FOREST INVASION ON ABANDONED PASTURE LAND AT THE STRONGHOLD IN OGLE COUNTY, ILLINOIS

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ABSTRACT.—A pasture of 34 acres was abandoned in 1948. Several surveys of invasion by woody plants into sample areas were conducted from 1959 through 1972. Twenty-seven species of trees, 20 shrubs and vines, and 78 herbaceous plants were identified. Pioneer invaders were dominated by *Acer negundo*. Other important invaders were *Ulmus americana*, *U. rubra*, *Prunus americana*, and in small areas, *Rhus glabra*. *Quercus velutina* has been an abundant secondary invader. Recently, numerous seedlings of *Fraxinus americana* have appeared. Concentrations of various invading trees have been related to proximity of seed sources, which were mostly fencerows, an abandoned roadway, and adjacent forests. A central gully in a more advanced stage of forest development is also influencing the adjacent parts of the field. It is obvious that in a quarter of a century, abandoned pasture land in a northern Illinois river valley situation can develop into a savanna-like open woods that will gradually progress into a deciduous forest.

The Stronghold, located north of Oregon, Illinois, along the west side of Illinois route 2, consists of about 450 acres of forested hills and valleys. The property is owned by The Presbyterian Camping Association of Northern Illinois and is used for summer camping by youth groups.

Separating the forest into north and south portions is a 34-acre field abandoned as pasture in 1948. This particular site was apparently cleared of its forest shortly after settlement of the area about 1835. It was used for cultivated agriculture until it was badly eroded, with topsoil gone and a deep gully cut through the middle. It was planted in grasses and possibly legumes and used as pasture for livestock for several decades. Since 1948, it has been idle, except for hiking by small groups over established trails. Use and disturbance have been minimal.

The site is located in the center of section 33 of Rockvale Township (T24N., R10E.), Ogle County, Illinois. It is adjacent to Illinois route 2 and extends westward for about 2500 feet (Fig. 1). Its elevation ranges from 700 feet at the east end to 830 feet at the west end. The field is almost entirely sloping, with drainage by old gully channels.

Succession under similar circumstances has been studied and documented for southern Illinois by Voight and Mohlenbrock (1964), Bazzaz (1968), and others. No information on succession is available for other sites in northern Illinois.

Previous papers on the Strong field have reported on competition between forest and prairie vegetation (Bullington, 1970), successional development of the main gully (Bullington, 1971), and a half-century of vegetational development of an old roadway that crosses the east end of the field (Bullington, 1973).

This report, combining data obtained in various surveys from 1959 through 1972, will show the present status of the woody vegetation of the Strong field and will indicate the presence of herbaceous species. This information should be of value in future ecological studies of the field.

Soils The soils of The Stronghold, including the study field, have been typed by technicians of the Ogle County Soil Conservation Service. Additional observations by the author and a soil scientist have veri-

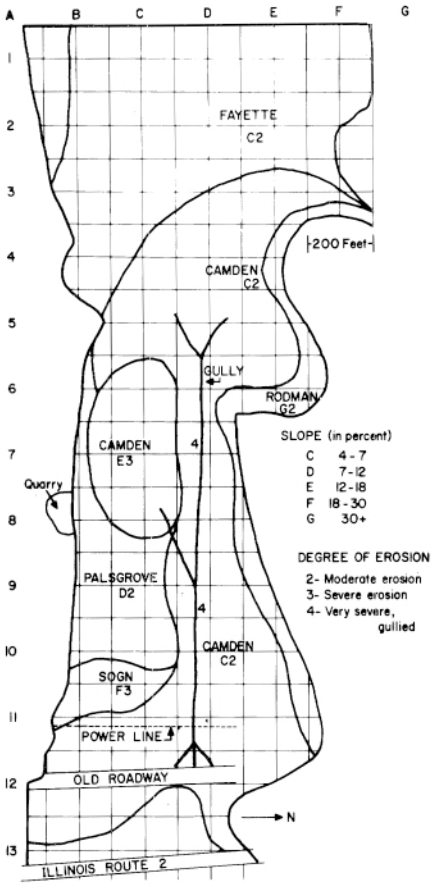

FIGURE 1.—Map of the Strong field at The Stronghold, Oregon, Illinois.

fied the characteristics of the four kinds of silt loam soils identified in the field. Figure 1 gives the locations of the kinds of soil. Letters with the names indicate the percent of slope, and numbers, the degree of erosion. (See explanation with Figure 1).

