Long Island Botanical Society

Vol. 17 No. 4 | The Quarterly Newsletter | Fall 2007

Regional and Global Environmental Threats to Long Island's Pine Barrens

Gilbert N. Hanson
Department of Geosciences, Stony Brook University

There are a number of regional and global environmental threats that are influencing and will continue to influence the plant communities of Long Island's Pine Barrens and other undeveloped natural areas on Long Island. These include acid rain, ground level ozone, increased atmospheric CO_2, and global warming. All of these are interrelated and associated with the use of fossil fuels as an energy source. These are threats that we cannot mitigate on the local level. Their mitigation requires national and global action. To a certain extent we will be observers of an ecological change that we need to understand.

The Long Island Pine Barrens contain a tremendous variety of ecosystems. Besides the Pine Barrens, there is a unique area of dwarf pine plains, coastal dune ecosystems, and fresh and saltwater wetlands that support the greatest diversity and number of rare and endangered species in New York State. The environmental threats may affect endangered species as well as the more common species that may not be able to cope with the changes that are occurring.

As a result, we may see the introduction or survival of mainly species that can thrive in or at least be tolerant of a warmer climate, higher atmospheric CO_2, acid soil, and ground level ozone. This report gives just a hint of what may be happening to our air, soil, and water. Better documentation based on continued research and monitoring are necessary so that it will be possible to predict what may happen to the plant communities in our Pine Barrens and to explain at each stage what is happening and why to the Long Island citizenry.

Acid Rain

The main sources of acid rain are the addition of sulfur oxides to the atmosphere by the burning of coal primarily for electricity generation west and south of Long Island and the addition of nitrogen oxides to the atmosphere from internal combustion engines and from other high-temperature combustion such as in furnaces.

Prior to World War II acid rain was a less serious problem in this area. Natural rain without the anthropogenic sulfur and nitrogen oxides has a pH of about 5.6 as compared to a neutral pH of 7. The natural acidity is due to the carbon dioxide in the atmosphere that forms carbonic acid. By 1970s, however, it was noted that lakes and streams in northeastern North America were becoming more acidic and that a major source was the burning of coal. This was recognized as a regional problem and the Federal Government became involved. In 1980, Congress passed an acid deposition act. In 1990, amendments were made to the Clean Air Act to reduce emissions of sulfur and nitrogen oxides. As a result, there has been a slight increase in the pH of rain in northeastern North America. Greller *et al.* (1990) report that from 1970 to 1975, precipitation in Flushing, N.Y. had a pH of 3.6 to 4.2 in the summer and 4.2 to 4.8 in the winter. In 1994, the average pH for precipitation for the region including Long Island was 4.3 to 4.4. By 2005, acidity decreased some so that pH was 4.6 to 4.7 (National Atmospheric Deposition Program).

Howard *et al.* (2004) analyzed soil samples in 1998 from 21 separate sites in the Pine Barrens in Suffolk County and 22 sites from mixed hardwood forests in Suffolk and Westchester Counties. They found that the soil pH was consistent and averaged 3.38 ± 0.05 (one standard error) in the Pine Barrens and 3.53 ± 0.04 (one standard error) mixed hardwood forest.

Are these low soil pH values natural and not a result of acid rain? Bailey *et al.* (2005) note that it is hard to find places in the northeastern U.S. where it is possible to compare soil pH analyzed before acid rain to answer this question. They did study a site in the Allegheny Plateau where they were able compare soil pH that they analyzed in 1997 with a study in 1967, but rain

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Society News

LIBS hosted a visit of the Niagara Frontier Botanical Society to Suffolk County on August 29, 30, and 31. Eric and Mary Laura Lamont took them to Orient Point, the Sunken Forest, the Riverhead Bog, North Hubbard Creek Marsh, North Street in Manorville, and to the Calverton Ponds, plus a number of other spots. Rich Kelly, Andy Greller, and Barbara Conolly assisted. The list of rarities that were recorded on these three days will be reported in the next newsletter.

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Steve Clemants announced the publication of a new botanical book: *A Field Guide to Native Plants of the New York City Region* by Margaret Gargiullo.

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Steve Young is compiling information on the flowering and fruiting dates of rare native plants in our area.

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LIBS is in the process of creating an index of back issues. Once our back issues have been published on the Web site, this index will enable researchers to quickly find articles containing references to individual species. The index will also include authors, LIBS members, localities, and phenomena.

