

VEGETATIONAL FEATURES OF SOME STRIPPED LAND IN PERRY COUNTY, ILLINOIS

RICHARD BREWER AND EDWARD D. TRINER
Southern Illinois University, Carbondale

DESCRIPTION OF THE AREA

An ecological survey of lands stripped for coal by the Truax-Traer Coal Company between 1932 and 1950 was conducted from June 23 to August 4, 1954. This paper summarizes the results of that portion of the survey which dealt with the terrestrial vegetation.

The study tract is located in Perry County, Illinois, about three and one-half miles south of Pinckneyville and one mile west of Illinois Route 13 at Pyatt. It is roughly rectangular and comprises about 1829 acres. It is surrounded by similar striplands to the north, east, and in some places to the south; elsewhere to the south and to the west, the study tract is bounded by agricultural lands.

Elevation before stripping varied from about 412 to 431 feet above mean sea-level. Several intermittent streams drained south across the tract.

The present topography of the stripped lands is one of alternate valleys and ridges known as spoil banks. The spoil banks thrown up in different years and even during different parts of the same year differ in length, direction, and contour. Within each restricted period of stripping (as January to August, 1936), the banks are fairly uniform. The estimated average height of spoil banks is 20 feet and the esti-

mated average slope about 45 degrees. In general, the tops of ridges are more rounded in older strippings. Patches of shale, rock outcroppings, and exposed rocks are common to all ages of stripped lands. Banks everywhere show evidence of erosion, and all valleys hold alluvial material which may be either fine and sandy or heavy and clayey.

The spoil bank material, which can hardly be called soil (Croxtton, 1928), is largely determined by the character of the overburden. Limstrom and Deitschman (1951) stated that a generalized section of the overburden in Perry County would include, from top to bottom the following: 20 to 25 feet of soil, glacial till, and loess; 4 to 10 feet of hard, yellow, massive limestone; 10 to 15 feet of calcareous (sometimes acid) dark gray shale; 2 to 8 feet of hard, gray, massive limestone; and 1 inch to 10 feet of gray, massive shale. Spoil bank material is said to be low in organic matter and nitrogen but is rich in many mineral nutrients, especially potash and phosphorus. Transverse sections of spoil banks on the study tract showed no soil structure and revealed large rocks at all depths.

Water bodies on the tract varied from temporary pools a fraction of an acre in extent to lakes of 15 or more acres. The largest lakes were usually long and narrow with steep

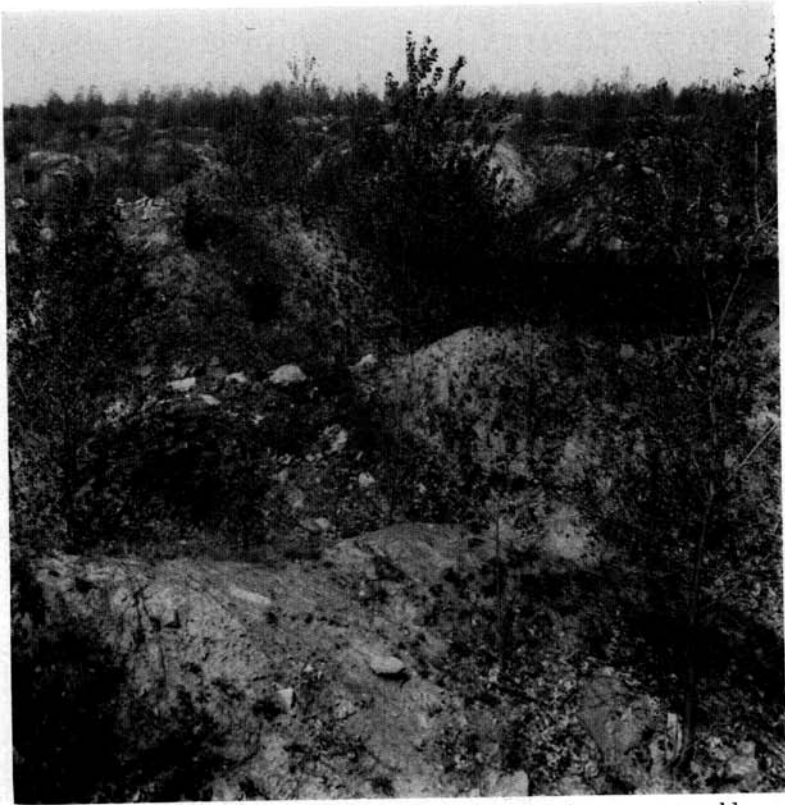


FIG. 1.—Striplands in Perry County, Illinois, about seven years old.

banks and represented the final path of mining equipment in each section.