The largest portions of the field are covered with Camden silt loam and Fayette silt loam. Camden is found at lower elevations and has developed in silt deposits, some sandy and others of clay. Fayette silt loam covers the western portion of the field which is the most level. It developed in a loess deposit. Much of the east part of the field has Palsgrove silt loam over sandy limestone. Crumbling rocks are found very near the surface. Only this part of the field has an alkaline pH, and it is here that the principal development of sweet clovers (*Melilotus*) and hop tree (*Ptelea trifoliata*) occur.

At the east end and south edge are small areas of Sogn silt loam, developed on steeper slopes over limestone. This type is present in the entire strip of adjacent forest on the south side. An old limestone quarry is present at the midpoint of this forest edge. It was opened on the north slope of a steep valley.

The adjacent forest on the north has Rodman gravelly loam, a loose soil with a small amount of loam over calcareous gravel. It drains rapidly. This fact may be the chief reason for the dominance of black oak (*Quercus velutina*) in much of this forest, for this species is usually dominant on relatively xeric sites of sand or gravel in northern Illinois.

All of these soils are types that developed under deciduous forest. They tend to be well drained, with good permeability of air and water, but they are subject to erosion. Their best use, recommended by the SCS, is pasture, woodland, or wildlife area. Agriculture should be limited to the more level portions. The first settlers made a mistake in clearing the original forest and cultivating the soil of this site. The result was eventual loss of topsoil and formation of gullies, which in turn led to use as pasture.

Bard (1952) reported very little change of Piedmont soils after 60 years of succession. To date the Strong field shows little evidence of topsoil restoration. Neglible amounts of humus have been incorporated into the upper layer of soil.

METHODS

The first observations in the Strong field were made in 1958, ten years after cessation of use as pasture. In 1959, six permanent quadrats of 4x25 m. were established along the north side (Fig. 1, D, 6-11). All plants in each were recorded. A report of this and other early observations have been published (Bullington, 1970).

More recent surveys include a quarter-method study of 18 points at 100-feet intervals through the middle of the field in 1967. This was followed in 1970 by a study of 18 quadrats of 10x10 m. randomly selected along or near the same transect. (Fig. 1, C, 1-11). Figure 2 shows a typical area sampled in these surveys.

In order to check on seed sources from the adjacent forests, a survey was made in 1969 of all trees in 50-feet strips of forest border at both the north and south margains of the east half of the field. The north forest strip was approximately 1000 feet long (Fig. 1, E6-F11), and the south was 600 feet long (Fig. 1, B8-B11). Figure 3 shows the east end of the field with the northern forest in the background.

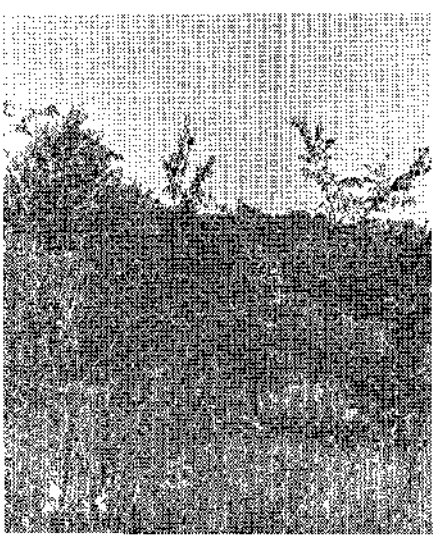

FIGURE 2.—Twenty years of development of mixed species of trees in abandoned bluegrass pasture.

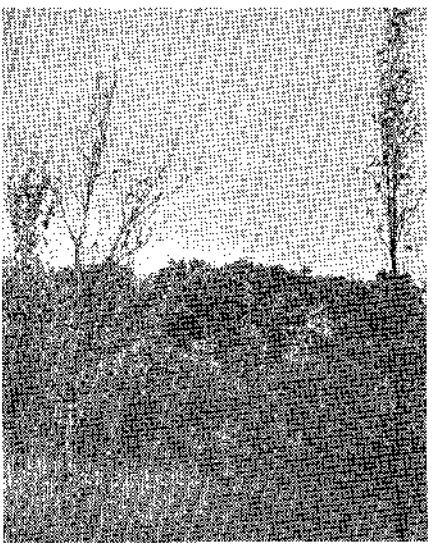

FIGURE 3.—East end of Strong field looking north, showing tree invasion in abandoned pasture, with oak forest in background.

In 1970 a repeat study of the tree population was made in the six permanent quadrats. Also in that year, the largest tree of each common species in the field was sought and measured.

A final search for new herbaceous species and for tree seedlings was made by reconnaissance in various parts of the field in 1972.

