SOUTH FLORIDA RESEARCH CENTER

Report SFRC-87/03

Old Field Succession in Everglades National Park

NATIONAL PARK SERVICE
DEPARTMENT OF THE INTERIOR

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OLD FIELD SUCCESSION

IN

EVERGLADES NATIONAL PARK

SFRC-87/03

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1987

KRAUSS, Pamela. 1987. Old Field Succession in Everglades National Park. South Florida Research Center Report. SFRC-87/03.

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ABSTRACT

A characterization of successional vegetation patterns on abandoned farmland in the Hole-in-the-Donut area of Everglades National Park was performed. Vegetative community composition and structure was examined in detail in 21 study plots located throughout the study site. Successional assemblages are described qualitatively and quantitatively. Distinct community types are defined using methods that emphasize site-to-site comaprisons. The relationship between vegetation and substrate, farming history, hydroperiod, and spatial arrangement was examined. Results were used to summarize and predict trends of old field succession on abandoned farmland in southern Florida. Post-farming vegetation patterns do not resemble prefarming conditions. Successional forest, frequently dominated by exotic species, is a relatively new community in southern Florida. It is likely a final stage in secondary succession on abandoned farmland.

INTRODUCTION

The effects of man and management decisions on ecological change in southern Florida are well documented (Carter, 1974; McCluney, 1969). These ecological changes become more apparent with every passing decade. With local land use ordinances (Metropolitan Dade County Master Plan, 1979; East Everglades Planning Study, 1980) that lead to land use changes in agricultural areas, there is a growing importance to understand succession on abandoned farmland. The results of this research together with the findings of other studies begin to answer questions about successional trends on old-fields in southern Florida.

The mechanisms and processes related to old-field succession have been the subject of detailed regional studies in the southeastern United States (Oosting, 1942; Keever, 1950; McCormick and Buell, 1957; Odum, 1960). In southern Florida, Davis (1943) discussed the potential utilization of Everglades for farmland. Egler (1952), in his paper on the management of the southeastern Everglades discussed and predicted trends of secondary succession on abandoned farmland. Robertson (1953, 1955) qualitatively described early seral stages on abandoned farmland in Everglades National Park. Alexander and Crook (1973) discussed a successional scheme based on a study of long term qualitative changes of old fields in the Hole-in-the-Donut (Donut) area of Everglades National Park. Hilsenbeck (1976) quantitatively studied early stages of old-field succession in the Donut and also provided data on the relative effects of management techniques on initial successional assemblages. Meador (1977) investigated the role of mycorrhizae in influencing succession in the Donut. Loope and Dunevitz (1981) reevaluated vegetation changes in areas that Hilsenbeck (1976) studied as well as reporting on succession following selected management in the Donut. They also discussed the establishment of exotic trees on abandoned farmland. Ewel et al. (1982) provided a detailed ecological study of Schinus terebinthifolius, the most abundant exotic tree in the Donut.

Although there is scientific literature describing the major communities that occur in southern Florida (Harshberger, 1914; Harper, 1927; Davis, 1943; Craighead, 1971), mature abandoned farmland vegetation has not been thoroughly described. Robertson (1953, 1955), Alexander and Crook (1973), Hilsenbeck (1976), Meador (1977), Loope and Dunevitz (1981) and Ewel et al. (1982) referred to abandoned farmland assemblages dominated by tree species including Persea borbonia, Ilex cassine, Myrica cerifera, and Schinus terebinthifolius.

The general purpose of this research is to quantitatively and qualitatively describe these mature successional forests. The specific objectives are: to identify community structure and composition in the Hole-in-the-Donut; to define community types in the present vegetation mosaic; to assess site-to-site differences in seral assemblages that will provide information on successional trends; to examine relationships between vegetation and substrate, farming history, hydroperiod and spatial arrangement; to provide baseline successional data; and to establish permanent study plots for future study of old-field succession in Everglades National Park.

MATERIALS AND METHODS

Study Area

The study area is located in the southern Everglades. It consists of the Hole-in-the-Donut and nearby abandoned farmland in eastern Everglades National Park (Figure 1). The Hole-in-the-Donut comprises approximately 4000 hectares of abandoned farmland occupying portions of Townships 58 and 59 S, Range 36, 36½, and 37 E. The area is located west of Royal Palm Visitor Center and is bound on the south and east by the Old Ingraham Highway and to the north by Long Pine Key. Abandoned farmlands adjacent to Pine Island and south of the Everglades National Park Visitor Station are also included in the study area.

Climate, ecology, hydrology, and geology of the southern Everglades have been described by Craighead (1971), Egler (1952), Davis (1943), and Robertson (1953). Site-specific accounts of pre-farming vegetation in the Hole-in-the-Donut have been described by Hilsenbeck (1976).

Study Plots

Twenty-one permanent plots were established within the Donut during 1978 and 1979 (Figure 2). Study plots were selected in old fields representing varying hydroperiods, substrates, ages and vegetative compositions. Plot locations were selected for ease of accessibility and avoidance of edge effects. All plots were oriented on a north-south or east-west axis. The corners of each plot were marked by a blue-tipped reference pole. All study plots were 5 x 20 m

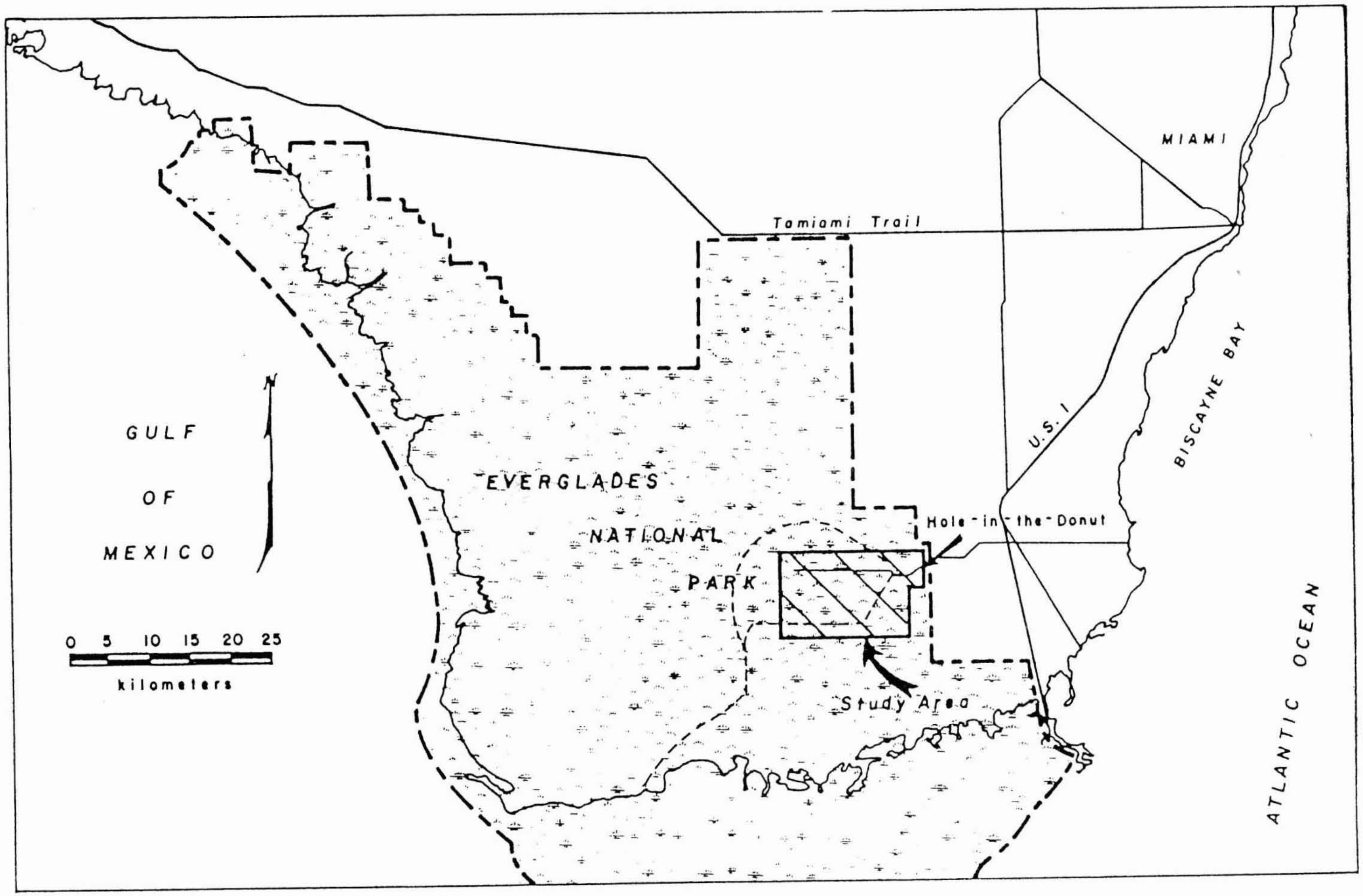

FIGURE 1. Map showing location of the study area.