We hope to accomplish this with automated indexing software, but at this moment are considering the possibility that manual indexing is more feasible. Anyone who is able to help by spending a few hours going over back issues is asked to contact Margaret Conover.

Under the supervision of Jessica Gurevitch, graduate student Camilo Salazar will compile the species data and document the frequency with which LIBS members have reported invasive species, as it has changed over time.

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Marilyn Jordan reported that, on July 12, Suffolk County Executive Steve Levy signed Local Law 22-2007, a law to prohibit the sale, introduction, and propagation of invasive, nonnative plant species. The law states, in part, that beginning January 1, 2009, 57 invasive plant species will be banned, including such common menaces as multiflora rose (*Rosa multiflora*), wineberry (*Rubus phoenicolasius*), lesser celandine (*Ranunculus ficaria*), princess tree (*Paulownia tomentosa*), and purple loosestrife (*Lythrum salicaria*). Several additional species are to be banned in the following year. You can read the text of the law at the Suffolk County Legislature Web site at http://www.co.suffolk.ny.us/legis/. Click on "Online Documents," then "Search the Laws of Suffolk County." Enter 22-2007 in the search box at the bottom left.

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was already acidic by 1967. They did, however, find a significant decrease in soil pH that they attributed to the effects of acid rain (pH=3.8 in 1967 and pH=2.9 in 1997 for the Oa/A soil horizon).

An important study for Long Island is that of Wherry (1923) who in 1922 did an extensive survey of the soil pH and plant types in the Hodenpyl Estate in Locust Valley. Greller *et al.* (1990) repeated the survey in 1985. The results showed a significant decrease in the soil pH over this period (see Table 1). The estate is dominantly a deciduous forest on the Harbor Hill Moraine and has more than 100 feet of relief. The soil in the bottomland or bottoms of valleys showed the largest change—from a pH of 6.5 in 1922 to a pH of 4.1 in 1985. Because pH is on a logarithmic scale, this is actually an increase in acidity by a factor of 250. Greller *et al.* (1990) also found that the flora had become less diverse since the 1922 study with acid tolerant species more common in all areas whereas Wherry (1923) had found acid tolerant species mainly on the ridge tops. Greller *et al.* (1990) concluded that the change in soil pH was a result of acid rain.

Acid rain affects both the soil and surface water environments (Driscoll *et al.,* 2001), resulting in altered soils, stressed forest vegetation, and acidified lakes and streams. Many fish and other aquatic life cannot survive in acidified water. The effects in the water include not only a decreased pH but also a decrease in total base cations in the water and an increase in aluminum. Aluminum is a poison to many plants at high concentrations.

The chemistry of calcium and aluminum in the soil is seriously affected by acid rain. Organic and mineral particles in the soil attract the base cations. These base cations are dominantly calcium, magnesium, sodium, and potassium. Acid rain is buffered by the base cations that are adsorbed onto organic and soil particles. As long as there is a sufficient amount of base cations ,the soil pH should not be affected.

Calcium in particular is an important nutrient for plants. Weathering of the minerals in the soil profile may provide base cations. A study, however, by Xin and Hanson (1994) of the strontium budget of the Peconic River watershed suggests that most of these cations are deposited as dry precipitation (dust). (Strontium is a trace base cation similar to calcium.) Weathering is probably not an important source in the Pine Barrens as the sandy soil is dominated by quartz, which has no base cations. This means that base cations must be continually added to the soil–plant system by dry deposition.

Table 1. pH of soil in Locust Valley (Greller *et al.,* 1990).

Habitat	1922	1985
Bottomland	6.5	4.1
Slopes	5.5	3.9
Ridge tops	4.5	3.8

Acid rain causes the pH of the soil to decrease. As a result, aluminum hydroxide in the soil, which is very insoluble, is converted to a soluble form. The soluble aluminum ions displace the other base cations adsorbed onto the soil particles, and they are transported down the soil column. The farther they are transported the less available they are to the plant root systems.

As a result, the first evidence of the effects of acid rain is an increase in the calcium content in plants that take up the calcium displaced by aluminum. Later there is a decrease in the calcium content of plants because there is less calcium adsorbed onto the soil particles. These effects can be preserved in a tree's growth rings.