Data concerning relative frequency, relative density, relative dominance, and importance values (IV) were determined according to Curtis and Cottam, 1962. A modification was made in the determination of relative dominance. Diameter readings (dbh) at 4½ feet were made on all trees over six feet in

height in the various surveys. Because of the small diameters of many trees, basal areas were not determined. Therefore, diameters rather than basal areas were used in figuring relative dominance.

The botanical nomenclature follows that used by Fernald (1950). All identifications were checked in both Fell (1955) and Swink (1969) for confirmation of their likely presence in northern Illinois.

RESULTS

Twenty-seven species of trees have been identified in the Strong field. Table 1 lists them with their rank order of abundance indicated from various surveys. Symbols assigned to each species in Table 1 are used in other tables.

TABLE 1.—Summary of trees of Strong field with rank order of abundance for various locations.

	Sample Area		Gully	S. Field	N. Field	N. Forest	S. Forest	Field Seedlings
	Method		Survey	Quad.	Quad.	Survey	Survey	Recon.
	Year		1969	1970	1970	1969	1969	1972
Scientific Name	Common Name	Symbol						
Acer negundo L.	box-elder	BE	5	1	5	F	9	F
Acer saccharum Marsh.	sugar maple	SM	F					F
Betula papyrifera Marsh.	white birch	WB					F	
Carya cordiformis K. Koch	bitternut hickory	BHi						F
Carya ovata K. Koch	shagbark hickory	SH	7		6	1	4	F
Catalpa sp.	catalpa	Ca	F					
Celtis occidentalis L.	hackberry	H	3	F	10	5	6	F
Crataegus crus-galli L.	cockspur-thorn	CT		8				
Crataegus mollis Scheele	red haw	RH	12	6	8			
Fraxinus americana L.	white ash	WA	13	F			2	1
Gleditsia triacanthos L.	honey locust	HL						F
Juglans nigra L.	black walnut	BW	2	7	1	F	3	F
Juniperus virginiana L.	red cedar	RC	11	F		F	F	F
Populus grandidentata Michx.	large-toothed aspen	A	9		7	6		6
Prunus americana Marsh.	wild plum	P	F	A				
Prunus serotina Ehrh.	black cherry	BC	6	5	11	7	5	3
Ptelea trifoliata L.	hop tree	HT	F					F
Pyrus ioensis Bailey	wild crab	WC	10	2	4			4
Quercus alba L.	white oak	WO	F			4	F	5
Quercus macrocarpa Michx.	bur oak	BO	F					
Quercus rubra L.	red oak	RO			F			
Quercus velutina Lam.	black oak	B10	4	9	2	2	7	2
Tilia americana L.	basswood	B						F
Ulmus americana L.	American elm	AE	3	3	9		8	
Ulmus pumila L.	Siberian elm	SE						F
Ulmus rubra Muhl.	red elm	RE	1	4	2	3	1	
Viburnum prunifolium L.	black haw	BHa	F					

Key: A = Abundant, but not included in rank
F = Few, less than five specimens

TABLE 2.—Quarter method survey: Tree population of 18 points at 100-feet intervals along an east-west transect (July 1967).*

Species in Order of Importance	No. Points of Occurrence	Total No. Trees	Rel. Frequency	Rel. Density	Rel. Dominance	Importance Value
BE	15	32	32.6	44.4	27.8	104.8
AE	4	5	8.7	6.9	33.8	49.4
RE	6	9	13.0	12.5	8.4	33.9
RH	6	9	13.0	12.5	5.1	30.6
P	5	5	10.9	6.9	4.7	22.5
SE	3	5	6.5	6.9	7.8	21.2
BC	3	3	6.5	4.2	5.4	16.1
WC	3	3	6.5	4.2	2.6	13.3
BW	1	1	2.2	1.4	4.3	7.9
Totals	46	72				

* Symbols of species are from Table 1.

The results of quarter and quadrat surveys along a transect through the middle of the field are shown in Tables 2, 3, and 4. The IV's of the tree species have been determined. In the quadrat survey of 1970, the wild plum (*Prunus americana*) and hop tree were included with the shrubs, etc., of Table 4.

The quarter survey of 1967 (Table 2) showed only nine tree species including wild plum. The box-elder (*Acer negundo*) was much more important than other species. The american elm (*Ulmus americana*), red elm (*U. rubra*), and red haw (*Crataegus mollis*) were next in order.

TABLE 3.—Quadrat survey: Tree population in 18 quadrats located at random along an east-west transect (Oct. 1970).