Plantings of short-leaf pine (*Pinus echinata*), jack pine (*Pinus Banksiana*), black locust (*Robinia Pseudo-Acacia*), and osage orange (*Maclura pomifera*) were established on some sites. (The nomenclature here and throughout the paper is that of Fernald, 1950.) Where present, these plantings generally formed dense thickets below the volunteer trees.

METHODS OF STUDY

The study tract was divided into nine areas, each consisting of land

stripped during two consecutive years. The nine areas represented lands of the following ages in years subsequent to stripping: 4-5, 6-7 (Fig. 1), 8-9, 10-11, 12-13, 14-15, 16-17, 18-19, and 21-22 (Fig. 2). In each area, general observations were made with regard to the physiognomy of the vegetation, topography, erosion, and similar information.

Data concerning the species composition, density, and distribution of the herbaceous and shrubby vegetation were obtained by quadrat sampling. Several strip transects, consisting of 2 to 15 one square-



FIG. 2.—Striplands in Perry County, Illinois, about 21 years old.

meter quadrats, were taken at irregularly spaced points in each study division. The numbers of stems of each species of plant were determined for every quadrat, and the quadrat's position relative to spoil banks (*i.e.*, whether on a ridgetop, in a valley, or on a northern, southern, eastern, or western slope) was recorded. In all, 310 square meters were examined.

The trees were studied by means of the random-pair method (Cottam and Curtis, 1949). Distances between the trees composing random pairs were determined as an index of density, and distribution with regard to spoil banks was recorded. A total of 85 random pairs was considered. On several areas, ages of trees were determined with an increment borer.

Soil samples, taken to a depth of about four inches, were obtained in all areas except two. The pH of the samples was measured with the La-Motte-Morgan soil testing apparatus.

COMPOSITION OF STRIPLANDS VEGETATION

A total of 105 different species of plants was recorded in the 310 samples. Included were 75 herbs, 20 trees, 6 shrubs, and 4 vines. Sixty-three species were perennial, 39 annual, and 3 biennial. Ninety-one species were native to North America, while 14 were introduced, adventive, or naturalized. Best represented among the families were grasses (Gramineae) with 16 species; composites (Compositae), 14 species; pulses (Leguminosae), 9 species; and roses (Rosaceae), 8 spe-

cies. No pteridophytes were observed and bryophytes appeared to be uncommon.

An analysis of the vegetation according to Raunkaier's life form system, which is said to offer a physiognomic in contrast to a floristic classification (Braun-Blanquet, 1932), showed the plants of the tract to be predominantly therophytes, phanerophytes, and hemicyptophytes (Table 1). Geophytes were scarce and no chamaephytes were recorded.

Table 1.—Biological Spectra of Each Age of Stripped Land in Perry County, Illinois.

Years since stripped	Percentage in each class			
	Ph ¹	H	G	Th
21-22.....	27	19	7	46
18-19.....	23	27	10	40
16-17.....	41	22	7	30
14-15.....	35	28	7	28
12-13.....	32	27	6	35
10-11.....	14	31	6	49
8-9.....	11	32	3.5	53
6-7.....	9	30	4	57
4-5.....	6	19	6	69
All areas..... (101 species)	27	25	8	40

¹ Raunkaier's life forms: phanerophytes (Ph); hemicyptophytes (H); geophytes (G); and therophytes (Th). No chamaephytes (Ch) were recorded.

Twenty-two species of herbaceous plants were considered characteristic of the tract (Table 2). This number included plants with an average abundance of more than 0.2 stems per square meter, plants which occurred in more than half of the nine study areas, and the four most abundant species in each of the nine areas. White sweet clover (*Melilotus alba*), horse-nettle (*Solanum*

carolinense), goldenrod (*Solidago ulmifolia*), and common ragweed (*Ambrosia artemisiifolia*) were the most ubiquitous plants, occurring in every area. The five most numerous plants were *Solidago ulmifolia*, *Melilotus alba*, cheat (*Bromus secalinus*), three-seeded mercury (*Acalypha virginica*), and aster (*Aster pilosus*).

