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# CURRENT VEGETATION CHARACTERISTICS WITHIN TREE-KILL ZONES OF F- AND H-AREAS (U)

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Current Vegetation Characteristics Within Tree-Kill Zones of F- and H-Areas (U)

by

Eric A. Nelson and Julie E. Irwin

## INTRODUCTION

Vegetation of two wetland areas previously adversely affected by outcropping groundwater was characterized to evaluate the type and extent of revegetation. When the damage first became evident in the late 1970's and early 1980's the areas were examined and described to try to establish the cause of the extensive tree mortality (Loehle and Gladden, 1988; Mackey, 1988; Haselow et al., 1990; LeBlanc and Loehle, 1990; Greenwood et al., 1990). The F- and H-Area seepage basins above the wetland areas received waste products from the separation areas beginning in 1955. The operation, estimated loading, and current status of the basins were summarized by Killian et al. (1987a, 1987b). Analysis of soil and water at the affected seeplines where the tree-kill was occurring confirmed that the surface water was strongly influenced by constituents of the F- and H-Area seepage basins (Looney et al., 1988). While no single cause of the forest mortality was defined, alterations in the hydrology and siltation patterns, pH changes, increased conductivity, and increased levels of sodium, nitrogen compounds, and aluminum, were believed to be interacting to cause the mortality.

The results of subsequent sampling (Dixon and Rogers, 1993) have shown that the contamination at the seeplines from the basins has begun to subside as the plume moves into the wetlands and down gradient towards Fourmile Branch. This vegetation evaluation was undertaken to assess the recovery, if any, that has taken place since the initial damage.

## STUDY AREAS AND METHODS

The two areas examined in 1993 were the most severely affected ones in F- and H-Areas (Figure 1). These areas are among those previously described and sampled in the 1980's. Prior to damage the sites were pure swamp tupelo (*Nyssa sylvatica* var. *biflora*) stands. All mature individuals were killed by the stress that occurred in the wetland areas. No overstory, other than a few widely scattered individuals, remained in either location.

A series of vegetation characterization plots was installed to quantify the recovery. These plots were circular milacre plots (43.56 sq. ft/plot, 4.05 sq. m/plot) installed at uniform intervals along transects in the two areas. The F-Area sampling was done along four transects that crossed the area (Figure 2) and the H-Area sampling was along a single transect through the center of the area extending the length of the tree-kill area (Figure 3). The transects were placed to best characterize the variation present in the areas based on preliminary visual assessments.

Forty plots were installed in the F-Area location and 56 plots were installed in the H-Area location. Within each plot, all individuals were identified to species, where possible. Taxonomic nomenclature followed Radford et al. (1968). Sampling took place in August and September 1993. For each plot the height of the tree and shrub seedlings, the number of stems of the vines, and the percent cover of the herbs were recorded on data sheets. Unless otherwise indicated, the terms "tree" and "shrub" throughout this report refer to tree and shrub seedlings, generally only one or two years old and quite small. Plot data were summarized to indicate qualitative and quantitative information about the current status of the two tree-kill areas sampled. The two sampling areas were considerably different and will be discussed separately.

## F-AREA LOCATION

The substrate within the F-Area tree-kill area consists of thick, flocculent, deep, muck with water flowing through it and algae growing on top of it. Vegetation within the F-Area tree-kill area is sparse. The canopy has been almost totally destroyed; only a few live trees remain. Some standing dead trunks and many fallen trunks are scattered throughout the area. Most of the existing understory vegetation is growing in widely scattered clumps on stumps, fallen logs, and accumulated debris. An occasional herbaceous wetland plant was noted growing in the muck near the upland edge of the tree-kill area.

## F-AREA SAMPLING RESULTS

Twenty six species were encountered in sampling (Table 1). Of the 40 plots sampled, seven (17.5%) were totally devoid of vegetation. Transect 1, closest to the source of the groundwater discharge and farthest from the surrounding forest, contained the least number of species (11), 4 (36%) of which were ground cover. Transect 1 also contained the least number of individuals in all strata (Table 2). Transects 2, 3 and 4 contained approximately the same number of species each (Table 2). Transect 4, which is closest to the adjacent forest and Fourmile Branch, contained the highest number of tree seedlings (69 individuals versus 22 or less in each of the other transects).

Canopy Stratum: Live canopy-height trees occurred in only two plots (7.5%)—one swamp tupelo (*Nyssa sylvatica* var. *biflora)* in each. Both live trees showed signs of stress including adventitious leaves tightly clustered on the trunks and a scarcity of limbs. No other species were present in the canopy. Two standing dead canopy-sized swamp tupelo individuals were also encountered in sampling.

Understory Stratum: All individuals in the understory stratum were growing on stumps, fallen logs, or clumps of debris. Tree seedlings occurred in 65% of the plots and shrub seedlings occurred in 20%. Tree seedlings were more numerous than shrub seedlings (Fig 4). Seven species of tree seedlings and four species of shrub seedlings were encountered in sampling (Table 1). Data by plot for the tree and shrub seedlings and the vine stems are included in Table 3 and illustrated in Figure 5.

The most abundant tree seedlings were red maple (42%) and pine (25%). It is not surprising that red maple and pine were the most abundant species. Mature individuals of both species were present in the adjacent forest to provide a seed source; and the fruits of both (samaras) are wind dispersed. They are early successional species able to invade, germinate, and grow rapidly under disturbed habitat conditions of high light intensity and poor substrate.

Only 12.7% of the tree seedlings were swamp tupelo (*Nyssa sylvatica* var. *biflora*) which was probably the dominant canopy species prior to canopy destruction. The low numbers of swamp tupelo seedlings indicate that the former canopy dominant is not currently re-establishing in the impacted area. The swamp tupelo fruits (drupes), being heavy, are not wind dispersed. If they fall on soil, they tend to stay where they land. If they fall into water, they float with the current. Given the scattered nature of above-water substrate in the tree-kill area, the chances of a swamp tupelo drupe's landing on or floating onto a substrate suitable for germination are limited. Therefore, the low number of swamp tupelo seedlings is to be expected.

That none of the shrubs is wind dispersed probably accounts for their low numbers. Virginia-willow (*Itea virginica*), a shrub normally found in swamps, wet woodlands, and along wooded streams, was the most abundant shrub seedling. It made up 40 % of the shrub population but occurred in only 5% of the plots.

