# VEGETATION OF THE PINE HILLS FIELD STATION IN SOUTHWESTERN ILLINOIS

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The Pine Hills Field Station of Southern Illinois University is located in the unglaciated Illinois Ozarks of the southwestern part of the state (Fig. 1). The land was recently acquired on long-term lease from the Trojan Powder Company. A topographic map (Fig. 2) shows details of the ridges, slopes, and floodplain. The area of 258 acres includes on-the-floodplain alluvial or outwash fill deposits and pond and swamp habitats in ancient channel depressions of the Mississippi-Big Muddy River at 350 feet elevation. Adjacent to much of the floodplain is a line of fifty foot or higher massive Bailey Limestone cliffs, highly weathered and capped by cherty gravels of the siliceous Grassy Knob Formation. These represent truncated spur ridges from a central north-south ridge system. Ravine systems at both the northwest and southwest corners of the Station extend from the floodplain approximately one-quarter mile into the highlands. The eastern part drains to the south from a central broad ridge which has narrower prolongations to the north and the south. The upland areas are blanketed by loess which remains on ridges and may be found on ravine slopes. The predominant soil is a silty-clay with


FIGURE 1.—An outline map of the central Mississippi Valley showing the location of the Pine Hills Field Station.

rocky or gravelly phases. Litter is essentially continuous for all forest areas and the upper soil is darkened with organic matter.

Climatically the area has been classified Caf, humid subtropical with warm summers (Trewartha, 1954). Average annual temperature approximates 58° F. (January 36° to July 80° F.) with about 200 frost-free days. Precipitation averages approximately 40 inches with May the wettest month and with a rela-

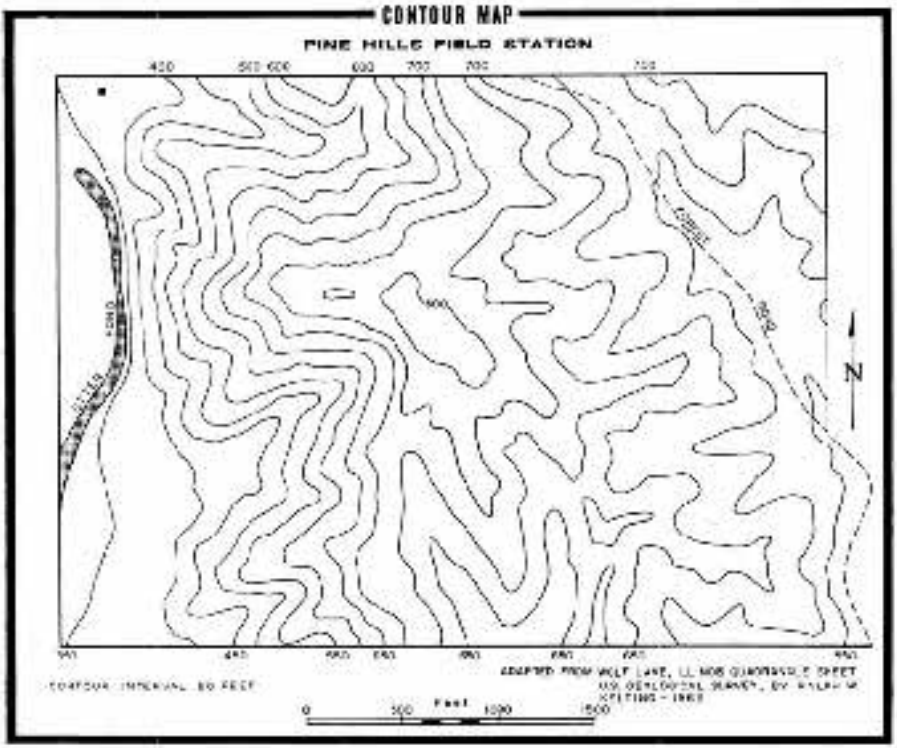


FIGURE 2.—Topographic map of the Pine Hills Field Station.

tively dry summer and early autumn. Snowfall averages 10 to 15 inches annually. Invasions of cold air from the north may bring more typically northern Illinois conditions of severe winter weather, or may ameliorate summer heat. Spring and fall are the seasons of most frequent wild fires in the region. We do not know of fires having occurred on the Station for the past 30 years. This may be related to the general isolation of the area, the swamps on the west, National Forest ownership on the east, north, and west, and protection furnished by the powder manufacturing company on the south. Basal fire scars are present on the uphill side of medium-sized white oak and other trees. Lumbering may have been general over the area at sometime in the past. A widespread distribution of sassafras may be related to this or to fire.