Of 17 naturally occurring trees, nine were recorded on lands of more than one age class and were considered characteristic of the tract (Table 3). The most numerous of these, based upon average percentage frequency in random pairs, were cottonwood (*Populus deltoides*), sycamore (*Platanus occidentalis*), American elm (*Ulmus americana*), sandbar willow (*Salix interior*), and box-elder (*Acer negundo*). Only *Populus deltoides* occurred in all areas.

Of the shrubs, only brambles (*Rubus flagellaris* and *R. frondosus*) were considered numerically important. They were present in all stripplings more than eight years old. Small thickets of smooth sumac (*Rhus glabra*), shining sumac (*Rhus copallina*), rough-leaved dogwood (*Cornus drummondii*), and plum (*Prunus* sp.) occurred in the older stripplings. The vines, poison ivy (*Rhus radicans*), pigeon-grape (*Vitis cinerea*), virginia creeper (*Parthenocissus quinquefolia*), and trumpet creeper (*Campsis radicans*), also formed small patches in the earlier stripplings.

CHANGES ASSOCIATED WITH AGE OF STRIPPING

The number of species found in samples, the average density of stems of herbaceous vegetation, and

TABLE 2.—Mean Abundance of Characteristic Herbs for each Age of Stripped Land (Stems Per Square Meter).

Species	Years since stripped										Mean
	21-22	18-19	16-17	14-15	12-13	10-11	8-9	6-7	4-5		
<i>Bromus secalinus</i>	5.38			30.81	6.33	0.48	2.76		3.07	5.07	
<i>Aristida oligantha</i>	1.29				5.75	2.11		0.37	0.14	1.19	
<i>Aristida purpurascens</i>									0.02	0.24	
<i>Panicum lanuginosum</i>	0.12	0.12			1.87		0.36	0.45	0.07	0.33	
<i>Andropogon virginicus</i>	0.51	0.06	0.93		0.18	1.02	14.44	1.63	0.78	2.17	
<i>Parietaria pennsylvanica</i>		2.64								0.29	
<i>Chenopodium leptophyllum</i>	0.03	0.12			0.15	0.06			0.04	0.04	
<i>Melilotus alba</i>	4.19	28.45	10.46	2.74	5.48	1.80	.03	1.00	0.07	6.02	
<i>Strophostyles leitosperma</i>	0.48	0.48	1.16			0.94	7.42	2.80	9.39	2.52	
<i>Acalypha virginica</i>	31.54	1.69	1.36	4.25	1.93	1.40	0.63		0.41	4.71	
<i>Apocynum cannabinum</i>		0.67	0.06	0.03	0.31		0.23		0.17	0.16	
<i>Asclepias syriaca</i>	2.12	0.27								0.27	
<i>Ampelamus albidus</i>		0.15	0.03	0.14	0.18	0.28	0.25	0.03		0.11	
<i>Teucrium canadense</i>					6.03						
<i>Solanum carolinense</i>	1.87	0.12	0.10	0.28	0.39	0.37	0.07	0.11	0.22	0.39	
<i>Diodia teres</i>	0.32					0.23	0.44	0.03	0.95	0.22	
<i>Solidago ulmifolia</i>	8.51	7.06	12.33	6.33	3.57	8.31	7.80	3.20	0.14	6.36	
<i>Aster pilosus</i>	5.00	1.00	0.63		0.09	3.60	2.55	9.06	12.23	3.79	
<i>Ambrosia bidentata</i>							0.13		2.12	0.25	
<i>Ambrosia artemisiifolia</i>	5.03	0.76	0.23	0.94	0.15	0.60	0.15	0.48	0.43	0.97	
<i>Lactuca scariola</i>	0.42	0.15		0.03	0.36	0.74	1.23	0.17	0.65	0.42	
<i>Cirsium discolor</i>	0.06	0.03		0.03	0.03	0.11	0.16	0.03	0.05	0.05	
All plants (85 species).....	72.39	42.69	30.93	57.13	38.76	26.82	48.67	21.12	41.83	53.49	

the tree density (based on average distances between trees of random pairs) varied from area to area. In none of the three cases, however, was there any noticeable pattern with respect to age of stripping. There appeared to be an inverse relationship between density of herbaceous vegetation and tree density.