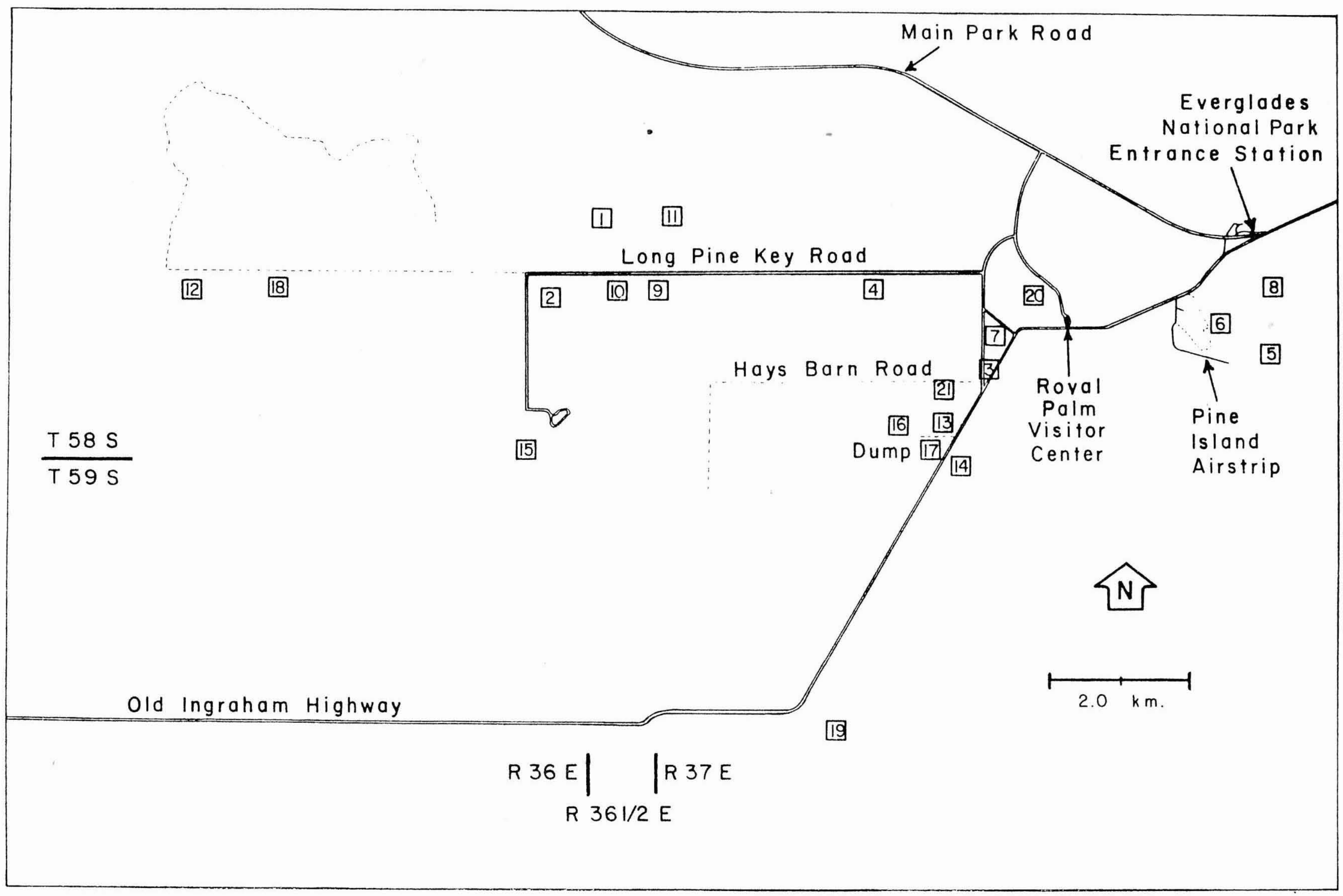

FIGURE 2. Map showing location of the twenty-one study plots.

($100 \ m^2$). Plot size was consistent with other research studies in Everglades National Park (Olmsted, Loope and Hilsenbeck, 1980). Exact plot locations were filed in the plant ecology files, South Florida Research Center, Everglades National Park.

Vegetational Analyses

Vegetation was analyzed using the quadrat method of Mueller-Dombois and Ellenberg (1974). For ease of analysis, vegetation was sampled in three size (height) classes: <60 cm high (size class one), <2 m and >60 cm high (size class two), and >2 m high (size class three). Size classes one, two and three represent herbaceous plants and grasses, shrubs and saplings, and trees and tall shrubs, respectively. Size class one was sampled in sixteen $0.25 \ m^2$ subsamples systematically located throughout the study plot. Each $0.25 \ m^2$ is designated as a subquadrat. Size class two was sampled in four $5 \ m^2$ subsamples systematically located within the study plot. Each $5 \ m^2$ is designated as a subplot. Size class three was sampled in four $25 \ m^2$ subsamples. Each $25 \ m^2$ was designated as a quadrat; all trees and tall shrubs were sampled in the study plot. Orientation and location of subsamples within each study plot is illustrated in Figure 3. A summary of size class sampling areas and designations appears in Table 1. In each size class, vegetation was identified, counted, and the percentage of cover contributed by each species was visually estimated. Sufficiency of sampling area was verified by constructing species area curves (Brower and Zar, 1977) for plots that were most floristically rich. Percentage of litter cover was visually estimated in each subquadrat. All study plots