The presence of abundant and diverse animals is shown in numerous studies which have been carried out by workers at Southern Illinois University and other institutions. Direct influences of animal life on plant growth or distribution were not generally evident. Girdling of trees up to 12 inches in diameter by beaver was found in the swamp forests of the floodplain. Wood-

chucks, squirrels, deer, rabbits, foxes, many birds, reptiles, and amphibians were observed. A six-foot chain link fence topped with barbed wire was erected on two sides of the Station in the last two years.

A road cuts across the northeastern corner of the Station and a research building and yard occupy part of the northwestern corner. Except for Otter Pond, the remainder of the area is covered by forest. Comparisons of the United States Department of Agriculture's 1938, 1952, and 1959 aerial photos show increased canopy coverage. Changes in species composition were not detected on these photos.

The Illinois Ozarks are mapped by Shantz and Zon (1924) as Oak-Hickory. Cypress-Tupelo-Red (Sweet) Gum (River Bottom Forest) reaches to the Station area from a more southern occurrence. Braun (1950) maps the Station location at the eastern edge of the Oak-Hickory Forest Region and at the western edge of the Western Mesophytic with the Southeastern Evergreen, Mississippi Alluvial Plain a few miles to the south.

Detailed study in our small area revealed more diverse vegetation than could be shown on the above two maps. Classification and mapping of the plant communities were carried out by the combined use of stereoscopic interpretation of the 1959 U. S. Department of Agriculture aerial photographs at 1:20,000 and by ground surveys. Kuchler (1956) presented a full explanation and use of these techniques. In our study, fifty units of visual homogeneity were delineated on the aerial photographs prior to extensive field work. The physical characteristics of tree size, shape, spacing, and reflectance properties of the canopy were those primarily evident under a stereo viewer. After this essentially physiognomic delineation of unit areas, field surveys were carried out. Each unit was walked through one or more times depending on the size of the area. Floristic lists were compiled of the canopy trees, understory trees and shrubs, and herbs. Additional notes were taken on tree sizes, and diameters at breast height (DBH) were recorded for the largest trees. The ecological structure was briefly described. Habitat information included the type of topography, the direction and angle of slope, the extent and thickness of the litter layer, and the surface geology.

After the field data had been obtained, a map for the Station area showing eight plant communities was compiled (Fig. 3). A similar height and density, similarity in the number and kind of strata present, and a similar total species composition and distribution of dominant and indicator species were criteria for grouping certain of the 50 units on the aerial photographs into a given plant community. Greatest importance was placed on the largest trees. Transgressives from one community would frequently be found in others, but often not attaining full growth. The ground surveys resulted in the elimination of some presumed boundaries and in the drawing of a few new ones. The aerial photo outlines were, however, usually found to be the best boundaries for separating two communities on the map and were used in