The lack of correspondence between age of stripping and tree density (Table 4) suggests that in a given area there were no important changes in tree density subsequent to the initial establishment of trees. The fact that trees in any single study area were the same age, within two or three years, seems to support this view. Original density was probably due to local factors, such as soil and soil moisture, as well as to the proximity of other vegetation.

Certain other features did exhibit a correspondence with increasing age of stripped land. Among these features were increasing size and age of trees; for example, the cottonwoods of the latest strippings were less than 5 cm. in diameter at breast

height (d.b.h.) and averaged about 8 feet in height whereas those of the earliest strippings averaged between 20 and 30 cm. d.b.h. and were about 65 feet tall. The age at breast height was 4-5 years in strippings 6-7 years old and 14-15 years in strippings 18-19 years old. Other species showed a similar trend.

In general, the number of species of tree increased with increasing age of the land. *Populus deltoides* and *Salix interior* were the only species which occurred in samples from strippings less than seven years old. In somewhat older strippings, *Platanus occidentalis*, *Ulmus americana*, *Ulmus rubra*, and *Acer negundo* were encountered fairly frequently, and in land from 16-22 years old, silver maple (*Acer saccharinum*) and persimmon (*Diospyros virginiana*) were found. There was some evidence that this situation was at least partly a result of the decreasing amount of natural vegetation within dispersal range of stripped areas as mining in the vicinity progressed. Soil conditions and water relationships may also have been important, for the greatest number of species occurred in an area of intermediate age which appeared to be the wettest portion of the study tract.

An increase in the number of perennial species appeared to be correlated with increased age of stripped land, as did a decrease in the number of annual species. An index of the relative proportions of perennials and annuals may be obtained by assigning a value of plus one to each perennial species and minus one to each annual species and adding the resulting figures.

TABLE 4.—Distances Between Trees of Random Pairs for Each Age of Stripped Land.

Years since stripped	Distance in meters	
	Mean	Range
21-22.....	33	8-108
18-19.....	23	8-37
16-17.....	17	1.5-60
14-15.....	45	21-80
12-13.....	20	4-50
10-11.....	20	8-30
8-9.....	16	11-20
6-7.....	31	7-72
4-5.....	24	13-42

The indices of perennials to annuals for the nine areas of the tract, in order of increasing age, are as follows: -7, +1, 0, +2, +13, +12, +12, +10, +13.

The abundance of certain plants showed definite relationships to the age of strippings. *Melilotus alba* became more abundant on the older spoils. Its success was probably due to its rapid growth habit during the spring, when moisture is most abundant, its preference for alkaline soils, and the fact that, being a legume, it is not adversely affected by nitrogen deficiencies. *Acalypha virginica*, a small plant generally found in shade, also showed increased abundance in the older strippings, while the reverse was true of *Strophostyles leiosperma* which requires direct sunlight. Increasing shade was probably the most important factor in both cases. The pattern exhibited by the annual grasses, most of which reached a peak abundance in the strippings of intermediate age and then declined, is less easily explained. Shade, competition for moisture and local

physiographic and edaphic factors may have been important.

When stripped land of the various age classes was analyzed according to Raunkaier's life form system, the spectra showed considerable variation (Table 1). The relative percentages of therophytes and phanerophytes showed an inverse relationship for most ages of strippings, with the largest numbers of therophytes occurring in the latest strippings and the largest numbers of phanerophytes in strippings of intermediate age. These variations are reflected to some extent in the ratio of annuals to perennials. The percentages of hemicryptophytes and geophytes showed minor fluctuations.

RELATIONSHIP OF VEGETATION TO TOPOGRAPHY

Fifty-two percent of all trees occurred either on ridgetops or in valleys while 48% occurred on slopes of all exposures (Table 5). It is important to note that the combined areas of the slopes made up about 80% of the tract, whereas the ridge-

TABLE 5.—Distribution of Some Trees With Regard to Position on Spoil Banks (Percentage of each species).

