Effects of grazing, clearing, and stream channelization on riparian and associated vegetation of Guthrie County, Iowa

by

James P. Vogler

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INTRODUCTION

The success of any species depends on its ability to survive. Through evolution, characteristics and attributes which enhance the ability of an organism to live and reproduce are selected. During the evolutionary descent of Man, we have acquired the ability to reason and have developed it to a far greater extent than any other species so far as we know. Our ability to reason, and perhaps other attributes such as the opposable thumb, have helped Man survive. Indeed, they have allowed us through manipulation of our surroundings to expand to all corners of the Earth. The environmental effects of most of our manipulations, no matter how they influence our survival, are little understood. In this study, a description will be attempted of some of the changes associated with an example of our manipulation of the environment along wooded streams in central Iowa.

Most natural woodland in the western half of Iowa is closely associated with rivers (Dick-Peddie 1955). Periodic flooding or steep topography make agriculture unprofitable in many of these areas. However, with a greater need for increased agricultural production, more of these lands are becoming profitable to farm (Holder 1969). Those lands which are not farmed, even with abundant trees, are commonly used as pasture.

Although numerous studies have been carried out on the vegetation of floodplains and upland streamside forests (Oosting 1942; Shelford 1954; Rice 1965; Boggess and Geis 1967; Sanders 1967; Crites and Ebinger 1969; Burgess et al. 1973; Bell 1974a, 1974b; Johnson et al. 1976), very few have dealt with effects of grazing, clearing, or channelization.

Most reports on the effects of channelization on streamside vegetation discuss the clearing of natural vegetation but do not include information on the vegetation which becomes established afterwards. Gunter (1957) stated that the effect of the flood control program on the animal and plant life of the Mississippi Valley "has been bad", and Peters and Alvord (1964) wrote, "In developing flood plain land, man often removes stream bank vegetation...." Vegetation may be removed during construction of ditches and the channelization of streams from an area often between 10 and 15 m and sometimes up to 100 m from the ditch or stream (Allen 1969; Little 1973 as cited in Hill 1976). Barstow (1971) reported an estimated loss of woodland of about 70% for a channelization project in the Obion-Forked Deer Basin, Tennessee.

The effects of grazing on farm woodlands in southern Wisconsin were studied by Steinbrenner (1951). Dambach (1944a, 1944b) compared adjoining grazed and ungrazed woodlands in northeastern Ohio, and Burgess et al. (1973) briefly described some of the effects of grazing on the floodplains of the Missouri River in North Dakota. Hosner and Minckler (1960) and Burgess et al. (1973) have briefly discussed some of the effects of opening the overstory canopy in floodplain forests.

Land use practices can affect natural vegetation in numerous ways and to varying degrees. The intent of this study is to detect some of the changes in riparian and associated vegetation caused by channelization, clearing, and grazing in Guthrie County, Iowa. This study was done in conjunction with studies to determine the effects of stream channelization on land-use practices, avian and mammalian communities. (Best et al. 1978, Geier 1978, Stauffer 1978).

MATERIALS AND METHODS

Site Selection and Field Methods

Riparian and associated vegetation is defined as the strip of vegetation, not exceeding 250 m, between a river and the adjoining cropland. Following a survey of aerial photos, the project leaders chose 28 study plots in Guthrie County, Iowa. Criteria for selecting plots included the desirability of the greatest variety in vegetation community types, close together, along streams with different levels of human impact. Landowner permission was obtained, and plots were set up on the Middle and South Raccoon Rivers, Beaver Creek, and Brushy Creek in Spring 1976 (Fig. 1).

Northeast Guthrie County is situated on Wisconsin glacial drift and has gently rolling topography. The remainder of the county is on loess overlaying Kansan till and has varied topography with steep slopes and nearly level bottom lands. Annual precipitation averages about 30 inches with about 70% falling during the growing season (U.S. Dept. Agr. 1974).

Two sampling grids were set up in each plot. The frequency grid consisted of a series of transects parallel to the stream, the first of which was 25 m from the stream bank or midway between the bank and adjoining cropland, and successive transects were placed 50 m apart. Each plot contained a maximum of five transects consisting of flagged markers placed 25 m apart with a maximum of 21 markers in each transect. The cover grid, which was placed inside the frequency grid, was made up of transects, which were parallel to the stream, placed 12.5 m apart with the first transect 12.5 m from the bank of the stream or midway between

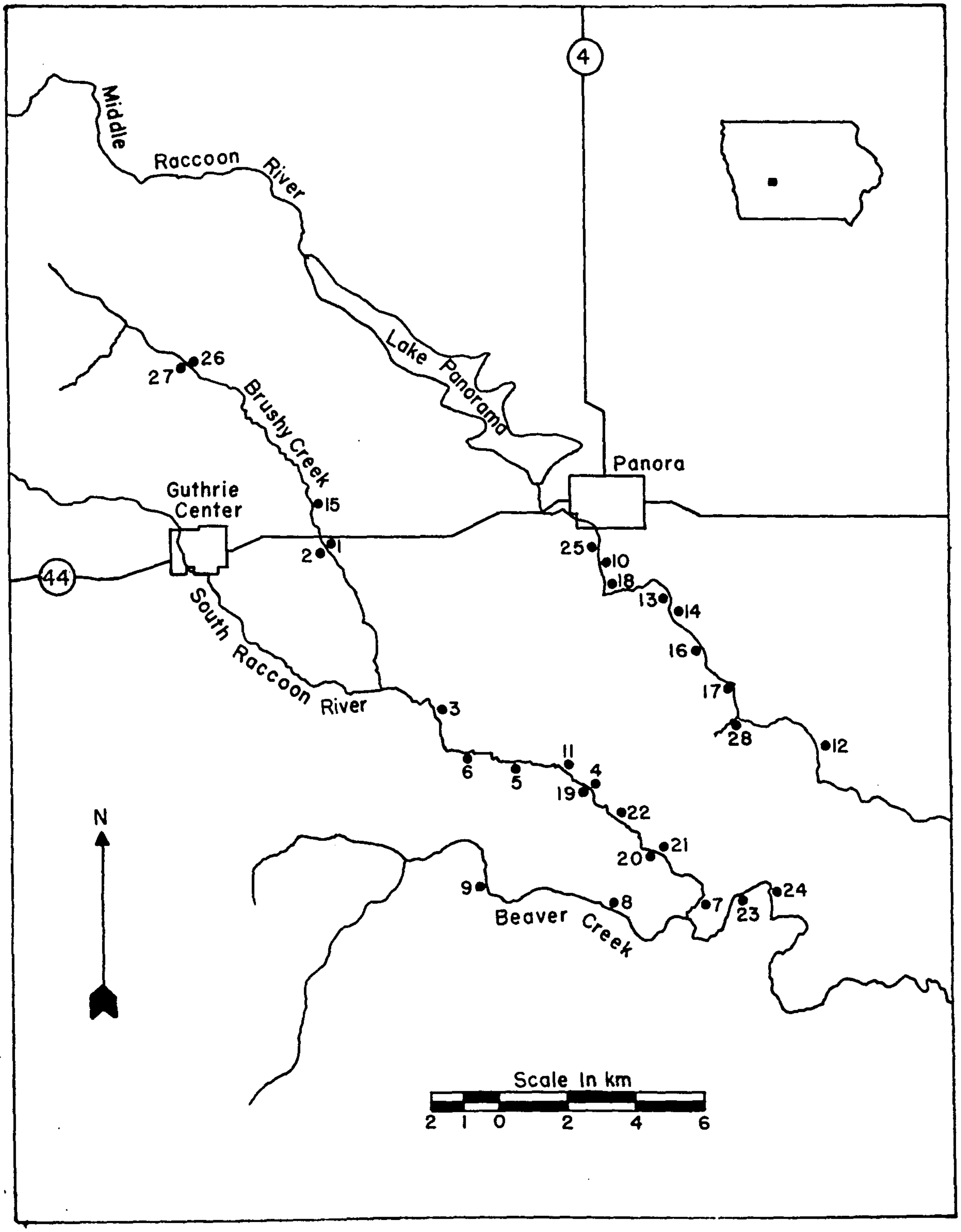

Fig. 1. Location of the 28 study plots in Guthrie County, Iowa

the bank and adjoining cropland. Markers in each transect were placed 12.5 m apart. The shape of the cover grid was determined by the width of the vegetation with a maximum of 15 transects and a total of about 150 markers. At least part of every frequency grid was contained in the cover grids. Examples of grid construction are illustrated in Figs. 2 and 3.

Frequency points were sampled throughout Summer 1976 and cover points were sampled from July through mid-August 1976. A one-meter square frame was placed three steps from each grid marker in one of the four directions 45 degrees from the transect line. Choice of the direction was consistent unless the vegetation in the frame was visibly disturbed by investigators during previous sampling. General slope of the land within each meter frame was visually estimated using the slope classes 0-25%, 26-50%, 51-75%, >75%. The values one through eight, representing the directions clockwise from north to northwest, were used to record the aspect of the land contained in each meter frame.

At each frequency point, presence was recorded of each species, any part of which was found inside the meter square or in the column projected vertically above it. Representatives of unidentified plants and voucher specimens were collected. Point-centered quarter data as described in Mueller-Dombois and Ellenberg (1974) were taken at each frequency point. If present, one tree (DBH $\geq$ 5 cm) and one sapling (DBH < 5 cm) were measured from each quarter. At each cover point an estimate of the percent of the meter frame covered by the vertical projection of each species in the column using the classes 5, 25, 50, 75, and 95% coverage was recorded.

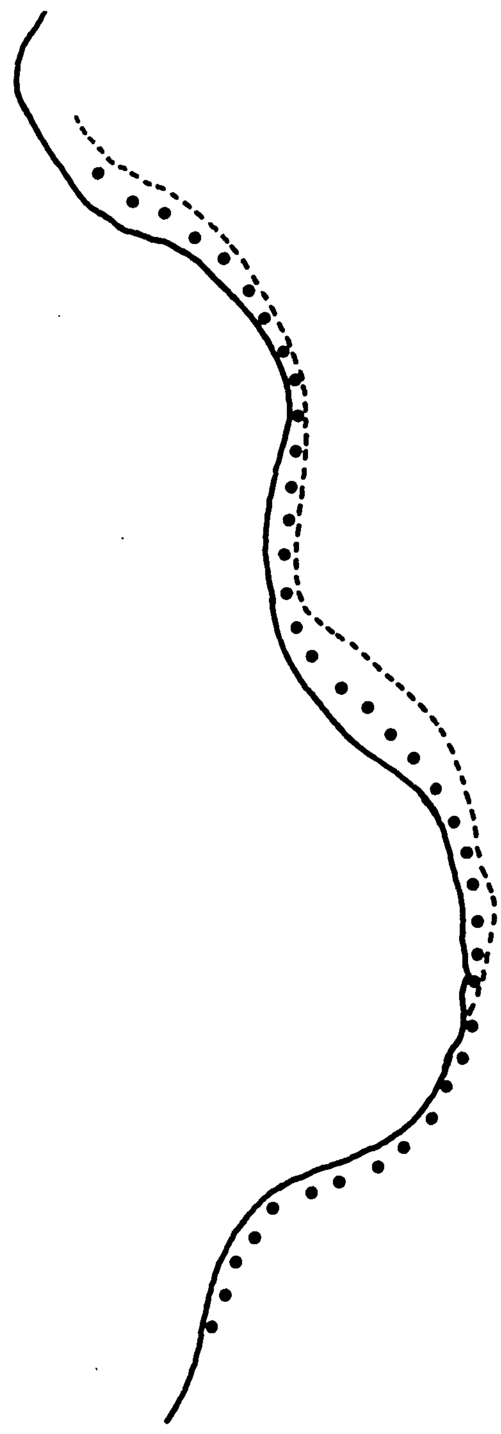

Fig. 2. An example of the position of sampling points on a narrow plot. The solid line represents the stream, the dotted line the crop edge. Frequency points are 25 m apart; cover points are 12.5 m apart

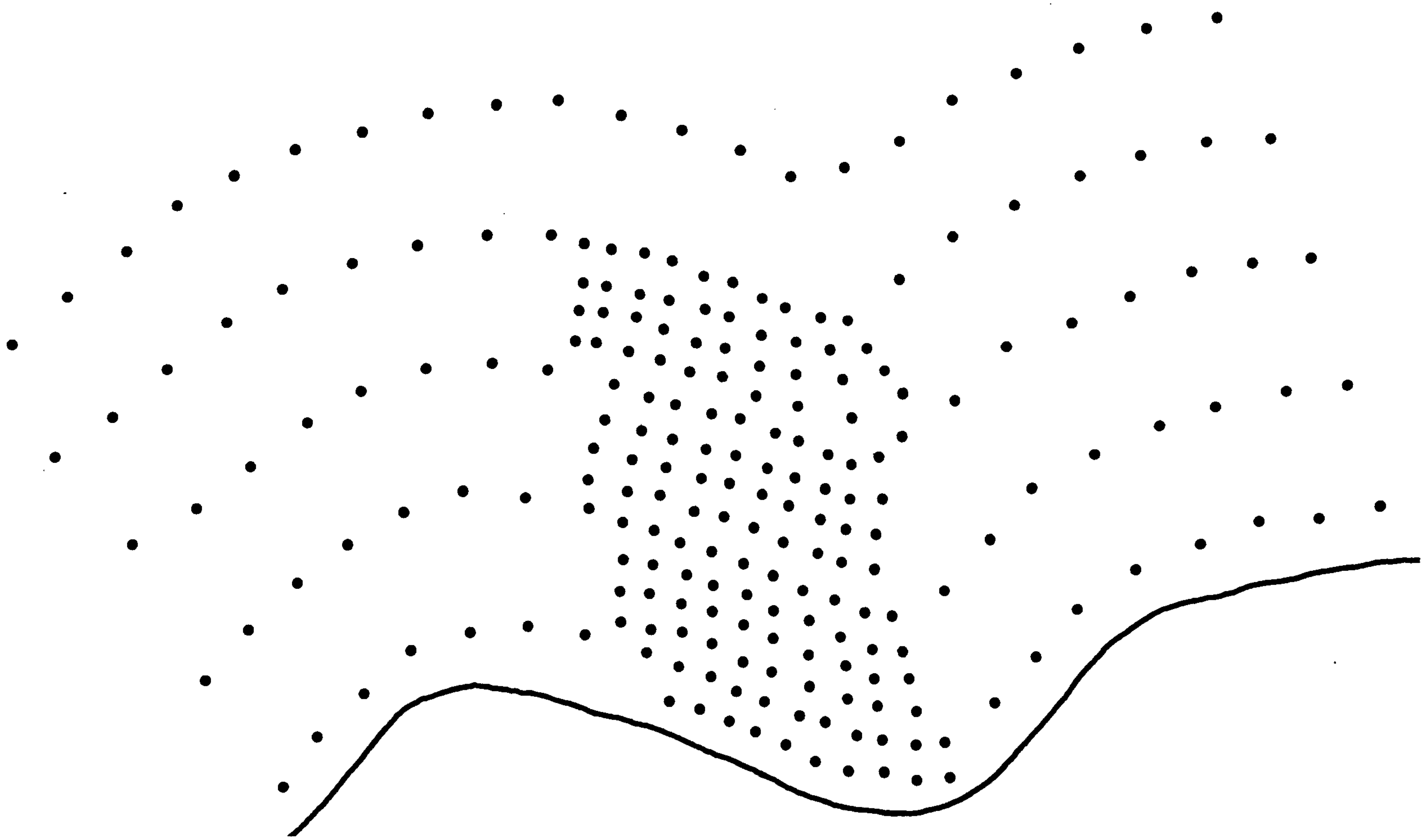

Fig. 3. An example of the position of sampling points on a wide plot. The solid line represents the stream. Frequency points along each transect are 25 m apart; cover points are 12.5 m apart

Table 1. Plot and community type information including plot length, width, and area; type area, slope, and aspect as well as information concerning channelization, clearing, and grazing for each type. In the community type identifiers, U, F, and O signify the kind of canopy in in each type (upland, floodplain, or open, respectively)

	Plot			Community type				Kind of disturbance		
Plot #	Length (m)	Width (m)	Area (ha)	Type	Area (ha)	Slope (%)	Aspect[a]	Channel-ization	Clearing[b]	Grazing
1	500	10-40	1.3	F1	1.3	0-25	S-W	No	No	No
2	500	50-100	4.2	F2	4.2	0-25	NE-SE	No	No	No
3	450	100-150	5.0	O3	5.0	0-25	S-SW N-E	No	Yes	All year
4	500	25-50	1.9	O4	1.9	0-25	S-SW	Yes	Yes	Yes
5	500	250	12.2	U5	12.2	0-50	NW-E	No	Partial	Spring-Fall
6	500	200	8.5	F6A	2.7	0-25	E-N	No	No	No
				F6B	2.0	0-25	E-N	No	No	Yes
				F6C	3.8	0-25	E-N	No	No	Yes
7	500	30-50	1.7	U7	1.7	25-100	W	No	No	Winter
8	475	18-50	1.8	F8	1.8	0-25	NE-W	No	No	No
9	500	5-30	0.9	F9	0.9	0-25	N	No	No	No
10	500	250	12.0	U10	12.0	0-75	S-W	No	Partial	Summer
11	500	1-30	0.7	F11A	0.6	0-25	S	No	No	Fall
				O11B	0.1	0-25	S	No	No	Fall

12	500	250	12.1	F12A	1.3	0-50	S-W	No	No	Yes
				U12B	0.8	0-50	S-W	No	No	Yes
				U12C	1.4	0-50	S-W	No	No	Yes
				U12D	8.6	0-100	S-W	No	No	Yes
13	500	20	0.8	F13	0.8	0-25	E-SE	No	No	In the past
14	500	250	12.2	U14A	4.3	0-50	S-W	No	No	Light
				U14B	7.9	0-75	S-W	No	No	Light
15	350	100-150	4.8	F15	4.8	0-75	SW-NW	Yes	No	No
16	500	100	4.8	F16A	3.8	0-25	N-SW	No	Partial	Yes
				O16B	1.0	0-25	N-SW	No	Yes	Yes
17	500	200	10.1	U17A	2.7	0-50	NE-SE	No	No	No
				U17B	7.4	0-50	NE-SE	No	?	Yes
18	475	10-50	1.0	F18A	0.3	0-25	S	No	No	Light
				F18B	0.7	0-25	SE-S	No	No	Light
19	500	30-50	2.2	F19A	1.7	0-25	N	Yes	Yes	Yes
				O19B	0.5	0-25	N	Yes	Yes	Yes
20	500	100	5.2	F20	5.2	0-25	NE-E	No	No	Winter
21	500	1-20	0.4	O21A	0.2	0-25	SW-W	No	Yes	No
				O21B	0.2	0-25	SW-W	No	Yes	No

[a]Aspect ranges are in a clockwise direction.