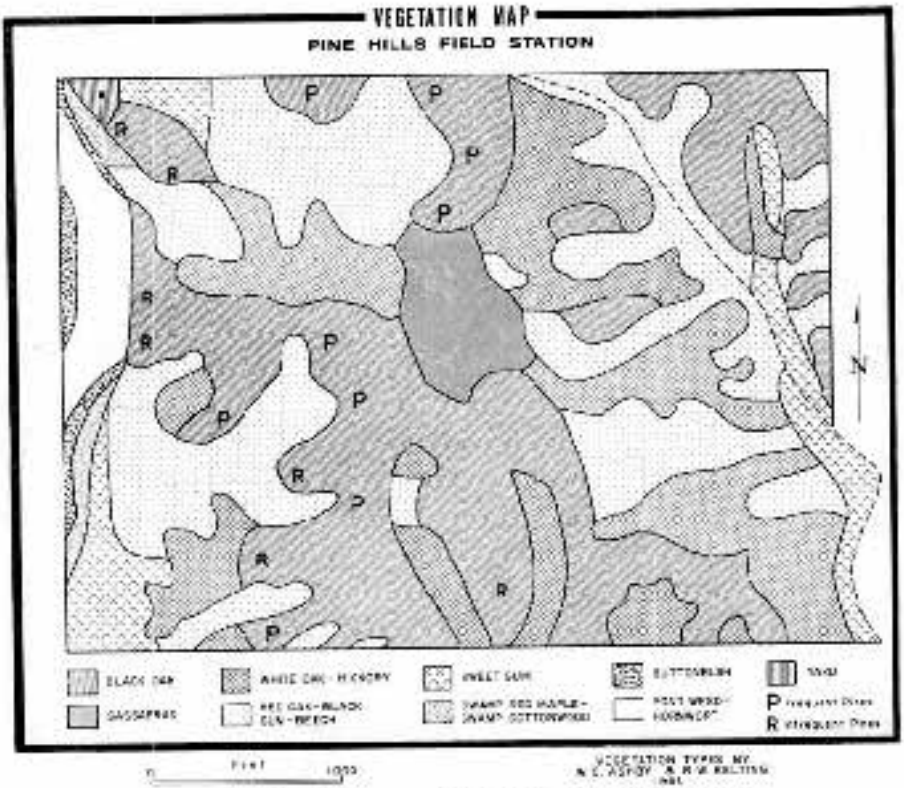


FIGURE 3.—Vegetation map of the Pine Hills Field Station.

the majority of instances. Our emphasis was on functional plant communities, even though a thorough floristic census would very likely be amenable to presentation from the continuum point of view. Further study is continuing in each community described. Permanent plots which would be fully censused for successional studies are planned in conjunction with a survey for a grid system on the Station.

Gray's Manual (Fernald, 1950) was used for names of species. County distribution maps for Illinois (Jones and Fuller, 1955), a manual for southern Illinois (Mohlenbrock and Voigt, 1959), and a checklist for the Pine Hills (Mohlenbrock and Voigt, in press) are available.

Table 1 shows the number of areas for each community, their total percentage area, and their acreage. In field distribution the communities are found in aquatic, bottomland and ravine, or slope and ridge habitats. Aquatic communities can be directly related to the distance from the shore with the Pondweed (*Potamogeton*)-Hornwort (*Ceratophyllum*) furthest out and then the Buttonbush (*Cephalanthus occidentalis*) and, nearest the shore, the Swamp Red Maple (*Acer rubrum* var. *drummondii*)-

TABLE 1.—Areas of the Plant Communities on the Pine Hills Field Station.

| Plant community | Number of areas | Percent of total area | Area in acres |
|---|---|---|---|
| A. Yard | 1 | 0.2 | 0.7 |
| B. Aquatic | | | |
| 1. Pondweed-Hornwort | 1 | 2.5 | 7.5 |
| 2. Buttonbush | 5 | 1.2 | 3.1 |
| 3. Swamp Red Maple-Swamp Cottonwood | 2 | 1.6 | 2.6 |
| C. Bottomland and Ravine | | | |
| 1. Sweet Gum | 4 | 5.0 | 12.9 |
| 2. Red Oak-Black Gum-Beech | 13 | 27.7 | 71.5 |
| D. Slope and Ridge | | | |
| 1. White Oak-Hickory | 13 | 25.7 | 66.3 |
| 2. Sassafras | 1 | 3.5 | 9.0 |
| 3. Black Oak | 10 | 32.7 | 84.4 |
| Total | 50 | 100.0 | 258.0 |

Swamp Cottonwood (*Populus heterophylla*) communities. In the bottomland and ravine areas were found the Sweet Gum (*Liquidambar styraciflua*) and the Red Oak (*Quercus rubra*)-Black Gum (*Nyssa sylvatica*) -Beech (*Fagus grandifolia*) communities, each of which embrace an appreciable floristic diversity. On the slope and ridge areas were found the White Oak (*Quercus alba*)-Hickory (*Carya glabra*), the Sassafras (*Sassafras albidum*), and the Black Oak (*Quercus velutina*) communities.

## Aquatic Habitats

*Pondweed-Hornwort.* This community is composed primarily of submerged species. Occasional emergent plants such as yellow water lily (*Nuphar advena*) are found. Duckweeds cover the water where the surface is relatively undisturbed by wind. Sponge plant (*Limnobium spongia*) is common. In summer the plant growth is sufficiently dense to obstruct the movement of a small boat over the entire surface of Otter Pond (Fig. 4).

*Buttonbush.* Fringing the Pondweed-Hornwort community is a zone of buttonbush which varies from a few to many yards in width. It is relatively pure with some admixture of swamp rose (*Rosa palustris*) and black willow.