Species in Order of Importance	Presence Number Quadrats	Total No. Trees	Trees Over 6 ft.	Rel. Frequency	Rel. Density	Rel. Dominance	Importance Value
BE	16	272	152	17.4	42.9	30.6	90.9
WC	16	147	76	17.4	23.2	10.5	51.1
AE	10	68	67	10.9	10.7	20.9	42.5
RE	15	55	53	16.3	8.7	17.5	42.5
BC	14	43	34	15.2	6.8	10.5	32.5
RH	5	19	19	5.4	3.0	3.5	11.9
BW	5	13	12	5.4	2.0	4.3	11.7
B10	5	5	3	5.4	0.8	0.7	6.9
CT	2	6	4	2.2	1.0	0.5	3.7
H	2	2	2	2.2	0.3	0.6	3.1
RC	1	2	1	1.1	0.3	0.4	1.8
WA	1	2	1	1.1	0.3	0.0	1.4
Totals	92	634	424				

TABLE 4.—Presence of shrubs, vines and small trees in 18 quadrats (Oct. 1970).

	Number of Quadrats				
	Of East 9	Of West 9	Total	Percent Of 18	Total Specimens
Species					
Prunus americana	8	7	15	83.3	256
Ptelea trifoliata	5	1	6	33.3	8
Rhus glabra	2	1	3	16.8	102
Rhus radicans		3	3	16.8	many
Ribes missouriense		1	1	5.5	2
Sambucus canadense		1	1	5.5	3
Smilax tamnoides		1	1	5.5	1
Vitis riparia	1	4	5	27.8	30

The quadrat survey of 1970 (Table 3) revealed more species of trees, a total of 12, probably because of the larger sampling by this procedure. There were 634 trees compared to 72 in the 1967 quarter-method study. Box-elder was again the most important. Wild crab (*Pyrus ioensis*) was second, with the elms next with equal IV. It should be noted that some dead American elms were not counted. Black cherry (*Prunus serotina*) was fifth in IV.

The location of the transect for these two surveys was chosen because of its mid-position in the east-west axis of the field. It was the most remote from influence by adjacent forests and gully. This central strip had the least dense tree population of the field. The seeds of all invaders, with the exception of walnut and oak, were probably introduced by either wind or birds. In general, the more abundant tree species were wind disseminated. The second survey showed no evidence of invasion of new species following the study of three years earlier. Nearly all trees had been established during the early days after abandonment of the pasture, or possibly before. At present, the central portions of the field are stabilized in the pioneer stage of forest succession with 1426 trees per acre plus an additional 993 shrubs, vines, and small trees, the latter including plum and hop tree.

The six permanent quadrats at the north side of the field contained 11 species of trees in 1959 and only one additional, a single specimen of white oak (*Quercus alba*), in 1969 (Table 5). Black walnut (*Juglans nigra*), black oak, and red elm had the greatest abundance and also the greatest IV in 1970. All had increased in numbers since 1959. Only the box-elder was more common than these three in 1959. It decreased from first rank in 1959 to fourth, with a decrease in specimens from 64 to 28. Many had died, apparently from shading. The decline of this pioneer invader has been noted for the more open center of the field. In the central gully, it was found that one half of the box-elder trees were dead in 1969 (Bullington, 1971).

Wild crab and large-tooth aspen (*Populus grandidentata*) made significant increases in numbers and in rank. Several other species declined by a few specimens each.

In a period of 11 years there was no significant change in overall numbers and little change in species composition, but there was a decided increase in growth. The number of

TABLE 5.—Tree population in six permanent quadrats at north side of field (Nov. 1970).

Species in Order of Importance	No. in 1959	Presence Number Quadrats	Total No. Trees	Trees Over 6 ft.	Rel. Frequency	Rel. Density	Rel. Dominance	Importance Value
BW	55	6	59	45	16.2	18.8	22.3	57.3
B10	47	4	56	34	10.8	17.9	26.5	55.2
RE	41	4	56	34	10.8	17.9	14.0	42.7
WC	23	5	41	20	13.5	13.1	6.5	33.1
BE	64	3	28	22	8.1	9.0	11.0	28.1
AE	14	3	10	7	8.1	3.2	6.6	17.9
A	5	2	17	14	5.4	5.4	5.7	16.5
RH	18	3	13	5	8.1	4.2	1.9	14.2
BC	8	3	5	5	8.1	1.6	4.3	14.0
SH	25	2	21	5	5.4	6.7	1.1	13.2
H	4	1	6	1	2.7	1.9	0.1	4.7
WO	0	1	1	0	2.7	0.3	0.0	3.0
Totals	304	37	313	192				

trees over six feet in height increased from 30 to 192. The total number of trees per acre was 2,112 in 1970, much greater than the concentration through the middle of the field.

