8-1956

Bulletin No. 9: Six points of Especial Botanical Interest in Connecticut

Richard H. Goodwin

Frank E. Egler

William A. Niering

Charles E. Olmsted

David M. Smith

See next page for additional authors

Authors
Richard H. Goodwin, Frank E. Egler, William A. Niering, Charles E. Olmsted, David M. Smith, Henry W. Hicock, Herbert I. Winer, and Edward C. Childs

THE CONNECTICUT ARBORETUM

SIX POINTS OF ESPECIAL BOTANICAL INTEREST IN CONNECTICUT

CONNECTICUT COLLEGE
NEW LONDON, CONNECTICUT

25 TH
ANNIVERSARY

BULLETIN NO. 9
AUGUST 1956

THE CONNECTICUT ARBORETUM

BULLETIN NO. 9 **AUGUST 1956**

CONTENTS

THE CONNECTICUT ARBORETUM ASSOCIATION

Association membership comprises organizations and individuals interested in supporting the Arboretum and its program. Members receive Arboretum publications and enjoy other privileges, including notices of special field trips, reduced prices on season tickets to the Nature Screen Tours, and the use of Arboretum facilities.

Individual memberships: annual, \$5; sustaining, \$10.

Organization memberships: annual, \$10; sustaining, \$25; supporting, \$100.

Checks should be made payable to the Connecticut Arboretum and sent to the Director, Dr. Richard H. Goodwin, Connecticut College, New London, Conn.

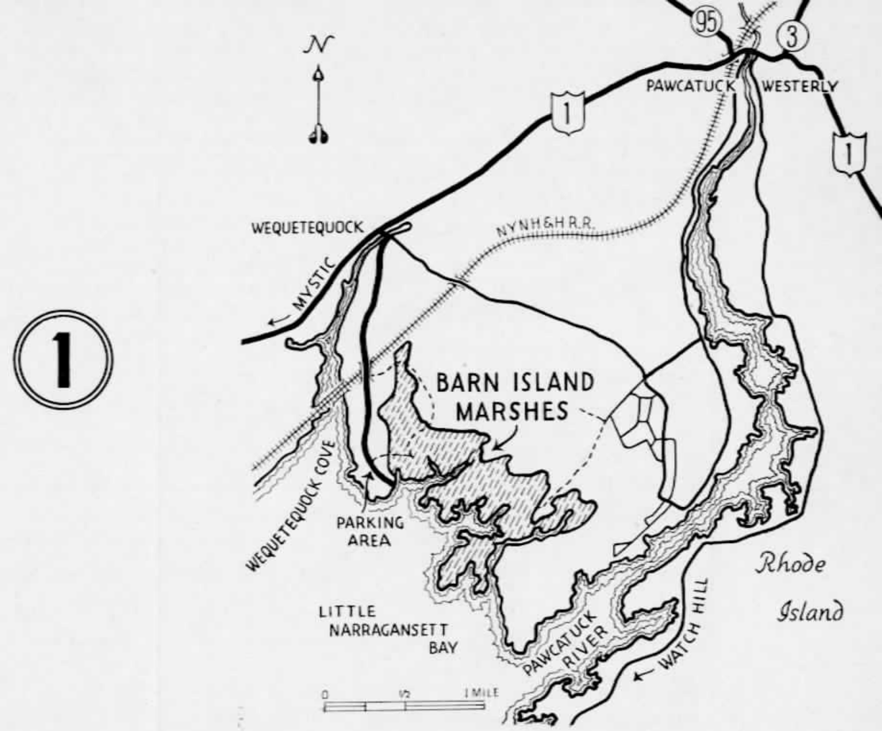
Foreword

TWENTY-FIVE YEARS ago the Trustees of Connecticut College set aside sixty-four acres of woodland and abandoned pasture, then owned by the College, for the establishment of the Connecticut Arboretum. During the past quarter century the Arboretum has more than quadrupled in size, while its plantations have been laid out and its program of education and research has been developed. Today the Arboretum is one of the private institutions in Connecticut playing an active role in the conservation movement.

This bulletin has been prepared to celebrate the Arboretum's twenty-fifth anniversary. It is our hope that it will serve to introduce visiting scientists attending the meetings of the American Institute of Biological Sciences, as well as residents of the state, to a few places of especial botanical interest in Connecticut. These spots will be visited on the August 30-31 field trip planned for members of the Ecological Society of America and other interested persons.

Richard H. Goodwin

Director



The Barn Island Marshes

FRANK E. EGLER, *Aton Forest, Norfolk, Connecticut*

THE BARN ISLAND MARSHES, referred to elsewhere as the Wequetequock-Pawcatuck tidal-marsh (2) is a single compact unit of about 0.5 square mile, in New London County, lying close to the Rhode Island border. The marshes occupy a protected area bounded on the west by a headland at the mouth of Wequetequock Cove, on the east by a headland at the mouth of the Pawcatuck River, and on the south by Little Narragansett Bay, which is separated from Long Island Sound by bars and islands extending west from the Rhode Island mainland.

The marsh is not only continuous between the headlands of the two rivers, but it extends up as fingerlike projections into six minor valleys, of which the westernmost one is considerably larger than the other five.

This area, with its uniform bay-front marsh, and its six essentially similar "valley-marshes," makes the region ideally suited for a research program involving different treatments for each of the valleys. In these respects, the Barn Island Marshes are unsurpassed by any other marsh on the coast of Connecticut.

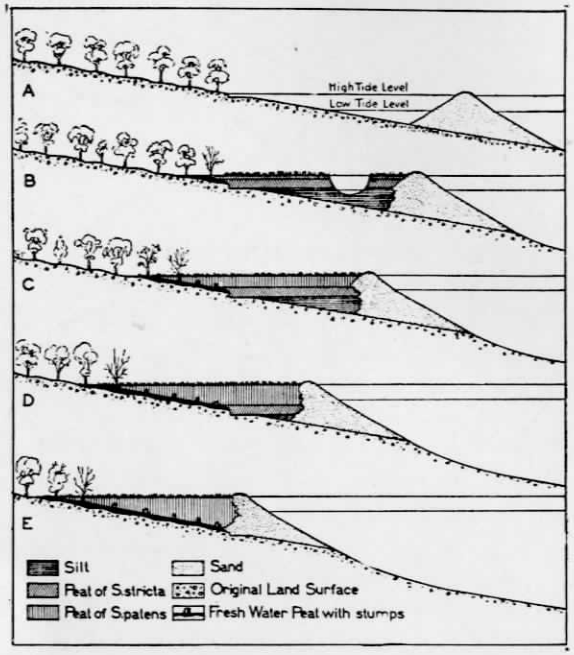


Fig. 1. Diagram illustrating theoretical constructional history of a typical New England tidal marsh (after Knight [1]). Spartina stricta *is now called* S. alterniflora.

Over 400 acres of marsh and adjacent woodland, comprising the five western fingerlike projections, are owned by the State Board of Fisheries and Game, and are designated the Barn Island Game Management Area. This area is being developed through management and research in connection with the control of waterfowl populations. Four dikes have been constructed, creating four impoundments of brackish water that should supply additional feeding grounds for many types of waterfowl, chiefly ducks (Fig. 4).

ORIGIN OF THE MARSHES.—In Connecticut the development of tidal-marshes often follows a typical pattern as shown in figure 1. The site is the result both of a gradually rising sea level, and of an off-shore sandbar which, as a result of normal wave action, slowly advances towards the land. The lagoon behind the bar fills up with sediments. First, inorganic silts are deposited in the deepest portions, followed by peat of the deeply flooded salt water grass *(Spartina alterniflora)*, and later by peat of the shallowly flooded salt meadow grass *(Spartina patens)*. As the bar advances and the ocean level rises, the marsh also advances landward, until finally only salt meadow peat overlies what had been upland, with tree stumps still in place. Eventually, the bar itself is eroded away and, in protected places, the bay is directly cutting the peat as shown in figure 2. This is the present situation on the Barn Island tidal-marshes.