Species	Site							
	Valley	Ridgetop	Slope exposure					Unspecified
			North	South	East	West		
<i>Populus deltoides</i>	29	26	9	5	13	13	5	
<i>Salix interior</i>	67	11	..	..	..	11	11
<i>Ulmus americanus</i>	9	18	37	9	27	..	..
<i>Platanus occidentalis</i> . . . . .	..	40	40	20	..	..	..
Other trees	18	27.5	9	..	..	27.5	18
ALL TREES	28	24	13	5.5	11	12	6.5	

TABLE 6.—Mean Abundance of Characteristic Herbs with Relation to Spoil Banks (Stems Per Square Meter).

Species	Site												
	Valley	Ridgetop	North	Slope exposure									
				N-East	N-West	South	East	S-West	S-East	West			
<i>Bromus secalinus</i>	7.66	12.50				25.41					24.00		14.24
<i>Aristida oligantha</i>	0.09				2.55	7.53			4.88				2.12
<i>Aristida purpurascens</i>	5.40	2.61	1.33										
<i>Panicum lanuginosum</i>	6.41	6.00	0.66										
<i>Andropogon virginicus</i>	0.20		4.66		1.00	0.91			1.22				0.16
<i>Parietaria pennsylvanica</i>									10.77			2.14	1.20
<i>Chenopodium leptophyllum</i>			1.01										
<i>Melilotus alba</i>	3.71	43.09	4.48										
<i>Strophostyles leiosperma</i>	5.00	4.01	1.45		0.50	1.38				6.65	4.07		9.85
<i>Acalypha virginica</i>	8.90	2.19	5.43		1.80	8.75			6.41		6.41		4.39
<i>Asclepias syriaca</i>	0.48	0.90	1.91			1.18			6.60		6.60		0.40
<i>Apocynum cannabinum</i>													
<i>Ampelamus albidus</i>	0.12	0.07				1.14							0.47
<i>Teucrium canadense</i>	0.60	6.90				0.37					0.11		0.35
<i>Solanum carolinense</i>	0.57	0.60	1.40		0.83	0.37					10.80		
<i>Diodia teres</i>	0.72		1.40			1.11				0.22	0.25		0.38
<i>Solidago ulmifolia</i>	7.52	11.39	4.97			7.38			7.22		1.00		1.75
<i>Aster pilosus</i>	6.89	13.24	4.14			3.15			5.57		0.70		6.67
<i>Ambrosia bidentata</i>	3.45	2.66									4.93		7.98
<i>Ambrosia artemisiifolia</i>	1.91	0.70	0.94		0.16	0.74			1.00		2.14		0.54
<i>Lactuca scariola</i>	0.24	2.78	0.17			0.47					0.39		0.58
<i>Cirsium discolor</i>	0.10	0.28	0.08			0.18			0.33		0.36		0.62
ALL PLANTS (85 species).....	110.31	132.88	40.84		26.97	71.66			31.54		73.41		58.94

tops and valleys each totaled only about 10%. Fifty-two percent of all trees, then, were found on 20% of the total area.

This hyperdispersion was particularly noticeable in the case of *Salix interior*. Two-thirds of all individuals of this species occurred in valleys, probably because of increased moisture on these sites. *Populus deltoides* occurred everywhere, but the greatest numbers were on valleys and ridgetops. The fewest were found on south slopes. The favorable soil and moisture conditions of valleys and the fact that ridgetops are the highest points on the strip-lands, and as a consequence receive a large percentage of windblown seeds, are believed to be important factors in determining the distribution of cottonwoods as well as other trees. The relative instability of the slopes may also be of importance. The sparseness of tree growth on south slopes is probably a result of the xeric conditions which exist there.

The herbaceous and shrubby vegetation (Table 6) showed a somewhat similar distribution, probably for the same reasons. Densest growths were in valleys and on ridgetops. Fairly high densities were also recorded for east- and south-facing slopes. These were the slopes that held the lowest densities of trees; consequently shading and competition for moisture might not have been particularly severe.

Certain other species and groups of species showed more or less definite trends with regard to topography. The grasses seemed to occur predominantly on south, east, and west slopes, or in valleys. The

shrubs also appeared to be more abundant in valleys and on slopes. American Germander (*Teucrium canadense*) seemed almost restricted to shaley slopes and ridgetops. *Melilotus alba* was most abundant on ridgetops and on south and west slopes.

