

Students contribute to Highstead Research while applying classroom lessons and learning new approaches to science

Dana Graef and Lisa Schauer focused on field measurements in a dense forest stand on Redding Land Trust property.

Based on a successful trial program in 2004, this past summer Highstead established an undergraduate internship program and invited Lisa Schauer (New Mexico State University) and Dana Graef (Princeton University) to spend 12 weeks working on our forest ecology project. The internship program was developed in collaboration with Harvard University's Summer Ecology Program for Undergraduates and is open to students nationwide. Participating students undertake hands-on research where they can apply their classroom backgrounds to active research problems working with Highstead and collaborating scientists and staff. While this program greatly extends the research, educational, and conservation goals of Highstead, it provides students with the training, research skills, and experience needed to make and advance graduate school and career decisions.

This summer Lisa and Dana worked closely with ecologist Ed Faison and greatly enhanced their skills in plant identification, field sampling, dendrochronology, orienteering, and data analysis. In the future, we anticipate selecting two to four undergraduates annually to work on a range of projects in ecology, conservation biology, conservation planning, and plant collection development and management. Students are provided a stipend and housing and participate in lectures, field trips and related educational activities.

For additional information students interested in the program should visit http://harvardforest.fas.harvard.edu/education/reu/reu.html.

Openings for the Summer of 2007 will be posted in December and applications will be due in March 2007.

Questions may be addressed to Ed Faison at Highstead, efaison@highsteadarboretum.org or 203-938-8809.

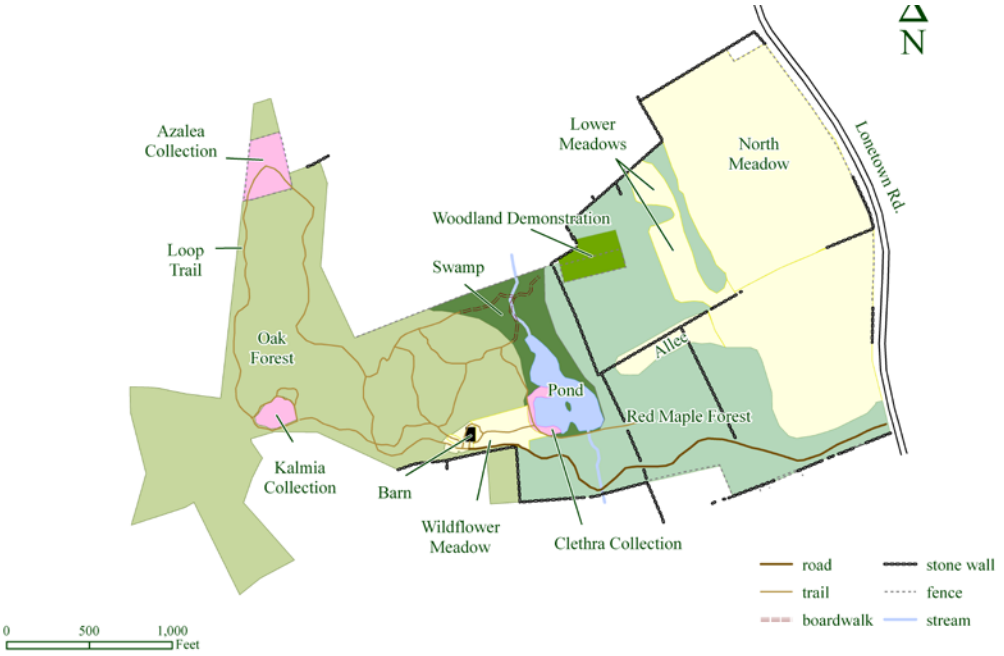
Highstead

Kalmia:
Native and cultivated mountain laurel

Kathleen Kitka *is the Landscape and Collections Manager at Highstead where she is responsible for developing and curating the Kalmia, Clethra, and Azalea Collections, overseeing the native tree and shrub walk and other self-guided trails, and leading informal educational programs.*

An arboretum, loosely defined, is a living museum of woody plants that provides meaningful contributions to research, education and aesthetic appreciation. At Highstead's Arboretum, the plant collections provide conservation and educational value to our visitors while the landscapes in which they are displayed yield visual aids for understanding and interpreting the geological setting, environment, and land-use history of southern New England. Extremely well documented collections like Highstead's, which are as complete as possible for this temperate climate, offer additional opportunities for scientific inquiry for professionals. They also enable Highstead to participate in a network of institutions that curate and preserve plants worldwide.