[b]Clearing does not include selective cutting.

Table 1. (Continued)

	Plot			Community type				Kind of disturbance		
Plot #	Length (m)	Width (m)	Area (ha)	Type	Area (ha)	Slope (%)	Aspect[a]	Channel-ization	Clearing[b]	Grazing
22	350	130-150	4.9	F22A	1.2	0-50	S-SW	No	No	Winter
				F22B	1.1	0-25	W-S	No	No	Winter
				F22C	2.6	0-25	SW-E	No	No	Winter
23	500	150	8.0	O23A	5.5	0-25	N-NW	No	Yes	All year
				U23B	2.5	0-25	SW-W	No	?	All year
24	500	100	4.2	U24	4.2	0-50	SW-W	No	No	Yes
25	500	200	9.9	U25A	7.7	0-75	NE-SE	No	No	Yes
				U25B	2.2	0-75	NE-SE	No	No	Yes
26	500	5-15	0.5	F26A	0.4	0-25	S	Yes	Yes	No
				O26B	0.1	0-25	S	Yes	Yes	No
27	500	1-5	0.2	O27A	0.1	0-25	N	Yes	Yes	No
				O27B	0.1	0-25	N	Yes	Yes	No
28	500	100-250	10.7	F28A	0.8	0-25	W	No	No	No
				U28B	9.9	0-100	SW-NE	No	No	No

Information concerning the history of each plot was obtained through interviews with landowners or their relatives. Brief grazing, clearing, and channelization histories of each plot are shown in Table 1.

Analysis

Taxonomy follows Hitchcock (1950) for grasses, Little (1953) for trees, and Gleason and Cronquist (1963) for species other than grasses or trees. A list of all species sampled in this study is shown in Appendix A. Following identification and cross-referencing of collected plants, all raw data from each sample point were punched on computer cards. A printed copy of all raw data cards was obtained from the computer and used to check the card values against original field values.

Species frequency within each frequency grid was used as the importance value for species other than trees and saplings found on frequency sampling points. Raw cover values of all species other than trees and saplings were used as the importance values for species found on cover sampling points. Importance values were calculated for each herbaceous, shrub, and vine species at each point. Total basal area of each tree species and each sapling species measured using the point-centered quarter method was calculated for trees and saplings, respectively.

The most important tree species were determined for each frequency point using total basal area. Similar points were combined to produce a mosaic of general tree composition for each plot. Mosaics for sapling types on each plot were obtained in a similar manner. A groundlayer (herb and shrub) mosaic for each plot was drawn by arranging all frequency sampling points by reciprocal averaging ordination using the frequency importance values of each species other than trees and saplings which were greater than 5 percent. Cornell Ecology Program 20A written by Hugh G. Gauch, Jr. (Dept. of Ecology and Systematics, Cornell University, Ithaca, New York) was used for the ordinations. This program uses the algorithm in Appendix 2 of Hill (1973). Each tree, sapling, and groundlayer type in each plot had to contain at least four frequency points in a continuous area to be included in the mosaics. The tree, sapling, and groundlayer mosaics were overlaid to determine the vegetation community types on each plot (Table 2). The first letter in each community type identifier (U, F, or O) signifies the kind of canopy on each type (upland, floodplain, or open, respectively).

Type importance values (TIV) were calculated for each species in each community type. Basal areas per ha, scaled to values between 0 and 100 over all types, for each species in each of the types were used as the type importance values of both trees and saplings. Except for using actual number of individuals sampled in the density calculation, the basal area per ha values determined from the point-centered quarter method were calculated as in Mueller-Dombois and Ellenberg (1974). The use of actual number of individuals sampled overestimates density and hence basal area per ha when one or more of the sampling quarters of the point-centered quarter method are empty. Frequency values, scaled from 1 to 10 over all types of species occurring in each community type, were used as the type importance values of species other than trees and saplings. Only species with frequency values greater than or equal to 30 percent were used.

Table 2. Community type identifiers with the major species of overstory trees, understory trees, and herbs and shrubs. In the community type identifiers, U, F, and O signify the kind of canopy in each type (upland, floodplain, or open, respectively)

Community type identifier	Important species: Overstory trees / Understory trees / Herbs and shrubs
F1	Silver maple Ash, white mulberry Honewort, wood nettle, Virginia wild-rye
F2	Silver maple, boxelder Silver maple, boxelder, ash Giant ragweed, honewort, wood nettle
O3	Open Open Foxtail barley, Kentucky bluegrass
O4	Open Open Smooth brome
U5	American basswood, northern red oak, shagbark hickory Eastern hophornbeam, shagbark hickory Yellow wood-sorrel, sedge, violet
F6A	Silver maple, willow Silver maple Wood nettle
F6B	Silver maple, willow Silver maple Common dandelion, Kentucky bluegrass
F6C	Hawthorn Hawthorn Common dandelion, Kentucky bluegrass
U7	Northern red oak, American basswood Hackberry White snakeroot, Virginia wild-rye, hog-peanut
F8	Willow, boxelder Boxelder, American elm Giant ragweed, honewort

Table 2. (Continued)

Community type identifier	Important species: Overstory trees / Understory trees / Herbs and shrubs
F9	Boxelder Open Giant ragweed, lambsquarters
U10	Black walnut, shagbark hickory Eastern redcedar, shagbark hickory Buckbrush, sedge, violet
F11A	Willow, American elm American elm Giant ragweed
O11B	Open American elm Giant ragweed
F12A	Boxelder, American elm, Ohio buckeye Ohio buckeye, hackberry Wood nettle, green-headed coneflower
U12B	Boxelder, American elm, Ohio buckeye Ohio buckeye, hackberry Hog-peanut, Virginia creeper, buckbrush
U12C	Boxelder, American elm, Ohio buckeye Eastern hophornbeam Hog-peanut, Virginia creeper, buckbrush
U12D	Northern red oak, white oak Eastern hophornbeam Hog-peanut, Virginia creeper, buckbrush
F13	American elm American elm Buckbrush
U14A	White oak, American elm, eastern hophornbeam American elm Gooseberry, buckbrush, Virginia creeper

Table 2. (Continued)

Community type identifier	Important species: Overstory trees / Understory trees / Herbs and shrubs
U14B	White oak, American elm, eastern hophornbeam Eastern hophornbeam Gooseberry, buckbrush, Virginia creeper
F15	Silver maple Silver maple, American elm Wood nettle
F16A	Boxelder, American elm, black walnut American elm Kentucky bluegrass, clover, common dandelion
O16B	Open Open Kentucky bluegrass, clover, common dandelion
U17A	Northern red oak, white oak Eastern hophornbeam Wild ginger, sweet cicely
U17B	Northern red oak, white oak Eastern redcedar Buckbrush, sedge, violet
F18A	Hackberry, black walnut, boxelder Open Virginia wild-rye, field bindweed
F18B	Hackberry, black walnut, boxelder Ash, American elm Wood nettle, honewort
F19A	Eastern cottonwood Eastern cottonwood, willow Reed canary grass, smooth brome
O19B	Open Open Reed canary grass, smooth brome

Table 2. (Continued)

Community type identifier	Important species: Overstory trees / Understory trees / Herbs and shrubs
F20	Boxelder, honeylocust, willow, ash Ash, American elm Giant ragweed, whitegrass
O21A	Open Willow Giant ragweed
O21B	Open Open Giant ragweed
F22A	Black walnut Honeylocust, slippery elm Honewort, giant ragweed
F22B	Silver maple, boxelder, American elm, honeylocust Ash, American elm Smartweed
F22C	Silver maple, boxelder, American elm, honeylocust Ash, American elm Honewort, giant ragweed
O23A	Open Open Yellow wood-sorrel, Kentucky bluegrass, common dandelion
U23B	Hawthorn, black walnut Hawthorn, common prickly-ash Yellow wood-sorrel, Kentucky bluegrass, common dandelion
U24	Bur oak, hawthorn, shagbark hickory Hawthorn Kentucky bluegrass, muhly
U25A	Black walnut, honeylocust, eastern redcedar American elm Buckbrush, Kentucky bluegrass

Table 2. (Continued)

Community type identifier	Important species: Overstory trees / Understory trees / Herbs and shrubs
U25B	Eastern redcedar, honeylocust American elm Buckbrush, Kentucky bluegrass
F26A	Silver maple Silver maple, boxelder, ash Reed canary grass, field bindweed
O26B	Open Open Giant ragweed
O27A	Open Open Virginia wild-rye, hemp
O27B	Open Open Giant foxtail
F28A	American elm American elm Hog-peanut, Virginia creeper, sedge
U28B	N. red oak, white oak, American basswood, eastern hophornbeam Ash, eastern hophornbeam Hog-peanut, Virginia creeper, sedge

Community types were arranged by a second series of ordinations using community type importance values for trees, for saplings, and for groundlayer plants. Each community type was plotted on a two dimensional axis using tree ordination site scores as the abscissa and sapling ordination site scores as the ordinate. A similar plot was made using groundlayer plant ordination site scores as the ordinate. All community types which were removed before final ordination to obtain a better distribution of types are called outliers, and those types which are the endpoints of the ordination axis are called endpoints.

Using ordination, all cover sampling points were arranged by plot using the cover importance values. Cover community types were determined for the cover grid in each plot by combining points with similar ordination site values. Cover type importance values were determined for each species within each cover type. The cover type importance values consisted of the percent cover of each species over all of the type. Only the most important species in each type were used, and all species with less than two percent cover were omitted. Cover community types were ordinated using cover type importance values.

Numbers of trees and saplings sampled and numbers of tree and sapling species sampled using the point-centered quarter method were calculated for each type. Number of tree and sapling species was regressed on number of tree and sapling individuals, respectively. Probabilities of finding residuals as large as those found for each community type were calculated for both regressions.

RESULTS AND DISCUSSION

Frequency Grid

Floodplain forest plots

Forty-seven vegetation community types were determined by ordination of the frequency sampling points in each plot (Table 2). The most common dominants of the floodplain overstory were silver maple (Acer saccharinum), boxelder (Acer negundo), and willow (Salix spp.). Often two of these species were found as codominants, and sometimes one or more of the three would be codominant with American elm (Ulmus americana), honeylocust (Gleditsia triacanthos), ash (Fraxinus spp.), hackberry (Celtis occidentalis), black walnut (Juglans nigra), or Ohio buckeye (Aesculus glabra). Lee (1945) found silver maple and American elm to be the most important trees in the floodplain forests of the White River, Indiana, and Turner (1936) stated that silver maple and American elm were the dominant trees in the lower Illinois River Valley floodplains. American elm was the only dominant tree on types F28A and F13 while eastern cottonwood (Populus deltoides) was the most important tree on type F19A.

Silver maple, ash, and American elm dominated the sapling layer in most of the floodplain plots. Other important sapling layer species included boxelder, willow, eastern cottonwood, hackberry, and Ohio buckeye. Silver maple, ash, American elm, and boxelder were found to be dominant understory trees in the floodplains of southern Illinois by Hosner and Minckler (1960). Commonly, dominant understory trees were the reproduction of one or more of the overstory dominants for a particular community type. Honewort (Cryptotaenia canadensis), wood nettle (Laportea *canadensis*), and giant ragweed (*Ambrosia trifida*) were usually dominant in the floodplain groundlayer. Patches of both wood nettle and giant ragweed were found in almost pure stands. These results are similar to those of Crites and Ebinger (1969), who found wood nettle to be by far the most common herb in the floodplain forests of east-central Illinois, and Bell (1974b) who found aster (*Aster* spp.), wood nettle, and poison ivy (*Rhus radicans*) in the floodplain groundlayers of Piatt County, Illinois. Several grasses, i.e., Kentucky bluegrass (*Poa pratensis*), reed canary grass (*Phalaris arundinacea*), Virginia wild-rye (*Elymus virginicus*), whitegrass (*Leersia virginica*), and smooth brome (*Bromus inermis*), and small forbs, i.e., clover (*Trifolium* spp.), common dandelion (*Taraxacum officinale*), field bindweed (*Convolvulus arvensis*), and smartweed (*Polygonum* spp.) were also found to be dominants in some floodplain community types. Type F13 was the only floodplain community type to have a shrub, i.e., buckbrush (*Symphoricarpos* spp.), as a dominant in the groundlayer.

Upland forest plots

Upland overstory dominants included oaks (*Quercus alba*, *Q. macrocarpa*, *Q. rubra*), American basswood (*Tilia americana*), shagbark hickory (*Carya ovata*), and black walnut. Hawthorn (*Crataegus* spp.), eastern redcedar (*Juniperus virginiana*), honeylocust, American elm, and eastern hophornbeam (*Ostrya virginiana*) were also important in some upland overstories. Of the major upland overstory dominants, only shagbark hickory was found to be important in the understory. Other dominant understory trees included hawthorn, eastern redcedar, American elm, eastern hophornbeam, hackberry, ash, and common prickly-ash (*Zanthoxylum americanum*). In three community types (U12D, U14B, U28B), eastern hophornbeam was by far the most important understory tree species. The upland forest groundlayer was extremely variable with the most common dominants being buckbrush, Virginia creeper (*Parthenocissus quinquefolia*), and sedge (*Carex* spp.). Hog-peanut (*Amphicarpa bracteata*), gooseberry (*Ribes missouriense*), violet (*Viola* spp.), yellow wood-sorrel (*Oxalis stricta*), common dandelion, and Kentucky bluegrass were also dominant in some types while muhly (*Muhlenbergia schreberi*) dominated one type (U24) along with Kentucky bluegrass. None of these species, however, were important in the groundlayer of type U17A which was dominated by wild ginger (*Asarum canadense*) and sweet cicely (*Osmorhiza claytoni*).

Intermediate and open plots

Two community types (F6C, F22A) seemed to be intermediate between upland and floodplain forest types. Type F6C had hawthorn as the dominant tree in both the overstory and understory, and Kentucky bluegrass and common dandelion were the most important species in the groundlayer. Type F22A had an overstory dominated by black walnut and a sapling layer with honeylocust and slippery elm (*Ulmus rubra*) as the most important species. Honewort and giant ragweed dominated the groundlayer.

Most open community types also lacked a sapling layer. Exceptions were O11B (American elm) and O21A (willow). The groundlayer consisted of either pasture plants, e.g., Kentucky bluegrass, smooth brome, clover, common dandelion, reed canary grass, yellow wood-sorrel, foxtail barley (*Hordeum jubatum*), or of large herbs and grasses, e.g., giant foxtail (*Setaria faberi*), Virginia wild-rye, hemp (*Cannabis sativa*), giant ragweed.

Grazing

The separation of all community types according to their overstory and sapling layer, excluding types which had one or both of these layers missing, is illustrated in Fig. 4. Fig. 5 is an illustration of the clustering of all types which had an overstory layer, according to their overstory and groundlayer. Points in areas A and B in Figs. 4 and 5 represent upland streamside community types. Vegetation types in area A were relatively undisturbed with types U17A and U28B not grazed, U14B lightly grazed, U7 winter grazed, and U12D grazed at least during the summer (Table 1). Points in the areas designated B (Figs. 4 and 5) represent the more disturbed upland streamside community types. Type U5 was grazed spring through fall, types U12B, U12C, U17B, U24, U25A, and U25B were grazed in the summer and probably all year, type U10 was summer grazed, U23B was grazed all year, and U14A was lightly grazed (Table 1). Community types F16A and F28A (Figs. 4 and 5) and types F6B and F6C (Fig. 5) appeared as upland communities with F6B, F6C, and F16A grazed at least during the summer and type F28A not grazed at all. The arrows in Figs. 4 and 5 indicate the direction of increasing disturbance on a gradient due at least in part to grazing.