*Swamp Red Maple-Swamp Cottonwood.* Characteristically in shallow standing water adjacent to the shore is a fringing belt up to 75 feet in width with scattered trees of swamp red maple and swamp cottonwood and lesser numbers of pumpkin ash (see Table 2 for tree nomenclature), water locust, and black willow. Pin oak, hackberry, and sugarberry are found on the shore. Scattered shrubs include buttonbush and, along the shore, deciduous holly (*Ilex decidua*), and Virginia willow (*Itea virginica*). The herb layer is locally well-developed, being composed pri-

FIGURE 4.—View from a canoe of Otter Pond covered with duckweed and of the fringing buttonbush zone. A path through the duckweed made by the canoe is visible. The Swamp Red Maple - Swamp Cottonwood community is here scarcely represented. The forest shown is the Sweet Gum community with a sweet gum evident as the largest tree in the center of the photo. The Black Oak community is barely evident at the far right on the top of the limestone cliff.

marily of lizard's tail (*Saururus cernuus*). This community does not correspond closely to a Forest Cover Type of North America recognized by the Society of American Foresters (1954).

BOTTOMLAND AND RAVINE HABITATS

*Sweet Gum.* Sweet gum, which is found in mixtures with a number of associates in varying frequency from location to location, is the indicator tree for this community. Characteristically the associated species include chinquapin oak, tulip tree, sugar maple, elm, bitternut hickory, ash, red mulberry, and sassafras.

TABLE 2.—Tree Canopy Composition of the Forested Communities on the Pine Hills Field Station. For each species the numbers listed show the communities in which it occurs. The bold faced numbers show dominance, or, at least, local abundance. Key: 1. Swamp Red Maple - Swamp Cottonwood; 2. Sweet Gum; 3. Red Oak - Black Gum - Beech; 4. White Oak - Hickory; 5. Sassafras; and 6. Black Oak.

*Acer rubrum* (Red maple)—2,3,4,5,6.
*A. r.* var. *drummondii* (Swamp red maple)—1.
*A. saccharum* SENSU LATO (Sugar maple)—2,3.
*Carya cordiformis* (Bitternut hickory)—2,3,4.
*C. glabra* (Pignut h.)—2,3,4,5,6.
*C. laciniosa* (Shellbark h.)—2.
*C. ovalis* (Sweet pignut or Small-fruited h.)—2,3,4,5,6.
*C. ovata* (Shagbark h.)—2,3,4,5,6.
*C. texana* (Black h.)—6.
*Celtis laevigata* (Sugarberry)—2.
*C. occidentalis* (Hackberry)—2,3.
*Diospyros virginiana* (Persimmon)—2,3,4.
*Fagus grandifolia* (Beech)—2,3
*Fraxinus tomentosa* (Pumpkin ash)—1.
*F.* spp. (white and green a.)—2,3,4.
*Gleditsia aquatica* (Water locust)—1.
*G. triacanthos* (Honey locust)—2.
*Gymnocladus dioica* (Kentucky coffee-tree)—2.
*Juglans cinerea* (Butternut)—2,3.
*J. nigra* (Black walnut)—2,3.
*Juniperus virginiana* (Eastern red cedar)—6.
*Liquidambar styraciflua* (Sweet gum)—2.
*Liriodendron tulipifera* (Tulip tree) 2,3,4.
*Magnolia acuminata* (Cucumber tree)—2,3,4,6.
*Morus rubra* (Red mulberry)—2,3,4.
*Nyssa sylvatica* (Black gum)—2,3,4,6.
*Pinus echinata* (Shortleaf pine)—6.
*Platanus occidentalis* (Sycamore)—2.
*Populus deltoides* (Cottonwood)—2.
*P. heterophylla* (Swamp c.)—1.
*Quercus alba* (White oak)—2,3,4,5,6.
*Q. falcata* var. *pagodaefolia* (Cherry-bark o.)—2.
*Q. macrocarpa* (Bur o.)—2.
*Q. marilandica* (Blackjack o.)—6.
*Q. muehlenbergii* (Chinquapin o.)—2,3.
*Q. palustris* (Pin o.)—2.
*Q. rubra* (Northern red o.)—2,3,4,5,6.
*Q. shumardii* (Shumard's red o.)—2.
*Q. stellata* (Post o.)—4,6
*Q. velutina* (Black o.)—2, 3, 4, 5, 6.
*Rhus. copallina* (Winged sumac)—6.
*Salix nigra* (Black willow)—1.
*Sassafras albidum* (Sassafras)—2,3,4,5,6.
*Tilia americana* (Basswood)—3.
*Ulmus alata* (Winged elm)—6.
*U. americana* (American e.)—2,3,4.
*U. rubra* (Red or slippery e.)—2,3,4.