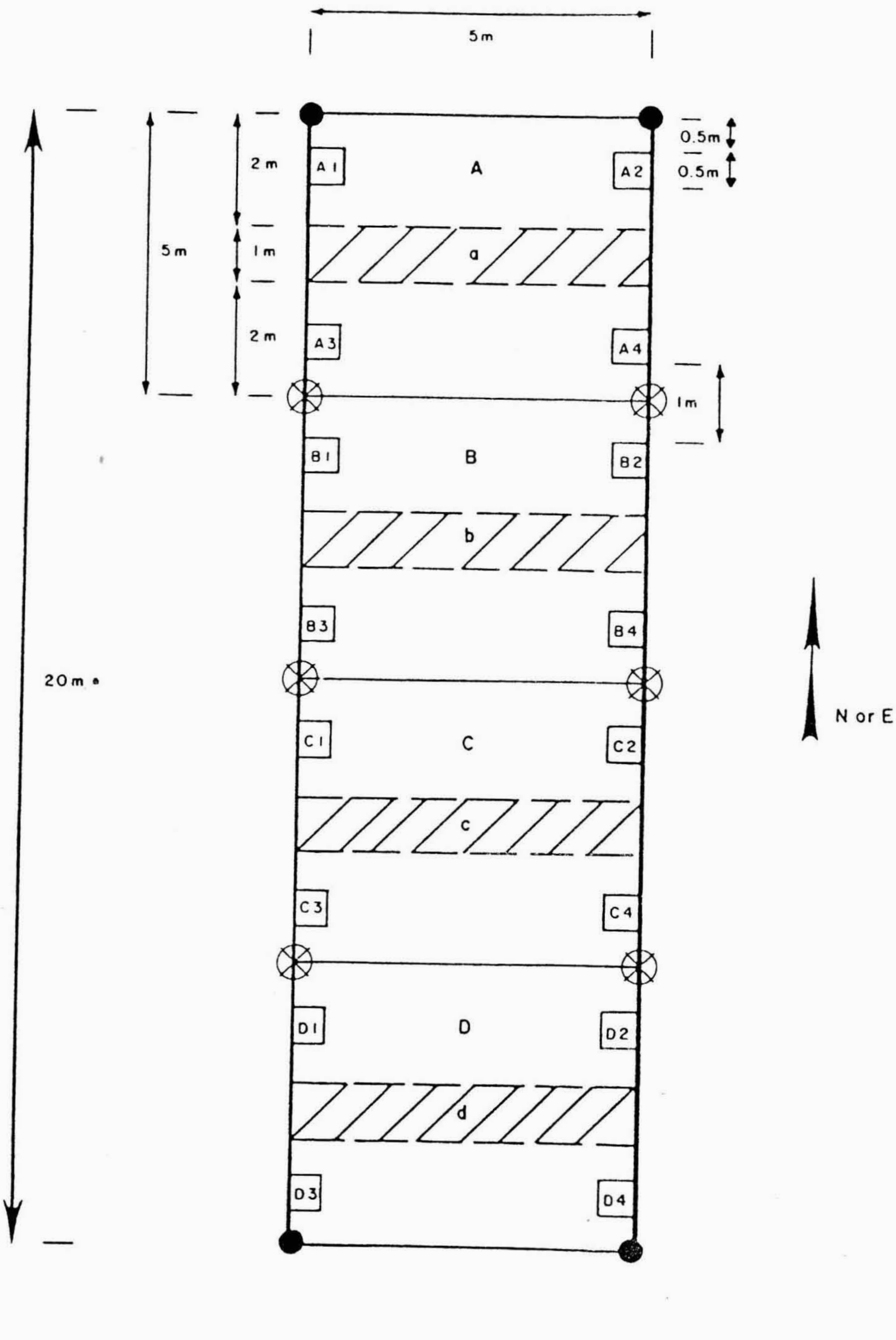

FIGURE 3. Orientation and locations of subsamples within each study plot. (● = corner of study plot; ⊗ = corner of quadrat).

TABLE 1. Size class sampling areas and designations.

Vegetation Size Class	Sampling Area	Dimensions	Designation	Number Per Plot
1 (<60 cm)	0.25 m^2 (1.0 m^2 per quadrat) 4 m^2/plot	0.5 m x 0.5 m	Subquadrat (A1, A2, A3, A4, B1, etc.)	16
2 (>2m and <60 cm)	5 m^2/quadrat 20 m^2/plot	1 m x 5 m	Subplot (a, b, c, d)	4
3 (>2m)	25 m^2 100 m^2/plot	5 m x 5 m	Quadrat (A, B, C, D)	4

were sampled once between December 1977 and February 1978, or in December 1979.

During the wet season (April through October) of 1978 and 1979 all study plots were examined bimonthly for standing water. When water was present, five randomly selected depth measurements were recorded per quadrat. Additionally a visual estimate of the percentage of area covered by water was recorded for each quadrat.

Similarity values were calculated using the Sorenson index (Mueller-Dombois and Ellenberg, 1974 and Sorensen, 1948). These values were used to generate a similarity matrix and cluster diagram (Dixon and Brown, 1979). The cluster analysis of variables used the weighted pair-group method (Sneath and Sokal, 1963). Clusters of variables were formed based on a measure of similarity between the variables; the measure of similarity is the correlation between the variables. The criterion used to combine variables into clusters or clusters into larger clusters were based on the average measure of similarity (average linkage) between the variables or clusters (Dixon and Brown, 1979 and Sneath and Sokal, 1973).

Diversity and evenness were calculated using the Shannon-Weiner Index (Brower and Zar, 1977 and Shannon, 1948). Linear regression analyses (Sokal and Rohlf, 1969) were used to determine if significant relationships existed between the number of exotic species or percent exotic species on species richness, evenness and diversity. Mann Whitney U tests (Siegal, 1956) were used to test the significance of environmental, physical and historical factors on aspects of community structure.

Taxonomic nomenclature follows Avery and Loope (1980). Designations of exotic species are consistent with Austin (1978).

RESULTS

Study Plots

A general description including a historical synopsis of each study plot follows. Table 2 summarizes physical characteristics, time of abandonment, and species richness of each study plot. Detailed summaries of vegetative cover, species composition, tree heights, litter coverage, vegetative density, and hydrological data are presented separately.

Plot 1. Myrica Forest.

This plot was located just south of a mature pineland. A fireroad plowed during the period between 1955 and 1957 separated the pineland from the Myrica forest. The canopy cover varied from 80-85% and was dominated by Myrica cerifera. Myrsine floridana contributed to the canopy but accounted for less than 1% of the cover. Schinus terebinthifolius occurred occasionally in the association, however it did not contribute to the canopy in this study plot.

The canopy height was fairly uniform with a mean of 5.0 m. Understory vegetation provided less than 5% cover in both shrub (size class 2) and seedling (size class 1) categories. Species composition in these size classes consisted of typical pineland species such as Guettarda scabra and Forestiera segregata. The vine, Ipomoea indica, was also a common understory component. The substrate was rocky and covered by a leaf litter from Myrica cerifera. The site was farmed after 1952 and was released from farming between 1960 and 1964. Prior to farming this site was a mature pineland. No standing water was observed.

TABLE 2. Summary of species richness and historical and physical characteristics of each study plot. (RL = Rockdale loam).

Study plot	Total number of species	Approximate date of abandonment	Soil type	Furrows	Rock-plowed	Seasonally flooded
1	19	1965	RL	no	yes	no
2	21	1965	marl	no	yes	yes
3	12	mid 1940s	marl/ organic	yes	no	yes
4	25	1973	RL	yes	yes	no
5	16	mid-late 1950s	marl	yes	no	yes
6	13	mid-late 1950s	marl	no	no	yes
7	40	mid 1940s	marl	no	no	yes
8	27	mid 1940s	marl	yes	no	yes
9	15	1965	RL	no	yes	no
10	13	1965	RL	no	yes	no
11	24	1964	marl	no	yes	yes
12	44	1940	marl	no	no	yes
13	13	mid 1940s	marl/ organic	yes	no	yes
14	40	prior to 1940	marl	no	no	yes
15	17	1973	marl/ organic	yes	yes	yes
16	22	mid 1940s	marl/ organic	no	no	yes
17	21	mid 1940s	marl/ organic	yes	no	yes
18	38	1940	marl	yes	no	yes
19	28	prior to 1940	marl	yes	no	yes
20	21	mid 1940s	marl/ organic	no	no	yes
21	38	mid 1940s	marl	no	no	yes

Plot 2. Schinus-Baccharis Subforest.

This plot was located southeast of the point where Long Pine Key Road turns south to the lower missile base. The canopy cover ranged from 10 to 20% with a mean height of 2.6 m and was composed predominantly of *Schinus terebinthifolius*. *Baccharis halimifolia* occurred commonly. The understory was variable with size class two providing less than 10% cover. It consisted of hydrophilic species such as *Pluchea rosea* and saplings of *Schinus* and *Baccharis*. Size class one cover varied from 2 to 65% and consisted mainly of ruderal species. Litter cover ranging from 20 to 98% consisted mainly of dead or dying herbaceous species and *Baccharis* from the canopy that had died and fallen over. The site was initially farmed and rockplowed after 1952 and was released during the late 1960's after the missile site was constructed in 1965. Standing water was seasonally observed. Originally, this site was on the pineland prairie ecotone. The substrate reflected this history by having a rocky, marl consistency.

Plot 3. Mixed Psidium Forest.

This plot was located on the eastern side of the Donut, just east of an unpaved farm road that connected Long Pine Key Road and Hays Barn Road. The canopy cover ranged from 30 to 75% with *Psidium guajava* dominating. *Myrsine floridana* was the most abundant species, accounting for 75% of all individuals, but less than 15% of the canopy cover. The understory cover varied up to 85% and was dominated by the exotic, *Ardisia solanacea*. The site was farmed before 1940 and abandoned prior to 1940. It is likely that the original vegetation, prior to farming, was prairie. The substrate consisted of a furrowed organic soil covered by marl. Occasionally the furrows were seasonally flooded.

Plot 4. Baccharis-Boehmeria Subforest.

This plot was located south of Long Pine Key Road and west of the Hilsenbeck (1976) plots. *Baccharis halimifolia* was the only species in size class three and accounted for all the cover which ranged from 2 to 25%. *Boehmeria cylindrica* and saplings of *Schinus terebinthifolius* were the dominant understory species. The substrate was rocky and furrowed. No standing water was observed at any time. The site was farmed from the mid-1950's until 1973. The land was acquired by the Park Service in 1974. Prior to farming, the site was part of the pinelands association.

Plot 5. Schinus Forest.

This plot was located adjacent to the airstrip at Pine Island. The canopy cover ranged between 75 and 80% and was dominated by multiple-stemmed *Schinus terebinthifolius* with a mean height of 4.8 m. *Myrsine floridana* was the most abundant species but accounted for less than 20% of the cover. The understory vegetation was noticeably sparse and composed primarily of *Baccharis halimifolia* and the vine, *Parthenocissus quinquefolia*. The site flooded seasonally and furrows remained from farming the marl substrate. The site was originally prairie. Farming started prior to 1940 and the area was acquired by the Park Service in 1948 or 1949. It was last farmed in 1950.