Over the past year we have been engaged in an intensive effort to document and map all of our collections and develop management plans that outline the purpose, collection philosophy and specific management regime for each of these areas. Below, as an example of this broad approach, we review the Kalmia collection and the broad directions that we envision for its future. The Kalmia area is the Arboretum's oldest collection and is comprised of two distinct sections: a native stand of mountain laurel (*Kalmia latifolia*; the Connecticut state flower) that forms the understory in more than forty acres of Highstead's oak forest and a one-acre concentrated display of over seventy *Kalmia* species, forms, and cultivars.



The Highstead landscape showing the Kalmia and Azalea collections (pink) along the Loop Trail. The cultivated Kalmia Collection is surrounded by an extensive natural area in which native Kalmia populations fill the understory of a mixed oak forest.

Highstead's Native Kalmia Stand

A walk through the Kalmia collection in early June introduces visitors to the beauty of Connecticut's woodlands and the mountain laurel in bloom. The varied perspectives also display the magnificence of Kalmia's structure, form, and habitat, which are shaped, in part, by Highstead's diverse topography, soils and history of natural and human processes. Many forces have shaped the native stands including drought, fire, cattle grazing, logging and more recent horticultural activities; collectively they enhance the aesthetic and ecological attributes of this landscape. The subtle history of these activities is exposed in the sprouting form, twisted shapes, and varied density of the native shrub and its tree, shrub, and herbaceous companions.

The native stand of mountain laurel was one of three natural communities selected for a 1992 study on basal burl formation in *Kalmia latifolia* undertaken by Peter Del Tredici at Harvard University's Arnold Arboretum. Burls are modified stem tissue located at or just below ground level that enable mountain laurel and other species including coastal redwood to re-sprout following injury. Among other results Dr. Del Tredici's research revealed that tissue-cultured plants exhibited a tendency towards reduced burl formation. Lacking this structure it is quite likely that plants propagated for the nursery trade may have limited ability to survive traumatic injury.

Highstead Board member, Dr. Peter Del Tredici on the Swamp boardwalk.

The native Kalmia form one of the natural areas at Highstead that are the subject of long-term ecological research in addition to intense botanical scrutiny (see adjoining article on ecological studies by Ed Faison). In the future we have no plans for active management of this area, which forms one of our living laboratories and classrooms. We will continue to measure the growth of trees and other changes in vegetation here and will encourage other researchers to bring additional questions and studies to these attractive oak woodlands.

The Cultivated Kalmia Collection

The one-acre Kalmia display set inside the larger natural area presents an opportunity to compare the characteristics of wild mountain laurel with those plants selected, hybridized and raised for cultivation. This focused collection presents an immense range of cultivars that emerged through the work of many plant breeders and horticulturists, most notably Dr. Richard A. Jaynes from Broken Arrow Nursery in Connecticut. Many of the cultivars displayed at Highstead are widely available through nurseries for use in home landscapes. Whether the Kalmias are in bloom or not, a wealth of information is available for study and further enjoyment of these broad-leaved evergreens. Readily available information includes accession records, maps, photographs, herbarium specimens, and library materials at Highstead and color images that can be viewed on-line.

Highstead maintains the most complete laurel collection of any botanical garden worldwide and consequently receives national and international attention. In 1995 the Arboretum was granted official status as holder of the genus *Kalmia* by the North American Plant Collections Consortium (NAPCC) - a division of the American Public Gardens Association (formerly American Association of Botanical Gardens and Arboreta). Highstead is the first collection in the northeastern U.S. to participate in the consortium, which was formed in the early 1990's to ensure the future biodiversity of plants in North America. In 2003, the Council of the International Society of Horticultural Science appointed Highstead as International Cultivar Registration Authority (ICRA) for *Kalmia*. As Registrar, the Arboretum is responsible for processing, recording and publishing cultivar names. Highstead is currently a participant in the IMLS Networking Plant Databases Project – a tool that will enable sharing of plant collections information worldwide, which will raise the profile of NAPCC collections and its important work. Having established a magnificent collection of cultivars, our long-term plans for this portion of the Kalmia collection are to maintain existing holdings, add new material at a measured pace, and encourage visitor enjoyment and educational opportunities in this unusual landscape.

Conclusion

The Kalmia collection, with its extensive native stands and diverse range of cultivars reflects the long-standing commitment at Highstead to combine aesthetic appreciation with opportunity for research and education, all presented with a standard of excellence. By highlighting the state flower of Connecticut this collection embodies the Highstead mission that is centered on native evergreens in their wild and cultivated condition.

127 Lonetown Road
P.O. Box 1097
Redding, CT 06875

203.938.8809

www.highsteadarboretum.org