More localized in their occurrence are Shumard's red oak and bur oak, big shell-bark or kingnut hickory, black walnut, Kentucky coffee-tree, honey locust, sycamore, persimmon, and cherry-bark oak, as well as occasional representatives from adjoining communities. Within small, local areas groupings of Shumard's Red Oak — Big Shellbark Hickory, or Lowland Bur Oak — Persimmon, or Sugar Maple (in the better drained areas) were found. Understory trees or larger shrubs which form a nearly continuous layer commonly include pawpaw (*Asimina triloba*) and spicebush (*Lindera benzoin* — essentially an indicator shrub), and less commonly, redbud (*Cercis canadensis*), bladdernut (*Staphylea trifolia*) and black haw (*Viburnum rufidulum*). Large vines of grape (*Vitis spp.*) and poison ivy (*Rhus radicans*) are present on trees. An almost continuous, variable, lower, shrubby-herbaceous layer includes the abundant poison ivy (*Rhus radicans*) and a diversity of herbs such as wild ginger (*Asarum canadense*), trillium (*Trillium recurvatum*), Virginia knotweed (*Tovara virginiana*), toothwort (*Dentaria laciniata*), Dutchman's breeches (*Dicentra cucullaria*), and Jack-in-the-Pulpit (*Arisaema triphyllum*). These herbs are distributed irregularly, presumably reflecting both the diverse microhabitats within the forest, and the

FIGURE 5.—A canopy beech in a ravine with the Red Oak - Black Gum - Beech community on the eastern side of the Station.

specific life requirements of individual species.

The Sweet Gum community occupies the areas adjacent to Otter Pond at elevations of approximately two to 15 feet above the water level. It also occupies the floor of the main ravine on the eastern side of the Station where the immediate channel is marked by rocky walls from two to four feet high. It is replaced by other communities in the middle portion of the ravine and may reappear in the narrow, steep-walled heads of a drainage where side slopes reach 40 degrees in slope and 20 feet or more in height. Only one such area is sufficiently large to be included on the map. In explaining such areas, local geologists and for-

esters have suggested a favorable soil condition due to the movement of loess off the ridges into the heads of the drainage systems as well as microclimatic influences.

This community shares some of the characteristics of the Pin Oak-Sweet Gum Forest Cover Type of the Central Forest Region (Society of American Foresters, 1954) and, without the loblolly pine, of the Sweet Gum-Yellow Poplar (*Tulip Tree*) of the Southern Forest Region.

*Red Oak-Black Gum-Beech.* The Red Oak-Black Gum-Beech community can be considered the "classic" ravine community of the Pine Hills Field Station. It borders the Sweet Gum community and shares species with it to a limited extent. The tree canopy is closed. Larger individuals of several tree species reach nearly 30 inches DBH. Many trees fall in the diameter classes from ten to thirty inches, and smaller size classes are present. A generally discontinuous, small tree-tall shrub layer is present. Herbs are variable, sometimes continuous, while a small shrub stratum is generally lacking. Litter is essentially continuous in summer, less than an inch deep. Rock is occasionally exposed on ravine banks and in the beds of the larger intermittent streams.

The community is somewhat variable in species composition. Red oak is a more consistent component species than black gum or beech. Canopy-size beech, in turn, tends to be exclusively found in this community (Fig. 5). It often occurs as groups of mature trees that may have resulted from earlier cutting practices which left the beech relatively pure in local areas. Black gum may be found within the Sweet Gum community and red oak in the White Oak-Hickory or even in the Black Oak communities. Tulip tree is found frequently in the ravine areas. It is not listed as a name species because of its frequency in the Sweet Gum community as well. Other species are listed in Table 2. Only one American basswood (*Tilia americana*) was found, this on a north-facing side slope. A number of basswood trees were found in two ravines to the north of the Station, though generally it is rare in Southern Illinois.