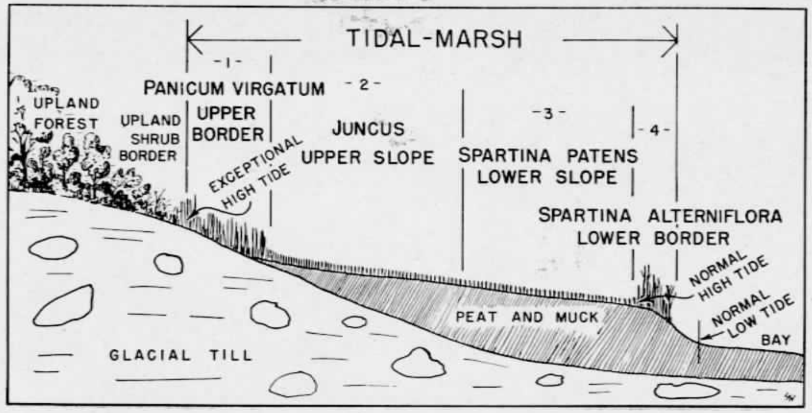


Fig. 2. Diagrammatic cross-section of the upland-to-bay sequence, showing characteristics of the major vegetational zones (after Miller and Egler [2]).

VEGETATIONAL PATTERN. *The upland to bay sequence.*—The tidal-marsh would be much easier to understand if there were no sandbar at the seaward side, no glacial till islands or boulders within it, and no estuaries cutting through it. We shall imagine that such a marsh exists. There would be four communities in such a marsh, arranged zonally from the upland to the bay (Fig. 2, 3). First is an upper border of switch grass *(Panicum virgatum)* with over 100 other species, including many plants from the upland. Second, covering most of the upper half, is a zone of black grass *(Juncus gerardi)*. Spike grass *(Distichlis spicata)* is sometimes abundant here, but the dozen other species are very infrequent. Third, covering most of the lower half, is a zone of salt meadow grass with spike grass locally abundant, and with only scattered plants of eight other species, all infrequent. Fourth and last is a narrow lower border of salt water grass in which only three other species are rarely present.

The panne sequence.—Roughly circular shallow basins, called pannes, frequently develop on the salt marshes (Fig. 3). These are due either to levees formed at the margins of estuaries or artificial ditches or to compaction of the peat. These pannes have concentric bands of vegetation that appear to be related to the high degree of salinity that can develop during evaporation. In those that never dry completely ditch grass *(Ruppia maritima)* is usually found. Others are dry, with salt crystals at the lowest level. Outward from this is a belt of stunted salt water grass very different from its tall luxuriant growth in the lower border. Peripheral to this stunted grass is the so-called "forb panne," one of the more widely distributed vegetation types. It is here that the colorful forbs (herbs which are not grasses) such as *Aster tenuifo-*

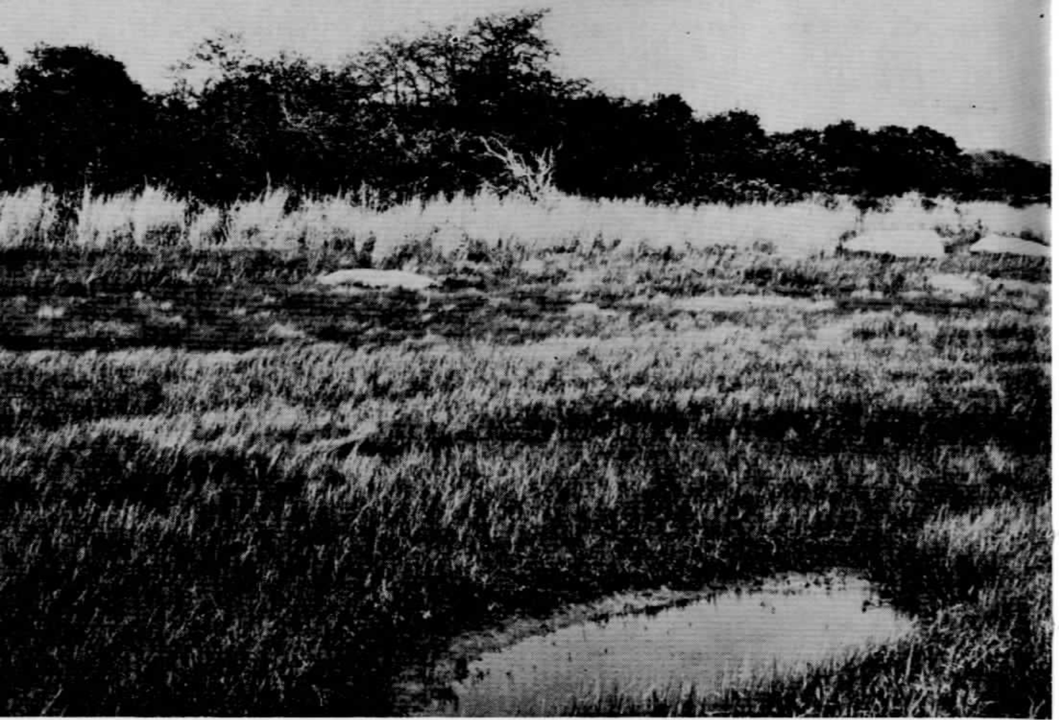


Fig. 3. View of a portion of the Barn Island Marshes with upland in the background. The upland vegetation gives way to switch grass (Panicum virgatum), *black grass* (Juncus gerardi), *and salt meadow grass* (Spartina patens). *Panne in foreground is surrounded by stunted salt water grass* (Spartina alterniflora). *Several scattered boulders are evident.*

lius, purple gerardia *(Gerardia maritima),* sea-lavender *(Limonium carolinianum),* seaside plantain *(Plantago juncoides* var. *decipiens),* glassworts *(Salicornia* spp.), and sand spurreys *(Spergularia* spp.), are most conspicuous.

FACTORS INFLUENCING THE VEGETATION. *Natural factors.*—The most obvious environmental factor operative on the tidal-marsh is its diurnal inundation by salt water. However, there are so many factors acting and interacting upon one another, continuously or intermittently, that it is difficult to say just what is the "cause" of the vegetation. At low tide, there is often an extreme amount of sunlight and high winds which cause the water to evaporate in shallow basins so that salts may be crystallized. Severe storms and hurricanes inundate the landward margins with salt water, while locally depositing such thick masses of flotsam on the vegetation as to kill it. In addition, salt spray is swept inland, killing the foliage. The soil is mainly organic matter, but silts and sands can be washed in by streams, or deposited from drifting ice blocks. Furthermore, small islands of glacial till emerge from the peat surface; huge boulders occasionally break through; and blocks of

peat, broken by wave action, are stranded here and there. The soil water is salty, but can become brackish if there are springs in the adjacent upland. Sometimes the peat compacts, lowering the surface level. At other times, a surface layer loosens, and tidal waters flow underneath, while in other instances the peat starts to decompose forming an odorous ooze in deep holes.

Human influences.—Unfortunately, we have no suitable reports or descriptions of the tidal-marshes when white man first appeared on the scene. Indians were in the vicinity, since artifacts are found in the croplands nearby. From our present understanding of the ways and habits of those people, light ground fires must have been frequent in the uplands. Regardless of whether we think that the Indian willfully used fire to make hunting easier, certainly there was no organization or agency trying to educate him to control fire. Thus it is very likely that fires often escaped and ran lightly over a dry marsh. Just what effects they actually had are not known, for no one now owning tidal-marshes has the interest or the opportunity to carry on such an experiment.

As the Indians gradually vanished, the white colonials took over. Although fires did not cease, it is very likely that they were reduced in frequency. A new factor that now entered was mowing for hay. Once again, we do not know the actual effects of cutting grass, for no observations or experiments have been made under controlled conditions. The greatest alteration would probably be in the tussock grassland of the high landward margins. In these places, repeated mowing would gradually destroy the mulch cover, bare the soil between the tussocks, and lead to soil erosion.

Because of the mosquito population, the marshes have been extensively ditched. The estuaries that wander through them overflow their banks, forming small natural levees. When one recognizes the complicated interactions of all these environmental situations, and realizes that while some factors act daily, others act seasonally or only at intervals of a decade or a century, it is understandable that the tidal-marsh is not to be "explained" in any simple manner.