Plot 6. Schinus Forest.

This plot was located near the airstrip at Pine Island, north of Plot 5. It had the same farming history as Plot 5. Community structure also resembled Plot 5, however furrows were not evident.

Plot 7. Ludwigia-Graminoid Association.

This plot was located north of Plot 3 on the eastern side of the Donut, east of an unpaved farm road that connected Long Pine Key Road and the Ingraham Highway. There was no canopy cover. Ludwigia octovalvis, Andropogon glomeratus and Lythrum lineare were the most abundant species and provided 5 to 30% cover in size class two. Herbaceous hydrophillic species such as Bacopa monnieri and Centella asiatica formed a cover of up to 95% in size class one. The soil was marl. Lower areas of the study plot flooded seasonally. This site was farmed and abandoned prior to 1940. Until 1972, this area was part of the same community that included Plot 3. In 1972, the Resources Management Division of Everglades National Park bulldozed, burned and planted Cladium jamaicensis and other species that were part of the prefarming prairie community in an attempt to restore the original community.

Plot 8. Mixed Ilex-Myrica Forest.

This plot was located east of the Donut and south of the Everglades National Park entrance station, and adjacent to a rocky prairie. The canopy cover ranged from 50 to 65% and was dominated by Ilex cassine and Myrica cerifera. The tangled shrub understory provided up to 75% cover and was dominated by Baccharis halimifolia. Common species in size class one, with a mean cover of 17%, included Toxicodendron radicans and seedlings of Baccharis halimifolia and Ilex cassine. The site was farmed and abandoned prior to 1940. Prior to farming the site was part of the surrounding prairie community. Furrows remained from farming and flooded seasonally. The structure and composition of this study area resembled a tree island.

Plot 9. Myrica-Schinus Forest.

This plot was located southeast of the research center on the southern side of Long Pine Key Road. The canopy cover varied to 80% and was dominated by Myrica cerifera and Schinus terebinthifolius. The understory was sparse providing between 8 and 39% cover. Most commonly occurring species were Baccharis glomeruliflora and saplings of Schinus terebinthifolius. In size class one cover varied to 50% and was dominated by a mix of herbaceous weedy species such as Bidens alba and Spermacoce assurgens, and pineland species such as Tetrazygia bicolor and Morinda royoc. The substrate was rocky and reflectedthe rockplowed substrate of the original pineland community. No standing water or furrows were observed. The site was initially farmed after 1952 and released from farming in 1965. In 1979 this site was bulldozed, windrowed and burned. A description of the vegetation assemblage after 1979 is presented in Loope and Dunevitz (1981).

Plot 10. Mixed Myrica-Schinus Forest.

This plot was located due south of the Research Center and west of Plot 9. Farming history and hydroperiod were identical to Plot 9, however this study plot was not disturbed in the management practices of 1979. Species composition and community structure in Study Plot 10 resembled Plot 9. However, the canopy was dominated by Schinus terebinthifolius and the understory had a cover in size class one that varied to 90% due to the presence of dense Baccharis halimifolia.

Plot 11. Baccharis Glade.

This plot was located north of the Research Center, on the southern side of a fire road plowed between 1955 and 1957. The road separated this farmed area from a rocky, transverse glade. The sparse canopy cover of Baccharis halimifolia ranged from 0 to 5%. Understory vegetation in both size classes was composed of hydrophillic, ruderal, graminoid and herbaceous species such as Andropogon glomeratus, Eupatorium coelestinum, Phyla nodiflora, and Teucrium canadense. The site was rockplowed and farmed between the mid-1950's and 1964. Prior to farming the site was part of the rocky glade that occupied the area north of the fire road. Standing water was present during the wet season.

Plot 12. Mesic Prairie.

This plot was located south of the unpaved western portion of Long Pine Key Road. There was no canopy. The species composition and distribution resembled that of surrounding priarie that had no history of farming. Typical prairie species such as Cladium jamaicensis, Muhlenbergia filipes, Proserpinaca palustris and Rhynchospora microcarpa commonly occurred in the study plot and surrounding area. The area flooded seasonally and was never rockplowed. The area was farmed from approximately 1940 and abandoned in 1955. Prior to farming the area was prairie.

Plot 13. Mixed Successional Forest.

This plot was located north of the unpaved dump road mid-way between the Ingraham Highway and the dump. A well developed canopy cover of up to 80% was dominated by Schinus terebinthifolius and Ilex cassine. Both the intermediate and small size classes were dominated by Ardisia solanacea and provided up to 95% cover. Leafless Ardisia solanacea twigs, probably freeze-damaged, and in some cases over 2 m tall, were sprouting from their main stems. Most of the Ardisia occurred on ridges between furrows. The site was farmed from the late 1930's until 1940. The site was flooded seasonally.

Plot 14. Ilex Forest.

This plot was located on the eastern side of the Ingraham Highway south of the unpaved road that leads to the dump. The dense canopy provided up to 95% cover with a mean height of 4.5 m. It was dominated by Ilex cassine with Persea borbonia commonly occurring. The intermediate size class cover ranged from 6 to 15% and was composed primarily of Baccharis halimifolia and Ludwigia octovalvis with saplings of Ilex cassine, Myrsine floridana, and Persea borbonia. Size class one was composed of seedlings from the canopy and shrub species in addition to hydrophyllics such as Cladium jamaicensis, Crinum americanum and Proserpinaca palustris. The substrate was marl which lacked litter and organic cover. The plot flooded seasonally. The area was farmed and abandoned prior to 1940. Before farming, the site was prairie.

Plot 15. Baccharis Forest.

This plot was located south of the lower missle base, west of an unpaved farm road. The mean canopy cover of 17.5% was provided exclusively by Baccharis halimifolia with a relatively uniform height of 2.9 m. The sparse intermediate size class cover ranged to 15% and consisted primarily of Baccharis halimifolia saplings and Ludwigia octovalvis. Size class one cover varied up to 92% and was dominated by a dense mat of Alternanthera philoxeroides. Seasonal flooding of the very prominent furrows occurred. The rockplowed site was farmed between 1960 and 1973. Prior to farming the site was occupied by prairie.

Plot 16. Mixed Successional Forest.

This plot was located north of the dump. The mean canopy cover of 25% with a mean height of 4.8 m was dominated by Persea borbonia. Baccharis halimifolia, Ilex cassine, and Myrica cerifera also contributed to the canopy cover. Baccharis halimifolia, Ardisia solanacea, and juvenile Ilex cassine were the major contributors to the sparse cover of 13 - 23% in size class two and 0.5 to 10% in size class one. The soil was not furrowed and had an organic layer over a marl substrate. The site flooded seasonally. Plot 16 was assumed to have the same farming history as Plot 13.

Plot 17. Mixed Successional Forest.

This plot was located south of the road that leads to the dump and southeast of the dump. The canopy varied up to 90% cover with a mean height of 6.1 m and consisted of seven species including Schinus terebinthifolius. Both understory size classes had a sparse cover consisting primarily of seedlings and saplings of canopy species and other common understory species such as Psychotria sulzneri and Thelypteris kunthii. The substrate was prominently furrowed and the site flooded seasonally. Plot 17 had the same farming history as Plot 13.

Plot 18. Mesic Prairie.

This plot was located south of the unpaved portion of the Long Pine Key Road, east of Plot 12. There was no overstory. Prominent furrowing distinguished this farmed area. Baccharis halimifolia, which commonly occupied the ridges between furrows, and were less than 2 m tall, provided up to 28% cover in the intermediate size class. Typical prairie species such as Cladium jamaicensis, Crinum americanum, and Panicum hemitomum were intermixed with hydrophillic ruderal species such as Bacopa monnieri, Phyla nodiflora, and Spermacoce prostrata and provided up to 80% cover. The site seasonally flooded and had the same farming history as Plot 12.

Plot 19. Mixed Furrowed Prairie.

This plot was located south of the point where the Ingraham Highway turns westward. There were eight individuals greater than 2 m tall which provided a mean cover of less than 4%. The most striking feature of the vegetation at this plot was its localized distribution on the ridges between the shallow furrows. Exposed marl occurred in the furrows. The vegetative composition reflected the proximity to Taylor Slough, and the scattered tree islands. Baccharis halimifolia occurred in all size classes. Andropogon glomeratus, Cladium jamaicensis, Ludwigia spp., Proserpinaca palustris, and Rhynchospora inundata were the most abundant species. Occasional immature Magnolia virginiana, Myrica cerifera, Myrsine floridana, Salix caroliniana and Taxodium distichum characterized the site. The seasonally flooded site was farmed for a very short period prior to 1940. Prior to farming the site was prairie.