A lower tree stratum includes sugar maple, flowering dogwood (*Cornus florida*), ironwood (hop-hornbeam) (*Ostrya virginiana*), winged elm (*Ulmus alata*), redbud, Hercules'-club (*Aralia spinosa*), pawpaw, service berry (*Amelanchier arborea*), wild plum (*Prunus americana*), and blue beech (*Carpinus caroliniana*). Shrubs and woody vines include frequent occurrences of wild hydrangea (*Hydrangea arborescens*), abundant poison ivy, and, infrequently, spicebush. In comparison to the forests of northern Illinois (the Chicago area), a number of expected shrubs absent from this habitat on the Station area included *Viburnum* spp., *Cornus* spp., *Lonicera* spp., *Prunus virginiana*, and *Ribes* spp. The herbaceous layer is relatively continuous. Both Christmas (*Polystichum acrostichoides*) and maidenhair (*Adiantum pedatum*) ferns are common. Many herbs are shared with adjacent Sweet Gum or White Oak-Hickory areas.

FIGURE 6.—White oak (on the left) and hickory (*Carya glabra*) on the right on an upper north-facing slope.

This community is not represented in the Forest Cover Types (1954) except possibly as a variant of the next one here listed.

### SLOPE AND RIDGE HABITATS

*White Oak-Hickory.* The ridge and slope communities are relatively distinct from those of the bottomland and ravine. They are less distinct from one another. Rather consistently associated with the white oak are hickories which key out to *Carya glabra* or *C. ovalis*. Many white oaks exceed 20 inches in diameter, and many hickories 15 inches (Fig. 6). The most important associated species which may reach the diameter of white oak is black oak. Other species found are usually in smaller diameter classes (Table

2). Understory trees frequently include ironwood (hop-hornbeam) and flowering dogwood. Except for the frequent poison ivy the shrub layer, including tree reproduction, is discontinuous. An evident herb layer is present, rarely more than scattered individuals, giving diversity on the otherwise litter-mantled soil. Bottlebrush grass (*Hystrix patula*), desmodium (*Desmodium nudiflorum* and *D.* spp. — also common in the Red Oak - Black Gum - Beech community), wild yam (*Dioscorea villosa*), and *Helianthus divaricatus* — more abundant in the Black Oak community, are frequently found. Few or no herbs are restricted to this community. More are shared with the ridge than with the ravine areas.

The White Oak-Hickory community is found on the north- and east-facing ridge slopes, occasionally on lower south slopes, on ravines which open to the south, or even on a narrow ridge top flanked by well-developed ravines. This may be related to microclimatic influences from the adjacent vegetation. On north-facing slopes it intergrades with the Red Oak-Black Gum-Beech below and the Black Oak community above.

*Sassafras.* Unlike the other forested areas, this community is characterized by trees of moderate stature. The canopy is essentially closed. Sassafras of about two to three inches DBH predominates, with a sparse admixture of winged sumac of approximately equal stature as the sassafras, of somewhat larger hickories (pignut and small-fruited) and an occasional black or white oak. This community is found on a relatively large flat area at the uppermost contour of the station (800 feet). The suggestion that it represents an old field was neither documented nor fully discarded. The most convincing evidence of possible natural origin was shown by the occurrence of quite similar sassafras stands on other small areas found on south-facing slopes between the Black Oak and the White Oak-Hickory communities. They likewise had admixed small diameter hickories or oaks, a general absence of shrubs, and similar herbaceous species. Explaining them all in terms of old fields seemed unlikely, though logging may have been a factor. For the present, they are simply recognized and one of the largest areas is mapped. No reasonably equivalent type is listed in the Forest Cover Types.

*Black Oak.* This community encompasses more localized diversity in the canopy species and shrubs than any other except the Sweet Gum community. The herb components are relatively consistent. Black oak, often over 20 inches DBH with several large branches, predominates in a majority of the areas, generally with an absence of other canopy species of equal stature. Sassafras of a few inches DBH usually accompanies and outnumbers the black oak. The Black Oak community predominates on the south- and west-facing slopes and ridges. It may make contact with either the White Oak-Hickory or with the Red Oak-Black Gum-Beech, more so with the latter on south-facing slopes where the Black Oak extends deeper into ravines. Shortleaf pine is found with-

FIGURE 7.—An east-west ridge in December. Snow cover remains on the upper north-facing slope. Little bluestem is a major component of the ground layer on the south-facing slope under sassafras with scattered small black or white oaks.

in the broad community on localized west- and south-facing steep upper slopes above the Mississippi River trench. Here the characteristic shrub layer includes sparkleberry (*Vaccinium arboreum*) and wild azalea (*Rhododendron roseum*). Black oak is present in these areas. Blackjack oak and post oak are locally frequent in pine areas and on south-facing ridge tops. Hickories, usually considered to be *Carya glabra*, are not conspicuously present in any part of the community. In a further variant on open west-facing rocky outcrops, small eastern red cedar (*Juniperus virginiana*) and ironwood (hop-hornbeam) are found. The understory here includes species of the hill prairies (Evers, 1955).