Associated with the acid rain is the deposition of nitrogen and sulfur oxides. Nitrate is a fertilizer and can affect plant communities that can thrive in a nitrogen-poor soil. The acid rain also kills off some of the microorganisms that break down the organic matter in the soil, damages the roots of plants, which results in stunted growth, and also damages the leaves of plants, which makes them vulnerable to disease.

Boguslavsky (2000) studied soil profiles on Long Island, including soils in the Central Pine Barrens. She found high percentages of exchangeable Al adsorbed

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Table 2. Percentage cation exchangeable Al and Ca relative to other major cations (Mg, Fe, Mn, Na, and K) and molar Ca/Al ratios (Boguslavsky, 2000).

Depth (cm) Cathedral Pines	Equivalent Al % Cathedral Pines	Equivalent Ca % Cathedral Pines	Molar Ca/Al Cathedral Pines	Depth (cm) Fox Pond	Equivalent Al % Fox Pond	Equivalent Ca % Fox Pond	Molar Ca/Al Fox Pond
0–30	75%	8%	0.16	5–20	60%	25%	0.63
30–60	82%	3%	0.06	20–30	62%	20%	0.48
60–90	79%	6%	0.11	30–50	80%	19%	0.35

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onto the soil particles. Table 2 shows the results for two sites: one in the Cathedral Pines County Park and the other near Fox Pond, Calverton, N.Y. The Cathedral Pines section was about 7 meters above the water table in a deciduous forest. The Fox Pond site was about 50 cm above the water table in a pitch pine-oak forest. These values show that in areas like the Cathedral Pines and Fox Pond there is a strong enrichment in exchangeable aluminum relative to calcium. Cronan and Grigal (1995) suggest that there is a 50% risk of adverse effects on tree growth or nutrition if the molar Ca/Al ratio is 1.0, a 75% risk at 0.5, and 100% risk if the ratio is 0.2 or less. If they are correct, the trees in the Pine Barrens may be facing adverse effects.

Lawrence and Hanson (1998) studied the chemistry of tree rings in five-year intervals from two tulip poplars in Caumsett State Park and two pitch pines in the Pine Barrens (Fig. 1). The data suggest that the calcium content of tulip poplars, while quite variable, may have increased since the 1920s. An increase in calcium in the tree rings is the first sign of acid rain effects. The calcium abundances in the pitch pines suggest that there may be a decline in calcium content in these trees since the 1960s. This would be consistent with the low calcium concentrations that Boguslavsky (2000) found in the soil profiles and suggests that the trees may have entered a more advance phase of base cation depletion in the soil associated with acid rain. The number of trees analyzed, however, is too few, and more trees need to be analyzed to better document any possible effects.

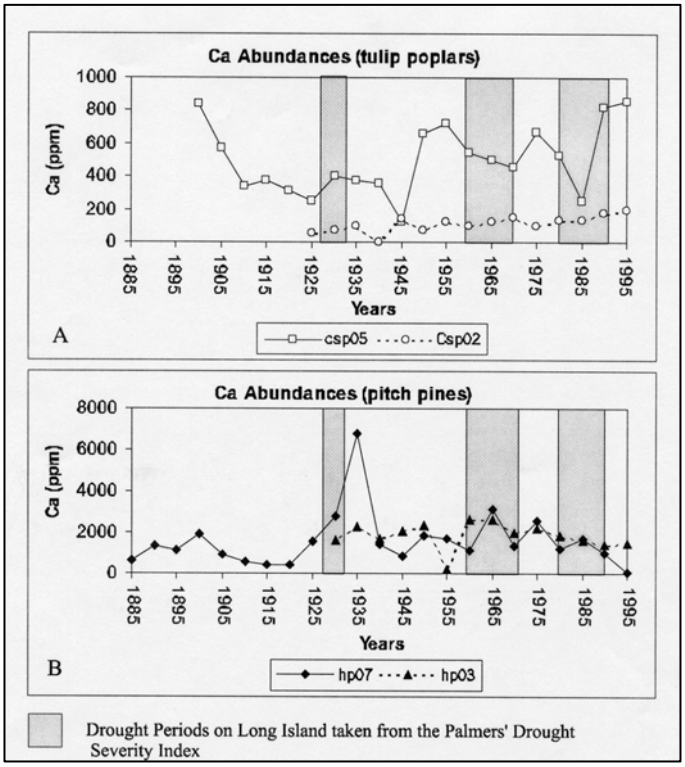

Fig. 1. Calcium abundances observed in tulip poplars (A) and pitch pines (B) with time, with Long Island drought intervals indicated in gray bars (Lawrence and Hanson, 1998).