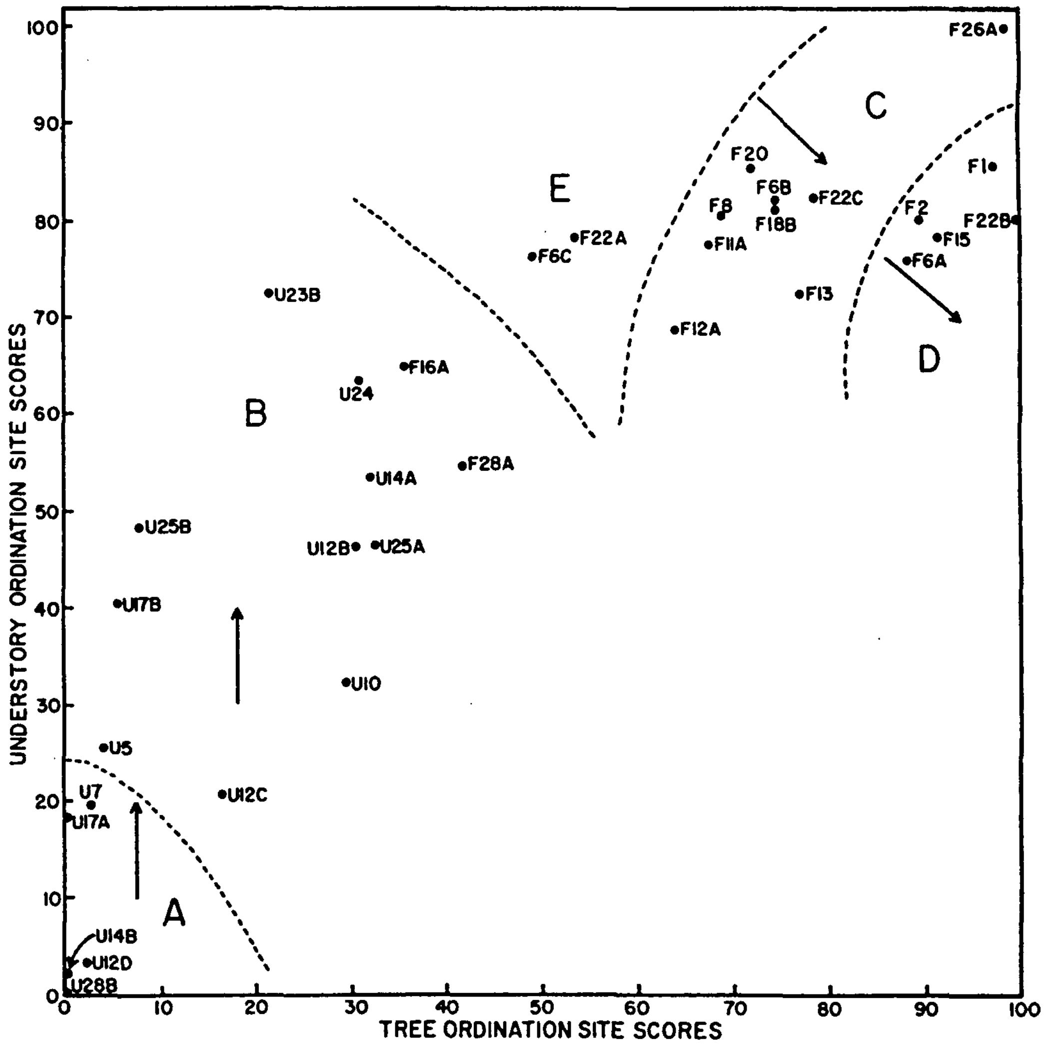

Fig. 4. Clustering of all community types which had an overstory and an understory layer, using overstory tree ordination site scores as the abscissa and understory (sapling) ordination site scores as the ordinate. Area A represents undisturbed uplands; B, disturbed uplands; C, disturbed lowlands; D, undisturbed lowlands; and E, intermediate types. Arrows indicate the direction of increasing disturbance on a disturbance gradient

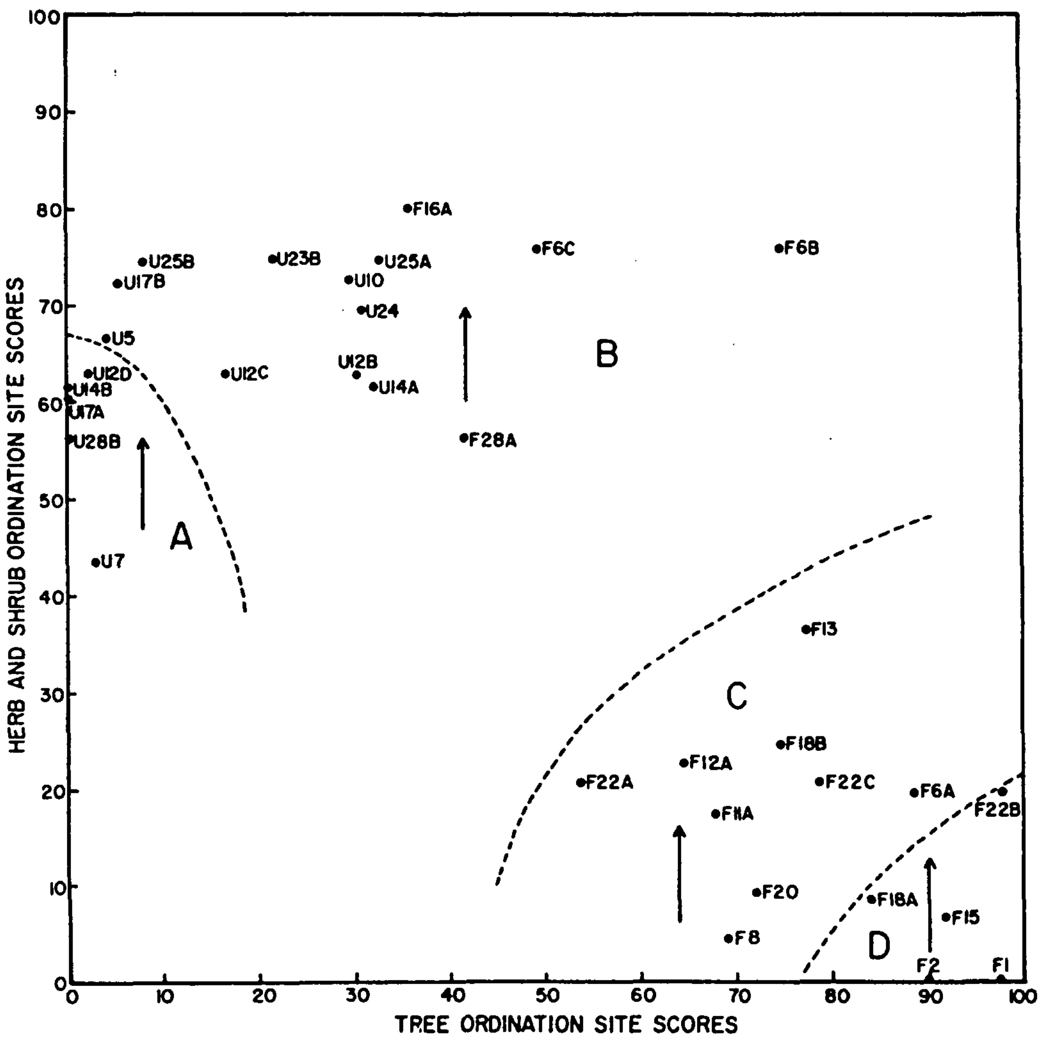

Fig. 5. Clustering of all community types which had an overstory layer, using overstory tree ordination site scores as the abscissa and herb and shrub (groundlayer) ordination site scores as the ordinate. Area A represents undisturbed uplands; B, disturbed uplands; C, disturbed lowlands; and D, undisturbed lowlands. Arrows indicate the direction of increasing disturbance on a disturbance gradient

The ordering of upland sapling layer types relative to a disturbance gradient is illustrated in Fig. 4, areas A and B. Types U28B, U12D, and U14B appeared lowest on the gradient. Although type U12D was open to grazing, it is suspected that grazing was light on the upper part of plot 12 (i.e., types U12C, U12D). Of the types in area A (Fig. 4), U17A and U7 were slightly higher on the disturbance gradient. The much reduced importance of eastern hophornbeam in the sapling layer of these two types as compared with the other types in area A is the main reason for the higher position on the gradient (Appendix B). The most obvious explanation for type U7 is that it was winter grazed which would result in damage to saplings, especially eastern hophornbeam. Type U17A was not grazed, instead it is possible that the dense overstory as indicated by the high overstory ordination site total (Table 3) and the easterly aspect (Table 1) made conditions too moist for the favorable growth of eastern hophornbeam which is typically found on drier slopes (Preston 1961).

In area B (Fig. 4), types U5, U10, and U12C appeared lowest on the disturbance gradient. Neither types U5 nor U10 were winter grazed and type U12C, like U12D was probably grazed very little. Types U12B, F16A, U17B, U24, U25A, and U25B were probably all grazed some during the winter and, as a result, appeared higher on the disturbance gradient (Fig. 4). Part of type U14A and all of F28A were close to the river, and the sapling layer of these types could have shown some disturbance due to occasional flooding. Community type U23B was highest on the gradient in area B (Fig. 4), probably as a result of year-round grazing.

In Fig. 6, types U12C, U17A, and F28A appeared above the regression line of number of sapling species sampled on number of individuals sampled.

Table 3. Overstory tree ordination site totals (totals of overstory tree importance values for each type) listed by community type

Community type	Ordination site total	Community type	Ordination site total
F1	93	U17A	124
F2	37	U17B	47
O3	--[a]	F18A	23
O4	--[a]	F18B	58
U5	68	F19A	4
F6A	151	O19B	--[a]
F6B	37	F20	48
F6C	30	O21A	--[a]
U7	83	O21B	--[a]
F8	52	F22A	64
F9	24	F22B	69
U10	32	F22C	73
F11A	51	O23A	--[a]
O11B	--[a]	U23B	35
F12A	41	U24	30
U12B	16	U25A	32
U12C	23	U25B	22
U12D	58	F26A	6
F13	113	O26B	--[a]
U14A	54	O27A	--[a]
U14B	93	O27B	--[a]
F15	140	F28A	41
F16A	14	U28B	97
O16B	--[a]		

[a]No overstory layer.

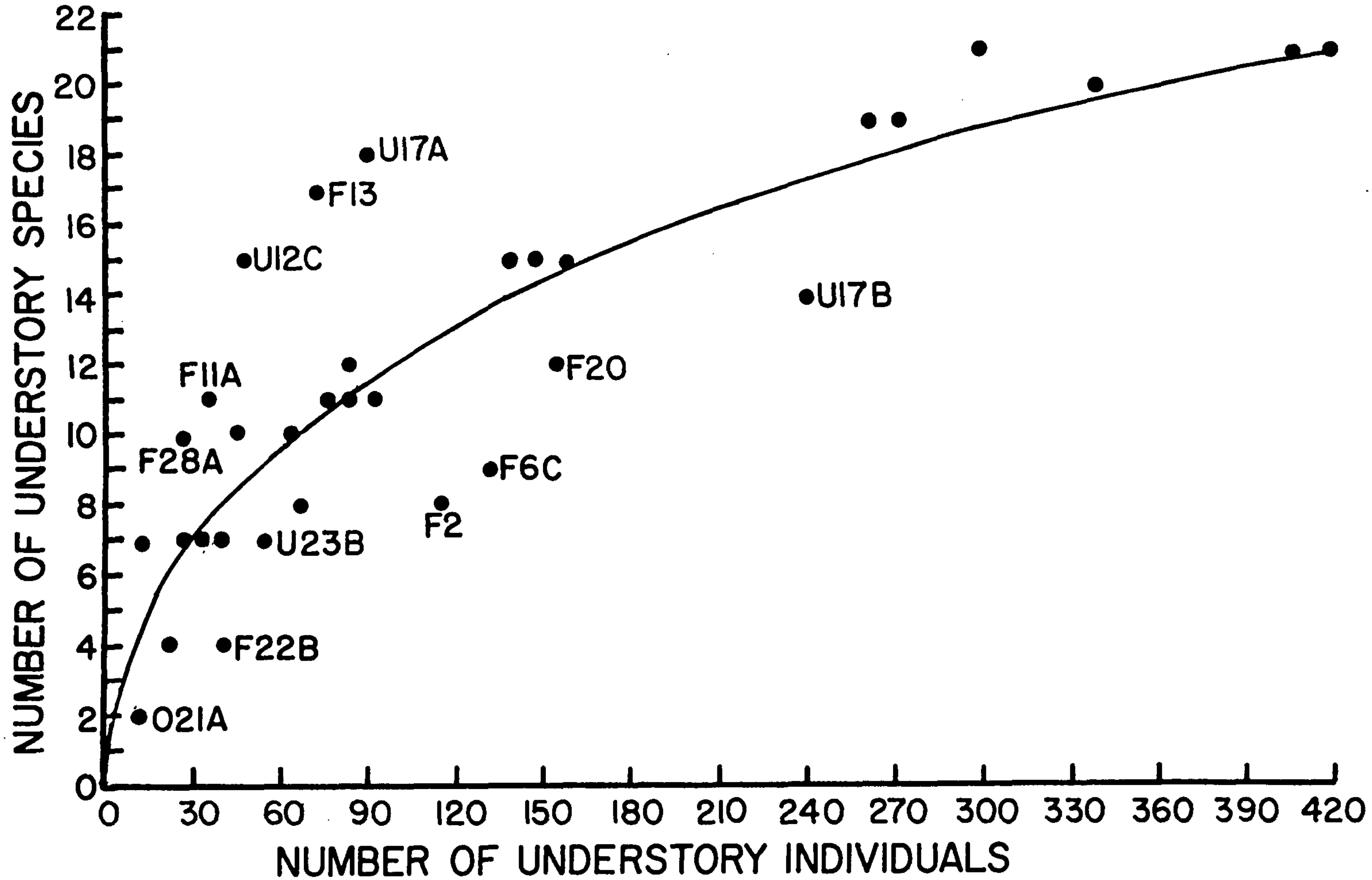

Fig. 6. Regression of number of understory (sapling) species on number of individuals, calculated from point-centered quarter data, using the equation $y = 1.445x^2 - 0.22x$. Community types with $p \geq 0.40$ are unlabeled

The probabilities of finding residuals as large as those for the three types were 0.05, 0.04, and 0.29, respectively (Table 4). These types were at most lightly grazed. The larger number of sapling species sampled suggests little disturbance and more mesic conditions than in the undisturbed types U28B, U12D, and U14B, the sapling layers of which were dominated by eastern hophornbeam. Types U17B ($p = 0.26$) and U23B ($p = 0.39$) fell below the regression line (Fig. 6), possibly indicating heavy disturbance to saplings from year-round grazing on type U23B and some winter grazing on U17B.

The responses of several understory tree species to very light or no grazing (types U14B, U17A, U28B), light or summer grazing (U5, U10, U14A, U12B, U12C, U12D), and winter or year-round grazing (U7, U17B, U23B, U24, U25A, U25B) on upland types are shown in Table 5. Eastern hophornbeam, shagbark hickory, American basswood, and common prickly-ash were sapling species most important in the undisturbed types, with eastern hophornbeam and shagbark hickory decreasing in importance with increasing grazing pressure. Common prickly-ash was important in undisturbed types due to a dense stand of this species in the lower part of type U14B which was probably persisting from some previous unrecorded disturbance. The importances of saplings of both American basswood and common prickly-ash were about the same in lightly grazed areas as in heavily grazed (browsed) areas. Eastern hophornbeam was by far the most important sapling species in undisturbed areas while American elm, ash, and eastern hophornbeam were the important saplings in lightly grazed areas. Saplings of eastern redcedar, northern red oak (*Quercus rubra*), ash, and American elm reached their highest importance in lightly grazed types. This may be due to a

Table 4. Probability values of finding residuals as large as those found for each type for the regression of number of understory tree species sampled on number of individuals sampled

Community type	Probability value	Community type	Probability value
F1	0.42	U17A	0.04
F2	0.07	U17B	0.26
O3	--[a]	F18A	--[a]
O4	--[a]	F18B	>0.50
U5	>0.50	F19A	0.40
F6A	>0.50	O19B	--[a]
F6B	>0.50	F20	0.35
F6C	0.10	O21A	0.20
U7	>0.50	O21B	--[a]
F8	>0.50	F22A	>0.50
F9	--[a]	F22B	0.15
U10	>0.50	F22C	>0.50
F11A	0.31	O23A	--[a]
O11B	0.44	U23B	0.39
F12A	>0.50	U24	>0.50
U12B	>0.50	U25A	>0.50
U12C	0.05	U25B	>0.50
U12D	0.46	F26A	>0.50
F13	0.04	O26B	--[a]
U14A	>0.50	O27A	--[a]
U14B	>0.50	O27B	--[a]
F15	>0.50	F28A	0.29
F16A	>0.50	U28B	>0.50
O16B	--[a]		

[a]No sapling layer.

Table 5. Average importance values (scaled basal areas per ha) in relation to three grazing intensities

Species	No grazing	Light grazing	Heavy grazing
Eastern hophornbeam	62.0	20.3	5.2
Shagbark hickory	7.0	4.3	1.3
American basswood	5.0	1.1	1.3
Common prickly-ash	2.0	0.5	0.8
American elm	7.3	13.8	3.0
Ash	8.7	11.7	1.8
Hackberry	3.0	6.3	5.3
Eastern redcedar	0.6	5.5	3.3
Black walnut	0.7	5.0	0.5
Northern red oak	2.7	4.1	0.5
Honeylocust	0.0	0.5	2.2
Hawthorn	0.0	0.3	2.3

reduction in competition with eastern hophornbeam and insufficient damage from grazing to impair growth of these species, one of which (ash) was found by Burgess et al. (1973) to be tolerant to grazing. Both honeylocust and hawthorn reached their highest sapling importance in heavily grazed types and generally increased in importance with increasing grazing intensity.

The ordering of different community types according to groundlayer is shown in Fig. 5. In the relatively undisturbed group (A) types U7, U28B, and U17A appeared lowest on the disturbance gradient. These three community types were not grazed during the growing season. Types U14B and U12D which were lightly grazed during the summer appeared slightly higher on the gradient. Community types U12B, U12C, and U14A were low on the disturbance gradient in area B (Fig. 5). Grazing on these types was fairly light. Type F28A was also low on the area B gradient and, although not grazed, probably received some disturbance due to occasional flooding. Community types U5, U10, F16A, U17B, U23B, U24, U25A, and U25B were fairly high on the disturbance gradient of area B, and all these types were grazed heavily during the summer at least.