All tree and shrub seedlings were fairly small. Mean height of tree seedlings was 23.2 cm. Mean height of shrub seedlings was 48.6 cm. Only 2 rather chlorotic individuals were taller than 100 cm—inkberry (*Ilex glabra*, a shrub) and sweet bay (*Magnolia virginiana*, a tree), at 110 cm each. All individuals showed evidence of stress: chlorotic leaves, stunted growth, and a lack of visible vigor normally associated with the seedling growth stage. The combination of poor substrate and the evidence of stress indicates that the current crop of seedlings is unlikely to survive to maturity to reforest the area.

Vines: Vines occurred in 25% of the plots sampled. Six species, including 3 species of greenbrier (*Smilax)*, were encountered in sampling (Table 1). Most of them were seedlings and quite small. All were growing above the substrate on stumps, fallen logs, or debris.

Groundcover Stratum: Ground-cover species were widely distributed, but sparse. They occurred in 80% of the plots sampled, but covered only 7.29% of the area. Grasses accounted for 98.4% of the vegetation cover. Nine ground-cover species (4 forbs, 3 grasses, one fern, and one moss) were encountered in sampling (Table 1). At least one species of grass occurred in each plot that contained ground cover vegetation. Forbs occurred 10% of the plots. One individual (*Peltandra virginica*, a forb) was growing in the substrate; all others were growing above the substrate on stumps, fallen logs, or piles of debris.

## H-AREA LOCATION

Soil in the H-Area tree-kill zone was much more consolidated than the soil in the F-Area site. Much of the area had standing water at the surface. Depth increased as the plot number increased along the transect. Very few canopy trees were still alive. Some standing dead trees were evident and many logs were on the ground throughout the area.

## H-AREA SAMPLING RESULTS

A total of 40 species were identified in the H-Area sampling location (Table 4). The affected area had two distinct characterizations. Plots 1 through 15 were less wet and showed evidence of revegetation by woody species. The plots were clearly impacted by the prior seep, but were recovering much faster than plots 16 through 56. Plots 16 through 56 were much wetter and dominated by cattails (*Typha* sp.) and cut grass (*Leersia oryzoides*).

Canopy Stratum: Only one live mature tree, a swamp tupelo (*Nyssa sylvatica* var. *biflora*), was encountered within the plots. Evidence of the former mature stand was present throughout the sampling area in the form of snags and logs.

Understory Stratum: Vegetation characteristic of this stratum occurred only in the first 15 plots (Table 5, Figure 6). The shrub species were much more numerous than were the tree species (128 individuals vs. 19 individuals). Of the tree seedlings encountered, red maple (*Acer rubrum*) was dominant (47.4%), followed by pine (*Pinus* sp.) and swamp tupelo (21% each). The remainder consisted of one tulip tree (*Liriodendron* *tulipifera*) and one sweetgum (*Liquidambar styraciflua*). The shrub species were dominated by red bay (*Persea borbonia*) (62.5%), followed by wax myrtle (*Myrica cerifera*) (14.1%), blackberry (*Rubus* sp.) (10.9%), and sea-myrtle (*Baccharis halimifolia*) (7.8%). The remaining four species encountered made up the remaining 4.7%.

The quantity and diversity of individuals encountered in the first 15 plots is indicative of the drier nature of this section which has allowed seeds to germinate and establish themselves on the soil. This tree-kill zone is narrow along the entire transect with ample seed sources on either side of it for seed production and dispersal. Many of the species present are early successional and would be the ones expected to recolonize disturbed areas.

In the first 15 plots, the general health of the shrub and tree seedlings was better than observed in the F-Area kill-zone. While all individuals of the tree species were small, averaging less than 30 cm, they appeared healthy. Lack of size was probably attributable to their age, most being only 1 or 2 years old. The shrub species were generally large and vigorous. Many species averaged over one meter in height. The largest individuals encountered, especially the red bay and wax myrtle, were often over 3 meters tall.

Vines: Species categorized as vines were identified in nearly half of the plots (48%) in the H-Area kill zone. They occurred in the first 15 plots along with the shrub and tree seedling component. The remaining plots that contained vines typically had a large log through them. This provided an elevated surface and localized disturbance of the cattail and cut grass component of the plots (e.g. plots 41-43) and allowed vines to establish.

*Smilax* sp. and *Mikania scandens* were the most common vine species encountered and made up 75% of the stems counted.

Groundcover Stratum: Herbaceous species occurred in all plots in the H-Area sampling. A total of 20 species of forbs, grasses and ferns were identified (Table 4). The average number of species occurring within the plot was greater for plots 1 through 15 (8.0 per plot) than for the remaining plots (4.4 per plot). Many of the herbaceous species occurred only in the first 15 plots (Table 6). Beginning with plot 16, *Leersia* and *Typha* began to dominate the plots. This plot was the point at which the water became slightly deeper and the soil slightly less consolidated. *Leersia* was more dominant than *Typha* on the exterior two or three plots (16, 17 and 52, 53, 54). These plots were probably a transition between the different hydrological environments. Plots 18 through 51 were dominated by *Typha* with a smaller component of *Leersia* (Figure 7). Reduced percent cover (such as in plot 43) was due to log debris in the plot.

## COMPARISON WITH ADJACENT FOREST

The sparse vegetation of the F- and H-Area tree-kill areas is in stark contrast to the adjacent forest. The species composition is similar, but the structure is very different. The tree-kill areas are not stratified as a relatively undisturbed forest would be. The species normally associated with canopy, subcanopy, and shrub layer are present in the F-Area, but as sickly seedlings perched above the substrate on stumps, logs, and piles of debris. None of the current species are capable of surviving continuous deep flooding that is typical of these areas. Therefore, without the stumps, logs, and debris the vegetation could not exist. The adjacent forest, however, is characterized by a closed canopy of mature mixed hardwoods and loblolly pines (*Pinus taeda*). The subcanopy and shrub layers are intact and well defined; and the plants are growing on a consolidated soil more characteristic of these wetland areas.

The composition of the first 15 plots of the H-Area tree-kill area indicates that this section is beginning to re-establish itself as a bottomland hardwood forest. Many years will be needed to allow the canopy to form and begin to layer itself into a self-perpetuating forest. The hydrology of the remainder of the H-Area tree-kill area and the lack of tree and shrub individuals indicate that this area is not currently suitable for natural regeneration of the bottomland hardwood forest.

## SUMMARY

This vegetation characterization of the F- and H-Area tree-kill zones is the first description of the recovery of these areas. With the exception of a small portion of the H-Area location, very little recovery has occurred. Indications are that the areas are not returning to their prior condition. Vegetation in the F-Area still shows signs of continuing stress. Vegetation in most of the H-Area is herbaceous and of the persistent emergent classification. This may be a successional stage which will later lead to a woody plant community, but the duration of this phase is unknown. An effort to quantify the current soil and water characteristics may be able to define some of the lingering problems of vegetation invasion into these wetland areas.