FUTURE OF THE MARSHES.—The tidal-marshes, in all their complexity, are not static. It is interesting from both practical and theoretical points of view to know what would happen to the marshes if they were left undisturbed. Unfortunately, even the scientists in charge of these lands do not yet realize the importance of setting aside small tracts, free from disturbance insofar as possible. Until such time as this can be done we can only conjecture. Assuming a gradually rising sea, the four vegetation zones previously described would move landward. Thus there would be a succession at any one spot from switch grass to black grass to salt meadow grass to salt water grass to open water. We must also consider what would happen in the absence of fire, of mowing, and of ditching. It is still a question as to whether the shrub, marsh elder *(Iva oraria),* now abundant along the margins of the

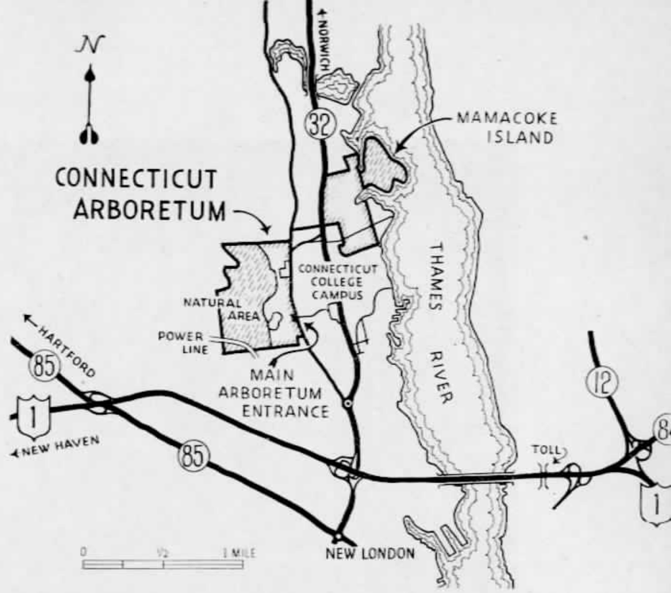
An impoundment in the Barn Island Marshes.

ditches, can eventually invade the rest of the marsh, and thus turn the area into a shrubland. In all respects, it is nearly impossible to separate the natural phenomena from those directly or indirectly induced by man. Until we have areas of tidal-marsh protected from human disturbance many of these theoretical questions will remain unanswered. Some of these may have very important practical implications.

BIBLIOGRAPHY

1. KNIGHT, J. B. A salt-marsh study. Amer. Jour. Sci. 28:161-181. 1934.
2. MILLER, W. R. AND F. E. EGLER. Vegetation of the Wequetequock-Pawcatuck tidal-marshes, Connecticut. Ecol. Monographs, 20:143-172. 1950. (The present article is a condensation of this paper.)

2



The Connecticut Arboretum

Ecological and Herbicide Research

WILLIAM A. NIERING, *Connecticut College, New London*

THE CONNECTICUT ARBORETUM, located at Connecticut College in New London, comprises 270 acres. Established by the College in 1931, its administration and research program are the responsibility of members of the Botany Department. The first director, Dr. George S. Avery, Jr., was succeeded in 1944 by Dr. Richard H. Goodwin. The Arboretum program is financed in part by the College and in part by Arboretum Association membership, which consists of organizations and individuals interested in the Arboretum.

The land is being managed on a multi-purpose basis. An extensive seminatural portion is devoted to the display of trees and shrubs native to the northeastern United States. A check list and guide to this area has been published (4). In 1952 a 100-acre tract, primarily in forest, was set aside as a Natural Area where long-term research is now in progress (5). An additional 40 acres of natural area was added to the Arboretum in 1955 by the acquisition of Mamacoke Island, a rocky wooded promontory connected to the mainland by a small tidal marsh (6). The remaining tracts are in either evergreen plantations or native vegetation where much of the herbicide research is being carried out.

LONG-RANGE ECOLOGICAL STUDIES.—Long-term studies in the Connecticut Arboretum Natural Area are aimed at acquiring permanent data on as many aspects of the biota as possible and then at suitable intervals resurvey-

Old hemlock stand at the edge of the ledge in the Arboretum Natural Area. This stand was destroyed by the 1938 hurricane. Photograph courtesy of Miss Edna Leighton Tyler.

ing the area in order to follow the biological changes over the years (8). As long as this area remains relatively undisturbed by man, these data should be invaluable to future ecologists in interpreting biotic changes in situ.

Vegetation mapping.—The initial vegetation studies were begun in 1952 by the Arboretum director. Permanent east-west strip transects 20 feet in width were laid out at 400-foot intervals across the area. Permanent markers were placed every 50 or 100 feet along the transects. Since 1952, college students have been working several weeks each summer mapping the vegetation in considerable detail (3). In these strip transects tree diameters, density and cover, shrub density and cover, and herb, moss and lichen cover have been recorded. Permanent photostations, which can be precisely relocated, have also been established along all four lines. The data are now being compiled and reproduced on microfilm for deposit in the archives of the Connecticut College library.

The topography of the Natural Area is irregular and underlain by granite-gneisses of complex origin. Except for numerous rock outcrops, a relatively thin mantle of ground moraine overlies the bedrock.

A generalized transect across the area includes wooded ledges, which give

way westward to a moist wooded ravine, traversed by a small intermittent stream, and beyond this, shrubland and semi-open fields. A considerable portion of the ledges has been owned by the College since 1911. Here various oaks—black *(Quercus velutina)*, scarlet *(Q. coccinea)*, and white *(Q. alba)*—predominate, with sweet birch *(Betula lenta)* and hemlock *(Tsuga canadensis)* scattered or locally abundant as pure stands in the understory. The majority of the trees are six inches or less in diameter, with only scattered oaks twelve inches or over. This pattern is the result of the 1938 hurricane which blew down over 100 large hemlocks, 106-171 years old (1). Therefore, much of the woodland is in a state of recovery from this catastrophe. In the shrub storey, mountain laurel *(Kalmia latifolia)* forms an almost continuous layer 6-10 feet in height. In the openings resulting from the windthrows, this species has increased markedly since 1938. Around the numerous rock outcrops huckleberry *(Gaylussacia baccata)* and lowbush blueberry *(Vaccinium* spp) are most common. Herbaceous cover is sparse. Species occasionally found include pink ladyslipper *(Cypripedium acaule)*, Canada mayflower *(Maianthemum canadense)*, wild sarsaparilla *(Aralia nudicaulis)* and wintergreen *(Gaultheria procumbens)*. In addition to the upland forest, the area includes a semi-open and a forested bog. In the former a sphagnum-sedge-rush complex is interspersed with shrubby species and red maple saplings. In the wooded bog a swamp woodland rather than a typical bog forest has developed. Here red maple *(Acer rubrum)* forms a continuous canopy. In the shrub stratum, highbush blueberry *(Vaccinium corymbosum)*, swamp azalea *(Rhododendron viscosum)* and sweet pepper bush *(Clethra alnifolia)* form a dense cover.

In the ravine the trees are larger with hemlock, red maple, sweet birch, red oak *(Quercus rubra)* and yellow birch *(Betula lutea)* predominant. In the shrub layer, mountain laurel is replaced by witch-hazel *(Hamamelis virginiana)* and spice bush *(Lindera benzoin)*. Herbaceous cover increases with the more mesophytic conditions.

Beyond the upper slopes of the ravine abandoned farm lands are now dominated by a semi-open field and shrubland complex. This area varies from continuous patches of greenbrier *(Smilax rotundifolia* and *S. glauca)* with scattered oaks and sweet birch to relatively open areas covered by grasses and golden-rod *(Solidago rugosa)*. In the open areas bayberry *(Myrica pensylvanica)* and sumac *(Rhus copallina)* are conspicuous along with tree saplings.

It is evident that most of the habitats surveyed are relatively unstable. Resampling at suitable intervals should reveal many interesting and striking changes.

Bird censuses.—In addition to the vegetation studies the breeding bird population is also being observed. Two initial breeding bird censuses were completed in 1953 and 1955 (7). In the forested areas just described the

Photograph at permanent photostation in Arboretum Natural Area, showing dense stand of hemlock (Tsuga canadensis), *a small black oak* (Quercus velutina) *at the right, and mountain laurel* (Kalmia latifolia) *in foreground. (Transect I, looking west at 380 feet.)*

dominant nesting species is the red-eyed vireo. Other species frequently encountered include the black and white warbler, wood thrush, oven bird, veery and hooded warbler. The semi-open fields and shrublands on the other hand, are dominated by the northern yellow throat, towhee, catbird and chestnut-sided warbler. As the vegetation changes, corresponding changes in the bird populations in the various habitats should be revealed by future censuses. It is anticipated that other faunistic studies will also be included in the program.

Student investigations.—In addition to long-range studies, the Natural Area provides unlimited opportunities for students to carry on independent research. Two undergraduates have already completed special projects. One investigated the vegetational development on rock outcrops over the ledge area (11). Frost action and innumerable other interacting factors were found to limit coverage of the outcrops. Another study concerned the past vegetational history of the area (2). This involved pollen analyses of the two bogs previously mentioned, as well as detailed soil studies, in order to detect past disturbances. Pollen spectra indicate an initial post-glacial spruce-fir forest followed by pine and finally by a deciduous complex. This forest sequence is similar to those found by other investigators in the northeast. Soil sampling revealed charcoal fragments to a depth of eight inches, indicating the occurrence of fires in the area. Their presence at this depth is probably correlated in part with the constant disturbance due to hurricanes and violent wind storms. Wind-throw mounds of different ages were detected, the oldest ones recognizable only by disturbed soil profiles. It would appear that severe wind storms and fire have influenced the vegetation, especially on the ledge, for hundreds of years.