The responses of some upland herbs and shrubs to very light or no grazing (U14B, U17A, U28B), light or winter grazing (U7, U12B, U12C, U12D), and summer or year-round grazing (U5, U10, U17B, U23B, U24, U25A, U25B) are shown in Table 6. Virginia creeper, Pennsylvania sedge (Carex pensylvanica), and moss reached their highest importance in ungrazed community types. Hog-peanut was slightly more important in lightly grazed types than in ungrazed types but was not important in heavily grazed community types. Violet was important in both ungrazed and heavily grazed types but was not an important species in lightly grazed types. The effects of grazing on violet could not be determined. The importance of buckbrush decreased from ungrazed to lightly grazed types but increased to a maximum in heavily grazed types. This increase is probably due to the relatively open canopy as indicated by the overstory tree ordination site totals for heavily grazed types (Table 3), which would favor rapid shrub growth. Lightly grazed types had either a dense overstory or a dense understory, and grazing is probably slightly detrimental to buckbrush if the canopy is not opened. In upland community types, Kentucky bluegrass, muhly (Muhlenbergia spp.), common dandelion, clover, yellow wood-sorrel, and plantain (Plantago spp.) were important only on the heavily grazed types indicating tolerance of these species to grazing but an inability to establish or compete where grazing is light or absent.

Table 6. Average importance values (scaled frequency values) in relation to three grazing intensities

Species	No grazing	Light grazing	Heavy grazing
Virginia creeper	5.0	4.0	1.7
Pennsylvania sedge	5.0	2.5	1.7
Moss	4.7	4.5	3.0
Hog-peanut	4.7	5.0	0.0
Buckbrush	3.0	2.0	5.0
Violet	4.7	0.0	5.5
Muhly	0.0	0.0	3.2
Clover	0.0	0.0	3.3
Common dandelion	0.0	0.0	4.0
Plantain	0.0	0.0	4.2
Yellow wood-sorrel	0.0	0.0	4.5
Kentucky bluegrass	0.0	0.0	5.5

Types F6C and F22A, which appeared to be intermediate between upland and floodplain forests in the sapling layer as well as the overstory layer, are shown in area E, Fig. 4. However in Fig. 5, type F6C is grouped with the disturbed upland types (area B) and type F22A is grouped with the disturbed floodplain types (area C). The similarity of the groundlayer of type F6C to the groundlayers of disturbed upland types reflects the heavy grazing pressure which was present on F6C (Table 1). Alternatively, the similarity of the groundlayer of type F22A to those of disturbed low-land community types reflects the relatively light grazing pressure which was present on F22A (Table 1).

The extents to which lowland community types were grazed are indicated in Table 1. Types F1, F2, F6A, and F15 were low on the disturbance gradient (area D, Fig. 4). None of these types was grazed. Community type F22B, which was winter grazed, was somewhat higher on the gradient of area D. Of the more disturbed floodplain sapling community types (area C, Fig. 4), F6B, F8, F11A, F12A, F18B, and F20 were lower on the gradient than F22C and F13. Community type F8 was not grazed and type F18B was lightly grazed with types F20 and F22C winter grazed, type F11A fall grazed, type F13 grazed in the past, and types F6B and F12A grazed in the summer and probably some during the winter. Community type F26A was channelized and is discussed elsewhere. Types F2, F6C, F20, and F22B fell below the regression line of number of sapling species sampled on number of individuals sampled (Fig. 6). Probabilities of finding larger residuals were 0.07, 0.10, 0.35, and 0.15, respectively (Table 4). All of these types except F2 were grazed. Type F13 appeared above the line in Fig. 6 with a probability value of 0.04 (Table 4). The effects of flooding and grazing on the floodplain sapling layer could not be readily separated in this study. Both the disturbed (area C, Fig. 4) and undisturbed (area D, Fig. 4) groups contained ungrazed as well as grazed community types, and probability values were somewhat high. However, effects of grazing were definitely apparent in the sapling layer of type F13 from its position in both Fig. 4 and Fig. 6. Both these results were caused by an increase in the number of sapling species following release from grazing.

The average type importance values of several understory trees from ungrazed lowland community types (F1, F2, F6A, F8, F15, F26A, F28A), light or summer grazed types (F11A, F12A, F18B), and winter or all-year grazed types (F6B, F19A, F20, F22B, F22C) are given in Table 7. All species except white mulberry (Morus alba) exhibited the highest importance in the lightly grazed community types. White mulberry had a higher average type importance value in the ungrazed types. All species except ash and

Table 7. Average importance values (scaled basal areas per ha) in relation to three grazing intensities

Species	No grazing	Light grazing	Heavy grazing
White mulberry	3.7	2.7	1.4
American elm	8.3	9.3	3.0
Silver maple	3.7	10.0	2.6
Boxelder	3.1	6.7	1.4
Hackberry	0.9	5.7	0.7
Ash	1.7	4.3	2.1
Willow	1.0	2.3	1.3

willow were at their lowest importance in the winter grazed community types. Light grazing seems to stimulate the growth of saplings in lowland communities. This could be due to a reduction in competition between saplings and the large herbs often found in floodplain habitats. The relatively high importance of ash in the heavily grazed types agrees with the conclusion that ash is fairly tolerant to grazing (Burgess et al. 1973). The low value of willow in the ungrazed types could be due to a reduction in importance through competition with species such as silver maple, boxelder, and American elm. The steady decrease in the importance of white mulberry with increasing grazing seems to indicate an intolerance to grazing.

Community types F1 and F2 appeared lowest on the disturbance gradient in area D of Fig. 5, with types F15 and F18A intermediate and type F22B highest. No grazing occurred on types F1, F2, or F15 (Table 1). The intermediate position of type F15 in Fig. 5 could be due to a reduction in flooding as discussed later in the channelization section. Standing water which was present on most of type F22B in the spring could account for the position of this community type on the disturbance gradient. Also, winter grazing, although probably not directly affecting the groundlayer, may have had some influence. The slight disturbance found in type F18A indicated in Fig. 5 was at least partially a result of light grazing.

Community types F8 and F20 were low on the disturbance gradient in area C of Fig. 5 because of protection from grazing during the summer months. However, types F6A and F22C were also not grazed in the summer, and it could not be determined what factors were involved in the higher positioning of these two types on the gradient (Fig. 5). Although both were lightly grazed (Table 1), type F18B was lower in relation to the water level of the river than type F18A and increased flooding in the former could account for the difference in position on the gradient in Fig. 5. Types F12A, F22A, and F11A appeared intermediate on the disturbance gradient of area C in Fig. 5. A number of factors such as grazing (Table 1) and flooding could account for this. Community type F13 appeared highest on the gradient in area C. Muhly, which was important in heavily grazed upland types, had a type importance value of four in type F13 (Appendix B). The high position of type F13 is due to the importance of muhly and buckbrush (TIV = 6). This indicates disturbance due to heavy grazing in the past.

The average type importance values of several herbs and grasses from ungrazed lowlands (F1, F2, F6A, F8, F15, F26A, F28A), light or winter grazed lowlands (F11A, F12A, F13, F18A, F18B, F20), and summer or all-year grazed lowlands (F6B, F16A, F19A) are shown in Table 8. Honewort, wood nettle, field bindweed, and Virginia wild-rye all had decreasing importance

Table 8. Average importance values (scaled frequency values) in relation to three grazing intensities

Species	No grazing	Light grazing	Heavy grazing
Wood nettle	3.7	2.5	0.0
Honewort	3.1	2.9	0.0
Virginia wild-rye	2.6	1.4	0.0
Field bindweed	2.4	1.4	0.0
Giant ragweed	2.3	2.5	0.0
Green-headed coneflower	1.0	2.3	0.0
Violet	1.6	1.8	2.0
Common dandelion	0.0	0.0	4.3
Kentucky bluegrass	0.0	0.0	4.7
Clover	0.0	0.0	4.7

with increased grazing pressure. Giant ragweed and green-headed coneflower (Rudbeckia laciniata) increased slightly from ungrazed types to lightly grazed types but were not important in heavily grazed types. Violet exhibited a slight increase in importance with increasing grazing intensity, and Kentucky bluegrass, clover, and common dandelion were important only in heavily grazed types. Wood nettle, honewort, field bindweed, and Virginia wild-rye seem to be floodplain species which are sensitive to grazing. A reduction in the importance of these species may allow giant ragweed and green-headed coneflower to become dominant. As the importance of grazing intolerant species decreased, pasture plants such as Kentucky bluegrass, common dandelion, and clover become dominant.

The type importance values of several herbs are compared between ungrazed open community types (O21A, O21B, O26B, O27A, O27B) and grazed open types (O3, O11B, O16B, O23A) in Table 9. Giant ragweed, hemp, and giant foxtail were reduced in importance with grazing while Kentucky

Table 9. Average importance values (scaled frequency values) in relation to channelization and grazing

Species	Channelized	Grazed and channelized	Grazed
Hemp	2.3	0.0	0.0
Giant foxtail	4.0	0.0	0.0
Giant ragweed	5.0	0.0	1.5
Kentucky bluegrass	1.0	0.0	4.7
Reed canary grass	0.0	6.0	0.0
Smooth brome	0.0	6.5	0.0
Yellow wood-sorrel	0.0	2.0	2.5
Common dandelion	0.0	0.0	2.5
Violet	0.0	0.0	2.5
Clover	0.0	0.0	3.0

bluegrass, yellow wood-sorrel, clover, common dandelion, and violet increased with grazing. Types O4, F19A, and O19B were plowed, seeded, and grazed. Important species on these types were smooth brome, reed canary grass, and yellow wood-sorrel. Reed canary grass and yellow wood-sorrel probably invaded these types naturally while smooth brome was a species in the seeding mixture.

Channelization

Five plots representing eight vegetation community types were bordered by channelized sections of stream (Table 1). Of the eight types, only three (F15, F19A, F26A) had an overstory layer. Type F19A contained four species of trees, i.e., white mulberry, eastern cottonwood, silver maple, and willow, all of which had type importance values of one (Appendix B), and as a result had a very low site total in the overstory ordination (Table 3). Silver maple (TIV = 5) and boxelder (TIV = 1) were the only trees found on type F26A (Appendix B). This type also had a very low ordination site total (Table 3). A probability value of 0.04 for type F26A (Table 10) indicated a lower number of tree species sampled than would be expected from the regression line in Fig. 7. Except for type F15, the overstories along channelized streams were relatively depauperate or absent. Often trees are removed from the area surrounding channelized sections of stream (Peters and Alvord 1964). Floodplain species such as silver maple, boxelder, willow, and eastern cottonwood seemed to be the first trees to recolonize the cleared areas. Hosner and Minckler (1960) found that eastern cottonwood and willow reproduced mainly in open areas. Most of the silver maple trees on F26A had sprouted from stumps.

The overstory of community type F15 was dominated by silver maple which had a type importance value of 99, the highest of any species in any community type (Appendix B). Eastern cottonwood, boxelder, ash, willow, and black walnut all had type importance values between five and ten while American elm, white mulberry, and slippery elm had type importance values of less than five. Type F15 had a very high ordination site total, second only to type F6A (Table 3). Vegetation types F1, F2, and F6A, all of which were relatively undisturbed floodplains (Table 1), were most similar to type F15 (Table 11). The probability of having a residual as large as that for type F15 was 0.34 (Fig. 7; Table 10). Although probability values were moderately high, both disturbed and undisturbed floodplain types were found to have fewer tree species sampled than what would be expected. This is probably due to the inability of many tree species to tolerate prolonged periods of flooding. Bell (1974a) reported that tree species richness increased with decreasing flooding

Table 10. Probability values of finding residuals as large as those found for each type for the regression of number of overstory species sampled on number of individuals sampled

Community type	Probability value	Community type	Probability value
F1	>0.50	U17A	0.28
F2	0.08	U17B	0.48
O3	--[a]	F18A	>0.50
O4	--[a]	F18B	>0.50
U5	>0.50	F19A	>0.50
F6A	>0.50	O19B	--[a]
F6B	>0.50	F20	0.09
F6C	>0.50	O21A	--[a]
U7	>0.50	O21B	--[a]
F8	>0.50	F22A	>0.50
F9	0.43	F22B	0.14
U10	>0.50	F22C	>0.50
F11A	>0.50	O23A	--[a]
O11B	--[a]	U23B	0.17
F12A	>0.50	U24	>0.50
U12B	0.19	U25A	0.34
U12C	0.34	U25B	>0.50
U12D	>0.50	F26A	0.04
F13	0.43	O26B	--[a]
U14A	0.13	O27A	--[a]
U14B	>0.50	O27B	--[a]
F15	0.34	F28A	0.22
F16A	>0.50	U28B	0.34
O16B	--[a]		

[a]No overstory layer.

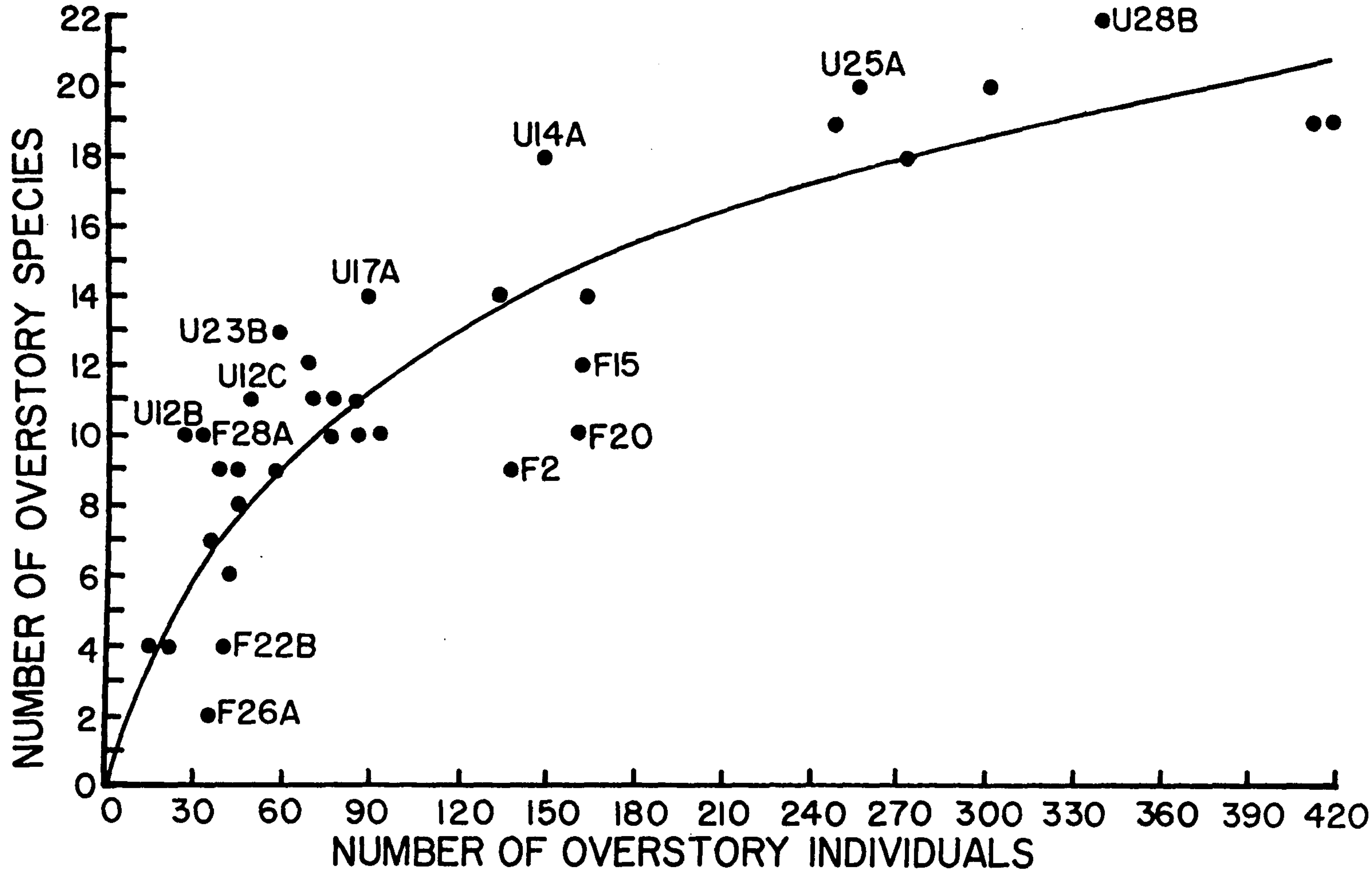

Fig. 7. Regression of number of overstory species on number of individuals, calculated from point-centered quarter data, using the equation $y = 1.338x^2 - 0.01x$. Community types with $p \geq 0.40$ are unlabeled

Table 11. Overstory ordination site scores of community types listed by site score

Site score	Community type	Site score	Community type
0.0000	U14B	53.7847	F22A
0.0163	U28B	64.1714	F12A
0.1572	U17A	67.7937	F11A
2.3362	U12D	69.0866	F8
2.9173	U7	72.0654	F20
4.0381	U5	74.7181	F6B
5.4918	U17B	74.7840	F18B
7.9898	U25B	77.3784	F13
16.4313	U12C	78.6729	F22C
21.5814	U23B	80.8305	F9
29.5744	U10	82.2357	F19A
30.4386	U12B	84.0284	F18A
30.9324	U24	88.2815	F6A
32.1038	U14A	89.7774	F2
32.7984	U25A	91.6396	F15
35.8289	F16A	97.3974	F1
41.9233	F23A	98.5744	F26A
49.1966	F6C	100.000	F22B

frequency. The similarity of type F15 to undisturbed floodplain community types and the high overstory site total of F15 illustrate that the effects of channelization on floodplain overstory trees are a result of physical clearing. If trees are not removed, little or no effects can be seen in the short run.