RELATIONSHIPS OF VEGETATION TO HYDRONIUM ION (H_3O^+) ACTIVITY

Croxtan (1928) stated that occurrence of vegetation on striplands is often correlated with soil acidity, dense vegetation occurring on neutral to slightly alkaline areas and no vegetation occurring on areas of pH less than 4.5. He believed that succession was largely "allogenic" rather than "phytogenic."

On Perry County striplands, determination of hydronium ion activity gave pH values of 4.6 to 7.8 (Table 7). The reading of 4.6 was from a large bare area. Other areas lacking vegetation gave values from 7.0 to 7.4. There appeared to be a trend toward higher acidity from slopes to ridgetops to valleys and from older to newer strippings. The differences were slight, however, and, considering the small number of

TABLE 7.—pH Determinations for Stripped Land of Seven Ages.

Years since stripped	No. of samples	Range
21-22.....	4	7.4-7.6
18-19.....	4	6.4-7.8
16-17.....	4	4.6-7.4
14-15.....	5	7.4-7.6
12-13.....	6	6.0-7.6
10-11.....	7	7.0-7.6
8-9.....	5	6.8-7.6

samples, could have been due to chance. *Melilotus alba*, which Croxton believed to be restricted mainly to neutral and alkaline areas, occurred in quadrats with pH values of from 6.4 to 7.6.

SIMILARITIES OF THE PERRY COUNTY STRIPLANDS TO OTHER AREAS

Striplands in central Illinois (Vermillion County) described by Croxton (1928) apparently bear considerable resemblance, both floristically and vegetationally, to the tract under discussion. The differences in species composition and changes associated with age appear to be mainly a result of the larger and more frequent acid areas found on the central Illinois strippings, the presence of more moisture there, and phyto-geographical factors.

The younger Vermillion County strippings described by McDougall (1925) also resemble the Perry County striplands, but apparently this is not true of some of the older ones. Stripped areas over 25 years old, according to McDougall, support typical bottomland forest. However, Croxton (1928) has shown that McDougall's work was done on low moist areas which were subject to flooding and deposition of silt and water-dispersed disseminules. In southern Illinois, floodplain areas and large sandbars often support communities similar floristically to the study tract. The stand is always thick at first and thinning occurs rapidly. Characteristic bottomland trees such as sweet gum (*Liquidambar styraciflua*), *Ulmus americana*, *Platanus occidentalis*, pin oak (*Quercus palustris*), *Acer saccharinum*, and hackberry (*Celtis occiden-*

talis) are soon dominant. This is in contrast to the Perry County striplands where trees are very widely spaced, from the most recent to the oldest strippings, and only a few bottomland trees are found. Nowhere is there the tangled growth of *Vitis* and *Smilax* characteristic of bottomland woods in southern Illinois.

Other communities to which the striplands bear some resemblance floristically are the *Salix-Populus* community of artificially bared ground in northern Illinois (Beecher, 1942) and certain seral stages of large areas of sand-dunes. The similarities between the striplands and all of these areas appear to result from the fact that only species whose propagules are wind dispersed and which are capable of making rapid growth under fairly harsh conditions are likely to become immediately established in any of them. Certain dissimilarities are due to soil conditions (best in river bottoms, worst in sandy areas and the striplands) and availability of moisture (perhaps least on southern Illinois striplands). Other dissimilarities result from the migration of additional species into these areas. On floodplains, this is rapid because of the relatively rich soil, the proximity of other vegetation, and the distribution of water-dispersed propagules by rivers and streams. On the striplands, the process may be slow because of the character of the spoil bank material and the lack of adjacent vegetated areas (if the stripped area is large).

Since the biological spectrum of Raunkaier measures the kind and amount of protection given the per-

ennating structures of plants, it offers a means of comparing the vegetational features and also presumably the conditions of life of various areas. Although the spectrum of the striplands resembles the spectra of some desert areas in its disproportionately large percentage of therophytes, in other ways it is very dissimilar. It differs from the spectra of forest areas in having relatively great numbers of therophytes and small numbers of geophytes. The aspen community of Michigan (Gates, 1930) presents some similarities, but application of the chi-square test shows the differences to be highly significant. About all that can be stated is that the spectrum of the study tract does not resemble closely any published spectrum.

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