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Table 1. F-Area tree-kill area plant species by strata, August 1993.

| | |
|---|---|
| TREE STRATUM | |
| Mature Trees | |
| *Nyssa sylvatica* var. *biflora* | swamp tupelo |
| SEEDLING STRATUM | |
| Tree Seedlings | |
| *Acer rubrum* | red maple |
| *Ilex opaca* | American holly |
| *Liquidambar styraciflua* | sweetgum |
| *Liriodendron tulipifera* | tulip tree |
| *Magnolia virginiana* | sweet bay |
| *Nyssa sylvatica* var. *biflora* | swamp tupelo |
| *Pinus* sp. | pine |
| Shrub Seedlings | |
| *Ilex glabra* | ink-berry |
| *Itea virginica* | Virginia-willow |
| *Myrica cerifera* | wax myrtle |
| *Rubus* sp. | blackberry |
| VINE STRATUM | |
| *Gelsimium sempervirens* | yellow Jessamine |
| *Parthenocissus quinquefolia* | Virginia creeper |
| *Smilax laurifolia* | laurel-leaf greenbrier |
| *Smilax glauca* | cat-brier |
| *Smilax walteri* | coral greenbrier |
| *Vitis rotundifolia* | muscadine |
| GROUNDCOVER STRATUM | |
| Forbs | |
| *Boehmeria cylindrica* | false nettle |
| *Eupatorium capillifolium* | dog-fennel |
| *Peltandra virginica* | arrow arum |
| *Hypericum walteri* | St. Johns wort |
| Grasses | |
| *Andropogon virginicus* | broomsedge |
| *Arundinaria gigantea* | giant cane |
| Unknown grass | |
| Ferns | |
| *Woodwardia areolata* | netted chain fern |
| Moss | |
| *Sphagnum* sp. | sphagnum |

Table 2. Number of plant species and number of tree, shrub, and vine individuals in each transect of F-Area.

| | Transect 1 | Transect 2 | Transect 3 | Transect 4 | TOTAL |
|---|---|---|---|---|---|
| Total # species | 11 | 16 | 14 | 15 | 26 |
| # Tree seedlings | 16 | 19 | 22 | 69 | 126 |
| # Shrub seedlings | 1 | 6 | 9 | 6 | 22 |
| # Vine stems | 4 | 7 | 7 | 9 | 27 |

Table 3. Number of tree seedlings, shrub seedlings, and vines per plot in each transect of F-Area.

| | PLOT# | Tree Seedlings | Shrub Seedlings | Vines |
|---|---|---|---|---|
| TRANSECT 1 | 1 | | | |
| | 2 | | | |
| | 3 | | | |
| | 4 | 4 | | |
| | 5 | | | |
| | 6 | | | |
| | 7 | 8 | 1 | 4 |
| | 8 | | | |
| | 9 | | | |
| | 10 | 1 | | |
| | 11 | 3 | | |
| TRANSECT 2 | 1 | 5 | 5 | 5 |
| | 2 | | | |
| | 3 | 1 | | 1 |
| | 4 | 6 | | |
| | 5 | 5 | | |
| | 6 | 1 | | |
| | 7 | | | |
| | 8 | | | |
| | 9 | 1 | 1 | 1 |
| TRANSECT 3 | 1 | 7 | 3 | 4 |
| | 2 | 3 | 6 | |
| | 3 | 2 | | |
| | 4 | 4 | | |
| | 5 | | | |
| | 6 | | | |
| | 7 | | | |
| | 8 | 3 | | 3 |
| | 9 | | | |
| | 10 | 3 | | |
| TRANSECT 4 | 1 | 2 | | 1 |
| | 2 | 13 | 1 | 2 |
| | 3 | 23 | | 4 |
| | 4 | 4 | 4 | |
| | 5 | 2 | | |
| | 6 | 3 | | |
| | 7 | 9 | 1 | |
| | 8 | 6 | | |
| | 9 | 1 | | |
| | 10 | 6 | | 2 |
| **TOTAL ALL PLOTS** | | **126** | **22** | **27** |

Table 4 H-Area tree-kill area plant species by strata, September 1993.

| | |
|---|---|
| **TREE STRATUM** | |
| Mature Trees | |
| *Nyssa sylvatica* var. *biflora* | swamp tupelo |
| **SEEDLING STRATUM** | |
| Tree Seedlings | |
| *Acer rubrum* | red maple |
| *Ilex opaca* | American holly |
| *Liquidambar styraciflua* | sweetgum |
| *Lirodendron tulipifera* | tulip tree |
| *Nyssa sylvatica* var. *biflora* | swamp tupelo |
| *Pinus* sp. | pine |
| Shrub Seedlings | |
| *Baccharis halimifolia* | sea-myrtle |
| *Callicarpa americana* | French mulberry |
| *Cephalanthus occidentalis* | button bush |
| *Ligustrum* sp. | privet |
| *Myrica cerifera* | wax myrtle |
| *Persea borbonia* | red bay |
| *Rubus* sp. | blackberry |
| **VINE STRATUM** | |
| *Berchemia scandens* | rattan vine |
| *Gelsemium sempervirens* | yellow jessamine |
| *Lonicera* sp. | honeysuckle |
| *Mikania scandens* | climbing hempweed |
| *Rhus radicans* | poison ivy |
| *Smilax glauca* | catbrier |
| *Smilax laurifolia* | laurel-leaf greenbrier |
| **GROUNDCOVER STRATUM** | |
| Forbs | |
| *Aneilema keisak* | |
| *Boehmeria cylindrica* | false nettle |
| *Hydrocotyle* sp. | water pennywort |
| *Hypericum walteri* | St. John's wort |
| *Ludwigia leptocarpa* | ludwigia |
| *Lycopus virginicus* | water-hoarhound |
| *Peltandra virginica* | arrow arum |
| *Pluchea camphorata* | marsh-fleabane |
| *Tillandsia usneoides* | Spanish-moss |
| *Typha* sp. | cattail |
| Grasses | |
| *Andropogon virginicus* | broomsedge |
| *Carex* sp. | carex |
| *Cyperus* sp. | sedge |
| *Eleocharis* sp. | spike rush |
| *Erianthus giganteus* | plume grass |
| *Juncus effusus* | juncus |
| *Leersia oryzoides* | cut grass |
| *Panicum* sp. | panicum |
| Unknown grass | grass |
| Ferns | |
| *Woodwardia areolata* | netted chain fern |