Plot 20. Mixed Successional Forest.

This plot was located northeast of Donut Lake. The canopy cover varoed up to 90% with a mean height of 3.0 m and was provided by five species with Myrica cerifera and Persea borbonia dominating. Ampelopsis arborea, Parthenocissus quinquefolia, and Toxicodendron radicans entangled into the understory and canopy contributed to the cover in all size classes. Baccharis halimifolia, Myrica cerifera and Persea borbonia occurred in all size classes. The intermediate size class, dominated by Baccharis halimifolia, formed a tangled cover providing up to 26% cover. Size class one with a cover ranging between 3 and 50% was dominated by seedlings of species in other size classes and hydrophillic species including Hydrocotyle umbellata and Ptilmnium capillaceum. The site flooded seasonally and was farmed and released prior to 1940. Before farming, the site was prairie.

Plot 21. Early Successional Glade.

This plot was located south of Hays Barn Road and south of the Hilsenbeck (1976) study plots. There was no vegetative cover in size class 2 or size class 3. Herbaceous cover in size class 1 ranging between 30 and 90% consisted of prairie and ruderal species. Some of the most common species were *Baccharis halimifolia*, *Dichromena colorata*, *Eupatorium capillifolium*, *E. coelestinum*, *Hydrocotyle umbellata*, *Ludwigia microcarpa*, *Lythrum lineare* and *Spermacoce prostrata*. The site had a marl substrate which flooded seasonally. It was bulldozed in 1978. Prior to this, it was occupied by a successional forest. The area was farmed prior to 1940 and abandoned in the mid-1950's. The site was rockplowed. Prior to farming the site was occupied by prairie.

Species Composition

Species composition in each study plot is presented in Appendix 1. A total of 139 species were recorded in this study from all 21 study plots. The greatest number of species occurred in size class one, in all plots. The percentage of exotic species varied between 0 and 91%.

Only 11 species formed the canopy in all study plots, with no more than seven in any one study plot. When a species occurred in the canopy, it was almost always found as saplings or seedlings. There were three plots whose canopy was provided only by *Baccharis halimifolia*. When this occurred, seedlings or saplings of other canopy species also occurred. Two exotic canopy species were

Schinus and Psidium. They occurred in 50% of all plots with a canopy and were one of the dominant species when present.

Figure 4 illustrates the frequency distribution of all species found in the 21 study plots. Many of the species encountered were relatively rare to uncommon. Of the 139 species encountered, 44 occurred in only one study plot, 22 occurred in only two study plots, and 20 occurred in only three study plots. Approximately 25% of the species occurred in more than half the study plots.

Table 3 presents the nine species that were found in over half of the 21 study plots. Baccharis halimifolia, Myrica cerifera, Myrsine floridana, and Schinus terebinthifolius all occurred in size class three. Schinus was the only exotic species that occurred in more than 50% of the study plots. The other eight species that commonly occurred were in size class one and two and were herbaceous perennials that are able to persist under variable conditions. These species usually appear in early succession and persist.

Study Plot Similarities

Table 4 shows the similarity index matrix for all study plots. This is based upon species presence and does not take into account relative abundances. Sorensen coefficient of similarity values ranged from 0 to 71%.

A common practice in evaluating similarity indices is to divide the range of the indices into equal intervals (Bloom 1981). Since the Sorensen index ranges from 0 to 100, five distinct similarities can be generated (very low, low, moderate, high and very high) based on 20% intervals. Using this technique, 128 values in the matrix were

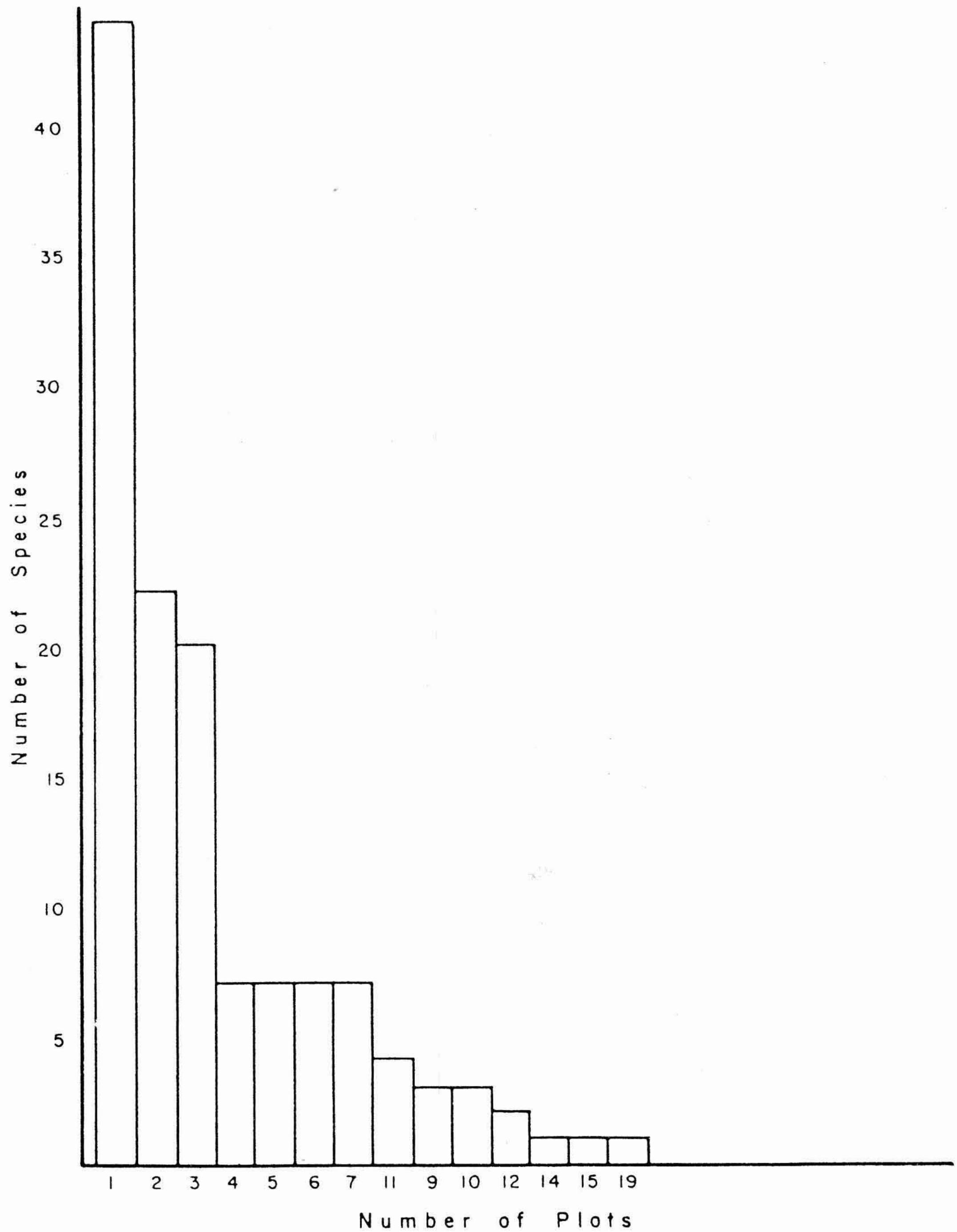

FIGURE 4. The number of species that occurred in one or more study plots.

TABLE 3. Species which occurred in more than 50% of all study plots. ((E) = exotic species).

Species	Percent Occurrence in Plots
Andropogon glomeratus	62
Baccharis halimifolia	86
Boehmeria cylindrica var. *drummondiana*	71
Eupatorium coelestinum	52
Myrica cerifera	71
Myrsine floridana	52
Parthenocissus quinquefolia	52
Schinus terebinthifolius (E)	57
Thelypteris kunthii	62

TABLE 4. Study plot similarities based on the Sorensen Coefficient of Similarity. (The matrix is symmetrical above and below the diagonal).