The results of the survey of adjacent forest strips are shown in Table 6. The data show 10 species of trees in the north forest strip and 12 in the south strip. The northern forest is a xerophytic association with black oak and shagbark hickory (*Carya ovata*) dominant. There is considerable recent reproduction of the latter. Red elm is the most common understory tree.

TABLE 6.—Tree populations in 50-feet-wide strip of adjacent forest edge (Nov. 1969).

	North Side of Field (1000-Feet Strip)						South Side of Field (600-Feet Strip)					
Size Classes in inches dbh	-1	1-6	6-9	9-12	12+	Total	-1	1-6	6-9	9-12	12+	Total
Species												
BE	1					1		5	2			7
WB											3	3
SH		141	15	7	6	169		12	10	7	5	34
H	4	3	2		2	11		15	1		2	18
WA								38	7	3		48
BW		1	1		2	4		9	21	7	6	43
RC	4					4	1					1
A		1	1	6	1	9						
BC		1	2	1	2	6		21	8	3		32
WO		3	2		7	12				1	1	2
B10	1	9	12	7	22	51		5		3	6	14
AE								1	7	2		10
RE	4	18	3	2		27	many	many	2		2	many
Totals	14	177	38	23	42	294	1+	106+	58	26	25	216+

The greater diversity of species in the south forest strip reflects a less xeric environment. There is no clear dominance among 10 species of canopy trees, although shagbark hickory, black walnut, and black oak outnumber the others among the larger trees. It is worthy of note that no sugar maple (*Acer saccharum*) or basswood (*Tilia americana*) were found in the south strip, even though they are abundant in a mesic valley a few hundred feet to the south. However, a few seedlings and saplings of each are now present in the southern portion of the Strong field.

Special mention should be made of the presence of three white birch (*Betula papyrifera*), all over 12 inches dbh, and a few additional dead ones at the edge of an old limestone quarry. Their presence is unusual in a dry-mesic forest environment in northern Illinois, but they are probably relics. They have been reproducing, for several vigorous saplings are growing in the south part of the field. These do not appear in the statistics of any of the study areas.

Table 7 shows the counts of tree seedlings observed in 50-feet-wide corridors by two persons walking in the areas indicated in the headings. The locations were chosen because they were near good seed sources and seemed to have the most new trees of all locations in the field.

White ash (*Fraxinus americana*) showed the most active reproduction, especially along the south side of the field adjacent to good seed sources. Black oak was second in abundance overall, prominent in all sample areas and the most common seedling near the gully. Black cherry was next in abundance and of first importance at the north edge.

Measurements of dbh of the largest trees of each species revealed a black cherry of 9.2 inches, a black oak of 8.6 inches, and a red elm of 8.5 inches. There was an American elm of 7.6 inches, but larger ones had died. Two other species had

TABLE 7.—Numbers of tree seedlings in selected areas, by reconnaissance survey (Oct. 1972).

Species	North Edge Near Forest	South Edge of Gully	South Edge Near Forest	Totals
BE	3	1		4
SM			1	1
BHi			1	1
SH		1	2	3
H		1	3	4
WA	11	5	many	many
HL			1	1
BW	1			1
RC			2	2
WC	7		4	11
A	2	4		6
BC	23	4	3	30
HT	1	2		3
WO	5		3	8
BIO	12	25	17	54
L			1	1

specimens over 5 inches, red cedar (*Juniperus virginiana*) at 5.7 and black walnut at 5.5. Among recent invaders, white ash was represented by a tree of 4.7 inches and sugar maple by one of 1.7.

Box-elder, although abundant and the dominant pioneer of the field, had no representative over 4.4 inches. However, in gully and roadside areas, there are large specimens of this species. In the field, there is a strong tendency for this tree to die in its second decade, leaving numerous short-lived basal sprouts.

DISCUSSION

Secondary succession has not been studied extensively in the midwestern states, in part because suitable sites of abandoned lands are not as common as in the New England and other east coast states. Of those studies in the midwest reported in the literature, few are concerned with former pastures or hay meadows.

Beckwith (1954), Weigert and Evans (1964), and Brewer, Reim, and Robins (1969) all reported on forest invasion into grass-dominated fields. Watts (1957) told an interesting story of the role of piles of cow dung as centers of invasion by hawthorns in a pasture of northern Illinois.

The Strong field appears to have been invaded by woody species very rapidly after cessation of pasturing in 1948. There may have been many small barren spots on which plants could develop. Within the past decade, there has been little change in species composition. During this period the soil has had a complete cover of grasses and forbs, even under well-developed trees, so there has been little space for new invaders. It is possible that woody plants were present prior to 1948, but in a suppressed condition because of grazing.