As in the overstory, only three channelized vegetation types (F15, F19A, F26A) had a sapling layer. In the ordination of sapling layer types (Table 12), F19A was an outlier and type F26A was an endpoint. Eastern cottonwood, willow, silver maple, and honeylocust constituted the understory tree layer of F19A while type F26A contained understory tree species

Table 12. Understory tree ordination site scores of community types listed by site score

Site score	Community type	Site score	Community type
0.0000	U28B	72.1198	F13
2.1960	U14B	72.8928	U23B
3.2657	U12D	74.9307	O11B
18.4096	U17A	76.0369	F6A
19.7009	U7	76.4698	F6C
20.6481	U12C	77.6383	F11A
25.7197	U5	78.2779	F15
32.4533	U10	78.3003	F22A
40.4966	U17B	80.0735	F22B
46.1869	U12B	80.0940	F2
46.3172	U25A	80.7616	F8
48.2777	U25B	81.2307	F18B
53.4854	U14A	81.3296	F6B
54.7856	F28A	82.2643	F22C
63.4555	U24	85.2134	F20
64.7578	F16A	85.8824	F1
68.8891	F12A	100.0000	F26A

of silver maple, boxelder, ash, willow, American elm, and white mulberry. The type importance value of silver maple on type F26A was ten, while boxelder had a value of six on the same type (Appendix B). The type importance values of the remaining species in type F26A except ash (TIV = 2) and for all understory tree species in type F19A were a value of one. The sapling layer ordination site total of type F26A was comparable to those of other floodplain community types such as F1, F2, F6A, F22B, and F20 (Table 13) indicating that recovery of the trees from channelization had begun. However, the predominance of only two tree species (silver maple, boxelder) in the understory of type F26A and the position of this type in Fig. 4 show the understory trees of type F26A are still in a very disturbed condition relative to other floodplain types. In addition

Table 13. Understory tree ordination site totals (totals of understory tree importance values for each type) listed by community type

Community type	Ordination site total	Community type	Ordination site total
F1	16	U17A	68
F2	13	U17B	17
O3	--[a]	F18A	--[a]
O4	--[a]	F18B	76
U5	29	F19A	--[b]
F6A	21	O19B	--[a]
F6B	12	F20	13
F6C	12	O21A	--[b]
U7	81	O21B	--[a]
F8	30	F22A	24
F9	--[a]	F22B	21
U10	31	F22C	36
F11A	29	O23A	--[a]
O11B	60	U23B	10
F12A	48	U24	21
U12B	95	U25A	46
U12C	168	U25B	23
U12D	147	F26A	21
F13	44	O26B	--[a]
U14A	93	O27A	--[a]
U14B	165	O27B	--[a]
F15	26	F28A	74
F16A	12	U28B	109
O16B	--[a]		

[a]No sapling layer.

[b]Outlier.

to silver maple, boxelder, and eastern cottonwood, some of the understory trees found on types F19A and F26A such as American elm, ash, or willow may become dominant in the overstories of vegetation communities recovering from clearing after channelization.

The sapling layer of community type F15 had silver maple, American elm, boxelder, white mulberry, and ash as its most important species.

Slippery elm, black walnut, hackberry, and eastern hophornbeam were also found in this type. Type importance values of all species of understory trees on F15 were five or less (Appendix B) and the ordination site total of type F15 was similar to most floodplain totals (Table 13). In the understory tree ordination, type F15 appeared most similar to types F6C, F11A, and F22A (Table 12). Both types F6C and F22A were intermediate between floodplain and upland forest types (Fig. 4). This in conjunction with the presence of hackberry and eastern hophornbeam in the understory, when absent from the overstory, could indicate that type F15 was experiencing less flooding, allowing flood intolerant tree species to become established. Type F15 was slightly more disturbed than types F1, F2, and F6A but not as disturbed as type F22B (Fig. 4) which was winter grazed (Table 1). This slight disturbance may be explained in part by the presence of flood intolerant tree species in the understory. As is the case with overstory trees, the immediate effect of stream channelization on understory trees is in most cases a complete loss. Immediate recovery comes about by establishment of floodplain species such as silver maple, boxelder, willow, eastern cottonwood, American elm, and ash. However, for channelized sections of stream in which the woody vegetation is not cleared and possibly in later recovery stages of cleared areas, flood intolerant species not normally found in floodplain forests seem to be able to establish.

All but two of the eight community types of channelized sections of streams were outliers in the groundlayer ordination. The outliers included type O4 which was dominated by smooth brome having the highest possible groundlayer type importance value of nine. Yellow wood-sorrel and milkweed (Asclepias syriaca) both had type importance values of four while reed canary grass had a type importance value of three on type 04 (Appendix B). Types F19A and 019B had reed canary grass as the most important species (TIV = 9), and smooth brome was subdominant with a type importance value of four. Outlier type F26A had a groundlayer consisting of reed canary grass, field bindweed, Virginia wild-rye, stinging nettle (Urtica dioica), and sunflower (Helianthus tuberosus) with type importance values of six, six, five, four, and three, respectively (Appendix B). Both types 026B and 027B were outliers with giant ragweed (TIV = 9), lamsquarters (Chenopodium album) (TIV = 3), and giant foxtail (TIV = 3) being the most important species in type 026B and giant foxtail (TIV = 9) the only dominant in 027B (Appendix B).

In the ordination of groundlayer vegetation, type 027A was most similar to type F18B (Table 14) yet none of the important species was in common. This similarity was because both types had a mixture of upland associated species and lowland associated species as dominants causing both to be placed in the middle of the ordination axis. In type 027A, Virginia wild-rye, giant ragweed, and field bindweed with type importance values of seven, six, and three, respectively (Appendix B), were species found mostly in floodplains. Common upland associated species such as muhly, Kentucky bluegrass, and yellow foxtail (Setaria lutescens), with type importance values of five, three, and three, respectively, were also found in type 027A. Hemp, with type importance value of seven, was a dominant species only in type 027A (Appendix B). The groundlayer of type F15 was most similar to those of F8 and F18A (Table 14). Wood nettle was the most important species in the groundlayer of F15 with a type importance value of nine while

Table 14. Groundlayer ordination site scores of community types listed by site score

Site score	Community type	Site score	Community type
0.0000	F1	43.6286	U7
0.1101	F2	56.1893	F28A, U28B
4.2975	F8	60.1438	U17A
6.9274	F15	61.6493	U14A, U14B
8.5670	F18A	62.9470	U12B, U12C, U12D
9.2512	F20	66.7132	U5
16.6296	F22B	69.3125	U24
17.2418	F11A, O11B	72.1975	U17B
19.5362	F6A	72.4167	U10
20.8610	F22A, F22C	74.6716	U25A, U25B
22.9757	F12A	74.7686	O23A, U23B
24.5466	F18B	75.9733	F6B, F6C
27.4777	O27A	80.0726	F16A, O16B
37.4492	F13	100.0000	O3

touch-me-not (Impatiens pallida) and honewort had type importance values of four. Black snakeroot (Sanicula marilandica) had a type value of three (Appendix B). Wood nettle was also important in type F18A, and honewort was one of the dominant plants in the groundlayer of type F8. Black snakeroot was an important plant in moist uplands but not in any floodplains except F15 (Appendix B) which may indicate a reduction in flooding frequency. As in the case of the understory, type F15 was slightly more disturbed than F1 and F2 but not as disturbed as type F22B again indicating a reduction in flooding (Fig. 5). Giant ragweed, giant foxtail, and hemp were important species in the groundlayers along sections of stream which were channelized but not grazed, and smooth brome, reed canary grass, and yellow wood-sorrel were important in areas which were both channelized and grazed (Table 9). With the exceptions of giant ragweed, yellow wood-sorrel, and giant foxtail, none of these species were important in any other community types (Appendix B). When groundlayer vegetation is cleared due to channelization, replacement species are generally not those found in the unchannelized floodplains.

Clearing

The wholesale or partial clearing of trees is sometimes done to increase pasture production. The removal of the overstory can greatly affect understory plants (Burgess et al. 1973). The twelve community types which had little or no overstory are designated by an "O" in the community type identifiers (Table 2). Vegetation types O4, O16B, F19A, O19B, F26A, O26B, O27A, and O27B were cleared of all trees, shrubs, and probably most herbs. All of these types except O16B were channelized and are discussed in the channelization section. Type O16B was plowed and seeded for pasture production. Clover, Kentucky bluegrass, common dandelion, and fleabane (*Erigeron annuus*) were the most important species on type O16B with type importance values of eight, six, five, and five, respectively. No shrubs were found to be important in this type.

It is not known whether shrubs were cleared from vegetation types O3, O21A, O21B, or O23A, but very few were found there (Appendix B). Most shrubs found on plot 23 were in the wooded community type U23B and not in O23A. Smartweed, Kentucky bluegrass, common dandelion, yellow wood-sorrel, and violet were dominant in type O23A with type importance values of six, six, five, five, and five, respectively. Foxtail barley with a type importance value of eight was the most dominant plant on type O3 followed by Kentucky bluegrass with a type value of seven and Japanese chess (Bromus japonicus) and little barley (Hordeum pusillum) both with type importance values of five. By far the most important species on types O21A and O21B was giant ragweed which had a type importance value of nine, followed by giant foxtail and lambsquarters both with type values of three (Appendix B). Community types which were cleared and grazed but not channelized tended to have pasture species such as Kentucky bluegrass, common dandelion, clover, yellow wood-sorrel, and barley (Hordeum spp.), while those not grazed supported more weedy species such as giant ragweed and giant foxtail. Wholesale clearing seemed to be detrimental to shrubs in all community types.

Partial clearing of trees and/or shrubs occurred on types U5, U10, and F16A. Several trees and shrubs were cleared from type U5, and only trees were partially cleared from U10. Type F16A was completely cleared except for a row of trees next to the river and a group of trees about 100 m from the river. The uncleared portion of F16A was not grazed but the cleared portion was. The important plants of the groundlayer in F16A were the same as those in O16B discussed earlier. Sedge and violet were codominant in type U5 having type importance values of seven, and yellow wood-sorrel with a type value of six was also important. No shrub species were important in type U5 (Appendix B). Codominants sedge and buckbrush had type importance values of seven on type U10. Other important species were violet, moss, and Kentucky bluegrass with type values of six, six, and five, respectively. Opening the canopy may stimulate shrub growth (Burgess et al. 1973) as seen in type U10. However, when shrubs as well as some trees are removed as in types U5 and F16A, shrubs seem to recover slowly if at all. Effects of partial opening of the canopy on herbs could not be distinguished from grazing effects.

Cover Grid

When two or more cover community types per plot were determined, the letters A, B, and C were arbitrarily assigned to the cover type identifiers. There is no connection between the letters of the identifiers and the letters of the areas in Fig. 8.

Three of the ten cover community types which bordered channelized sections of streams (15, A26, A27) were grouped with types which were not on channelized sections (Fig. 8). Of the remaining seven, one (B27) was an outlier and six (A4, B4, A19, B19, C19, B26) were in area A of Fig. 8. Although channelized, cover types A26 and A27 were similar to unchannelized types (area B, Fig. 8) containing mostly giant ragweed and hemp. Cover type 15 was not cleared when channelized and was similar to undisturbed floodplain cover types such as A2, A6, and A12. The dissimilarity between most of the channelized cover types and the unchannelized cover types demonstrated that the vegetation which arises following channelization is often not the same as that bordering unchannelized streams.

Upland cover types are shown in area C of Fig. 8. Cover types where grazing pressure was high (3, A5, B6, 10, B13, A16, B16, 23, 24, B25) had the lower ordination site scores of area C. Ungrazed or lightly grazed cover types (7, B12, 28) had the higher scores. These results are similar to those found in the grazing section for frequency sampling points. No disturbance gradient could be distinguished in area B of Fig. 8.

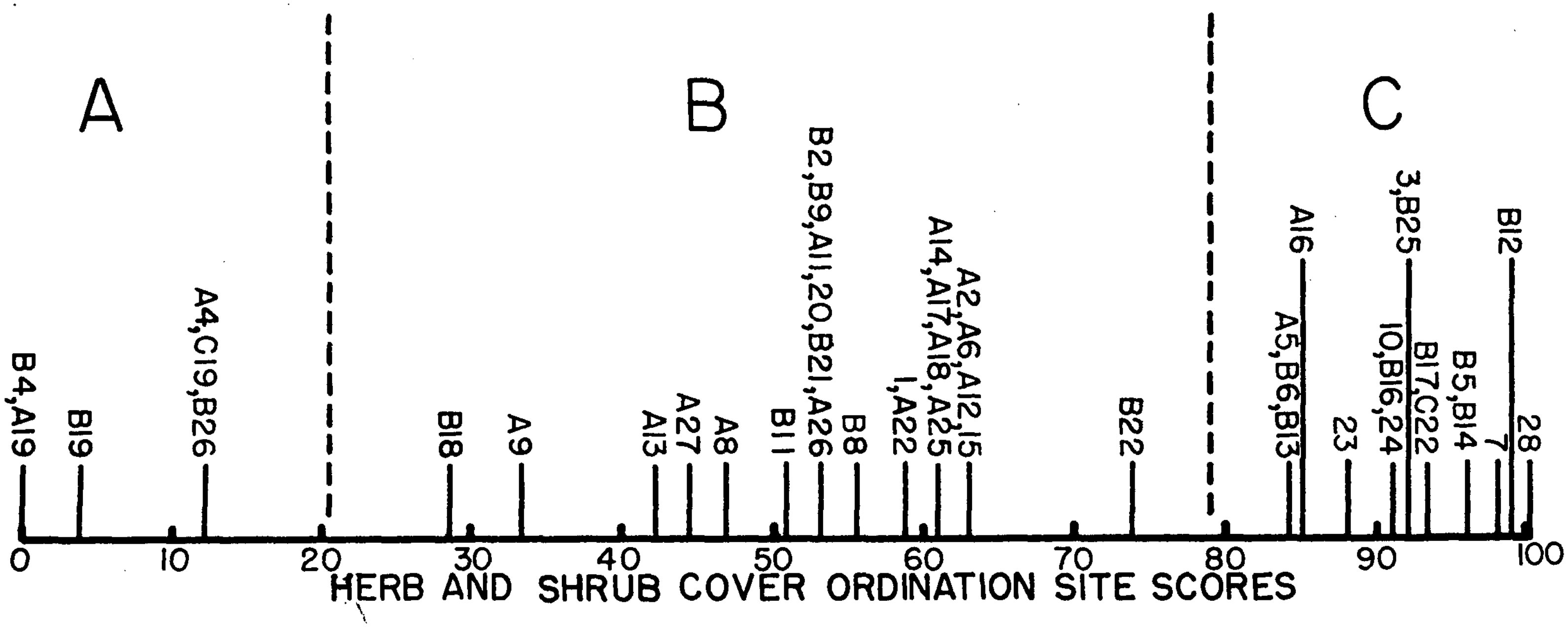

Fig. 8. Ordination of cover community types. Area A represents channelized; B, lowland; and C, upland types

Critique of Field Techniques

The major fault in the field technique of this study is a failure to meet one of the guidelines of point quarter sampling: that of recording an individual in each quarter. Because of differences in plot size, extremes of tree and sapling density, and variation in types of vegetation communities, no one sampling method will give unbiased estimates of tree and sapling importance. A good review of several forest sampling methods is given by Lindsey et al. (1958). The overestimation of basal area per ha caused by the bias in the point-centered quarter technique probably did not affect the conclusions of this study. However, a rearrangement of disturbed lowland community types in the sapling ordination probably would have occurred. This may have resulted in a more distinct disturbance gradient among these types.

Cover estimates of all species at each frequency point would have been useful in this study to help alleviate inaccuracies in species importances due to patchiness. Also, calculating vertical heights of each point above the water level of the stream would have been useful. Heights of points would facilitate separation of disturbance effects due to flooding and moisture effects from grazing effects.

CONCLUSIONS

Channelization

In most cases, streamside vegetation is removed during stream channelization. When this occurs, reestablishment is usually by floodplain species such as silver maple, boxelder, willow, and eastern cottonwood. American elm and ash may also become dominant in floodplains recovering from channelization. Virginia wild-rye, hemp, reed canary grass, field bindweed, and giant foxtail replace the common floodplain herbs (i.e., honewort, wood nettle, and giant ragweed) after clearing due to channelization. However, giant ragweed may persist following channelization. When vegetation is not removed, no short-term effects are evident. However, over time, flood intolerant tree species may become dominant because of a reduction in flooding duration or frequency, or a lowering of groundwater levels. When not cleared, floodplain herbs remain but may be replaced in the long run by more flood intolerant species, e.g., black snakeroot.

Clearing

Opening the canopy is favorable to shrub growth. However, partial clearing of overstory trees is favorable to shrubs only if shrubs are not cleared along with trees. For all cases in this study, when overstory trees were completely cleared, shrubs were cleared also. The effects of clearing overstory trees on herbs could not be distinguished from grazing effects in this study.

Grazing

Eastern hophornbeam and shagbark hickory are upland tree species which are sensitive to grazing. Eastern redcedar, northern red oak, ash, and American elm saplings are favored by light grazing in uplands possibly due to a reduction in competition with eastern hophornbeam. In uplands, honeylocust and hawthorn increase in importance with increasing grazing intensity. Virginia creeper, Pennsylvania sedge, and moss are important in ungrazed uplands. Kentucky bluegrass, muhly, common dandelion, clover, yellow wood-sorrel, and plantain replace the above species in grazed areas.

In lowlands, white mulberry is sensitive to grazing, but light grazing seems to stimulate saplings of other floodplain trees. This could be due to a reduction in competition with large floodplain herbs. Honewort, wood nettles, field bindweed, and Virginia wild-rye decrease in importance with increasing grazing intensity. Giant ragweed and green-headed coneflower are important in lightly grazed lowlands. Kentucky bluegrass, common dandelion, and clover replace the floodplain herbs when lowlands are heavily grazed.

In open communities, giant ragweed, hemp, and giant foxtail are reduced in importance with grazing while Kentucky bluegrass, yellow wood-sorrel, clover, common dandelion, and violet increase.