HERBICIDE RESEARCH PROGRAM.—In the Arboretum, herbicides are being used in general maintenance and as a tool for manipulating vegetation (9, 10). They are being used to control weed species in the native tree and shrub collections, evergreen plantations and upland forest and to retrogress late stages of old field succession to shrubland and grassland stages. The latter is done in order to maintain as many different wildlife habitats as possible throughout the Arboretum. By this technique areas are also being landscaped with native species by leaving ornamentally desirable shrubs and low trees and by eliminating those which are undesirable.

Right-of-way demonstration area.—In recent years many public utilities have turned to chemicals as a means of controlling the vegetation along their rights-of-way. However, much spraying has been done indiscriminately, thus arousing considerable public concern. Indiscriminate spraying with little or no regard for aesthetic values or ecological principles has prompted the establishment of a right-of-way demonstration area on a 1500-foot sector of the Connecticut Power Company easement that crosses the Arboretum. Here the vegetation is being manipulated by various methods in order to produce those cover types with the greatest stability and maximum wildlife benefits which still answer the requirements of the utility companies.

At the beginning of the project in 1953 the vegetation covering the right-of-way varied from continuous thickets of greenbrier and other shrubs with scattered trees to dense stands of oak and black birch stump sprouts 8-12 feet in height, within which scattered shrubs occurred.

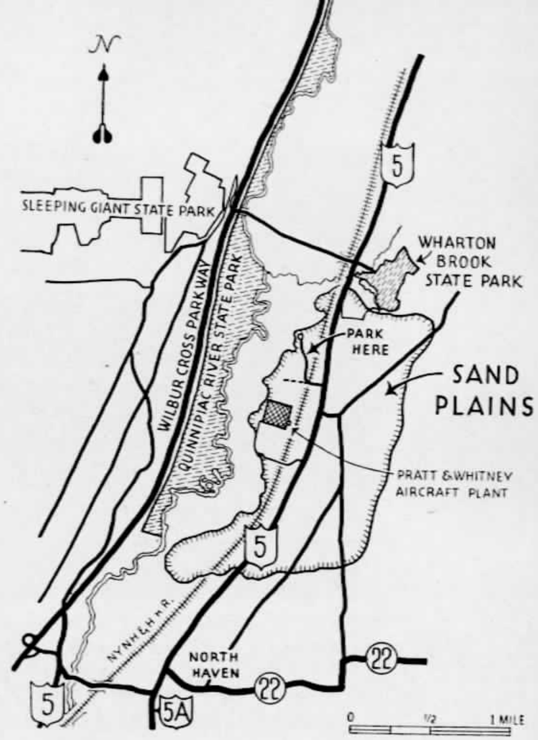
In order to satisfy the utilities, the rights-of-way must be kept free of trees which might eventually grow or fall into the lines. In addition, the rights-of-way must be accessible to repair and inspection crews. The area is now being managed with these needs in mind. Under the lines a road will be kept open for the use of the maintenance crews. Large tree species are being eliminated by various chemical treatments. Low shrubs, except for greenbrier, will be left as long as they do not impede access to fallen lines. These shrubs are valuable for wildlife food and cover, and they may serve as a relatively stable vegetation type, since there is evidence that tree seedlings do not readily become established under dense shrub cover. On the sides of the line, beyond the wires, low trees and taller shrubs such as dogwood and witch-hazel, as well as greenbrier, will be maintained. In the adjacent forest along the right-of-way tall trees, which might eventually fall into the wires, will be treated before they reach the height of the wires.

Over twenty plots have already been sprayed using water-borne foliage, selective basal, and other spray techniques at different seasons of the year. It is anticipated that this demonstration area will eventually show results of considerable value to those concerned with right-of-way management. Here it will be possible to evaluate impartially the effectiveness of various techniques and the resultant cover types from the standpoint of right-of-way maintenance and maximum conservation values.

BIBLIOGRAPHY

1. Avery, G. S., Harriet B. Creighton and C. W. Hock. Annual rings in hemlocks and their relation to environmental factors. Amer. Jour. Botany, 27:825-831. 1940.
2. Beetham, Nellie. The vegetational history of the Connecticut Arboretum Natural Area. Honors thesis, 1956. (Unpublished).
3. Erisman, Adele. Why preserve natural areas? Audubon Mag. 58(2):72-74. 1956.
4. Goodwin, R. H., Katherine H. Heinig, and Kaleb P. Jansson. Checklist of woody plants growing in the Connecticut Arboretum and guide to the Arboretum. Conn. Arboretum Bull. No. 6:1-32. 1950.
5. Goodwin, R. H. The Connecticut Arboretum. Conn. Arboretum Bull. No. 7:1-11. 1952.
6. Goodwin, R. H. Mamacoke Island. Conn. Arboretum Bull. No. 8:2-7. 1955.
7. Kashanski, Barbara, and W. A. Niering. Breeding bird census: 34. Oak-hemlock forest and semi-open fields and shrubland. Audubon Field Notes, 9(6):429-430. 1955.
8. Niering, W. A. Long-range studies in the Natural Area. Conn. Arboretum Bull. No. 8:11-13. 1955.
9. Niering, W. A. Research projects on herbicides. Conn. Arboretum Bull. No. 8:14-17. 1955.
10. Niering, W. A. Herbicide research at the Connecticut Arboretum. Proceedings of the Ninth Annual Meeting, Northeastern Weed Control Conf., pp. 459-462. 1955.
11. Rice, Barbara. Rock succession in the Connecticut Arboretum Natural Area (Eastern section.) Thesis, 1954. (Unpublished.)

3



The North Haven Sand Plains

Charles E. Olmsted, *Department of Botany, University of Chicago*

Nearly level, dry plains of sandy stratified deposits stretch along the east side of the Quinnipiac River from North Haven to Wallingford (1). The spread of agriculture, industrialization, and urbanization has left only remnants of native vegetation on them. The areas remaining, however, provide interesting examples of (a) plant colonization, (b) the differing abilities of plant species to cope with the environmental extremes found in such soil and topographic environment, (c) the replacement of one plant community by another, (d) the amelioration of the environment by the presence of plants, and (e) the all-important influences of man's past and present actions in helping to determine the patterns found in native vegetation (2). These points are so easily seen on the sand plains that the intelligent observer hardly needs to have them pointed out.

Efforts toward the agricultural utilization of these plains by the colonial pioneers and their descendants had largely ceased by the early 1800's. The property lines, or those separating field from pasture, were often fenced with zigzag rail fences, laid on rocks at each angle. Both before agricultural abandonment and after, these fences served as centers for the invasion of

Fig. 1. Invasion of the Andropogon-lichen community by pitch pine. Smaller pines in the center are probably offspring of the large tree at the right. A black oak, originally isolated in the lichen-grass community, is at the left. All are on a non-eroded field cultivated in the 18th century.

wind-, animal-, and bird-dispersed plants. Numerous trees, some now one hundred or more years old, either naturally invaded the fence lines or were deliberately planted in them. Several species, notably black oak *(Quercus velutina)* and gray birch *(Betula populifolia)*, form an open canopy along the old fence lines. Under them several species of shrubs are intermixed with herbaceous seed plants, mosses, and lichens. The trees provide enough shade to ameliorate the summer temperature conditions and the rapid and extreme fluctuations in surface soil moisture found in the open, exposed areas.

In most of the open fields or pastures their abandonment has led to the rapid colonization of the original plowed or disturbed soil by bunchgrass *(Andropogon scoparius)*. These bunches of various size alternate with a low cover of mosses and lichens to provide an almost complete carpet of vegetation. The chief moss is *Polytrichum piliferum*, and most of the lichens are species of *Cladonia* of all three life form types—crustose, foliose, and fruticose. All are indicators of relatively sterile, dry soil, and all tolerate extreme desiccation and high temperatures in summer. The soil surface temperatures may rise to 160°F. Invasion of these grass-lichen communities by woody plants is mostly a slow process of movement from the trees in the old fence lines or from marginal areas never completely deforested. Activities of squirrels or other animals in burying black oak acorns at some distance from the original seed trees, and wind dispersal of seeds of pitch pine, *(Pinus rigida)*, do lead in some areas to the development of a savanna-like condition. In

Fig. 2. Two adjoining groups of black oaks originating from animal caches in the Trichostema-Andropogon community on an eroded old-field surface. Group to the right is nine years old.

one old field included in the marked area on the accompanying map, invasion of pitch pine has come largely through the dispersal of seed from a few old trees, 85 to 100 years old, located in the southwest corner of a field. The resulting community may now truly be called a forest (Fig. 1). Numerous forest mosses, herbs, and shrubs have come into its undergrowth, and the species of lichens and bunchgrass characteristic of the open conditions have disappeared. Black oak forests have been similarly established in some areas.