Table 5. Number of tree seedlings, shrub seedlings, and vines by plot in H-Area

| Plot # | Tree Seedlings | Shrub Seedlings | Vines | Plot # | Tree Seedlings | Shrub Seedlings | Vines |
|---|---|---|---|---|---|---|---|
| 1 | 1 | 3 | 3 | 29 | | | |
| 2 | | 8 | | 30 | | | |
| 3 | 4 | 3 | 6 | 31 | | | |
| 4 | 1 | | 5 | 32 | | | 1 |
| 5 | | 9 | 5 | 33 | | | |
| 6 | | 7 | 4 | 34 | | | |
| 7 | 1 | 3 | 4 | 35 | | | |
| 8 | 3 | 17 | 7 | 36 | | | |
| 9 | 1 | 17 | 8 | 37 | | | |
| 10 | 3 | 10 | 5 | 38 | | | |
| 11 | | 8 | 1 | 39 | | | |
| 12 | 1 | 20 | 7 | 40 | | | |
| 13 | 1 | 6 | 7 | 41 | | | |
| 14 | 3 | 6 | 3 | 42 | | | |
| 15 | | 9 | 3 | 43 | | | 3 |
| 16 | | 1 | | 44 | | | 6 |
| 17 | | | 1 | 45 | | | 1 |
| 18 | | | | 46 | | | 2 |
| 19 | | | 2 | 47 | | | 2 |
| 20 | | | 1 | 48 | | | |
| 21 | | | 4 | 49 | | | |
| 22 | | | | 50 | | | |
| 23 | | | | 51 | | | |
| 24 | | | 1 | 52 | | | |
| 25 | | | | 53 | | | |
| 26 | | | | 54 | | | 1 |
| 27 | | | | 55 | | 1 | 2 |
| 28 | | | | 56 | | | |
| | | | | **TOTALS** | **19** | **128** | **95** |

Table 6. Groundcover stratum (major components) by plot of H-Area

| Plot | Leersia | Juncus | Eleocharis | Typha | Aneilema | Erianthus | Boehmeria |
|---|---|---|---|---|---|---|---|
| | % Cover | | | | | | |
| 1 | | 3 | | | 5 | 2 | |
| 2 | | | 35 | | | | |
| 3 | | 2 | 5 | | | 15 | |
| 4 | | 40 | | 2 | | 15 | |
| 5 | 2 | | | | | | |
| 6 | | | 2 | 4 | | | |
| 7 | 5 | | 20 | | | | |
| 8 | | | | | | | |
| 9 | | 2 | | | | | |
| 10 | | | 40 | | | | |
| 11 | | 9 | 5 | | | 5 | |
| 12 | | | | | | | |
| 13 | | | | | | | |
| 14 | | | | | | | |
| 15 | | | 5 | | | | |
| 16 | 90 | | | | | | |
| 17 | 90 | | | | | | |
| 18 | 30 | | | 40 | | | |
| 19 | 10 | | | 70 | | | |
| 20 | 35 | | | 75 | | | |
| 21 | 45 | | | 85 | | | |
| 22 | 25 | | | 100 | | | |
| 23 | 15 | | | 100 | | | |
| 24 | 10 | | | 90 | | | |
| 25 | 20 | | 3 | 100 | | | |
| 26 | 10 | | 5 | 40 | | | |
| 27 | 20 | | 8 | 90 | | | |
| 28 | 25 | | | 85 | | | |
| 29 | 15 | | | 100 | | | |
| 30 | 10 | | | 70 | | | |
| 31 | 30 | | | 85 | | | |
| 32 | 10 | | | 100 | | | |
| 33 | 40 | | | 100 | | | |
| 34 | 50 | | | 100 | | | |
| 35 | 40 | | 2 | 90 | | | |
| 36 | 40 | | | 100 | | | |
| 37 | 35 | | | 100 | | | |
| 38 | 40 | | | 100 | | | |
| 39 | 30 | | | 100 | | | |
| 40 | 50 | | | 100 | | | |

| Plot | Leersia | Juncus | Eleocharis | Typha | Aneilema | Erianthus | Boehmeria |
|---|---|---|---|---|---|---|---|
| 41 | 40 | | | 100 | | | |
| 42 | 40 | | | 80 | | | |
| 43 | 25 | | | 40 | | | |
| 44 | 55 | | | 95 | | | |
| 45 | 75 | | | 80 | | | |
| 46 | 25 | | | 100 | | | |
| 47 | 40 | | | 100 | | | |
| 48 | 40 | | | 90 | 20 | | |
| 49 | 75 | | | 80 | | | 5 |
| 50 | 60 | | | 95 | | | |
| 51 | 60 | | | 80 | | | |
| 52 | 100 | | | 75 | | | |
| 53 | 100 | | | 2 | | | |
| 54 | 100 | | | | | | |
| 55 | 10 | | | | 100 | | 6 |
| 56 | 7 | | | | 100 | | |