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APPENDIX A. LIST OF SPECIES FOUND IN STUDY PLOTS

Species[1]	Common name
Abutilon theophrasti Medic.	Velvetleaf
Acalypha virginica L.	Three-seeded mercury
Acer negundo L.	Boxelder
Acer nigrum Michx. f.	Black maple
Acer saccharinum L.	Silver maple
Acer saccharum Marsh.	Sugar maple
Achillea millefolium L.	Yarrow
Actaea alba (L.) Mill.	Baneberry
Adiantum pedatum L.	Maidenhair fern
Aesculus glabra Willd.	Ohio buckeye
Aethusa cynapium L.	Fool's parsley
Agastache foeniculum (Pursh) Kuntze	Giant hyssop
Agastache nepetoides (L.) Kuntze	Giant hyssop
Agrimonia pubescens Wallr.	Agrimony
Agrimonia striata Michx.	Agrimony
Agrimonia spp.	Agrimony
Agropyron repens (L.) Beauv.	Quackgrass
Agropyron trachycaulum (Link) Malte	Slender wheatgrass
Agrostis alba L.	Redtop
Agrostis perennans (Walt.) Tuckerm.	Autumn bent
Alisma plantago-aquatica L.	Water-plantain
Alisma subcordatum Raf.	Water-plantain
Alopecurus carolinianus Walt.	Foxtail
Amaranthus albus L.	Tumbleweed
Amaranthus hybridus L.	Prince's feather
Amaranthus tamariscinus (Nutt.) Wood	Amaranth
Amaranthus spp.	Amaranth
Ambrosia artemisiifolia L.	Small ragweed
Ambrosia trifida L.	Giant ragweed
Amelanchier arborea (Michx. f.) Fern.	Downy serviceberry
Amorpha canescens Pursh	Lead-plant
Ampelamus albidus (Nutt.) Britt.	Climbing milkweed
Amphicarpa bracteata (L.) Fern.	Hog-peanut
Anemone cylindrica Gray	Windflower
Anemone quinquefolia L.	Wood anemone
Anemone virginiana L.	Windflower

[1]Nomenclature for grasses: Hitchcock (1950); nomenclature for trees: Little (1953); nomenclature for species other than grasses or trees: Gleason and Cronquist (1963); individuals identified only to genus are indicated by "genus spp.".

Species	Common name
Anemonella thalictroides (L.) Spach	Rue anemone
Antennaria neglecta Greene	Pussy-toes
Antennaria plantaginifolia (L.) Richards.	Pussy-toes
Anthemis arvensis L.	Dogfennel
Anthemis cotula L.	Mayweed
Apios americana Medic.	Wild bean
Apocynum sibiricum Jacq.	Indian hemp
Apocynum spp.	Dogbane
Aquilegia canadensis L.	Columbine
Arabis canadensis L.	Sickle-pod
Arctium minus Schk.	Common burdock
Arisaema triphyllum (L.) Schott	Jack in the pulpit
Artemisia ludoviciana Nutt.	Sage
Asarum canadense L.	Wild ginger
Asclepias incarnata L.	Swamp-milkweed
Asclepias purpurascens L.	Milkweed
Asclepias sullivantii Engelm.	Milkweed
Asclepias syriaca L.	Milkweed
Asclepias verticillata L.	Milkweed
Asclepias spp.	Milkweed
Asparagus officinalis L.	Asparagus
Aster azureus Lindl.	Aster
Aster cordifolius L.	Aster
Aster ericoides L.	Heath aster
Aster laevis L.	Aster
Aster pilosus Willd.	Aster
Aster praealtus Poir.	Aster
Aster sagittifolius Willd.	Aster
Aster simplex Willd.	Aster
Barbarea vulgaris R. Br.	Winter-cress
Bidens cernua L.	Beggar-ticks
Bidens frondosa L.	Beggar-ticks
Bidens polylepis Blake	Beggar-ticks
Bidens spp.	Beggar-ticks
Botrychium virginianum (L.) Sw.	Rattlesnake fern
Brassica hirta Moench	White mustard
Brassica juncea (L.) Cosson	Brown mustard
Brassica rapa L.	Turnip
Brassica spp.	Mustard
Bromus inermis Leyss.	Smooth brome
Bromus japonicus Thunb.	Japanese chess
Bromus purgans L.	Canada brome
Bromus tectorum L.	Downy chess
Campanula americana L.	Tall bellflower
Cannabis sativa L.	Hemp

Species	Common name
Capsella bursa-pastoris (L.) Medic.	Shepherd's purse
Carduus nutans L.	Nodding thistle
Carex pensylvanica Lam.	Pennsylvania sedge
Carex spp.	Sedge
Carya cordiformis (Wangenh.) K. Koch	Bitternut hickory
Carya ovata (Mill.) K. Koch	Shagbark hickory
Cassia fasciculata Michx.	Partridge-pea
Catalpa speciosa Warder	Northern catalpa
Celastrus scandens L.	Bittersweet
Celtis occidentalis L.	Hackberry
Cenchrus pauciflorus Benth.	Field sandbur
Cerastium vulgatum L.	Mouse-ear chickweed
Chenopodium album L.	Lambsquarters
Chenopodium hybridum L.	Goosefoot
Chenopodium rubrum L.	Goosefoot
Chenopodium spp.	Goosefoot
Cichorium intybus L.	Chicory
Cinna arundinacea L.	Stout woodreed
Circaea quadrisulcata (Maxim.) Franch. & Sav.	Enchanter's nightshade
Cirsium altissimum (L.) Spreng.	Thistle
Cirsium discolor (Muhl.) Spreng.	Thistle
Cirsium vulgare (Savi) Tenore	Bull thistle
Cirsium spp.	Thistle
Clematis virginiana L.	Virgin's bower
Convolvulus arvensis L.	Field bindweed
Convolvulus sepium L.	Hedge bindweed
Conyza canadensis (L.) Cronq.	Horseweed
Cornus racemosa Lam.	Dogwood
Cornus rugosa Lam.	Dogwood
Cornus stolonifera Michx.	Red-osier dogwood
Cornus spp.	Dogwood
Crataegus spp.	Hawthorn
Cryptotaenia canadensis (L.) DC.	Honewort
Cuscuta gronovii Willd.	Dodder
Cuscuta spp.	Dodder
Cystopteris fragilis (L.) Bernh.	Bladder fern
Dactylis glomerata L.	Orchard grass
Danthonia spicata (L.) Beauv.	Poverty oatgrass
Daucus carota L.	Queen Anne's lace
Desmodium cuspidatum (Muhl.) Loud.	Tick-trefoil
Desmodium glutinosum (Muhl.) Wood	Tick-trefoil
Digitaria sanguinalis (L.) Scop.	Crabgrass
Digitaria spp.	Crabgrass
Dioscorea villosa L.	Wild yam
Dipsacus sylvestris Huds.	Teasel

Species	Common name
Echinochloa crusgalli (L.) Beauv.	Barnyard grass
Eleocharis spp.	Spike rush
Ellisia nyctelea L.	
Elymus canadensis L.	Canada wild-rye
Elymus villosus Muhl.	Wild-rye
Elymus virginicus L.	Virginia wild-rye
Equisetum arvense L.	Common horsetail
Equisetum hyemale L.	Scouring rush
Eragrostis hypnoides (Lam.) B. S. P.	Lovegrass
Erigeron philadelphicus L.	Fleabane
Erigeron strigosus Muhl.	Fleabane
Euonymus atropurpureus Jacq.	Eastern wahoo
Eupatorium fistulosum Barratt	Joe-pye weed
Eupatorium maculatum L.	Joe-pye weed
Eupatorium purpureum L.	Joe-pye weed
Eupatorium rugosum Houtt.	White snakeroot
Euphorbia corollata L.	Flowering spurge
Euphorbia cyparissias L.	Cypress-spurge
Euphorbia esula L.	Leafy spurge
Euphorbia maculata L.	Wartweed
Festuca arundinacea Schreb.	Reed fescue
Festuca obtusa Bieler	Nodding fescue
Festuca rubra L.	Red fescue
Fragaria virginiana Duchesne	Strawberry
Fraxinus spp.	Ash
Galium aparine L.	Bedstraw
Galium boreale L.	Bedstraw
Galium circaezans Michx.	Bedstraw
Galium triflorum Michx.	Bedstraw
Gentiana spp.	Gentian
Geranium maculatum L.	Wild geranium
Geum canadense Jacq.	Avens
Geum spp.	Avens
Glecoma hederacea L.	Ground-ivy
Gleditsia triacanthos L.	Honeylocust
Glyceria striata (Lam.) Hitchc.	Fowl mannagrass
Hackelia virginiana (L.) Johnst.	Stickseed
Hedeoma hispida Pursh.	Pennyroyal
Hedeoma pulegioides (L.) Pers.	American pennyroyal
Helianthus strumosus L.	Sunflower
Helianthus tuberosus L.	Jerusalem artichoke
Hepatica acutiloba DC.	Hepatica
Heracleum lanatum Michx.	Cow-parsnip
Hibiscus trionum L.	Flower of an hour
Hibiscus spp.	Rose-mallow
Hieracium canadense Michx.	Hawkweed

Species	Common name
Hordeum jubatum L.	Foxtail barley
Hordeum pusillum Nutt.	Little barley
Hydrophyllum virginianum L.	Water-leaf
Hystrix patula Moench	Bottlebrush
Impatiens pallida Nutt.	Touch-me-not
Ipomoea purpurea (L.) Roth	Common morning-glory
Ipomoea spp.	Morning-glory
Juglans cinerea L.	Butternut
Juglans nigra L.	Black walnut
Juncus tenuis Willd.	Path rush
Juniperus virginiana L.	Eastern redcedar
Lactuca biennis (Moench) Fern.	Lettuce
Lactuca canadensis L.	Lettuce
Lactuca floridana (L.) Gaertn.	Lettuce
Lactuca serriola L.	Prickly lettuce
Laportea canadensis (L.) Wedd.	Wood nettle
Lappula echinata Gilib.	Stickseed
Lechea tenuifolia Michx.	Pinweed
Leersia oryzoides (L.) Swartz	Rice cutgrass
Leersia virginica Willd.	Whitegrass
Leonurus cardiaca L.	Motherwort
Lepidium campestre (L.) R. Br.	Field-cress
Lepidium spp.	Peppergrass
Lespedeza capitata Michx.	Bush-clover
Liatris squarrosa (L.) Michx.	Blazing star
Linum sulcatum Riddell.	Flax
Lobelia inflata L.	Indian tobacco
Lobelia spicata Lam.	Lobelia
Lonicera spp.	Honeysuckle
Lychnis alba Mill.	White campion
Lycopus americanus Muhl.	Bugle-weed
Lycopus uniflorus Michx.	Bugle-weed
Lycopus virginicus L.	Bugle-weed
Lysimachia nummularia L.	Moneywort
Maclura pomifera (Raf.) Schneid.	Osage-orange
Malus spp.	Apple
Medicago lupulina L.	Black medick
Medicago sativa L.	Alfalfa
Melilotus alba Desr.	White sweet clover
Melilotus officinalis (L.) Desr.	Yellow sweet clover
Melilotus spp.	Sweet clover
Menispermum canadense L.	Moonseed
Mentha piperita L.	Peppermint
Mimulus ringens L.	Monkey-flower
Monarda fistulosa L.	Horse-mint
Morus alba L.	White mulberry

Species	Common name
Muhlenbergia frondosa (Poir.) Fernald	Wirestem muhly
Muhlenbergia racemosa (Michx.) B. S. P.	Muhly
Muhlenbergia schreberi Gmel.	Nimblewill
Nepeta cataria L.	Catnip
Oenothera biennis L.	Evening-primrose
Osmorhiza claytoni (Michx.) Clarke	Sweet cicely
Osmorhiza longistylis (Torr.) DC.	Sweet cicely
Ostrya virginiana (Mill.) K. Koch.	Eastern hophornbeam
Oxalis stricta L.	Yellow wood-sorrel
Panicum dichotomiflorum Michx.	Fall panicum
Panicum lanuginosum Ell.	Panicum
Panicum latifolium L.	Panicum
Panicum scribnerianum Nash	Panicum
Panicum spp.	Panicum
Parietaria pensylvanica Muhl.	Pellitory
Parthenocissus quinquefolia (L.) Planch.	Virginia creeper
Pastinaca sativa L.	Wild parsnip
Pedicularis canadensis L.	Lousewort
Penthorum sedoides L.	Ditch stonecrop
Phalaris arundinacea L.	Reed canary grass
Phleum pratense L.	Timothy
Phlox divaricata L.	Phlox
Phryma leptostachya L.	Lopseed
Phyla lanceolata (Michx.) Greene	Fog-fruit
Physalis heterophylla Nees	Ground-cherry
Physalis pubescens L.	Ground-cherry
Physalis virginiana Mill.	Ground-cherry
Physocarpus opulifolius (L.) Maxim.	Ninebark
Physostegia virginiana (L.) Benth.	False dragonhead
Pilea pumila (L.) Gray	Clearweed
Plantago aristata Michx.	Buckhorn
Plantago lanceolata L.	English plantain
Plantago major L.	Plantain
Plantago rugelii Decne.	Plantain
Poa compressa L.	Canada bluegrass
Poa pratensis L.	Kentucky bluegrass
Polygala verticillata L.	Milkwort
Polygonatum biflorum (Walt.) Ell.	Solomon's seal
Polygonum aviculare L.	Knotweed
Polygonum coccineum Muhl.	Water smartweed
Polygonum erectum L.	Knotweed
Polygonum hydropiper L.	Smartweed
Polygonum hydropiperoides Michx.	Smartweed
Polygonum natans Eat.	Water smartweed
Polygonum pensylvanicum L.	Smartweed

Species	Common name
Polygonum scandens L.	False buckwheat
Polygonum virginianum L.	Virginia knotweed
Polygonum spp.	Smartweed
Populus deltoides Bartr.	Eastern cottonwood
Potentilla norvegica L.	Cinquefoil
Potentilla recta L.	Cinquefoil
Potentilla simplex Michx.	Cinquefoil
Potentilla spp.	Cinquefoil
Prenanthes alba L.	White lettuce
Prenanthes racemosa Michx.	White lettuce
Prunella vulgaris L.	Self-heal
Prunus americana Marsh.	American plum
Prunus serotina Ehrh.	Black cherry
Prunus virginiana L.	Common chokecherry
Quercus alba L.	White oak
Quercus macrocarpa Michx.	Bur oak
Quercus muehlenbergii Engelm.	Chinkapin oak
Quercus rubra L.	Northern red oak
Quercus stellata Wangenh.	Post oak
Quercus velutina Lam.	Black oak
Ranunculus abortivus L.	Small-flowered crowfoot
Ratibida pinnata (Vent.) Barnh.	Coneflower
Rhus glabra L.	Smooth sumac
Rhus radicans L.	Poison ivy
Rhus typhina L.	Staghorn sumac
Ribes missouriense Nutt.	Gooseberry
Rorippa islandica (Oeder) Borbas	Yellow cress
Rosa carolina L.	Rose
Rosa multiflora Thunb.	Rose
Rosa rugosa Thunb.	Rose
Rosa setigera Michx.	Prairie rose
Rosa spp.	Rose
Rubus allegheniensis Porter	Common blackberry
Rubus occidentalis L.	Black raspberry
Rubus strigosus Michx.	Red raspberry
Rubus spp.	Bramble
Rudbeckia laciniata L.	Green-headed coneflower
Rudbeckia triloba L.	Coneflower
Rumex acetosella L.	Red sorrel
Rumex crispus L.	Sour dock
Rumex obtusifolius L.	Bitter dock
Rumex orbiculatus Gray	Great water-dock
Rumex patientia L.	Patience-dock
Rumex spp.	Dock
Sagittaria spp.	Arrow-head

Species	Common name
Salix spp.	Willow
Sambucus canadensis L.	American elder
Sanguinaria canadensis L.	Bloodroot
Sanicula canadensis L.	Black snakeroot
Sanicula marilandica L.	Black snakeroot
Sanicula trifoliata Bickn.	Black snakeroot
Saponaria officinalis L.	Soapwort
Scirpus spp.	Bulrush
Scrophularia marilandica L.	Figwort
Scutellaria lateriflora L.	Skullcap
Senecio vulgaris L.	Groundsel
Setaria faberii Herrm.	Giant foxtail
Setaria lutescens (Weigel) Hubb.	Yellow foxtail
Setaria viridis (L.) Beauv.	Green foxtail
Setaria spp.	Foxtail
Silene noctiflora L.	Catchfly
Silene stellata (L.) Ait. f.	Starry campion
Silphium perfoliatum L.	Cup-plant
Sisymbrium officinale (L.) Scop.	Hedge-mustard
Sisyrinchium campestre Bickn.	Blue-eyed grass
Smilacina spp.	False Solomon's seal
Smilax ecirrhata (Engelm.) Wats.	Carrion flower
Smilax herbacea L.	Carrion flower
Smilax hispida Muhl.	Cat briar
Solanum carolinense L.	Horse-nettle
Solanum nigrum L.	Black nightshade
Solanum rostratum Dunal.	Buffalo-bur
Solidago canadensis L.	Goldenrod
Solidago flexicaulis L.	Goldenrod
Solidago hispida Muhl.	Goldenrod
Solidago missouriensis Nutt.	Goldenrod
Solidago rugosa Mill.	Goldenrod
Solidago ulmifolia Muhl.	Goldenrod
Solidago spp.	Goldenrod
Stachys tenuifolia Willd.	Hedge-nettle
Staphylea trifolia L.	American bladdernut
Stellaria spp.	Chickweed
Symphoricarpos spp.	Buckbrush
Taraxacum officinale Weber	Common dandelion
Teucrium canadense L.	Germander
Thalictrum dasycarpum Fisch. & Ave-Lall.	Meadow rue
Thalictrum dioicum L.	Meadow rue
Thlaspi arvense L.	Penny-cress
Tilia americana L.	American basswood