There has been an increase in the pH of rain (reduced acidity) as a result of the clean air act that limited sulfur and nitrogen oxide emissions. Associated with the increase in pH has been a decrease in base cations in the rain. Recovery from acid rain requires not only an increase in pH but also in making available more base cations that can replace the exchangeable aluminum on the soil particles. Even if we can increase the pH of rain significantly, it will take decades for the soil–tree systems to recover. This recovery probably cannot even start without greater reductions in sulfur and nitrogen oxide emissions from power plants and motor vehicles (Driscoll *et al.*, 2001).

Other Environmental Threats

It is not just that acid rain is stressing plants in the Pine Barrens and other undeveloped areas on Long Island but that these areas will also be facing the effects of rising CO_2 levels, climate change, and ground level ozone. The latest Northeast Climates Impact Assessment (Frumhoff *et al.*, 2007) predicts that climatic zones in the eastern U.S. will shift between 350 and 500 miles to the north by the end of this century. This is expected to result in an increased frequency of extremely hot days and one- to three-month droughts every summer. The culprit thought to be responsible for global warming is increasing CO_2. Some plants can do better with a higher CO_2, others not as well. Individual plant species will migrate across the area as some plant species find the conditions more favorable and others find conditions less favorable.

Ground level ozone results in foliar injury and reduced growth in plants (Krupa *et al.*, 2001). Ground level ozone is directly related to motor vehicles exhaust. It is created when sunlight on a hot sunny day interacts with organic compounds and nitrogen oxides in the atmosphere forming smog and ozone. Often the highest concentrations of ground level ozone are downwind of metropolitan areas where natural organic compounds from forested areas react with the nitrogen oxides (Chappelka and Samuelson, 1998). Prior to World War II, background levels of ground level ozone were 10 to 20 ppb. Background ozone levels are expected to increase by 0.5–2% per year (Vingarzan, 2004) as a result of increased emissions of nitrogen oxides unless there is a global effort to reduce nitrogen oxide emissions. Background ground level ozone can be expected to increase to 70 ppb by 2050.

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Damage to plants appears to be a function of dose: the duration as well as the concentration. Plants can be affected at levels of 40 ppb and serious damage can occur at levels greater than 80 ppb. Lefohn *et al.* (1997) state that, "Ozone is considered the pollutant of greatest concern with respect to the potential regional impacts to trees in North America." This ozone is not only dangerous to plants it is also dangerous to humans (Ashmore, 2005). The American Lung Association (2006) gives Suffolk County an "F" as in Failing for the high ground level ozone in the county. With continued global warming we can expect hotter summer days with increased production of ground level ozone added to an expected increase in background ozone.

Conclusion

What is the conclusion? We cannot preserve the present Pine Barrens plant communities. They are going to change. Can we affect how they change? I do not know. But we need to be able to explain to the public what is happening and why it is happening. There are going to be dying plants and there will be exotic plants replacing them. We need to monitor the environmental threats to the Pine Barrens, and we need to be aware of which plants are more sensitive to the individual environmental threats. Whether we just sit back paying no particular attention or just document the changes or try do something about the changes is a management decision that must be made.

Acknowledgments

I want to thank Margaret Conover for inviting me to prepare this document; Marilyn Jordan for discussions and bringing the Greller *et al.*, 1990, and Wherry, 1923, studies to my attention; and Jessica Gurevitch, Gary Halada, and Glenn and Sandy Richard for encouraging me to look harder at the regional and global environmental threats to Long Island's Pine Barrens.

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Plant Sightings

Bob McGrath reported that the Lazy Point population of pale crested orchid (*Platanthera pallida*) in Napeague has been suffering terribly from deer browsing. Although the population is still very large, Bob estimates that in some areas seven out of every 10 plants had been browsed in 2007.

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Eric Lamont reported that the population of white fringed orchid (*Platanthera blephariglottis*) at Quogue Wildlife Refuge had a banner year in 2007. Eric counted 196 flowering individuals during early August, compared to a previous high of 88 in 2001. During the early 1990s, the population was on the verge of extirpation due to succession of the open fen into a closed shrubland; in 1996 a restoration and management plan was successfully implemented.