In some cultivated fields wind erosion in the 18th century stripped away the top soil which was drifted into the fence lines to form low dunes a few feet high. The trees then present along the fences mostly survived the deposition of sand, and the dune surfaces are variously stabilized under their canopy. Some surfaces are still largely bare. Others are clothed with mosses and lichens, while still others show an essentially complete undercover of shrubby and herbaceous seed plants.

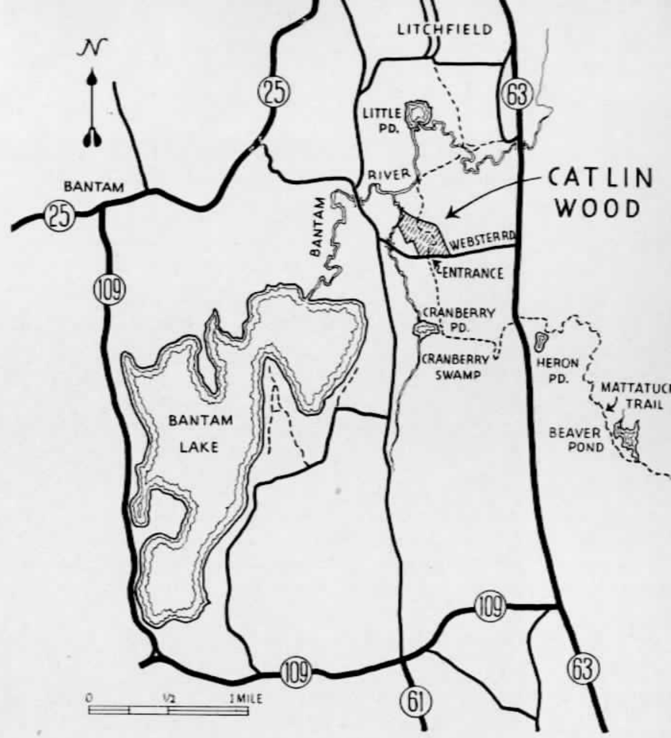
In the eroded fields plant colonization has been very slow over the century and a half or more since the erosion began. Little humus was present in the bared subsoil, and the temperature, moisture, and nutrient conditions have prevented establishment of a continuous vegetative cover. One dicotyledonous plant, bluecurls *(Trichostema dichotomum)*, is widespread but grows poorly. Occasionally clumps of *Andropogon* are found, mostly showing evidence of the original burial of seed in wheel tracks or foot prints. Animals, probably squirrels, have cached black oak acorns sporadically in these eroded fields. Although many of these acorns germinate, only a few trees have become established (Fig. 2). Most of the seedlings die before the stems emerge through the ground, their tips killed as a consequence of the high soil-surface temperatures. Shade from a grass clump, or an occasional cooler summer, has allowed a number of clumps of oak trees of differing age to appear in these barren spots. Sufficient amelioration of such an environment by natural means to allow establishment of a complete vegetative cover will apparently require many decades more.

All the communities and processes indicated above may be easily observed in a brief trip covering only a few acres at the area indicated on the accompanying map.

BIBLIOGRAPHY

1. Flint, R. F. The glacial geology of Connecticut. Conn. Geol. and Nat. Hist. Survey Bull. 47: 1-294. 1930.
2. Olmsted, C. E. Vegetation of certain sand plains of Connecticut. Bot. Gaz. 99: 209-300. 1937.

4

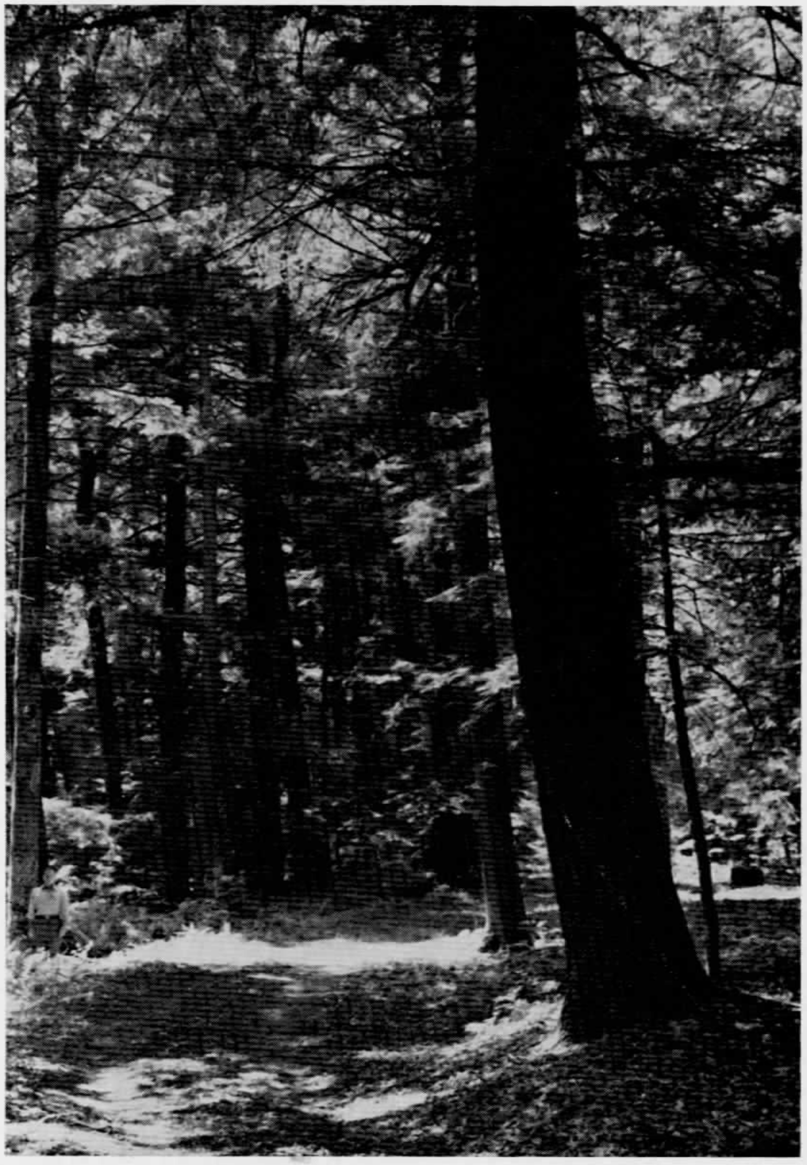


Catlin Wood

White Memorial Foundation, Litchfield

David M. Smith, *School of Forestry, Yale University*

The old stand of hemlock, white pine, and transition hardwoods, known as Catlin Wood, occupies approximately 15 acres situated one and one-half miles SSE of the center of Litchfield, Connecticut. It was reserved about 1910 and is owned by the White Memorial Foundation, a non-profit corporation set up to manage the natural resources of a large tract of land around Bantam Lake for the general benefit of the public. Although the main bulk of the 4000 acres owned by the Foundation is under intensive commercial forest management, Catlin Wood is reserved from all forms of cutting other than the salvage of timber killed by natural agencies. It is not a virgin stand but is regarded as representing a reasonable facsimile of the original forest and it probably approaches the climatic climax. A number of similar stands exist in southern New England but most of them are in deep ravines, rocky slopes, and other somewhat atypical sites characterized by difficulty of access. However, Catlin Wood is unusual in that it stands on a nearly flat, highly accessible area underlain mostly by sandy glacial outwash; the southern end of the stand is underlain by fine-textured glacial till. The



View of Catlin Wood, White Memorial Foundation, Litchfield, showing a portion of the stand that was not seriously disturbed by the chestnut blight. The hemlock in the foreground is one of the largest trees in the stand, being 32 inches in diameter at breast height.

site is fairly good; in fact, many areas of essentially similar soil are still in agricultural use. This stand can, therefore, be regarded as one of the best examples of an old, near-climax forest extant on a common kind of site in this part of Connecticut.