Plot No.	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21
1	100																				
2	8	100																			
3	11	6	100																		
4	10	28	9	100																	
5	25	12	47	17	100																
6	23	13	47	12	71	100															
7	3	29	4	20	4	4	100														
8	28	12	26	18	43	33	8	100													
9	36	20	12	25	29	22	6	27	100												
10	23	17	32	27	38	37	8	33	33	100											
11	2	33	0	26	3	0	25	6	12	12	100										
12	9	23	6	19	9	10	35	16	11	16	24	100									
13	18	6	24	15	36	35	2	32	21	42	3	12	100								
14	14	18	16	19	23	19	20	27	15	19	29	34	18	100							
15	9	23	12	20	14	11	16	10	19	20	14	17	11	12	100						
16	21	13	31	21	46	46	5	40	23	40	7	14	50	30	15	100					
17	21	11	37	24	48	42	7	45	20	48	7	12	46	28	12	59	100				
18	6	18	2	21	4	2	27	12	6	9	24	46	6	36	12	13	9	100			
19	7	12	9	11	11	6	27	13	8	15	14	21	11	34	11	12	15	24	100		
20	11	24	10	20	20	22	22	21	13	14	16	21	17	26	19	27	21	16	18	100	
21	2	20	2	4	4	4	27	12	6	6	24	26	8	23	10	9	7	38	26	16	100

very low, 67 values were low, 14 values were moderate and one value was high. The highest similarity (71) occurred between Plots 5 and 6. Plots 3 and 11 and 6 and 11 showed no similarity. Plot 15 showed the least similarity with all other plots, while plots 2, 7, 11, and 19 showed only low similarities with other plots. Plot 16 showed the most similarity with the greatest number of plots, while plots 5, 6, 8, and 17 exhibited relatively strong similarities with several plots.

In order to further characterize the similarities between study plots, a cluster analysis was performed. Figure 5 shows the resulting dendrogram. All study plots clustered above the 50% similarity level. Four cluster groups composed of at least three study plots per group were identified in the analysis. These are designated in Figure 5 as cluster groups A, B, C, and D. Cluster group A is characterized by study plots that were dominated mostly by a canopy cover varying to 90%, containing relatively few canopy species (no more than three), occurring on a marl substrate, flooding during the wet season, and abandoned in the 1940's and 1950's. Study plots in cluster group B contained a relatively low to moderate number of species with a high percentage (up to 46% or 7 species) providing a canopy cover of up to 90%. These were abandoned in 1965 and the mid-1940's. Group C study plots are characterized by moderate numbers of species with 10% or less producing a canopy cover of 25% or less, and abandoned in the 1960's and 1970's. Group D is characterized by study plots with a moderate to high number of species, no history of rockplowing, abandonment prior to or during the 1940's. With the

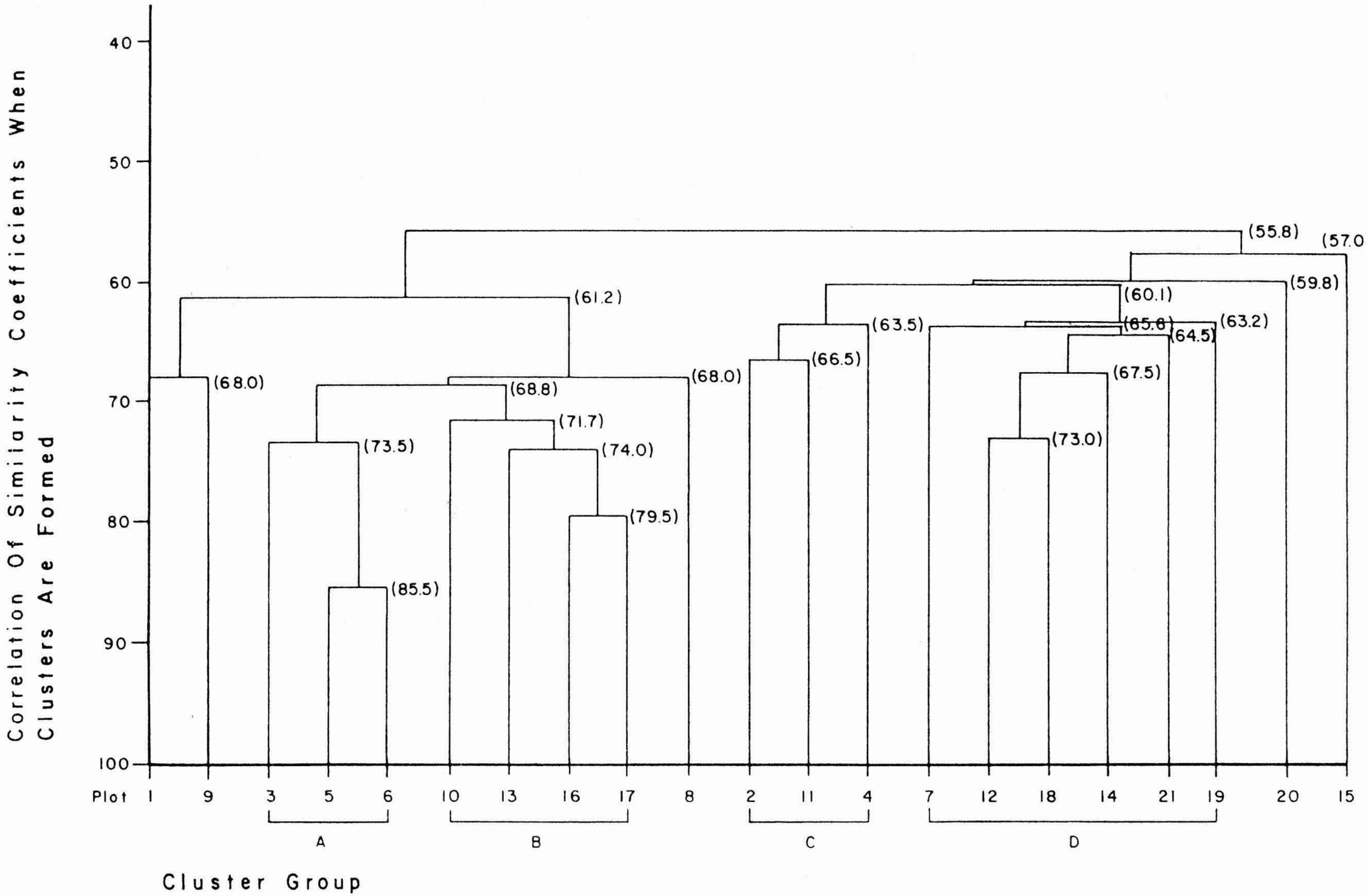

FIGURE 5. Dendrogram showing clusters of study plots generated by cluster analyses based on Sorensen's Coefficient of Similarity. (A, B, C, and D are cluster groups composed of at least three study plots per group).

exception of Plot 14, canopy cover is less than 7% and less than 12% of all species are present in size class three.

Study plots 1, 8, 9, 15, and 20 did not belong to any cluster group. Plots 1 and 9 had similar compositions in that typical pineland species, such as *Tetrazygia bicolor* and *Morinda royoc*, occurred. Although the vertical structure of Plot 8 was similar to plots in cluster B, it contained species that did not occur in any of the cluster B plots. Unlike characteristics of any of the groups, Plot 15 had an overstory composed entirely of *Baccharis halimifolia* and an understory of hydrophillic ruderal species. Study plot 20 was most similar to cluster D but it contained relatively few species.

Canopy Cover and Vegetation Size Class

Figures 6A-6D present the mean and range of percent cover for each vegetation size class in each study plot. Species that contributed to the cover in each size class are listed in Appendix 1. For all study plots, size class one cover varied from 0 to 95%, size class two cover varied from 1 to 85%, and size class three cover varied from 0 to 95%.

Abundance, Diversity and Evenness

Table 5 presents the number of individual plants in each size class for all plots. Size class one had the greatest number of individuals in all study plots, although in many plots these numbers are probably affected by seasonal changes.

Generally, those plots that lacked a canopy and had relatively large numbers of individuals were concentrated in size class one.