Species	Common name
Tragopogon pratensis L.	Goat's beard
Trifolium hybridum L.	Alsike clover
Trifolium pratense L.	Red clover
Trifolium repens L.	White clover
Trillium spp.	Trillium
Triodanis perfoliata (L.) Nieuwl.	Venus' looking glass
Triosteum perfoliatum L.	Feverwort
Ulmus americana L.	American elm
Ulmus parvifolia Jacq.	Chinese elm
Ulmus pumila L.	Siberian elm
Ulmus rubra Muhl.	Slippery elm
Ulmus spp.	Elm
Urtica dioica L.	Stinging nettle
Uvularia grandiflora Sm.	Bellwort
Verbascum thapsus L.	Mullein
Verbena hastata L.	Vervain
Verbena stricta Vent.	Vervain
Verbena urticifolia L.	Vervain
Verbesina alternifolia (L.) Britt.	Wingstem
Verbesina occidentalis (L.) Walt.	Wingstem
Vernonia baldwini Torr.	Ironweed
Veronica peregrina L.	Speedwell
Veronicastrum virginicum (L.) Farw.	Culver's root
Vinca minor L.	Periwinkle
Viola spp.	Violet
Vitis riparia Michx.	Forest-grape
Zanthoxylum americanum Mill.	Common prickly-ash
Zea mays L.	Maize
Zizia aurea (L.) Koch	Golden Alexanders

APPENDIX B. IMPORTANCE VALUES OF SPECIES USED IN ORDINATIONS OF TYPES BASED ON THE FREQUENCY GRID (TREE VALUES SEPARATED INTO TREES/SAPLINGS). IMPORTANCE VALUES FOR TREES AND SAPLINGS ARE SCALED BASAL AREAS PER HECTARE; FOR HERBS, SHRUBS, AND GRASSES, SCALED FREQUENCY VALUES

Table B.1. Importance values of species used in ordinations of types based on the frequency grid

Species	Community type											
	F1	F2	03	04	U5	F6A	F6B	F6C	U7	F8	F9	U10
American basswood	0/0	0/0	0/0	0/0	20/1	0/0	0/0	2/0	30/6	0/0	0/0	1/0
American elm	1/2	2/2	0/0	0/0	1/1	5/5	1/1	1/2	6/1	5/16	1/0	2/3
Ash	2/2	1/2	0/0	0/0	0/1	7/2	1/1	3/1	4/4	1/1	0/0	1/1
Aster	0	0	0	0	0	0	0	0	5	0	0	0
Avens	0	0	0	0	0	0	0	0	3	0	0	0
Barnyard grass	0	0	0	0	0	0	0	0	0	0	0	0
Bedstraw	0	0	0	0	0	0	0	0	0	0	0	0
Beggar-ticks	0	0	0	0	0	0	0	0	0	0	0	0
Bitternut hickory	0/0	0/0	0/0	0/0	1/1	0/0	0/0	0/0	0/1	0/0	0/0	1/4
Black cherry	0/0	0/0	0/0	0/0	0/1	0/0	0/0	0/0	0/6	0/1	0/0	0/0
Black medick	0	0	0	0	0	0	0	0	0	0	0	4
Black snakeroot	0	0	0	0	3	0	0	0	3	0	0	0
Black walnut	0/0	0/0	0/0	0/0	1/1	2/0	0/0	5/0	2/0	11/0	1/0	6/1
Bloodroot	0	0	0	0	0	0	0	0	0	0	0	0
Boxelder	3/2	7/3	0/0	0/0	0/0	17/2	9/1	2/0	0/0	10/3	16/0	1/1
Buckbrush	0	0	0	0	3	0	0	0	0	0	0	7
Bull thistle	0	0	0	0	0	0	5	5	0	0	0	0
Bur oak	0/0	0/0	0/0	0/0	5/0	0/0	0/0	0/0	5/0	0/0	0/0	0/0
Canada bluegrass	0	0	3	0	0	0	4	4	0	0	0	0
Canada wild-rye	0	0	0	0	0	0	0	0	0	0	0	0
Clearweed	0	0	0	0	0	0	0	0	0	3	0	0
Clover	0	0	0	0	3	0	6	6	0	0	0	4
Common dandelion	0	0	0	0	3	0	8	8	0	0	0	4
Common prickly-ash	0/0	0/0	0/0	0/0	0/1	0/0	0/0	0/0	0/0	0/0	0/0	0/1
Cup-plant	0	0	0	0	0	0	0	0	0	0	0	0
Eastern cottonwood	2/1	1/0	0/0	0/0	1/0	18/1	2/0	0/0	0/0	0/1	0/0	2/0
Eastern hophornbeam	0/0	0/0	0/0	0/0	1/7	0/0	0/0	0/0	5/25	0/0	0/0	1/3
Eastern redcedar	0/0	0/0	0/0	0/0	1/1	0/0	0/0	0/0	0/0	0/0	0/0	1/4
Enchanter's nightshade	0	0	0	0	4	0	0	0	0	0	0	0
False dragonhead	0	0	0	0	0	0	0	0	0	0	0	0

Fescue	0	0	0	0	0	0	0	0	0	0	0	0
Field bindweed	5	3	0	0	0	0	0	0	0	3	0	0
Fleabane	0	0	0	0	0	0	0	0	0	0	0	0
Foxtail barley	0	0	8	0	0	0	0	0	0	0	0	0
Giant foxtail	0	0	0	0	0	0	0	0	0	0	0	0
Giant ragweed	4	6	0	0	0	0	0	0	0	6	8	0
Goldenrod	3	0	0	0	0	0	0	0	3	0	0	0
Gooseberry	0	0	0	0	0	0	0	0	0	0	0	0
Green-headed coneflower	4	3	0	0	0	0	0	0	0	0	0	0
Ground-ivy	0	0	0	0	0	0	3	3	0	0	0	0
Hackberry	0/0	0/1	0/0	0/0	0/1	7/3	2/1	1/1	2/27	3/1	0/0	1/1
Hawthorn	1/0	0/0	0/0	0/0	1/1	0/0	1/2	3/4	0/0	1/1	0/0	0/1
Hedge-nettle	0	0	0	0	0	0	0	0	0	0	0	0
Hemp	0	0	0	0	0	0	0	0	0	0	0	0
Hog-peanut	0	0	0	0	0	0	0	0	6	0	0	0
Honewort	6	6	0	0	0	0	0	0	0	6	0	0
Honeylocust	0/0	0/0	0/0	0/0	0/1	0/0	1/1	1/1	0/0	0/0	0/0	1/1
Horse-mint	0	0	0	0	0	0	0	0	0	0	0	0
Horseweed	0	0	0	0	0	0	0	0	0	0	3	0
Ironweed	0	0	0	0	0	0	0	0	0	0	0	0
Japanese chess	0	0	5	0	0	0	0	0	0	0	0	3
Kentucky bluegrass	0	0	7	0	3	0	8	8	0	0	0	5
Lambsquarters	0	0	0	0	0	0	0	0	0	0	5	0
Little barley	0	0	5	0	0	0	0	0	0	0	0	0
Milkweed	0	0	0	4	0	0	0	0	0	0	0	0
Moneywort	0	0	0	0	0	0	0	0	0	0	0	0
Moss	0	0	0	0	4	0	0	0	5	0	0	6
Muhly	0	0	0	0	0	0	5	5	0	0	0	3
Nodding thistle	0	0	3	0	0	0	0	0	0	0	0	0
Northern red oak	0/0	0/0	0/0	0/0	17/0	0/0	0/0	0/0	23/2	0/0	0/0	1/1
Ohio buckeye	0/0	0/0	0/0	0/0	1/1	0/1	2/0	5/1	0/0	0/0	0/0	0/0
Orchard grass	0	0	0	0	0	0	0	0	0	0	0	0
Panicum	0	0	0	0	0	0	0	0	0	0	0	4
Pennsylvania sedge	0	0	0	0	4	0	0	0	0	0	0	3
Phlox	0	0	0	0	0	0	0	0	0	0	0	0
Plantain	0	0	0	0	3	0	6	6	0	0	0	3
Poison ivy	0	0	0	0	0	0	0	0	3	0	0	0

Table B.1 (Continued)

Species	Community type											
	F1	F2	O3	O4	U5	F6A	F6B	F6C	U7	F8	F9	U10
Quackgrass	0	0	3	0	0	0	0	0	0	0	0	0
Reed canary grass	0	0	0	3	0	0	0	0	0	0	0	0
Sedge	0	0	0	0	7	0	3	3	0	0	0	7
Shagbark hickory	0/0	0/0	0/0	0/0	6/6	0/0	0/0	0/0	3/5	0/0	0/0	5/6
Silver maple	82/3	22/3	0/0	0/0	3/1	81/4	4/2	1/1	0/0	3/1	2/0	0/0
Slippery elm	1/1	1/1	0/0	0/0	1/1	1/1	0/1	1/0	0/4	2/0	0/0	1/1
Small-flowered crowfoot	0	0	0	0	0	0	0	0	0	0	0	0
Small ragweed	0	0	0	0	0	0	0	0	0	0	0	0
Smartweed	0	0	0	0	4	0	5	5	0	0	3	0
Smooth brome	0	0	0	9	0	0	0	0	0	0	0	0
Stinging nettle	6	3	0	0	0	0	0	0	0	0	0	0
Sunflower	0	0	0	0	0	0	0	0	5	0	0	0
Sweet cicely	0	0	0	0	0	0	0	0	0	0	0	0
Touch-me-not	0	0	0	0	0	0	0	0	0	3	0	0
Vervain	0	0	0	0	0	0	3	3	0	0	0	0
Violet	0	0	0	0	7	5	6	6	0	3	0	6
Virginia creeper	0	0	0	0	4	0	0	0	3	0	0	3
Virginia wild-rye	6	3	0	0	0	0	0	0	0	4	4	0
Water-leaf	0	0	0	0	0	3	0	0	0	0	0	0
Whitegrass	0	0	0	0	0	0	0	0	0	4	0	0
White mulberry	1/4	1/0	0/0	0/0	1/1	3/1	2/1	2/1	0/0	2/2	1/0	1/1
White oak	0/0	0/0	0/0	0/0	7/0	0/0	0/0	0/0	3/0	0/0	0/0	5/0
White snakeroot	0	0	0	0	3	0	0	0	3	0	0	0
Wild ginger	0	0	0	0	0	0	0	0	0	0	0	0
Wild-rye	0	0	0	0	0	0	0	0	6	0	0	0
Willow	0/1	2/1	0/0	0/0	0/1	10/1	12/1	3/0	0/0	14/3	3/0	1/1
Wood nettle	5	3	0	0	0	9	0	0	0	0	0	0
Yellow foxtail	0	0	4	0	0	0	0	0	0	0	0	0
Yellow wood-sorrel	0	0	0	4	6	0	3	3	0	0	0	4

Table B.1 (Continued)

Species	Community type											
	F11A	O11B	F12A	U12B	U12C	U12D	F13	U14A	U14B	F15	F16A	O16B
American basswood	0/0	0/0	0/0	0/0	0/3	3/3	3/1	0/0	6/3	0/0	1/0	0/0
American elm	15/8	0/24	13/5	1/31	1/1	1/6	10/14	9/41	3/14	3/4	1/2	0/0
Ash	1/3	0/0	0/4	1/1	0/23	2/21	1/1	3/23	1/14	7/3	0/1	0/0
Aster	0	0	0	0	0	0	0	0	0	0	0	0
Avens	3	3	0	0	0	0	0	0	0	0	0	0
Barnyard grass	0	0	0	0	0	0	0	0	0	0	0	0
Bedstraw	0	0	0	0	0	0	0	0	0	0	0	0
Beggar-ticks	0	0	0	0	0	0	0	0	0	0	0	0
Bitternut hickory	0/0	0/0	0/0	3/17	1/1	1/2	0/0	2/2	1/1	0/0	0/0	0/0
Black cherry	0/0	0/26	0/0	0/0	0/0	0/0	0/1	0/1	0/1	0/1	0/1	0/0
Black medick	0	0	0	0	0	0	0	0	0	0	0	0
Black snakeroot	0	0	0	0	0	0	0	0	0	3	0	0
Black walnut	6/3	0/0	3/7	0/0	2/19	2/5	14/6	8/4	1/0	5/1	2/0	0/0
Bloodroot	0	0	0	0	0	0	0	0	0	0	0	0
Boxelder	3/5	0/0	6/5	2/0	0/0	0/0	5/1	2/4	1/1	7/4	3/1	0/0
Buckbrush	0	0	0	4	4	4	6	5	5	0	0	0
Bull thistle	0	0	0	0	0	0	0	0	0	0	0	0
Bur oak	0/0	0/0	0/0	0/0	6/0	2/0	0/0	0/0	0/0	0/0	0/0	0/0
Canada bluegrass	0	0	0	0	0	0	0	0	0	0	0	0
Canada wild-rye	0	0	0	0	0	0	0	0	0	0	0	0
Clearweed	0	0	0	0	0	0	0	0	0	0	0	0
Clover	0	0	0	0	0	0	0	0	0	0	8	8
Common dandelion	0	0	0	0	0	0	0	0	0	0	5	5
Common prickly-ash	0/0	0/0	0/0	0/0	0/0	0/0	0/1	0/1	0/5	0/0	0/0	0/0
Cup-plant	4	4	0	0	0	0	0	0	0	0	0	0
Eastern cottonwood	0/0	0/0	0/0	0/0	0/0	1/0	45/0	1/0	0/0	9/1	0/0	0/0
Eastern hophornbeam	0/0	0/0	0/0	2/0	3/33	3/78	0/0	1/1	7/99	0/1	0/0	0/0
Eastern redcedar	0/0	0/0	0/0	0/0	2/25	1/3	0/2	0/0	1/1	0/0	1/1	0/0
Enchanter's nightshade	0	0	0	0	0	0	0	0	0	0	0	0
False dragonhead	0	0	0	0	0	0	0	0	0	0	0	0

Fescue	0	0	5	0	0	0	0	0	0	0	3	3
Field bindweed	4	4	0	0	0	0	0	0	0	0	0	0
Fleabane	0	0	0	0	0	0	0	0	0	0	5	5
Foxtail barley	0	0	0	0	0	0	0	0	0	0	0	0
Giant foxtail	0	0	0	0	0	0	0	0	0	0	0	0
Giant ragweed	6	6	0	0	0	0	0	0	0	0	0	0
Goldenrod	0	0	0	0	0	0	0	0	0	0	0	0
Gooseberry	0	0	0	0	0	0	3	5	5	0	0	0
Green-headed coneflower	0	0	8	0	0	0	3	0	0	0	0	0
Ground-ivy	0	0	0	0	0	0	0	0	0	0	0	0
Hackberry	0/1	0/0	9/4	2/22	0/9	0/1	1/2	3/4	1/4	0/1	1/1	0/0
Hawthorn	1/3	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Hedge-nettle	0	0	0	0	0	0	0	0	0	0	0	0
Hemp	0	0	0	0	0	0	0	0	0	0	0	0
Hog-peanut	0	0	3	4	4	4	0	3	3	0	0	0
Honewort	0	0	7	0	0	0	4	0	0	4	0	0
Honeylocust	0/2	0/4	0/0	0/0	1/0	2/1	2/5	1/0	1/0	0/0	0/1	0/0
Horse-mint	0	0	0	0	0	0	0	0	0	0	0	0
Horseweed	0	0	0	0	0	0	0	0	0	0	0	0
Ironweed	0	0	0	0	0	0	0	0	0	0	0	0
Japanese chess	0	0	0	0	0	0	0	0	0	0	4	4
Kentucky bluegrass	0	0	0	0	0	0	0	0	0	0	6	6
Lambsquarters	0	0	0	0	0	0	0	0	0	0	0	0
Little barley	0	0	0	0	0	0	0	0	0	0	0	0
Milkweed	0	0	0	0	0	0	0	0	0	0	0	0
Moneywort	0	0	0	0	0	0	0	0	0	0	0	0
Moss	0	0	5	4	4	4	0	5	5	0	3	3
Muhly	0	0	0	0	0	0	4	0	0	0	0	0
Nodding thistle	0	0	0	0	0	0	0	0	0	0	0	0
Northern red oak	0/0	0/0	0/0	0/0	0/15	12/8	0/0	8/1	9/2	0/0	0/0	0/0
Ohio buckeye	0/0	0/0	2/8	4/7	6/15	2/5	0/0	1/5	1/3	0/0	1/1	0/0
Orchard grass	0	0	0	0	0	0	0	0	0	0	3	3
Panicum	0	0	0	0	0	0	0	0	0	0	0	0
Pennsylvania sedge	0	0	0	5	5	5	0	5	5	0	0	0
Phlox	0	0	0	0	0	0	0	0	0	0	0	0
Plantain	0	0	0	0	0	0	0	0	0	0	4	4
Poison ivy	0	0	0	0	0	0	0	0	0	0	0	0

Table B.1 (Continued)