The origin of the stand is obscure. All evidence as to its age has come from ring-counts made on the stumps of 7 dead or windthrown hemlocks cut in recent salvage operations. It is clear that all of these large trees were present in the stand as stunted advance growth before 1800 and one individual had attained a height of 16 inches by 1790. It is more significant that all of these trees were subsequently released in some sort of disturbance and then commenced long periods of relatively rapid growth. However, the dates of this release from suppression vary from 1806 to 1834. The limited amount of evidence tends to suggest that practically all the timber of the pre-existing stand was cut or windthrown in a series of disturbances centering around the years 1806, 1822, and 1833. In other words, the oldest trees in the stand are currently about 170 years old, but have been growing freely for only about 150 years.

It is probable that most of the disturbance of the early 19th century came from cutting, although the evidence of a disturbance around 1822 suggests that the tropical cyclone of September 3, 1821, the center of which passed close to Litchfield, may have caused some of the damage. There are a number of windthrown mounds in the stand but there is no information as to their age. In view of the fact that Litchfield was organized as a town in 1719 and was the chief town of the region by the time of the Revolution, it takes no stretch of the imagination to assume that the tract was heavily cut over early in the 19th century. There would even have been time for the area to have been cleared for agriculture and then abandoned before 1780, although it is more likely that the tract has always been under forest cover. Because of the close proximity of Litchfield and its outlying farms it can probably be assumed that the postulated cuttings involved removal of all trees suitable for any use, even including small ones useful only for fuelwood.

There is no evidence to suggest that any major disturbance occurred between 1834 and 1891. There then ensued a period of about 25 years during which all of the chestnut was removed from the stand. It seems certain that most of this cutting was simply salvage of chestnut killed by the blight fungus, *Endothia parasitica,* although the evidence from the ring-counts on the hemlock stumps that were adjacent to old chestnut stumps suggests that some of the chestnuts were cut before the blight could have spread this far north. In any event, the elimination of the chestnut was inevitable regardless of when it occurred. The chestnut stumps still persist and make it evident that patches within the stand were almost entirely dominated by chestnut. Visual comparison of the number and size of chestnut stumps on these patches with other areas where precise measurements have been made suggests that chestnut may have once comprised 80 per cent of the basal area of localized patches. The loss of the chestnut has resulted in the development of what can, for all practical purposes, be regarded as a second age-class, roughly 40-50 years old. However, most of the gaps left by the chestnut were closed up by the rejuvenation of suppressed trees of other species that were actually contemporaries of the chestnuts or by the spreading out of the crowns of trees that were of the same size as the chestnuts. Some of the larger gaps were filled by new black birches, this being about the only species of the region that has increased in abundance because of the chestnut blight.

In recent years, the older trees of the main canopy have been falling from the vicissitudes of age and the resulting holes have been occupied by new age-classes. However, this development has not proceeded to the point where anything resembling an all-aged forest has developed. In fact, except for the vacancies created by loss of the chestnut, the stand still retains most of the characteristics of an old, even-aged stand. It contains comparatively few seedlings or saplings and much of the forest floor is barren of anything but sparse herbaceous growth.

A stand table showing the distribution of species according to diameter class is given in Table 1. These data are based on a tally of 5 tenth-acre plots laid out on a north-south transect through the stand in June, 1956. An inspection of these data will show that hemlock is the only species that is represented in all diameter classes and is at all abundant in the understory. Beech shows somewhat the same tendency, but is far less abundant than hemlock; the stand has some beeches far larger than those shown in Table 1. The rather short-lived red maple is also represented over quite a range of diameter classes, indicating an ability to maintain its modest abundance in the stand without being favored by drastic disturbance. Black and yellow birch are represented chiefly in the intermediate diameter classes and probably represent mostly trees that came in after the loss of the chestnut. Relatively intolerant species like white pine, red oak and white oak are represented almost exclusively by large dominant trees; owing to their great longevity, existing trees of these species can probably persist for another century or longer, but will not replace themselves in any quantity unless there is some disturbance more severe than has occurred in the stand in the past century. The stand also has a few impressive specimens of species in the same category but which are so few in number that none fell on the sample plots. These species include yellow-poplar, white ash, shagbark hickory, and pitch pine. Tree species represented by a few small trees off the sample plots include basswood, striped maple, American elm, and hophornbeam. A partial list of the herbaceous plants of the forest floor and woody plants less than 4.5 feet in height is given in Table 2.

TABLE 1. *Stand table for Catlin Wood, showing number of trees per acre taller than 4.5 feet by species and 3-inch diameter classes, June 1956. These data are based on 5 tenth-acre plots laid out along a north-south transect through the stand. The species are given approximately in the order of their positions in the vertical stratification of the stand.*

	Mid-points of 3-in. classes of breast-high diameter, inches									
Species	1	4	7	10	13	16	19	22	25	Tot.
White pine *Pinus strobus*	2	—	—	—	—	2	2	2	—	8
Red oak *Quercus rubra*	—	—	—	2	4	—	2	6	—	14
White oak *Quercus alba*	—	—	—	2	4	4	—	—	—	10
Black birch *Betula lenta*	—	8	2	6	2	6	—	—	—	24
Yellow birch *Betula lutea*	2	4	2	4	—	—	2	—	—	14
Hemlock *Tsuga canadensis*	108	30	26	24	18	12	16	10	4	248
Red maple *Acer rubrum*	8	8	—	4	8	—	2	—	—	30
Beech *Fagus grandifolia*	12	10	2	—	—	—	—	—	—	24
Total	132	60	32	42	36	24	24	18	4	372

Species represented only in lowest diameter class (with number per acre): *Fraxinus americana* (2), *Castanea dentata* (16), *Amelanchier canadensis* (4), *Hamamelis virginiana* (30), *Lindera benzoin* (4).

Tree species occurring in the stand, but so infrequently that none fell within the sample: *Liriodendron tulipifera, Carya ovata, Pinus rigida, Ulmus americana, Tilia americana, Ostrya virginiana, Acer pensylvanicum.*

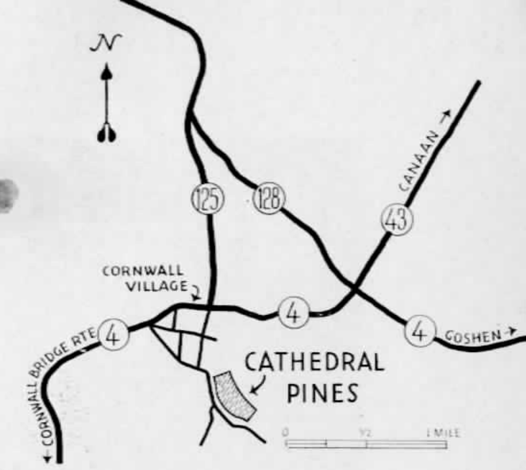
TABLE 2. *Partial list of herbaceous plants, shrubs, and trees less than 4.5 feet in height in Catlin Wood, June 1956.*

Acer saccharum (Sugar maple)
Aralia nudicaulis (Wild sarsaparilla)
Arisaema spp. (Jack-in-the-pulpit)
Clintonia borealis (Clintonia)
Coptis groenlandica (Goldthread)
Corylus americana (Hazelnut)
Cypripedium acaule (Stemless lady's-slipper)
Gaultheria procumbens (Wintergreen)
Kalmia latifolia (Mountain laurel)
Lycopodium clavatum (Common club-moss)
Lycopodium lucidulum (Shining club-moss)
Lysimachia quadrifolia (Whorled loose-strife)
Maianthemum canadense (Wild lily-of-the-valley)
Mitchella repens (Partridge-berry)
Monotropa uniflora (Indian pipe)
Onoclea sensibilis (Sensitive fern)
Osmunda cinnamomea (Cinnamon fern)
Osmunda claytoniana (Interrupted fern)
Polystichum acrostichoides (Christmas fern)
Prunus serotina (Black cherry)
Pyrola spp. (Shinleaf)
Rhus radicans (Poison ivy)
Smilacina racemosa (False spikenard)
Symplocarpus foetidus (Skunk cabbage)
Vaccinium augustifolium (Low sweet blueberry)
Viburnum acerifolium (Maple-leafed viburnum)
Viola spp. (Violets)

The main canopy of this stand has a layered structure typical of most aggregations of hemlock, hardwoods, and white pine in this region. The white pines, owing to their ability to continue height growth far longer than the other species, project substantially above the flat canopy formed by the other species. In fact, in viewing the stand from distance across open fields, one gets the impression that it contains a high proportion of white pine. The second layer of the canopy, which forms the relatively flat surface previously mentioned, is composed mostly of deciduous species that have nearly culminated in height growth at a common level. A few of the original hemlocks project up into this second layer, but most of them form a third layer beneath the hardwoods. In fact, an aerial photograph made during the summer would show only a small proportion of the hemlocks present in the stand. Hemlock is probably relegated to this position chiefly because of its low ability to become established on areas exposed to full sunlight. However, once established in the shade it has a remarkable ability to continue growth in height just as rapidly as the natural pruning of the hardwood overstory will permit. Whenever a large member of the hardwood overstory succumbs the hemlocks beneath grow up rapidly to fill the gap.