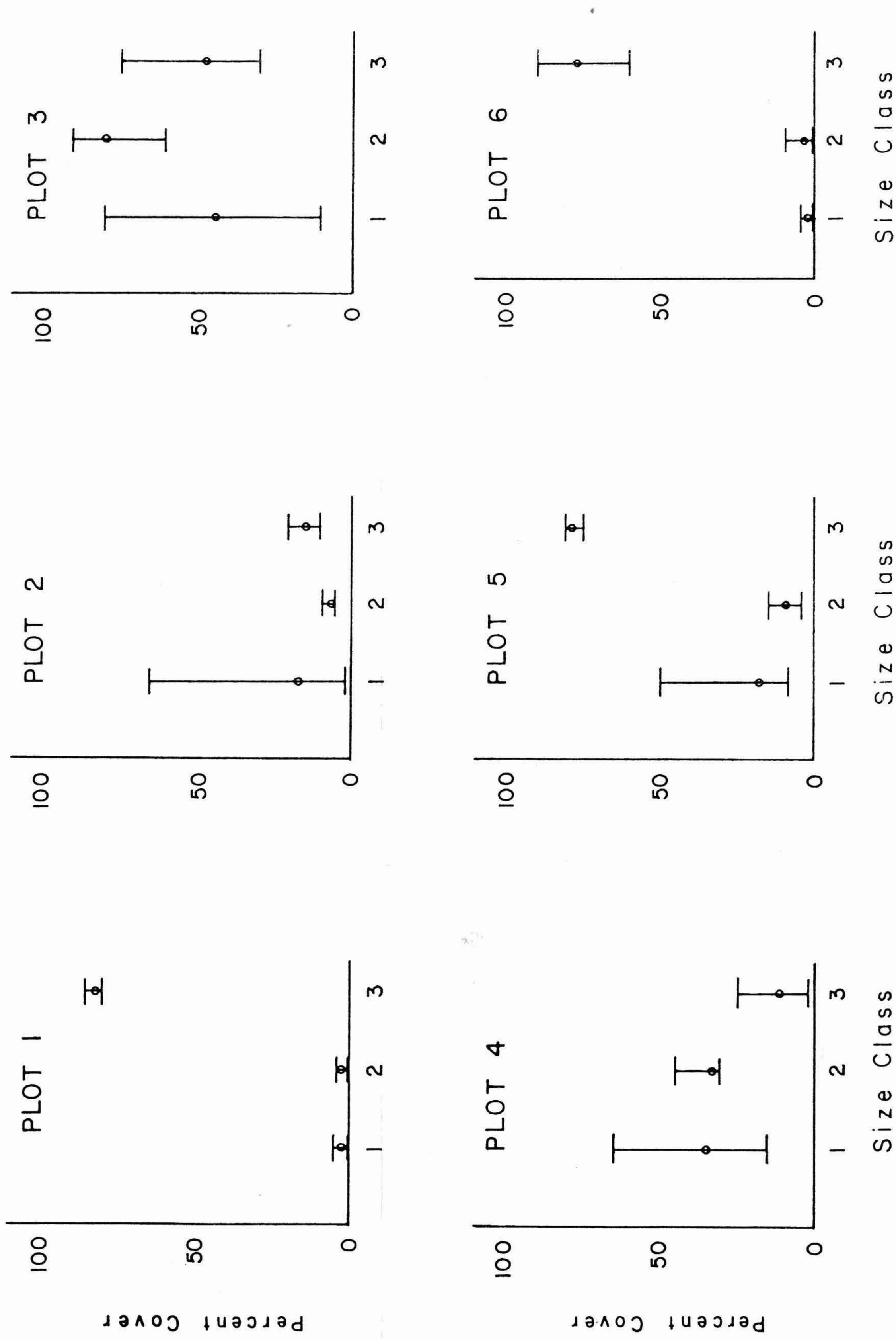

FIGURE 6A. Mean and range of percent cover for each vegetation size class in study plots 1-6.

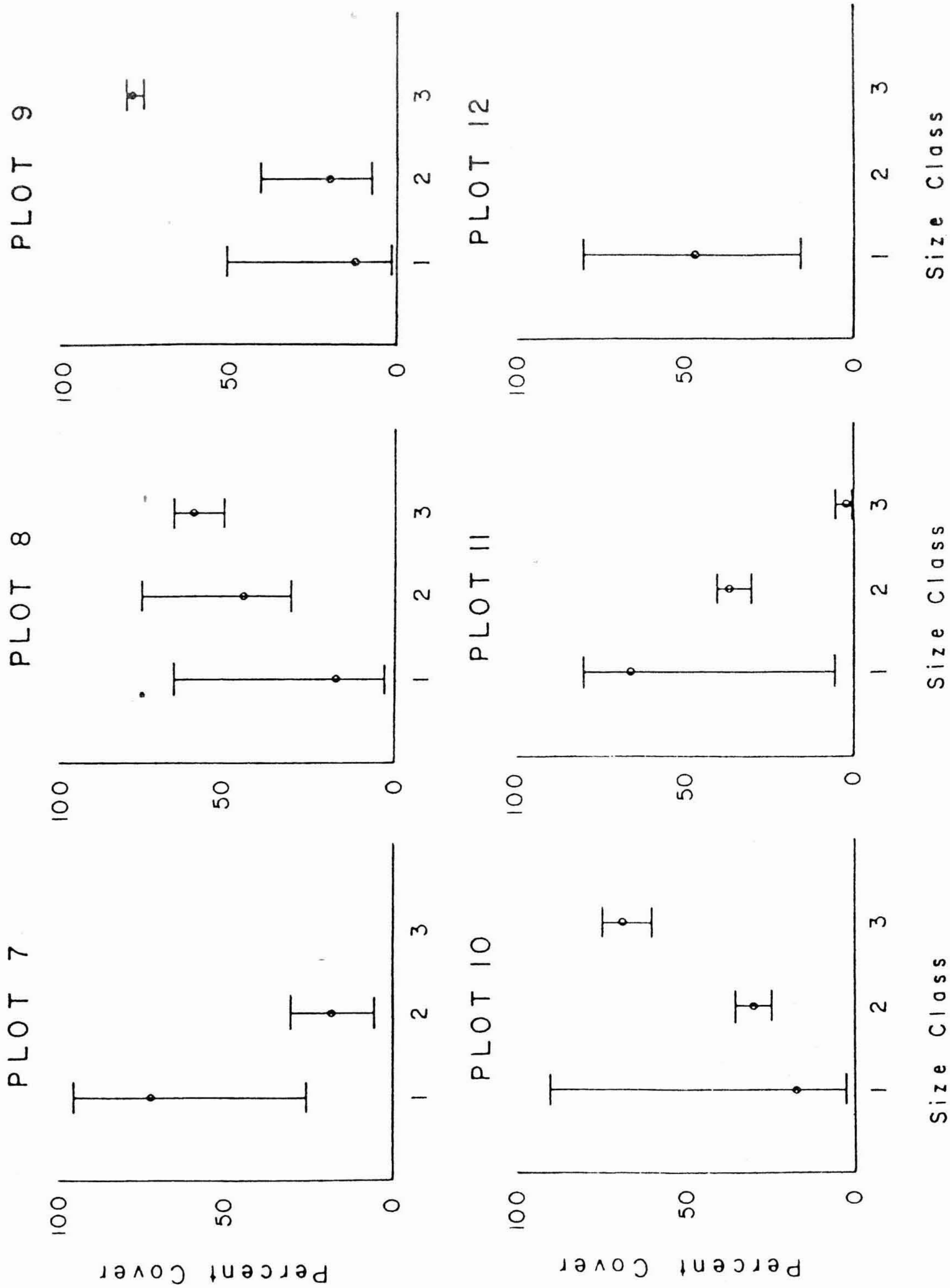

FIGURE 6B. Mean and range of percent cover for each vegetation size class in study plots 7-12.