Grassy areas likewise are found on south-facing ridge tops and upper slopes (Fig. 7).

In the Black Oak community the trees (Table 2) form a relatively open canopy, variable in height as a consequence of the large proportion of small tree species in the canopy. Tall shrubs include occasional sumac (*Rhus copallina*, with some *R. glabra*), and sparkleberry in well-developed pine stands. Small shrubs — New Jersey tea (*Ceanothus americanus*), aromatic sumac (*Rhus aromatica*), and blueberry (*Vaccinium vacillans*) — form occasional thickets; the New Jersey tea is more typical under black oak and the blueberry, under pine. Poison ivy grows less luxuriantly and abundantly in this type, though still the most frequent shrub. Within and adjacent to present pine areas, pine reproduction was conspicuous. The Pine Hills area and a stand in Randolph County thirty miles north represent the only natural occurrences of shortleaf pine in Illinois

Herbs form a scattered ground cover over most of the type. They are much less evident under the heath cover of several pine stands and are essentially continuous in open grassy woods. Here the main grass is little bluestem (*Andropogon scoparius*) with occasional big bluestem (*A. gerardi*) or Indian grass (*Sorghastrum nutans*). *Helianthus divaricatus* patches may be found in relatively open woods, often with New Jersey tea. Other species are *Solidago ulmifolia*, *Rudbeckia hirta*, *Cunila origanoides*, *Tephrosia virginiana*, and *Dodecatheon media*.

Measurements of maximum-minimum temperatures at selected sites from January through early June, 1962, indicate that minimum temperatures in this community differ but little from minima in bottomland and ravine areas. However, as the season progressed, differences in maxima as great as 20 degrees F. between an exposed, west-facing cliff area and a deep ravine were noted. The warmest (and presumably the driest) site supported eastern red cedar, black hickory, blackjack oak, New Jersey tea, and various grasses.

Of the Forest Cover types (Society of American Foresters, 1954) it resembles Post Oak-Black Oak, Shortleaf Pine, and Eastern Red Cedar to some degree. It should be noted that species reported for southern Illinois including southern red oak (*Q. falcata*), shingle oak (*Q. imbricaria*), scarlet oak (*Q. coccinea*), and chestnut oak (*Q. prinus*) were not found on the Station. Southern red and shingle oak are common around Carbondale, and scarlet oak still further east.

## Summary

Stereoscopic interpretation of the 1959 U. S. Department of Agriculture aerial photographs at 1:20,000 for the 258 acres of the Pine Hills Field Station showed 50 unit areas. These unit areas were examined by ground survey for their ecological structure, floristic composition, and topographic relations and were grouped in eight plant communities shown on a vegetation map. The Pondweed-Hornwort community was largely composed of submerged aquatics, while species in the Buttonbush community were rooted in areas of standing water. The Swamp

Red Maple-Swamp Cottonwood community is chiefly found in saturated soil or standing water.

Other forested areas were divided into those of lowland and ravine, and of slope and ridge. These correspond roughly to regional forest classifications of southern hardwoods and of oak-hickory. The Sweet Gum community found in lowlands or larger ravines had the largest number of tree species. Above the Sweet Gum community lies the Red Oak-Black Gum-Beech which is characteristically found in ravines and on lower slopes. The White Oak-Hickory community occurs on north- or east-facing upper slopes. Both red and black oaks also are found in the White Oak-Hickory community. An associate in the Black Oak community of south- or west-facing upper slopes and ridges is shortleaf pine. In several areas, one of which was large enough to map, sassafras was the predominant species. These areas may reflect earlier cutting or possible clearing, or fire. The present vegetation has developed with an absence of fire for perhaps 30 years. The aerial photos of 1938 show a more open cover than in 1959. This may also be related to drought.

## Acknowledgments

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