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Rich Kelly located a population of white fringed orchid along the uppermost headwaters of Quantuck Creek, just south of the railroad tracks, in Quogue. It is possible that this population might be the same one reported by Clarke in 1891 and Kobbe in 1903. Rich also reported five flowering individuals of the green adder's-mouth orchid (*Malaxis unifolia*) along North Street in Manorville and great lobelia (*Lobelia siphilitica*) at the Welwyn Preserve in Glen Cove.

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Steve Glenn reported a large adventive population of centaury (*Centaurium erythraea*), a member of the Gentian Family, from behind a park on Route 25, a quarter-mile northeast of Chapel Lane in Southold. The LIBS draft atlas of Long Island plants also records this species from Southold Township, but we have not yet determined if Steve's report represents a new sighting. Steve and Martin Bennett also reported English daisy (*Bellis perennis*) as naturalized along Shore Road in Cold Spring Harbor, Huntington Township; this report is a first for Suffolk County.

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Guy Tudor reported wild ginger (*Asarum canadense*) from just east of the railroad tracks in Forest Park, Queens County. This native wildflower was reported as rare from Queens County by Jelliffe (1899) in his *Flora of Long Island*, and Guy's report is the first recent record of this species for western Long Island. Guy also reported the nonnative cutleaf blackberry (*Rubus laciniatus*) from Forest Park.

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Andy Greller reported stickseed (*Hackelia virginiana*), a member of the Borage Family, from Alley Park; the native *Pachysandra procumbens* growing "in the wild" at Oakland Lake; and Chinese chestnut (*Castanea mollissima*) reseeding at the William Cullen Bryant Preserve in Roslyn. Andy and Michael Goudket reported nettle-leaved salvia (*Salvia urticifolia*) as persistent and possibly escaping from cultivation at the Old Bethpage Village in Nassau County

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Mary Laura Lamont reported a population of the broad beech fern (*Phegopteris hexagonoptera*) from woodlands at Peconic Dunes County Park; the last verified report of this fern from the North Fork was by Roy Latham in 1914. Mary Laura also reported mile-a-minute (*Polygonum perfoliatum*) as a new invasive at Orient Beach State Park.

◆

Barbara Conolly reported that the population of spreading goldenrod (*Solidago patula*) at Shu Swamp Preserve in Mill Neck was in severe decline, apparently being crowded out by shrubs and other vegetation; this goldenrod is rare to uncommon on Long Island. Barbara also noted that the squawroot (*Conopholis americana*) at Shu Swamp had not appeared during the past two years. Barbara, David Laby, and Michael Feder were "turned on by a pond ablaze with *Nymphoides peltata*, yellow floating-heart" on the LIBS field trip to the west edge of Brookhaven Preserve in July.

◆

On the June 23 LIBS field trip to the Scully Sanctuary in Islip, Eric Lamont collected and keyed out European hawkweed (*Hieracium lachenalii*) from a roadside just outside the sanctuary; this is the first Long Island record of this species according the LIBS draft atlas of Long Island plants.

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Richard Stalter reported the rare narrow-leaved bush-clover (*Lespedeza angustifolia*) from dry sandy soils at Brookhaven National Lab in Yaphank.

◆

Steve Young and Eric Lamont found a small population of the very rare screw-stem (*Bartonia paniculata*) at the junction of Upper and Lower Red Creek Road in Flanders. At the north end of Hubbard Creek marsh they located new populations of southern dodder (*Cuscuta obtusiflora* var. *glandulosa*) and southern seaside goldenrod (*Solidago sempervirens* var. *mexicana*), and relocated populations of saltmarsh loosestrife (*Lythrum lineare*), marsh fimbry (*Fimbristylis castanea*), seaside gerardia (*Agalinis maritima*), and seaside plantain (*Plantago maritima* subsp. *juncoides*), but they did not find the rare swamp sunflower (*Helianthus angustifolius*). Steve and Eric also searched the Shinnecock Indian Reservation for rare plants but only found one small population of rough

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Field Trips

SATURDAY, OCTOBER 13, 2007, 11 A.M. - 2 P.M.
Clark Botanic Gardens and the grounds of The Science Museum of Long Island (Leeds Pond Preserve)
Albertson and Plandome, Nassau County, NY
Trip Leader: Peter Warny
Meet at the Clark Botanic Gardens, located at 193 I.U. Willets Road between Roslyn Road and Willis (Mineola) Avenue). After an hour tour of the Botanic Gardens, drive to the 35-acre grounds of the Science Museum's Leeds Pond Preserve. See the beech forest (with kudzu), swamp, and the brackish Leeds Pond. End up on the beach with pricklypear cactus and developing salt marsh.