The future course of natural succession in this stand may well lead to a further increase in the abundance of hemlock. However, it will not lead to the development of a pure stand of hemlock, because this species lacks the ability to reproduce either in its own dense shade or on the barren patches of hemlock litter exposed to direct sunlight after the death of a veteran. Most of the area vacated by a dead hemlock is colonized by relatively intolerant species characteristic of the early stages of succession. Therefore, it appears that these mixed stands of hemlock, transition hardwoods, and white pine have a well-developed mechanism for their own renewal involving fluctuations in stand composition that cover almost the entire range of successional stages.

5



The Cathedral Pines

HENRY W. HICOCK, *The Connecticut Agricultural Experiment Station*

THE CATHEDRAL PINES, covering an area of some 20 acres near the village of Cornwall, represent one of the best examples of old growth white pine in Connecticut and perhaps in New England.

This account of the stand is based in part on the writer's observations over a period of 35 years and in part on fragments of written information, both published and in manuscript form. According to the late George Cromie (1) the stand was acquired by Mr. John E. Calhoun in 1883 to save the trees from being sold and lumbered. The tract is now owned by Mr. Calhoun's heirs. Local tradition relates that previous owners had cut trees very sparingly over a period of years but Mr. Calhoun allowed no trees to be cut except for salvage. One of the earliest bits of written information comes from a prepared lecture by a member of the staff of The Connecticut Agricultural Experiment Station who, in 1909, wrote of the pines—"Many of them tower up to a height of 150 feet and have diameters from three to four feet. The stand is dense, so that the yield per acre would, in some cases, exceed one hundred thousand feet." The stand may have been at its best at about this time. It was still very dense in the early 1920's but since then there have been many losses from various causes so that currently the stand is quite open in places. Although the principal species has been and still is white pine, there is an appreciable admixture of hemlock together with a few scattered hardwoods of approximately the same size. As long as the canopy was completely closed, there was little ground vegetation of any kind. With the gradual opening of the canopy many trees and shrubs have become established and it seems probable that within another half century the present even-aged stand will have given way to an uneven-aged hemlock-hardwood mixture with a

Road passing through the Cathedral Pines.

residue of the currently more vigorous white pines as the dominant feature. If this predication is approximately correct the stand will resemble the last remnant of "virgin" timber in Colebrook, Connecticut, which was logged off in 1913. The trees in the Colebrook stand ranged up to 350 years in age and up to four feet in diameter; hemlock was the principal component but there was a considerable admixture of hardwoods and some very large white pines which were taller than any other species. One may speculate that some 400 years ago the Colebrook stand may have been in the same condition that the Cathedral Pines are today.

There is no record of the origin of the Cathedral Pines. Since they are essentially even aged, it seems probable that they seeded in after some drastic disturbance such as fire, blow-down or land clearance. From the proximity of the tract to the village of Cornwall, which was incorporated in 1740, it could easily be assumed that the land may have once been cleared for agriculture and then abandoned. A little evidence for this assumption is the fact that at the easterly and higher end of the tract there was, as late as 1920, a gnarled and obviously open grown white pine with bark characteristics indicating that it was much older than the trees in the present stand.

By 1945 it was evident that the stand was slowly disintegrating and a small area was thinned, removing mostly narrow crowned white pines together with a few competing large hemlocks and white pines. This was done to determine whether release from competition would result in increased size of crown on the remaining large pines. As nearly as could be ascertained the thinning had no effect.

Four quarter-acre sample plots measured by Dr. H. I. Winer and students from the Yale School of Forestry in 1951 gave the tally shown in Table 1.

TABLE 1. *Size analysis of the trees in four quarter-acre sample plots in the Cathedral Pines stand.*

D.B.H. in inches	Number of Trees: White Pine	Hemlock	Hardwoods
1-10	0	77	56
11-15	5	28	4
16-20	11	10	1
21-25	16	10	0
26-30	15	7	1
30-35	7	3	0

Heights: white pine 96-153 feet; hemlock 72-127 feet. Ages of trees from increment borings: 150-170 years. Volume per acre in board feet for trees over 10 inches D.B.H.: white pine, 41,400; hemlock, 32,600; hardwoods, 1,100; total, 75,100.

The plots were deliberately chosen in the better parts of the stand and the volume figures are above average for the stand as a whole.

The figure on volume for white pine is quite misleading since it allows nothing for cull. Trees which have been removed from time to time have shown a high incidence of decay and the net usable volume per acre of white pine is much below the gross volume. The 1951 volume is appreciably below the estimate for the stand made in 1909. The earlier figure may have been an ocular estimate only but, on the other hand, it is entirely conceivable that net loss over a period of 42 years may have been 25,000 board feet. Actual losses may have been appreciably more than this because the trees remaining have increased in volume to some extent. Losses were confined almost wholly to white pine.

One forestry lesson that can perhaps be learned from the Cathedrals is that almost pure even-aged white pines cannot be grown to advance-age on heavy soils, at least in southern New England, without periodic thinning to maintain adequate crown size. Less than one half mile from the Cathedrals there is a small mixed hardwood-white pine stand of approximately the same age. Although white pine forms only a small part of the mixture, the individual pines appear to be in much better condition than those in the Cathedral tract.

BIBLIOGRAPHY

1. CROMIE, GEORGE A. Longer Life for Cathedral Pines. Conn. Woodlands, 10 (2):11-13. 1945.

An Old Growth Hemlock Stand

Bigelow Pond, Norfolk

HERBERT I. WINER, *Yale University, School of Forestry* and
EDWARD C. CHILDS, *Norfolk, Conn.*

AFTER MORE than two centuries of exploitation, undisturbed forest stands are extremely rare in northern Litchfield County. The last extensive relict of the virgin forest in this region was the Carrington Phelps stand, which covered about 300 acres in Colebrook. This stand was logged shortly before G. E. Nichols (1) published a description of its composition and structure in 1913.

The Canaan Mountain plateau in the town of Norfolk supports three small stands that have remained essentially undisturbed by human action (2). Of these, the hemlock forest on the west side of Bigelow Pond is the largest and most accessible. It is part of the estate of Mrs. Dorothy Bigelow Melville, and it has been deliberately protected against cutting for the last 50 years. The present note is based on a part of a dissertation presented for the degree of Doctor of Philosophy in Yale University (3).

The hemlock stand occupies about 5 acres on the lower part of a very rocky site, sloping westerly to Bigelow Pond, a former swamp that has been flooded by damming. The depth from litter to bed rock seldom exceeds 12 inches, and over much of the area hemlock has established itself directly on rocks covered only by a thin layer of litter or moss. The marginal nature of the site is ameliorated by its topographic position, which has provided a relatively moist and sheltered environment.

Hemlock dominates the present stand. While hemlock comprises only about half the total number of stems, it makes up three-fourths of the trees taller than 50 feet and 92 per cent of the high basal area of 270 square feet per acre (Table 1). The dominant hemlocks attain a height of 90 to 110 feet, with only a few scattered hardwoods reaching the upper portion of the crown canopy. Among the hardwoods are the typical components of the northern-hardwood association, sugar maple, beech, and yellow birch. White ash and black cherry are the chief representatives of intolerant, transitional species.

TABLE 1. *Diameter distribution and basal area of the old-growth hemlock stand at Bigelow Pond. Number of trees per acre and basal area in square feet per acre are given by species. These data are based on 4 tenth-acre plots measured June, 1950.*

	Breast-high diameter classes, inches											
Species	0-2	3-6	7-10	11-14	15-18	19-22	23-26	27-30	31-34	35-38	Total	Basal Area
Hemlock	178	8	5	5	12	28	22	12	2	2	274	247.5
Beech	148	52	—	2	—	—	—	—	—	—	202	8.1
Sugar maple	5	10	2	5	2	—	—	—	—	—	24	9.8
Yellow birch	5	2	10	—	—	—	—	—	—	—	17	4.8
White ash	2	—	—	—	—	—	—	—	—	—	2	0.1
Total	338	72	17	12	14	28	22	12	2	2	519	270.3

The high density of the overstory has limited the development of understory vegetation. Figure 1, which shows an interior view of the stand, is somewhat atypical in this respect. Over large parts of the area there are few trees less than 25 feet in height. Hemlock and beech are the only tree species represented in every stratum. Reproduction of other tree species is sparse and can survive only with the creation of openings in the canopy. The major shrubs are striped maple *(Acer pensylvanicum)*, maple-leaved viburnum *(Viburnum acerifolium)*, and hobblebush *(V. alnifolium)*; mountain laurel *(Kalmia latifolia)* is conspicuous by its absence. The scanty herbaceous flora includes wild lily-of-the-valley *(Maianthemum canadense)*, prince's-pine *(Chimaphila umbellata* var. *cisatlantica)*, and shining club-moss *(Lycopodium lucidulum)*.