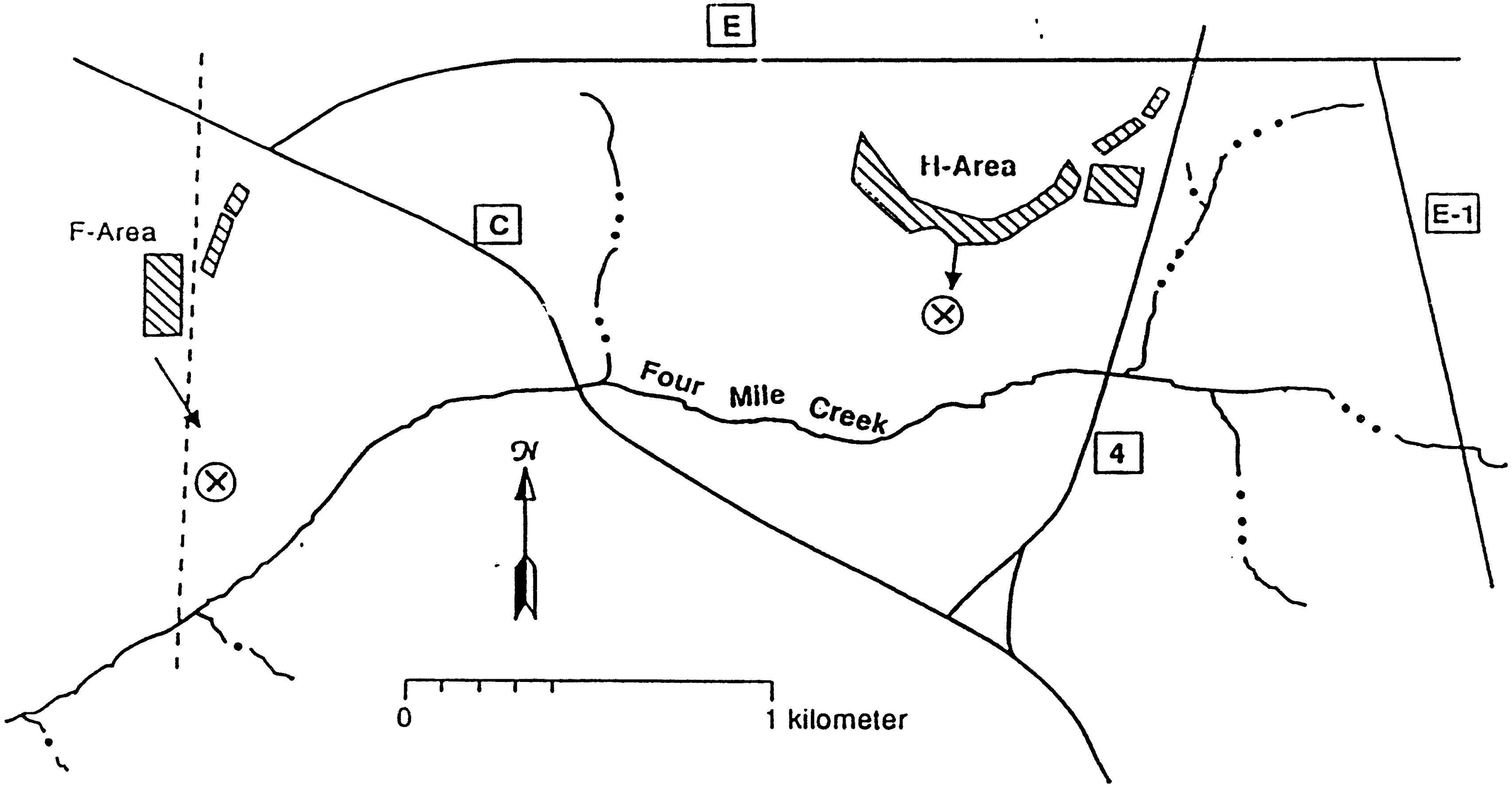



Figure 1. Map of study area showing sampling locations in localized tree-kill zones (X's). The dash line through F-Area is a steam pipeline. Letters and numbers within boxes are road designations. Cross-hatched