Directions: *By car:* Northern State Parkway to Exit 29 (Roslyn Road), turn left onto Roslyn Road, then right onto I.U. Willets Road, followed by a right into the Clark Botanic Garden parking field, just before the railroad crossing —OR—Long Island Expressway to Exit 36 and turn south onto Searingtown Road. Go about 1 mile, and then turn left onto I.U. Willets Road. Go about 3/4 mile, crossing over railroad tracks. Clark Garden is on your left.
By train: LIRR Oyster Bay line to Albertson station. The Garden is immediately east of the station.
By bus: N23 or N27 bus to I.U. Willets Road, then walk east 1/4 mile.

There is no fee for parking, and a $2 voluntary admission donation. For more information on the Clark Botanic Gardens, visit www.clarkbotanic.org.

Plant Sightings *(Continued from page 34)*

hedge-nettle (*Stachys hyssopifolia*). They unsuccessfully tried to relocate a historical occurrence of the very rare pink milkwort (*Polygala mariana*), but did find bitter milkwork (*Polygala polygama*).

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Ray Welch reported a nonplant sighting: two huge sassafras trees, close to record size, were recently cut down at the intersection of Horseblock Road and Portion Road in Holbrook.

Upcoming Programs

October 9, 2007* Tuesday, 7:30 p.m.
WEI FANG: "NATURE OR NURTURE: SOURCES OF VARIATION IN GROWTH, FORM, AND SURVIVAL IN DWARF AND NORMAL-STATURE PITCH PINES (*PINUS RIGIDA, PINACEAE*) OF LONG ISLAND PINE BARRENS." This talk is based on a recent publication in the American Journal of Botany (Fang *et al.,* 2006) about long-term transplant experiments (1996 to now) in the Long Island Pine Barrens.
Location: Bill Paterson Nature Center
Muttontown Preserve, East Norwich

November 13, 2007* Tuesday, 7:30 p.m.
VINCE PUGLISI: "FOSSIL POLLEN STUDIES." This program will explain how core samples containing fossil pollen can be indicators of past climatic change, based on species composition and pattern of deposition.
Location: Bill Paterson Nature Center
Muttontown Preserve, East Norwich

EXECUTIVE BOARD MEETING 6:15 p.m.
All members are invited to attend the Executive Board Meeting to be held before Vince's program begins.
Location: Bill Paterson Nature Center,
Muttontown Preserve, East Norwich

December 11, 2007* Tuesday, 7:30 p.m.
ANDREW GRELLER: "CYCADS: A DISTINCTIVE GROUP OF GYMNOSPERMS." The talk will cover a wide array of topics on this group that evolved before the dinosaurs. They have many chemicals which are unknown in other groups, and are used in anti-cancer experiments. Cycads are valuable landscape plants.
Location: Bill Paterson Nature Center
Muttontown Preserve, East Norwich

More Programs ⟶

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PO Box 507
Aquebogue, NY 11931

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Aquebogue, NY 11931

More programs…

Reminder: our schedule has changed, and there will be no meetings in January or February.

March 11, 2008* Tuesday, 7:30 p.m.
MEMBERS' NIGHT: Members are welcome to bring slides, stories, specimens, and tales of peculiar sightings of favorite plants. A great opportunity to show what you have found while exploring on Long Island or elsewhere. Please call Rich Kelly in advance to advise as to the approximate number of slides/images that you would like to show and preferred medium of presentation. Thanks.
Location: Bill Paterson Nature Center
Muttontown Preserve, East Norwich

* Refreshments and informal talk begin at 7:30 p.m. Formal meeting starts at 8:00 p.m.

Local Flora Committee

The Local Flora Committee will hold a special meeting at some point this fall to meet with Steve Young. Steve is the chief botanist with the New York Natural Heritage Program. He has phenology data for plants found on Long Island and would like to get our local, expert input and comments on the data. If you are not a regular member of this committee and would like to attend, please contact either Steve Clemants or Rich Kelly, and we'll let you know when the date and location have been established.