The study of Weigert and Evans in southeastern Michigan showed that areas dominated by various grasses remained in the grass-forb stage for 30 years. They predicted eventual oak-hickory forest, however. Levy (1970) reporting on upland openings in northern Wisconsin, stated that grass sod can reduce tree success by its mere physical presence.

Beckwith (1954) observed that succession was retarded in hay fields, for at the time of abandonment they had a heavy growth of perennials. He did not encounter an intolerant tree stage. This contrasts with the Strong field, where early invasion was largely by shade-intolerant tree species.

It should be noted that the more level portions of the west half of the field may have been used for cutting hay at one time. An aerial photo of 1939 by the U.S. Department of Agriculture shows patterns that were probably made by mowing and removing the grassy cover. A later photo of 1951 reveals no evidence of mowing.

Beckwith also emphasized the influence of brushy fencerows in promoting invasion, which tends to gradually spread from the periphery to the center of the field. Brewer *et al* noted two kinds of invasion, extension from the borders and scattered invasion promoted by wind and birds. He stated that density per acre was related to distance from source. Bard (1952) indicated that the smaller the field and the closer the woodlot, the sooner the invasion.

In the Strong field there is a fairly even distribution of wind-disseminated woody species (box-elder and elms) with a heavier concentration of mammal- and bird-carried species near the margins. This is especially true of the oaks and hickories which are concentrated near their seed sources. The black walnut is rather

widely distributed, spreading from both adjacent forests and central gully, probably with the help of squirrels.

Vegetative spread from the center of clones is common in many spots. Large-toothed aspen (*Populus grandidentata*) is enlarging its territory from two clones along an old fence of the north border and from scattered specimens in the gully. Especially noticeable are the clumps of smooth sumac (*Rhus glabra*) in several locations, steadily extending their coverage through the years. The dense shade under the older stems in the center of the clones tends to eliminate the grasses and forbs. Some trees, such as black walnut and black cherry, enter the area and eventually overgrow the sumac which then dies. Some of the older sumac stems were dying by 1970.

The hop tree (*Ptelea trifoliata*) is present mainly on the eastern slopes of the field where limestone is close to the surface. It is showing little reproduction. Cockspur thorn (*Crataegus crus-galli*) is scattered over the same area. It is not reproducing and is not present elsewhere in the vicinity, either in the field or adjacent to it.

Poison ivy (*Rhus radicans*) has been spreading rapidly in partially shaded areas. The dense ground-covering clones tend to have stems of even height because of the browsing by deer above winter snow cover. Extensive cropping of black oak and hackberry (*Celtis occidentalis*) seedlings has been noted along the north margin of the field. Winter girdling of small hackberry by rabbits has been observed after deep snow. It is apparent that various animals have an influence on both the spread and suppression of some woody species.

Except for grape (*Vitis riparia*) and poison ivy, common forest vines and shrubs are relatively scarce, even though a total of 20 species has been identified. They are listed in Appendix I.

Root, Geis, and Boggess (1971) reported that sassafras (*Sassafras albidum*) and persimmon (*Diospyros virginiana*) are usually the first woody plants to appear in fields abandoned from cultivation in southern Illinois. These species are not present in northern Illinois. The dominant pioneer woody species in Strong field have been box-elder, American and red elm, wild plum, smooth sumac in small areas, and to a lesser extent black cherry, wild crab, and red haw. The pioneer box-elder and American elm are now dying.

The role of the wild plum is puzzling. It is scattered throughout the middle of the field (Table 4) and dominant in dense thickets in the western half of the field in places that were apparently mowed for hay. The plum thickets are mostly less than six feet high, over a ground cover of bluegrass and with no other trees except stunted box-elders. To date there is no evidence of replacement of the plums.

After 25 years of successional development following several decades of grazing, the Strong field has the general appearance of a savanna of young trees in a setting of grasses and forbs, with local concentrations of shrubs, vines, or small trees. Only in the portion between the gully and the north forest (Fig. 1, D, 6-11) is there a definite development of forest. However, the rapid growth of a forest type in both the gully (Bullington, 1971) and the abandoned roadway (Bullington, 1973)at the east end point to an eventual restoration of a deciduous forest in the field. The recent invasion of numerous white ash along the south side of the field shows a trend toward more advanced forest development.

Black oak is likely to become an important component of the field vegetation in the future. It is second in abundance in the north quadrats, as it is in the adjacent forest, and is second among the seedlings. Many fine specimens are well established throughout the field. Whitford and Whitford (1971) found that in Wisconsin the black oak grew three times faster in an old field than in a forest, with a much better survival rate. Observations indicate similar development in Strong field. The well-drained soil is conducive to further black oak development and eventual dominance.