areas are seepage basins. Seepage basins are approximately 15-20 m in elevation above Four Mile Creek.

Figure 2. F-Area tree-kill vegetation sampling transects.

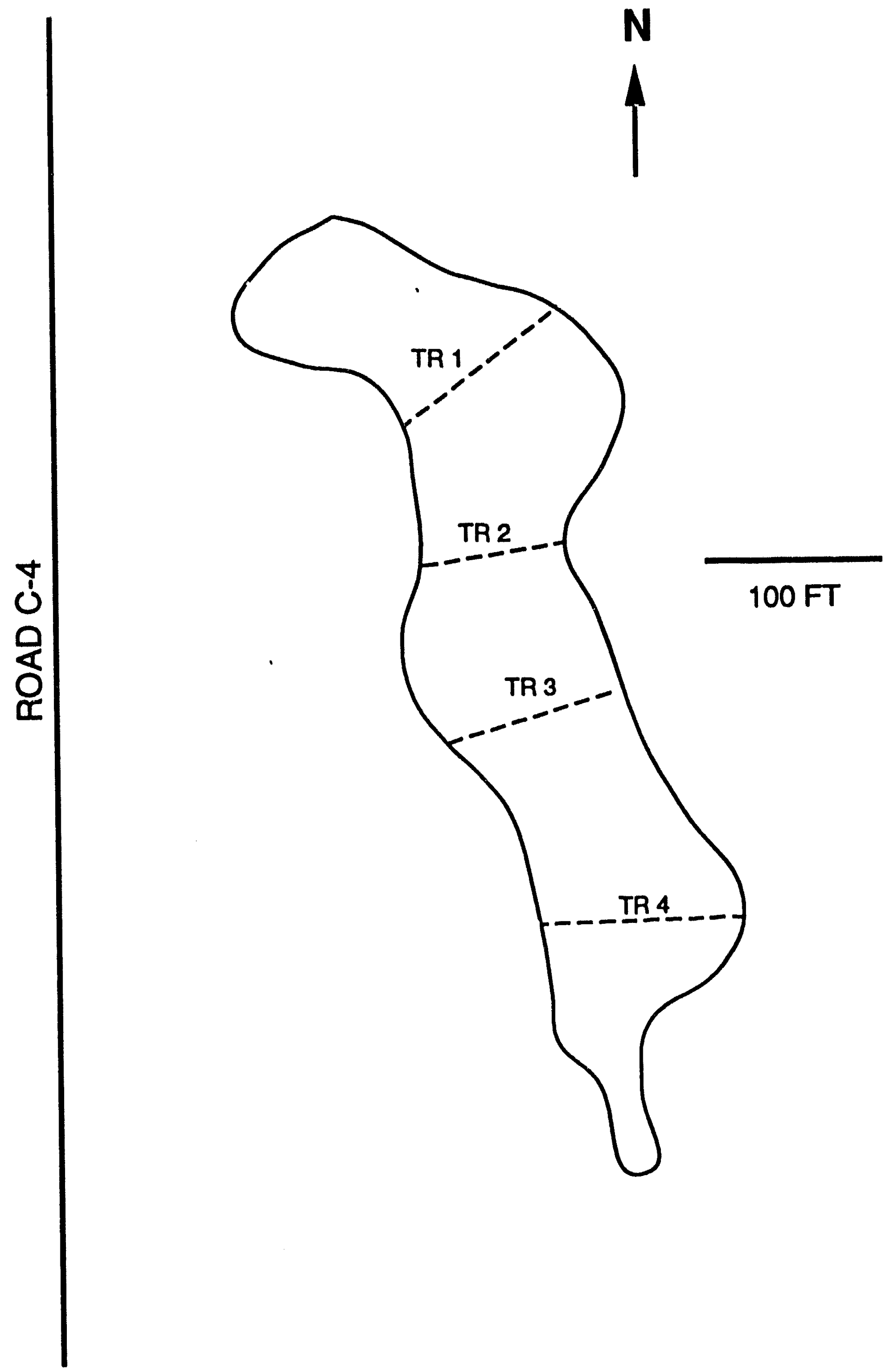
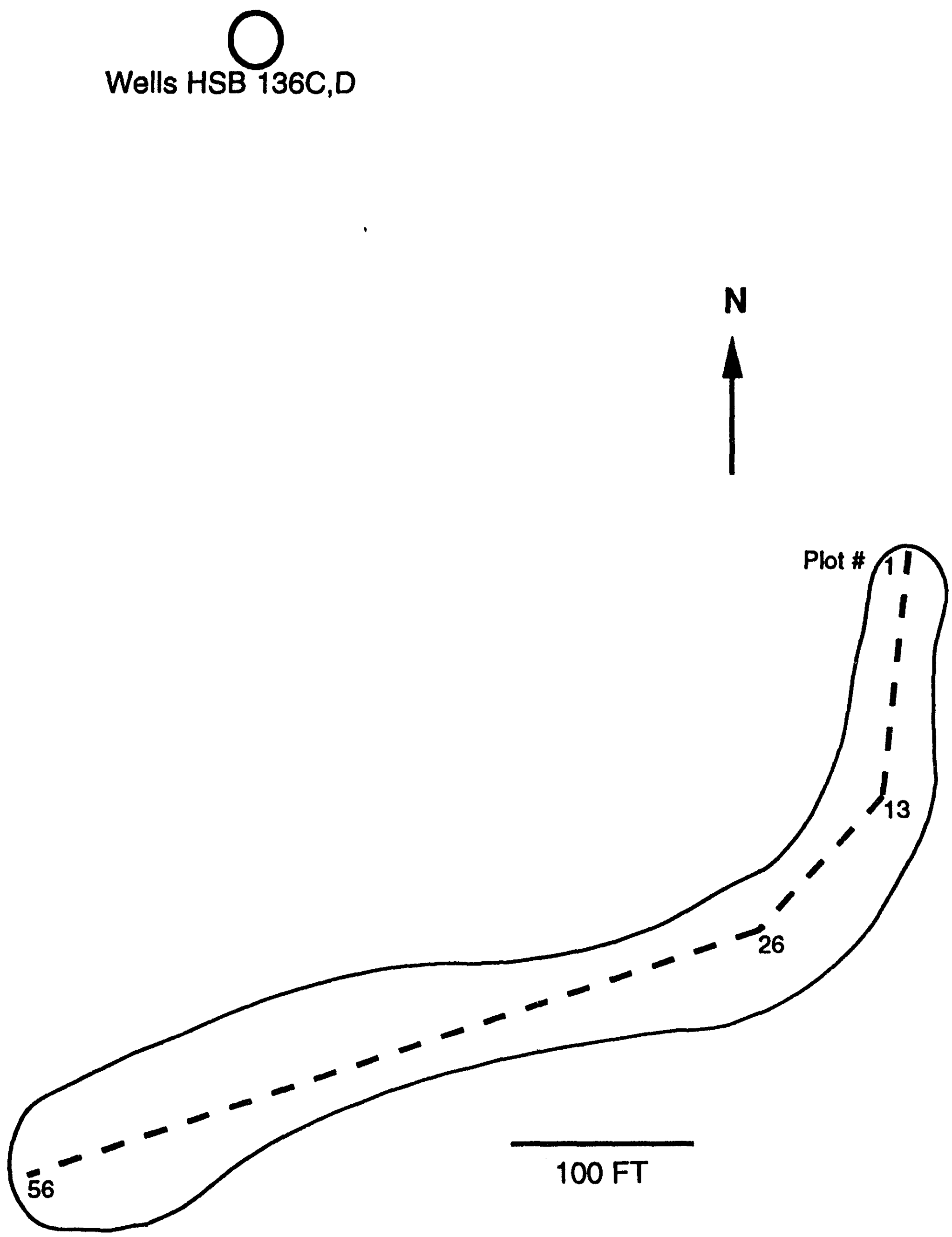