The dominant and codominant hemlocks originated during the seventeenth and eighteenth centuries. Sections cut from two windthrown hemlocks showed dates of origin before 1675 and 1617. Patterns of growth, as

Figure 1. Interior of the old-growth hemlock stand at Bigelow Pond, Norfolk. The hemlock at the right foreground is 27 inches in diameter (d.b.h.). The understory, composed largely of hemlock, beech, and striped maple, is here better developed than elsewhere in the stand. *(Photo by James G. Wendel.)*

illustrated by these sections and by increment cores from standing trees, have been typical of hemlock. They show a long initial period of supression, followed by one or more periods of relatively rapid growth, and a final decline in growth rate as the trees reach maturity. There is no evidence of fire in the history of the present stand, nor do the dates of release of individual trees suggest any pattern of major disturbance. Available evidence suggests that the stand has developed subject to the creation of small openings at irregular intervals, as the result of the death or windthrow of single trees or small groups of trees. An instance of such minor disturbance was the windstorm of November 25, 1950, which brought down a few veteran hemlocks. Evidence of similar occurrences in the past is also provided by the scattered pits and mounds caused by windthrow and by the traces of fallen trees on which hemlock and yellow birch have become established.

Stand changes resulting from such minor disturbances have largely been governed by the nature of advance reproduction in the openings. Occasional seedlings of intolerant species like white ash have become established or released. On the whole, however, hemlock and beech have been the most abundant component of the understory. Their ability to survive long periods of suppression and then respond to release has given them a distinct competitive advantage over their associates.

Data from the two other relicts on the plateau, together with Nichols' report on the Phelps stand, suggest that the old-growth of Bigelow Pond exemplifies an extreme variation of the hemlock-hardwood climatic climax. The hardwood component at Bigelow Pond is less abundant and poorer in species than in the other stands. Presumably this reflects a stand history at Bigelow Pond that has been free of any major disturbance. A few small scattered hardwood stumps in the present stand indicate that the area has not been completely undisturbed, but this cutting has made no substantial change in the composition or structure of the existing stand.

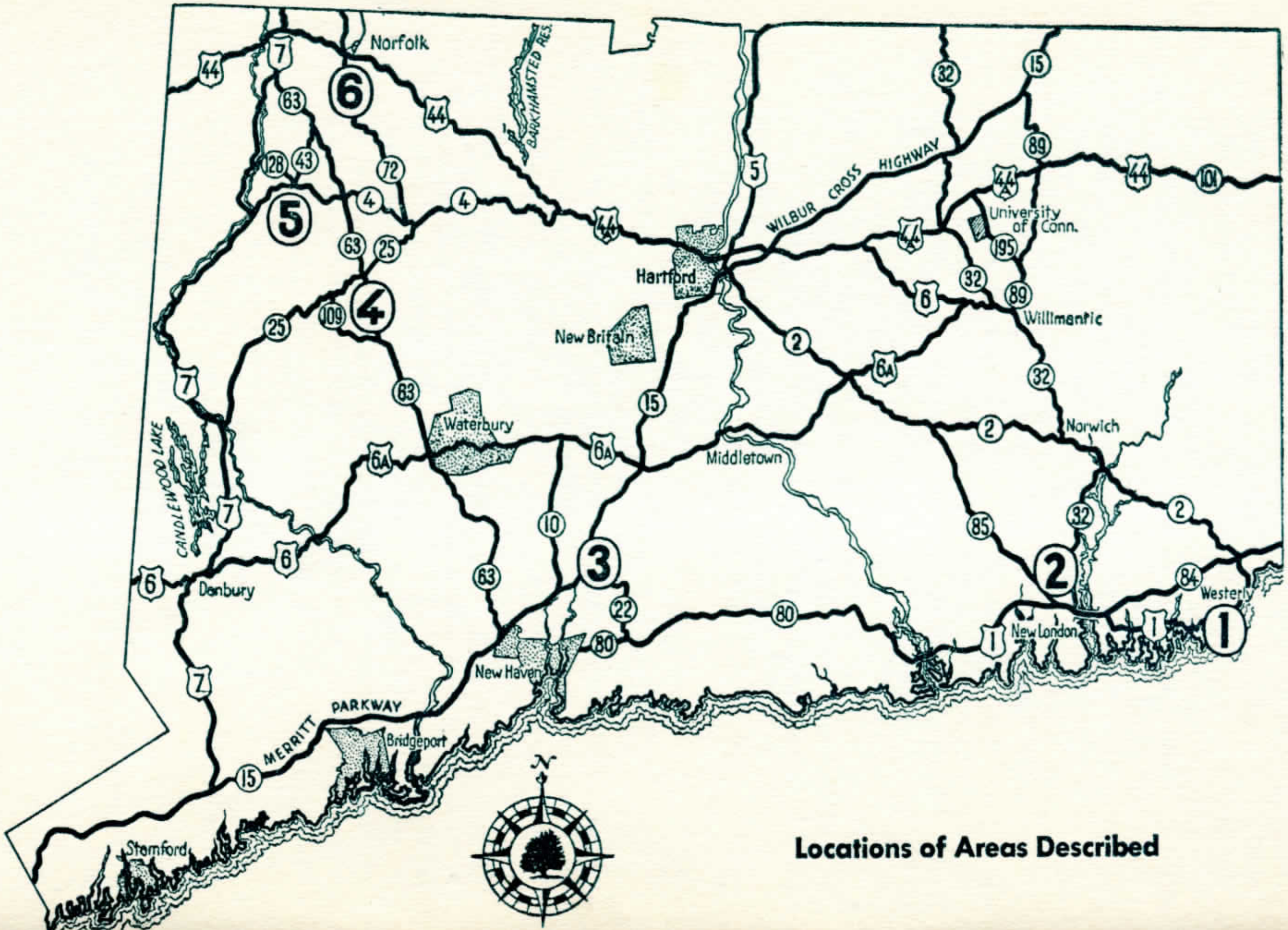
Forests surrounding the Bigelow Pond stand have been repeatedly cut, especially during the period from 1840 to 1905. Ready markets for charcoal and tanbark led to intensive utilization of both hardwoods and hemlock. Hemlock was also heavily cut for sawlogs. Since the old-growth stand was owned by lumbermen during most of the nineteenth century, it is not clear why it was spared. The most reasonable explanation probably involves the shaky and otherwise defective character of much of the hemlock, together with the difficulty of logging the stand without excessive breakage. It is possible, of course, that the stand was intentionally left uncut because of its exceptional aesthetic value.

From an ecological standpoint, the stand strengthens the concept that hemlock played a much more important role in the pre-colonial forests of northwestern Connecticut than it does today on areas that have been repeatedly cut. This concept accords with the silvical characteristics of hemlock and associated species, and is further supported by historical evidence I have presented elsewhere (3). Fire appears to have been the principal factor in limiting the occurrence of hemlock in many cutover stands.

The future of the present old-growth stand will depend largely on the nature of future disturbance. Barring a catastrophe, the stand will maintain essentially its present form and composition, with minor fluctuations in the importance of the transitional hardwoods. Although hemlock does not reproduce under a dense hemlock overstory, the canopy here is irregular enough to permit the establishment and survival of the limited amount of reproduction necessary to maintain its dominance.

BIBLIOGRAPHY

1. Nichols, G. E. The vegetation of Connecticut. II. Virgin forests. Torreya, 13: 199-215. 1913.
2. Russ, Darrell F., and Edward C. Childs. The Great Mountain Forest. Northeastern Logger, 1: 8-9, 24-25. 1953.
3. Winer, Herbert I. History of the Great Mountain Forest, Litchfield County, Connecticut. Ph.D. Thesis, Yale Univ. xiii + 278 pp. 1955. (Unpublished.)



Locations of Areas Described