Although the first decade of successional development in the Strong field was not observed, the early stages of invasion in an abandoned bluegrass lawn nearby (Fig. 1, AB, 12-13) have been closely watched. Within one year of the cessation of mowing, the lawn was populated by 19 species of grasses and herbs, most of which are considered weeds. No doubt many were there in suppressed condition during the years of mowing. An additional eight species appeared in the second season. Almost one half of the total were native species of open places; the remainder were introduced plants.

Seedlings of three species of trees appeared the first season, three more the second, and one more the third. Within five years the lawn had become a dense thicket dominated by box-elder, three species of elms, and black cherry. Good seed sources of all were adjacent to the area. This development in the lawn apparently closely duplicates what happened in most of the Strong field.

To date 78 kinds of herbaceous plants have been identified in the Strong field (Appendix II). Each year new ones are discovered. The list to date is not a complete inventory. Undoubtedly there are species of grasses, sedges, asters, and others not yet identified.

Diversity among the herbs is increasing. In the earlier years, farm weeds and cultivated grasses and legumes were abundant. Many of these are gradually being replaced in the openings by typical plants of openings such as asters and goldenrods and, under the trees, by an increasing number of forest types.

Still persisting, even in the shade, is Kentucky bluegrass (*Poa pratensis*) which tends to keep the soil covered, excluding most invaders and preventing erosion.

Caruso (1970) has reported that the biennial sweet clovers (*Melilotus alba* and *officinalis*) tended to occur in patches scattered throughout a carpet of blue grass and to spread out from the area of origin by heavy seed crops. This situation exists in the Strong field where there are large patches of the sweet clovers. Their dense growth eliminates most other plants but helps to improve the soil.

A few unexpected plants have been found, but in special habitats or fringe areas. Great blue lobelia (*Lobelia siphilitica*) has appeared in the low ground near the east end of the gully and showy orchis (*Orchis spectabilis*) is moving into the field from the gully. Ebony spleenwort (*Asplenium platyneuron*) has been tentatively identified at the gully margin. As previously reported (Bullington, 1971), the gully is in a much more advanced stage of forest development and is now populated by numerous forest species.

Special note should be made of the presence of almost an acre stand of Indian grass (*Sorghastrum nutans*) in a small valley along the north margin (Fig. 1, E, 5-6). Since 1959 the density of the stand has increased considerably, but so also has peripheral encroachment by

large-tooth aspen. On at least two ossacions, in 1968 and 1971, aspen and other woody invaders have been removed by cutting and pulling. This has not effectively controlled the aspen. Very few other herbaceous species are present in this Indian grass stand.

CONCLUSIONS

The quarter century since 1948 has brought definite and rapid changes to the character of the Strong field. It has progressed from open pasture to a savanna-like field with scattered trees and, in part, to a young forest of considerable variety. Such development has not been recorded for any other site in northern Illinois.

Numerous authors have discussed the values of studies of secondary succession. Voight and Mohlenbrock have given an excellent summary of this subject on pages 60-61. Also they have proposed a probable secondary succession sequence for southern Illinois.

There is insufficient information to make a complete proposal for a sequence in northern Illinois, much of which was originally prairie. Near river valleys there is an invasion by pioneer woody species on abandoned land and a trend toward ultimate development of a deciduous forest. It is obvious that local edaphic and physiographic factors as well as seed sources are important in determining the course of development.

The Strong field of this study offers a unique opportunity for future ecological studies of both floral and faunal development as well as soil and microclimatic changes. The management of The Stronghold, The Presbyterian Camping Association of Northern Illinois, is very cooperative and interested in preserving the area from excessive disturbance.

Many avenues of investigation are open because of the great diversity in the field and environs, from mature adjacent forests through gully, abandoned roadway and fencerows to grassy openings among the pioneer trees.

It is hoped that this paper and previous reports by the author are but the beginning of long and intensive studies of the Strong field.