Figure 3. H-Area tree-kill vegetation sampling transect.



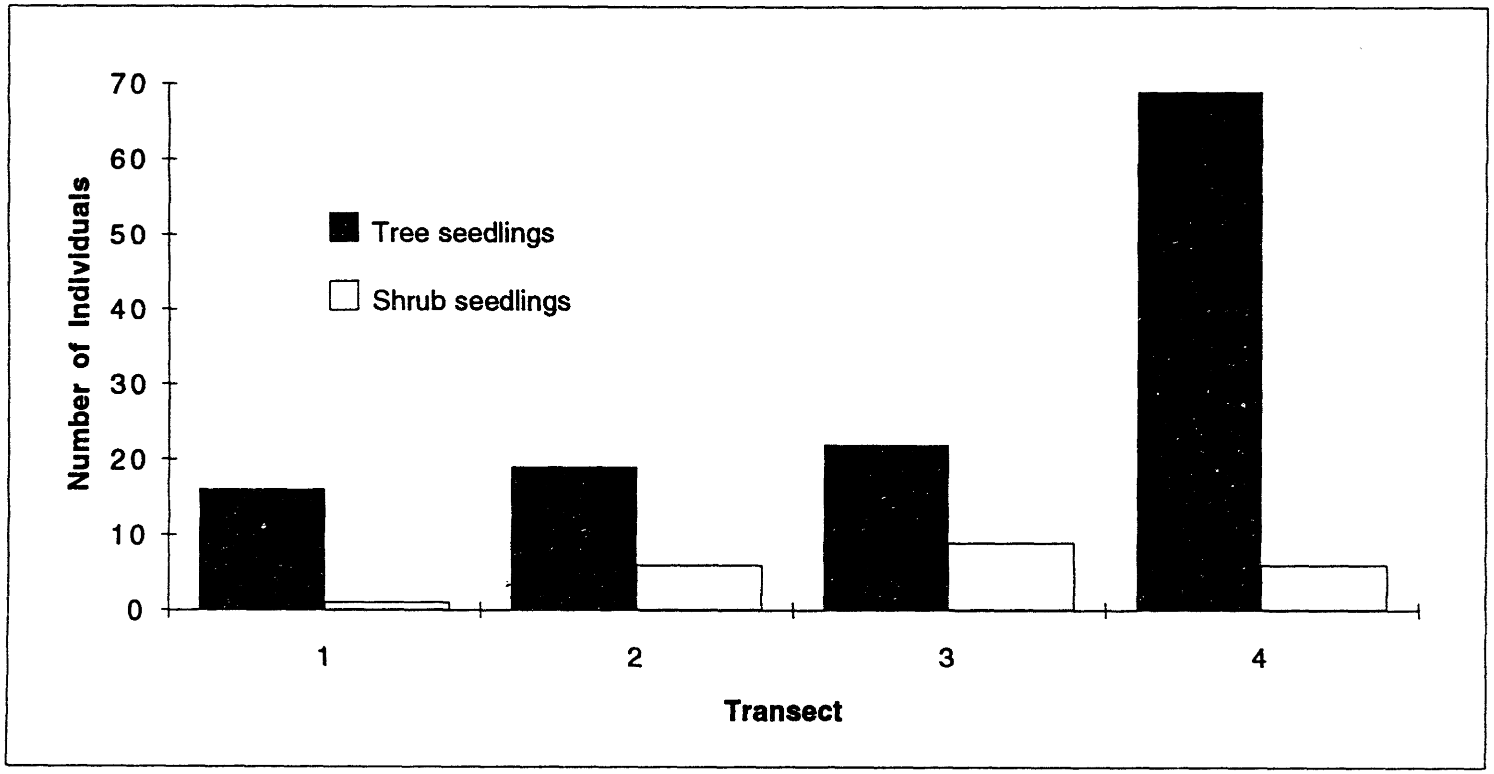



Figure 4. Total number of tree and shrub individuals by transect in F-Area.

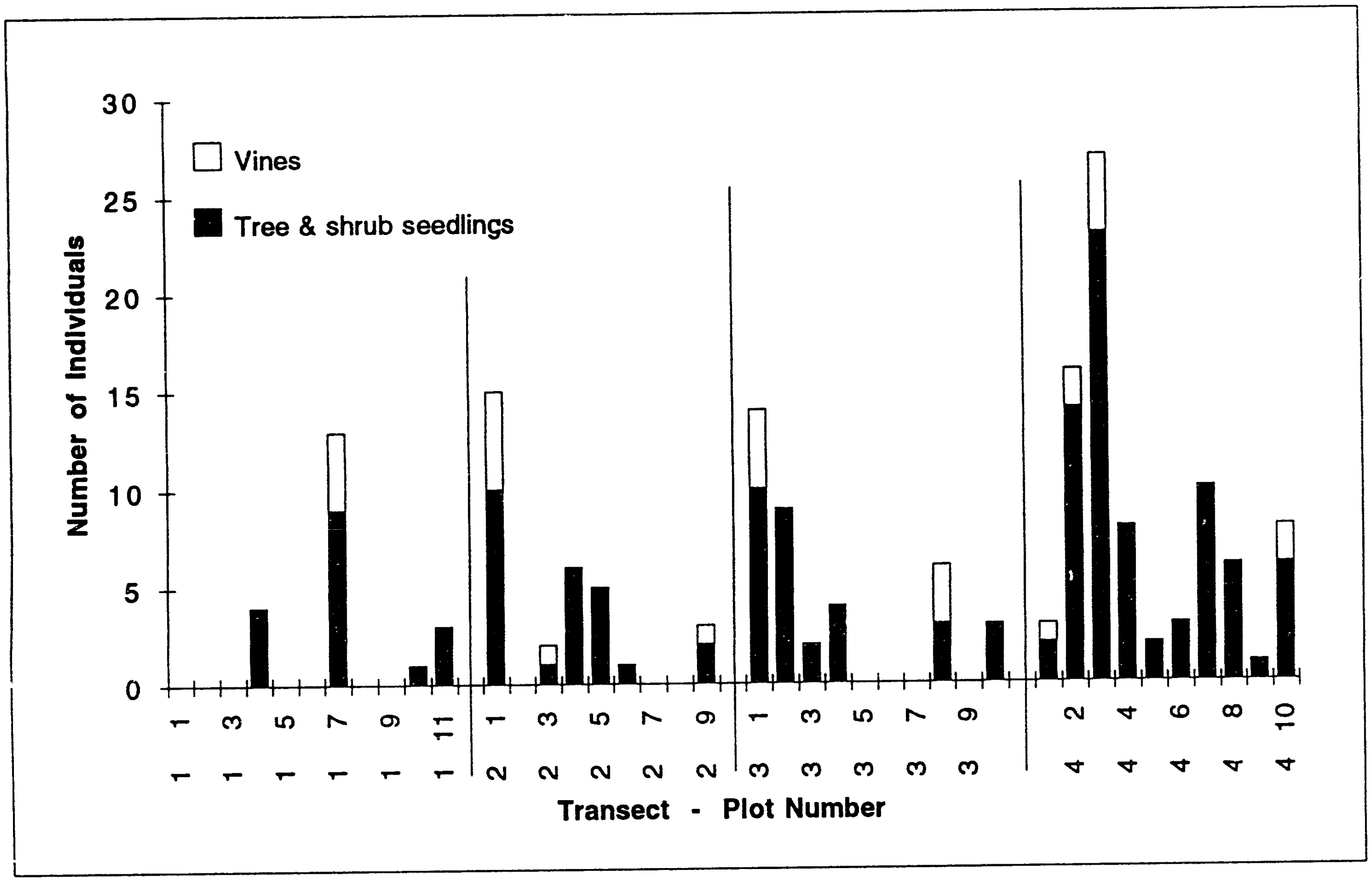



Figure 5. Number of tree and shrub seedlings and vines per plot in F-Area.