Species	Community type											
	F11A	O11B	F12A	U12B	U12C	U12D	F13	U14A	U14B	F15	F16A	O16B
Quackgrass	0	0	0	0	0	0	0	0	0	0	0	0
Reed canary grass	0	0	0	0	0	0	0	0	0	0	0	0
Sedge	0	0	4	0	0	0	0	4	4	0	0	0
Shagbark hickory	0/0	0/0	0/0	0/0	0/0	3/10	0/0	1/4	9/11	0/0	1/0	0/0
Silver maple	1/2	0/1	4/4	0/0	0/0	0/0	21/4	1/0	1/0	99/5	0/1	0/0
Slippery elm	0/0	0/0	0/0	1/17	1/24	0/4	0/0	1/1	1/6	3/1	1/1	0/0
Small-flowered crowfoot	0	0	5	0	0	0	0	0	0	0	0	0
Small ragweed	0	0	0	0	0	0	0	0	0	0	3	3
Smartweed	0	0	0	0	0	0	0	0	0	0	0	0
Smooth brome	0	0	0	0	0	0	0	0	0	0	0	0
Stinging nettle	0	0	3	0	0	0	0	0	0	0	0	0
Sunflower	5	5	0	0	0	0	0	0	0	0	0	0
Sweet cicely	0	0	0	0	0	0	0	0	0	0	0	0
Touch-me-not	0	0	0	0	0	0	0	0	0	4	0	0
Vervain	0	0	0	0	0	0	0	0	0	0	0	0
Violet	5	5	0	0	0	0	0	5	5	0	0	0
Virginia creeper	0	0	0	5	5	5	0	6	6	0	0	0
Virginia wild-rye	3	3	0	0	0	0	0	0	0	0	0	0
Water-leaf	0	0	0	0	0	0	0	0	0	0	0	0
Whitegrass	0	0	0	0	0	0	0	0	0	0	0	0
White mulberry	3/2	0/5	2/4	0/0	0/0	0/0	0/2	3/1	0/0	2/4	0/0	0/0
White oak	0/0	0/0	0/0	0/0	0/0	23/0	0/0	9/0	49/0	0/0	2/0	0/0
White snakeroot	0	0	0	0	0	0	0	0	0	0	0	0
Wild ginger	0	0	0	0	0	0	0	0	0	0	0	0
Wild-rye	0	0	0	0	0	0	0	0	0	0	0	0
Willow	21/0	0/0	2/7	0/0	0/0	0/0	11/4	0/0	0/0	5/0	0/1	0/0
Wood nettle	0	0	8	0	0	0	3	0	0	9	0	0
Yellow foxtail	0	0	0	0	0	0	0	0	0	0	0	0
Yellow wood-sorrel	0	0	0	0	0	0	0	0	0	0	4	4

Table B.1 (Continued)

Species	Community type											
	U17A	U17B	F18A	F18B	F19A	O19B	F20	O21A	O21B	F22A	F22B	F22C
American basswood	30/1	7/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
American elm	1/4	1/1	0/0	1/15	0/0	0/0	2/2	0/0	0/0	1/3	1/6	4/7
Ash	9/5	4/1	0/0	8/6	0/0	0/0	7/1	0/0	0/0	9/2	1/6	9/4
Aster	0	0	0	0	0	0	0	0	0	0	0	0
Avens	0	0	0	5	0	0	0	0	0	0	0	0
Barnyard grass	0	0	0	0	0	0	0	0	0	0	0	0
Bedstraw	3	0	0	0	0	0	0	0	0	0	0	0
Beggar-ticks	0	0	0	0	0	0	0	0	0	0	5	0
Bitternut hickory	10/4	1/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Black cherry	0/4	0/1	0/0	0/0	0/0	0/0	0/1	0/0	0/0	0/0	0/0	0/0
Black medick	0	3	0	0	0	0	0	0	0	0	0	0
Black snakeroot	3	0	0	7	0	0	0	0	0	0	0	0
Black walnut	1/0	1/1	2/0	9/7	0/0	0/0	2/1	0/0	0/0	42/0	0/0	6/2
Bloodroot	4	0	0	0	0	0	0	0	0	0	0	0
Boxelder	1/1	0/0	5/0	13/10	0/0	0/0	15/1	0/0	0/0	0/3	1/0	12/5
Buckbrush	4	6	0	0	0	0	0	0	0	3	0	3
Bull thistle	0	0	0	0	0	0	0	0	0	0	0	0
Bur oak	0/0	1/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Canada bluegrass	0	0	0	0	0	0	0	0	0	0	0	0
Canada wild-rye	0	0	3	0	0	0	0	0	0	0	0	0
Clearweed	0	0	0	0	0	0	0	0	0	0	5	0
Clover	0	5	0	0	0	0	0	0	0	0	0	0
Common dandelion	0	3	0	0	0	0	0	0	0	0	0	0
Common prickly-ash	0/0	0/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Cup-plant	0	0	0	0	0	0	0	0	0	0	0	0
Eastern cottonwood	0/0	0/0	0/0	17/0	1/1	0/0	1/1	0/1	0/0	0/0	0/0	0/0
Eastern hophornbeam	7/22	1/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Eastern redcedar	0/1	2/3	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Enchanter's nightshade	0	0	0	0	0	0	0	0	0	0	0	0
False dragonhead	0	0	0	0	0	0	0	0	0	0	3	0

Fescue	0	0	0	0	0	0	0	0	0	0	0	0
Field bindweed	0	0	7	0	0	0	0	0	0	0	0	0
Fleabane	0	0	0	0	0	0	0	0	0	0	0	0
Foxtail barley	0	0	0	0	0	0	0	0	0	0	0	0
Giant foxtail	0	0	0	0	0	0	0	3	3	0	0	0
Giant ragweed	0	0	5	0	0	0	9	9	9	6	0	6
Goldenrod	0	0	3	0	0	0	3	0	0	0	0	0
Gooseberry	0	0	0	0	0	0	0	0	0	0	0	0
Green-headed coneflower	0	0	3	0	0	0	4	0	0	0	0	0
Ground-ivy	0	0	0	0	0	0	0	0	0	0	0	0
Hackberry	0/3	0/0	5/0	3/12	0/0	0/0	0/0	0/0	0/0	1/1	0/0	3/2
Hawthorn	0/0	1/1	0/0	0/0	0/0	0/0	0/1	0/0	0/0	0/1	0/0	1/3
Hedge-nettle	0	0	4	0	0	0	0	0	0	0	0	0
Hemp	0	0	0	0	0	0	0	0	0	0	0	0
Hog-peanut	5	0	0	0	0	0	0	0	0	3	0	3
Honewort	0	0	0	8	0	0	4	0	0	6	0	6
Honeylocust	0/0	0/0	0/0	0/0	0/1	0/0	8/1	0/0	0/0	9/9	0/0	4/1
Horse-mint	0	0	0	0	0	0	0	0	0	0	0	0
Horseweed	0	0	0	0	0	0	0	0	0	0	0	0
Ironweed	0	0	0	0	0	0	0	0	0	0	0	0
Japanese chess	0	0	0	0	0	0	0	0	0	0	0	0
Kentucky bluegrass	0	6	0	0	0	0	0	0	0	0	0	0
Lambsquarters	0	0	0	0	0	0	0	3	3	0	0	0
Little barley	0	0	0	0	0	0	0	0	0	0	0	0
Milkweed	0	0	0	0	0	0	0	0	0	0	0	0
Moneywort	0	0	0	0	0	0	3	0	0	0	3	0
Moss	5	5	0	0	0	0	0	0	0	0	0	0
Muhly	0	3	0	0	0	0	0	0	0	0	0	0
Nodding thistle	0	0	0	0	0	0	0	0	0	0	0	0
Northern red oak	30/4	8/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Ohio buckeye	8/15	1/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Orchard grass	0	0	0	0	0	0	0	0	0	0	0	0
Panicum	0	0	0	0	0	0	0	0	0	0	0	0
Pennsylvania sedge	5	3	0	0	0	0	0	0	0	0	0	0
Phlox	4	0	0	0	0	0	0	0	0	0	0	0
Plantain	0	5	0	0	0	0	0	0	0	0	0	0
Poison ivy	3	0	0	0	0	0	0	0	0	0	0	0

Table B.1 (Continued)

Species	Community type											
	U17A	U17B	F18A	F18B	F19A	O19B	F20	O21A	O21B	F22A	F22B	F22C
Quackgrass	0	0	0	0	0	0	0	0	0	0	0	0
Reed canary grass	0	0	0	0	9	9	0	0	0	0	0	0
Sedge	4	7	0	0	0	0	0	0	0	0	0	0
Shagbark hickory	1/2	4/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Silver maple	0/0	0/0	11/0	7/24	1/1	0/0	6/1	0/0	0/0	0/0	66/8	30/5
Slippery elm	1/1	2/1	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/1	0/0	0/0
Small-flowered crowfoot	0	0	0	0	0	0	0	0	0	0	0	0
Small ragweed	0	3	0	0	0	0	0	0	0	0	0	0
Smartweed	0	0	0	4	0	0	0	0	0	0	7	0
Smooth brome	0	0	0	0	4	4	0	0	0	0	0	0
Stinging nettle	0	0	0	0	0	0	0	0	0	0	0	0
Sunflower	0	0	0	0	0	0	0	0	0	0	0	0
Sweet cicely	3	0	0	0	0	0	0	0	0	0	0	0
Touch-me-not	0	0	0	0	0	0	0	0	0	0	0	0
Vervain	0	0	0	0	0	0	0	0	0	0	0	0
Violet	6	6	0	3	0	0	6	0	0	6	0	6
Virginia creeper	3	0	0	0	0	0	0	0	0	0	0	0
Virginia wild-rye	0	0	5	0	0	0	3	0	0	5	0	5
Water-leaf	0	0	0	0	0	0	0	0	0	0	0	0
Whitegrass	0	0	0	4	0	0	6	0	0	0	3	0
White mulberry	0/1	1/1	0/0	0/2	1/0	0/0	1/1	0/0	0/0	1/3	0/0	2/4
White oak	25/0	12/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
White snakeroot	0	0	0	0	0	0	0	0	0	0	0	0
Wild ginger	3	0	0	0	0	0	0	0	0	0	0	0
Wild-rye	0	0	0	0	0	0	0	0	0	0	0	0
Willow	0/0	0/0	0/0	0/0	1/1	0/0	6/2	0/31	0/0	1/1	0/1	2/3
Wood nettle	0	0	3	6	0	0	0	0	0	4	0	4
Yellow foxtail	0	0	0	0	0	0	0	0	0	0	0	0
Yellow wood-sorrel	0	5	5	0	0	0	0	0	0	0	0	0

Table B.1 (Continued)

Species	Community type										
	O23A	U23B	U24	U25A	U25B	F26A	O26B	O27A	O27B	F28A	U28B
American basswood	0/0	4/0	0/0	2/1	0/0	0/0	0/0	0/0	0/0	0/10	18/6
American elm	0/0	2/1	2/3	1/8	1/4	0/1	0/0	0/0	0/0	7/28	1/4
Ash	0/0	0/0	1/1	2/4	2/1	0/2	0/0	0/0	0/0	5/0	7/7
Aster	0	0	0	0	0	0	0	0	0	4	4
Avens	0	0	4	3	3	0	0	0	0	0	0
Barnyard grass	4	4	0	0	0	0	0	0	0	0	0
Bedstraw	0	0	0	0	0	0	0	0	0	3	3
Beggar-ticks	0	0	0	0	0	0	0	0	0	0	0
Bitternut hickory	0/0	2/0	1/1	1/1	1/0	0/0	0/0	0/0	0/0	0/5	7/6
Black cherry	0/0	0/0	0/1	0/1	0/0	0/0	0/0	0/0	0/0	0/0	0/1
Black medick	0	0	0	0	0	0	0	0	0	0	0
Black snakeroot	0	0	0	0	0	0	0	0	0	4	4
Black walnut	0/0	9/0	4/1	5/1	0/0	0/0	0/0	0/0	0/0	2/0	1/2
Bloodroot	0	0	0	0	0	0	0	0	0	0	0
Boxelder	0/0	0/0	0/0	1/1	0/0	1/6	0/0	0/0	0/0	0/2	0/1
Buckbrush	0	0	7	7	7	0	0	0	0	0	0
Bull thistle	0	0	0	0	0	0	0	0	0	0	0
Bur oak	0/0	2/0	8/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	1/0
Canada bluegrass	3	3	0	0	0	0	0	0	0	0	0
Canada wild-rye	0	0	0	0	0	0	0	0	0	0	0
Clearweed	0	0	0	0	0	0	0	0	0	0	0
Clover	4	4	4	0	0	0	0	0	0	0	0
Common dandelion	5	5	4	5	5	0	0	0	0	0	0
Common prickly-ash	0/0	0/2	0/1	0/1	0/0	0/0	0/0	0/0	0/0	0/0	0/1
Cup-plant	0	0	0	0	0	0	0	0	0	0	0
Eastern cottonwood	0/0	0/0	3/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0
Eastern hophornbeam	0/0	1/0	0/0	1/4	1/1	0/0	0/0	0/0	0/0	2/0	7/65
Eastern redcedar	0/0	0/0	0/1	1/11	2/5	0/0	0/0	0/0	0/0	0/0	1/0
Enchanter's nightshade	0	0	0	0	0	0	0	0	0	0	0
False dragonhead	0	0	0	0	0	0	0	0	0	0	0

Fescue	0	0	0	0	0	0	0	0	0	0	0
Field bindweed	0	0	0	0	0	6	0	3	0	0	0
Fleabane	0	0	0	0	0	0	0	0	0	0	0
Foxtail barley	0	0	0	0	0	0	0	0	0	0	0
Giant foxtail	0	0	0	0	0	0	3	0	9	0	0
Giant ragweed	0	0	0	0	0	0	9	6	0	0	0
Goldenrod	0	0	0	0	0	0	0	0	0	0	0
Gooseberry	0	0	0	0	0	0	0	0	0	0	0
Green-headed coneflower	0	0	0	0	0	0	0	0	0	0	0
Ground-ivy	0	0	0	0	0	0	0	0	0	0	0
Hackberry	0/0	3/1	1/1	1/1	0/1	0/0	0/0	0/0	0/0	7/0	1/2
Hawthorn	0/0	1/5	1/7	0/1	1/0	0/0	0/0	0/0	0/0	0/0	0/0
Hedge-nettle	0	0	0	0	0	0	0	0	0	0	0
Hemp	0	0	0	0	0	0	0	7	0	0	0
Hog-peanut	0	0	0	0	0	0	0	0	0	6	6
Honewort	0	0	0	0	0	0	0	0	0	0	0
Honeylocust	0/0	0/0	0/1	4/7	1/5	0/0	0/0	0/0	0/0	0/0	0/0
Horse-mint	0	0	0	4	4	0	0	0	0	0	0
Horseweed	0	0	0	0	0	0	0	0	0	0	0
Ironweed	3	3	3	3	3	0	0	0	0	0	0
Japanese chess	0	0	0	4	4	0	0	0	0	0	0
Kentucky bluegrass	6	6	6	7	7	0	0	3	0	0	0
Lambsquarters	0	0	0	0	0	0	3	0	0	0	0
Little barley	0	0	0	0	0	0	0	0	0	0	0
Milkweed	0	0	0	0	0	0	0	0	0	0	0
Moneywort	0	0	0	0	0	0	0	0	0	0	0
Moss	0	0	0	3	3	0	0	0	0	4	4
Muhly	4	4	6	3	3	0	0	5	0	0	0
Nodding thistle	3	3	0	0	0	0	0	0	0	0	0
Northern red oak	0/0	8/0	2/1	0/0	2/0	0/0	0/0	0/0	0/0	0/6	23/2
Ohio buckeye	0/0	1/0	0/0	0/0	0/0	0/0	0/0	0/0	0/0	11/7	1/3
Orchard grass	0	0	0	0	0	0	0	0	0	0	0
Panicum	0	0	0	3	3	0	0	0	0	0	0
Pennsylvania sedge	0	0	0	0	0	0	0	0	0	5	5
Phlox	0	0	0	0	0	0	0	0	0	0	0
Plantain	3	3	5	6	6	0	0	0	0	0	0
Poison ivy	0	0	0	0	0	0	0	0	0	0	0

Table B.1 (Continued)

Species	Community type										
	O23A	U23B	U24	U25A	U25B	F26A	O26B	O27A	O27B	F28A	U28B
Quackgrass	0	0	0	0	0	0	0	0	0	0	0
Reed canary grass	0	0	0	0	0	6	0	0	0	0	0
Sedge	4	4	5	5	5	0	0	0	0	0	0
Shagbark hickory	0/0	0/0	4/1	1/1	0/0	0/0	0/0	0/0	0/0	0/0	4/8
Silver maple	0/0	0/0	1/0	1/0	0/0	5/10	0/0	0/0	0/0	0/0	0/0
Slippery elm	0/0	1/0	1/0	1/1	1/5	0/0	0/0	0/0	0/0	4/2	1/1
Small-flowered crowfoot	0	0	0	0	0	0	0	0	0	0	0
Small ragweed	0	0	0	5	5	0	0	0	0	0	0
Smartweed	6	6	3	0	0	0	0	0	0	0	0
Smooth brome	0	0	0	0	0	0	0	0	0	0	0
Stinging nettle	0	0	0	0	0	4	0	0	0	0	0
Sunflower	0	0	0	0	0	3	0	0	0	0	0
Sweet cicely	0	0	0	0	0	0	0	0	0	0	0
Touch-me-not	0	0	0	0	0	0	0	0	0	0	0
Vervain	0	0	0	0	0	0	0	0	0	0	0
Violet	5	5	5	4	4	0	0	0	0	3	3
Virginia creeper	0	0	3	0	0	0	0	0	0	6	6
Virginia wild-rye	0	0	0	0	0	5	0	7	0	0	0
Water-leaf	0	0	0	0	0	0	0	0	0	0	0
Whitegrass	0	0	0	0	0	0	0	0	0	0	0
White mulberry	0/0	0/1	1/1	1/2	0/1	0/1	0/0	0/0	0/0	2/14	1/0
White oak	0/0	1/0	0/0	7/0	10/0	0/0	0/0	0/0	0/0	0/0	23/0
White snakeroot	0	0	0	0	0	0	0	0	0	0	0
Wild ginger	0	0	0	0	0	0	0	0	0	0	0
Wild-rye	0	0	0	0	0	0	0	0	0	0	0
Willow	0/0	0/0	0/0	2/0	0/0	0/1	0/0	0/0	0/0	1/0	0/0
Wood nettle	0	0	0	0	0	0	0	0	0	0	0
Yellow foxtail	0	0	0	0	0	0	0	3	0	0	0
Yellow wood-sorrel	5	5	4	3	3	0	0	0	0	0	0