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APPENDIX I

SHRUBS AND VINES

Amelanchier sp.—Juneberry
Berberis Thunbergii DC.—Japanese barberry
Celastrus scandens L.—climbing bittersweet
Cornus racemosa Lam.—gray dogwood
Corylus americana Walt.—hazelnut
Lonicera sp.—ornamental honeysuckle
Parthenocissus quinquefolia Planch.—Virginia creeper
Rhus glabra L.—smooth sumac
Rhus radicans L.—poison ivy
Ribes missouriense Nutt.—Missouri gooseberry
Rosa arkansana Porter var. *suffulta* Cockerell—prairie rose
Rosa multiflora Thunb.—multiflora rose
Rubus allegheniensis Porter—blackberry
Rubus flagellaris Willd.—creeping blackberry
Rubus occidentalis L.—black raspberry
Sambucus canadensis L.—common elderberry
Smilax tamnoides L. *hispida* (Muhl.) Fern—bristly green brier
Viburnum prunifolium L.—black haw
Viburnum trilobum Marsh.—highbush cranberry
Vitis riparia Michx—riverbank grape

APPENDIX II

HERBACEOUS PLANTS

Abutilon theophrasti Medic.—velvet-leaf
Achillea millefolium L.—common yarrow
Ambrosia artemisiifolia L.—common ragweed
Ambrosia trifida L.—great ragweed
Amorpha canescens Pursh—leadplant
Amphicarpa bracteata Fern.—hog-peanut
Andropogon scoparius Michx.—little blue-stem grass
Anemone cylindrica Gray—thimbleweed
Antennaria neglecta Greene—pussy's toes
Apocynum androsaemifolium L.—spreading dogbane
Aquilegia canadensis L.—wild columbine
Asclepias sullivantii Engelm.—milkweed
Asclepias verticillata L.—whorled milkweed
Asparagus officinalis L.—asparagus
Asplenium platyneuron (L). Oakes (?)—ebony spleenwort
Aster azureus Lindl.—sky-blue aster
Aster laevis L.—smooth blue aster
Aster pilosus Willd.—hairy aster
Aster sagittifolius drummondii (Lindl). Shinners—Drummond's aster
Bouteloua curtipendula Michx.—tall grama-grass
Campanula americana L.—tall bellflower
Carex sp.—sedge

APPENDIX II Continued

Cirsium arvense Scop.—Canada thistle
Cirsium vulgare Tenore—common or bull thistle
Convolvulus arvensis L.—field-bindweed
Desmodium illinoense Gray—tick-trefoil
Dianthus armeria L.—Deptford pink
Erigeron annuus Pers.—daisy fleabane
Eupatorium rugosum Houtt.—white snakeroot
Euporbia corollata L.—flowering spurge
Galium circaezans Michx.—wild licorice
Gentiana flavida Gray—yellowish gentian
Gnaphalium obtusifolium L.—everlasting
Helianthus sp.—sunflower
Hypericum perforatum L.—St. John's-wort
Lactuca sp.—wild lettuce
Lespedeza capitata Michx.—round-headed bush clover
Liparis lilifolia Richard—broad-leaved twayblade
Lobelia siphilitica L.—great blue lobelia
Medicago lupulina L.—black medick
Melilotus alba Desr.—white sweet clover
Melilotus officinalis Lam.—yellow sweet clover
Monarda fistulosa L.—wild bergamot
Orchis spectabilis L.—showy orchis
Oxalis stricta L.—yellow wood sorrel
Panicum sp.—panic grass
Pastinaca sativa L.—parsnip
Penstemum hirsutus (L.) Willd.—beard tongue
Petalostemum perpureum (Vent.) Rybd.—prairie clover
Phleum pratense L.—timothy
Physalis heterophylla Nees—clammy ground cherry
Physalis subglabrata Mackenz. and Bush—tall ground cherry
Plantago major L.—common plantain
Poa pratensis L.—Kentucky bluegrass
Portulaca oleracea L.—common purslane
Potentilla arguta Pursh—tall cinquefoil
Prunella vulgaris lanceolata (Bart.) Fern.—self heal
Rudbeckia hirta L.—black-eyed Susan
Rumex acetosella L.—sheep sorrel
Rumex altissimus Wood—pale dock
Rumex crispus L.—curly dock
Sanicula gregaria Bickn.—black snakeroot
Setaria glauca Beauv.—yellow foxtail
Sisyrinchium albidum Raf.—common blue-eyed grass
Solanum carolinense L.—horse-nettle
Solidago altissima L.—tall goldenrod
Sorghastrum nutans Nash—Indian grass
Specularia perfoliata (L.) A. DC—Venus's looking-glass
Taraxacum officinale Weber—common dandelion
Tucrium canadense L.—wood sage
Tradescantia ohiensis Raf.—spiderwort
Tragopogon pratensis L.—goat's-beard
Trifolium pratense L.—red clover
Trifolium repens L.—white clover
Triosteum perfoliatum L.—late horse gentian
Verbascum thapsus L.—common mullein
Verbena stricta Vent.—hoary vervain
Verbena urticifolia L.—white vervain