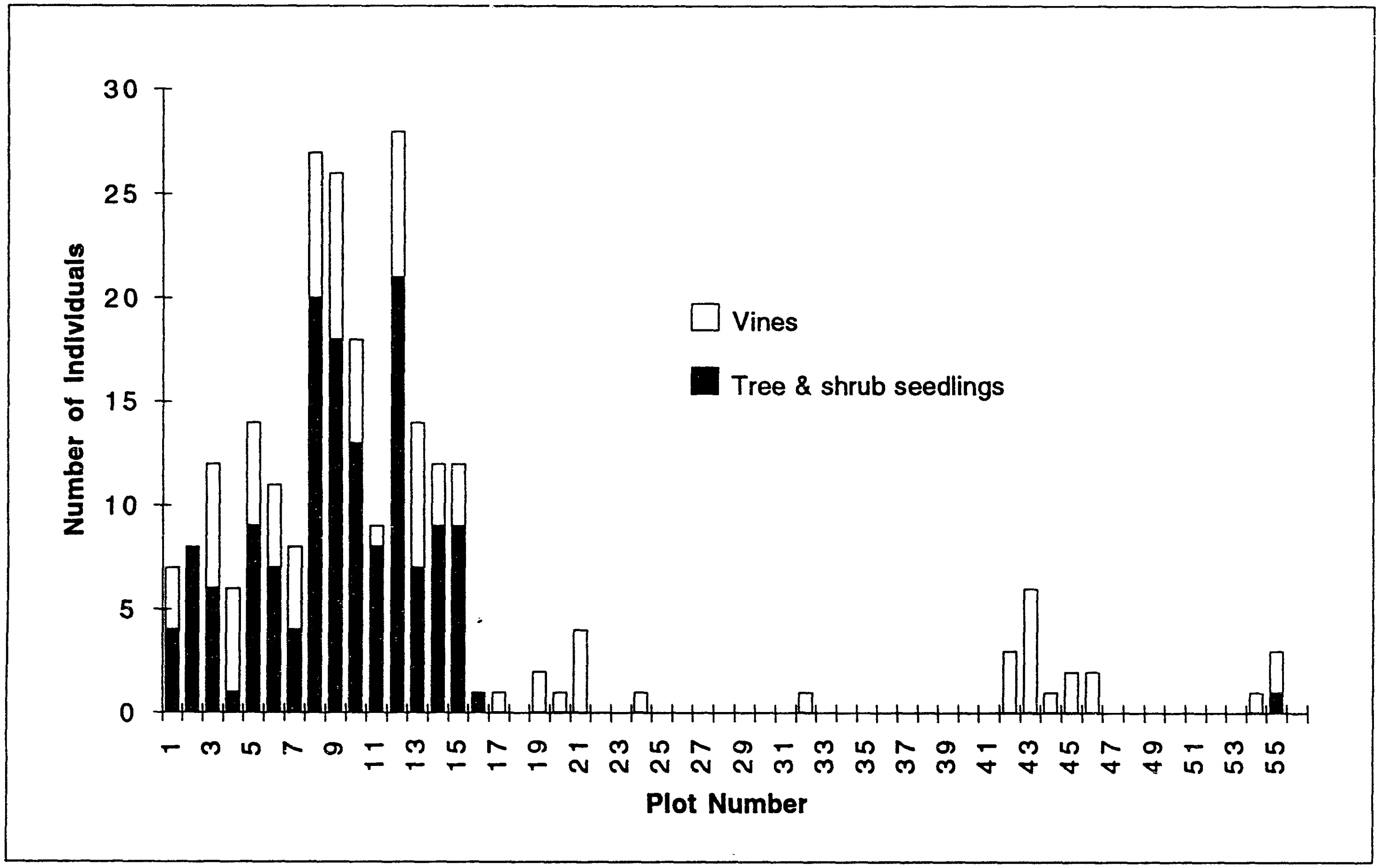



Figure 6. Number of tree and shrub seedlings and vines per plot in H-Area.

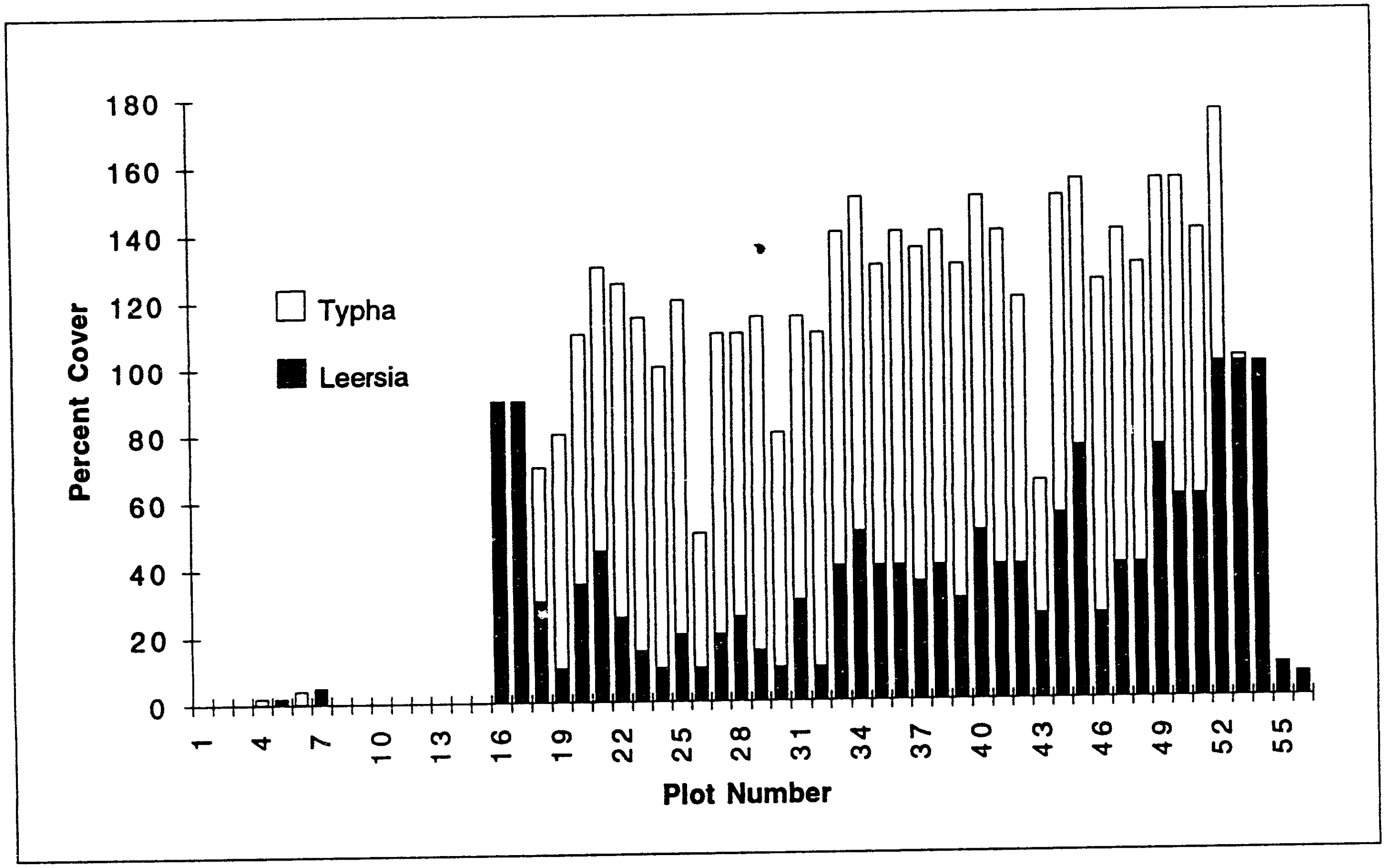



Figure 7. Percent cover by Typha and Leersia in H-Area plots.

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