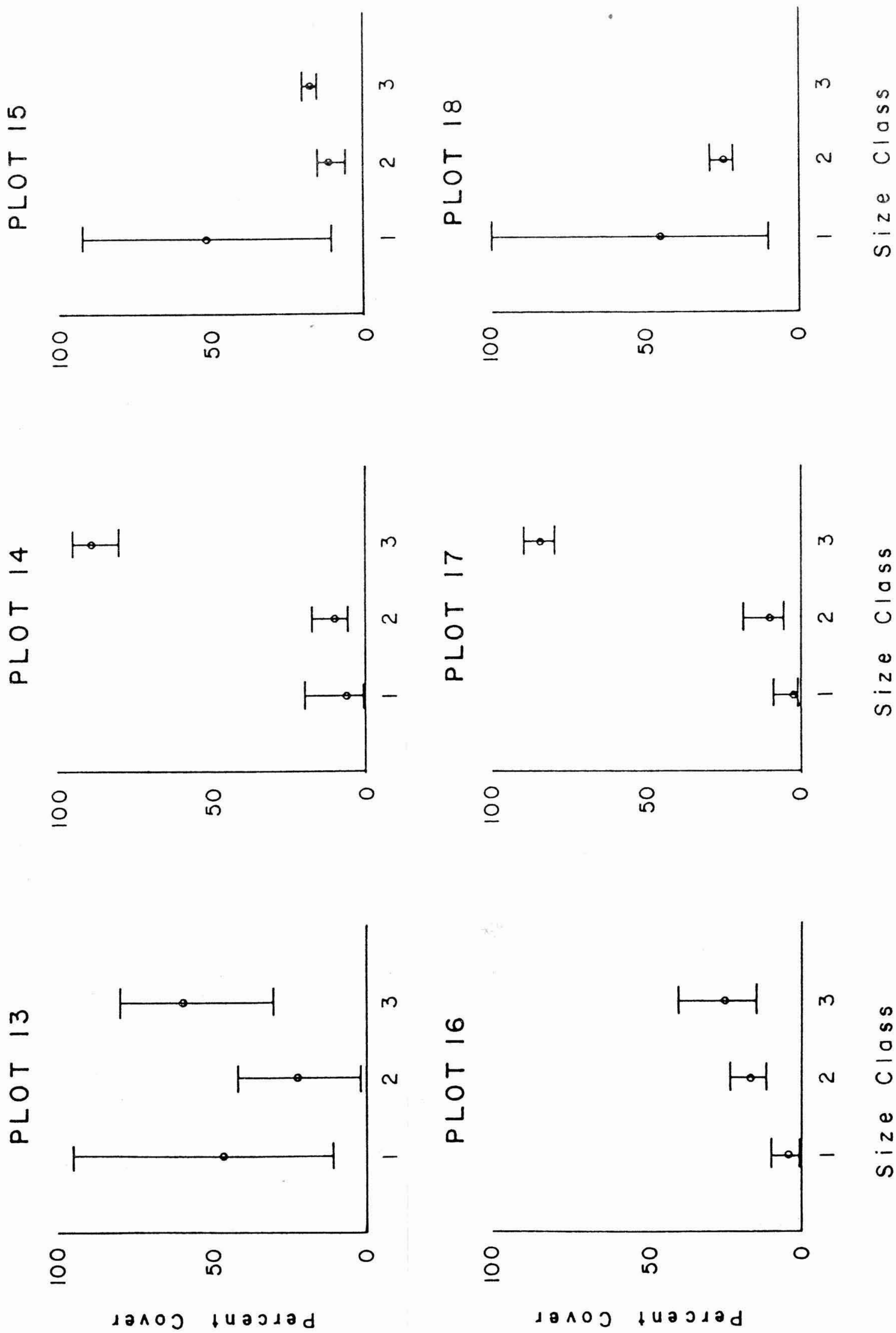

FIGURE 6C. Mean and range of percent cover for each vegetation size class in study plots 13-18.

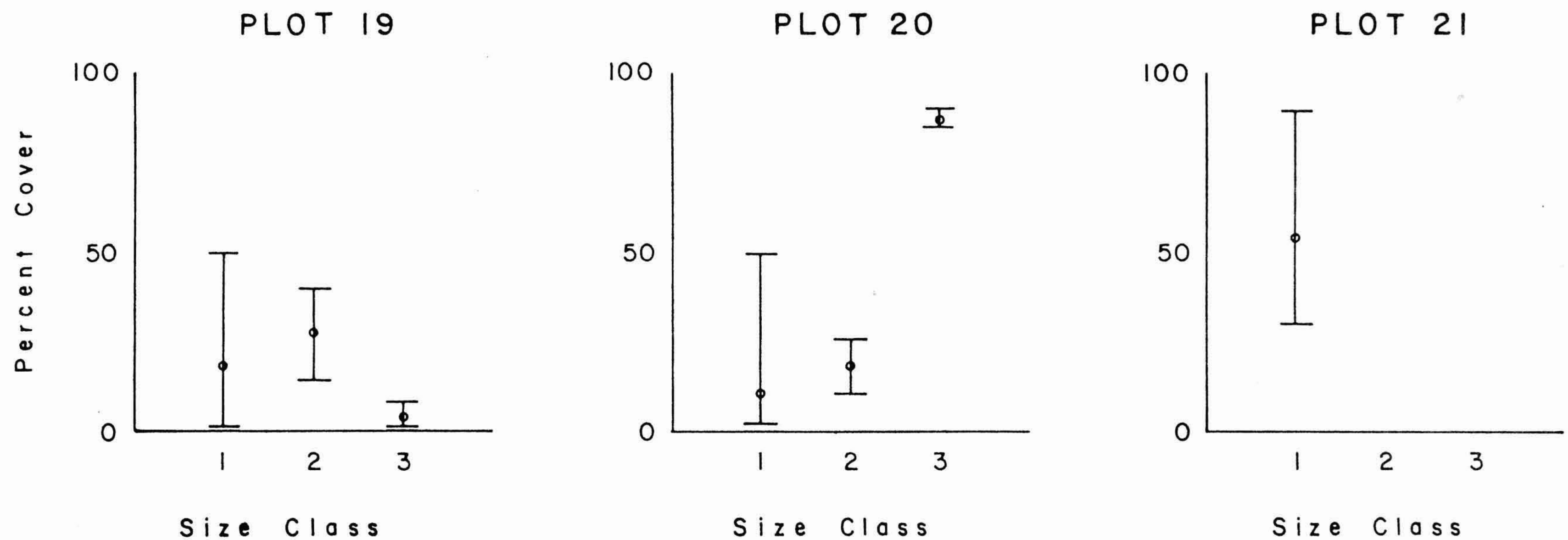

FIGURE 6D. Mean and range of percent cover for each vegetation size class in study plots 19-21.

TABLE 5. Total numbers of individual plants in each size class in each study plot.

Plot No.	Size Class (Height)		
	Size Class 1 Small (<60cm)	Size Class 2 Intermediate (>60cm <2m)	Size Class 3 Tall (>2m)
1	900	35	47
2	17650	235	49
3	2075	480	61
4	30950	1145	19
5	4200	1665	55
6	500	85	12
7	41475	710	0
8	6000	500	31
9	4425	245	46
10	6200	625	177
11	13540	280	4
12	14750	0	0
13	8200	170	22
14	5025	350	90
15	1800	440	111
16	2600	130	23
17	3500	185	28
18	20750	780	0
19	9060	565	8
20	11325	220	53
21	36150	0	0

Plots 1 and 6 had notably small numbers of individuals. The small numbers of individuals in size class three plots reflects either a sparse cover or a few well-developed individuals that formed a dense cover.

After determining that differences between subplots were minimal, diversity (H') and evenness (e) values were calculated for all study plots. These results are presented in Table 6. Diversity values were low for all assemblages. Both the richness and evenness component of diversity contributed to these low values. Those plots with the lowest and highest evenness also had the lowest and highest diversity values. Study plots 13 and 15 had the lowest diversity and evenness values. In both cases, the small number of species and the small number of individuals of rare species within the plot contributed to the low diversity values. Plots 12 and 18 had the highest evenness and diversity values. Both plots had a relatively high number of species that were relatively evenly distributed. Those plots with the lowest diversity values had a canopy, and those with the highest diversity values had no canopy. Table 6 also presents the percentage of exotic species found in each study plot. This is expressed two ways. Percent exotics one (% Exotics 1) is the percentage of the number of exotic species compared to the total number of species present. Percent exotics two (% Exotics 2) is the number of individuals of exotic species compared to the total number of individuals of all species. The number of exotic species always represented less than 34% of all species but in plots 2, 3, 13 and 15 more than 50% of the individuals were exotic. In addition to having

TABLE 6. Diversity, evenness, and % exotics in each study plot.

Plot	Diversity H'	Evenness e	% Exotics 1	% Exotics 2
1	0.51	0.40	0	0
2	0.63	0.48	24	55
3	0.59	0.55	33	79
4	0.56	0.40	8	1
5	0.84	0.70	19	41
6	0.80	0.72	23	28
7	0.98	0.68	12	1
8	0.94	0.66	4	2
9	0.84	0.71	7	20
10	0.55	0.49	8	42
11	0.99	0.73	9	17
12	1.22	0.74	5	15
13	0.25	0.22	15	88
14	0.85	0.53	5	0
15	0.28	0.22	12	91
16	0.94	0.70	9	20
17	0.82	0.62	10	26
18	1.15	0.74	6	17
19	0.68	0.49	4	0
20	0.82	0.63	5	1
21	1.09	0.69	3	0

H' Shannon Wiener diversity index based on abundance.

e Evenness index, from Shannon Wiener index.

% Exotics 1 is the percentage of the number of exotic species compared to the total number of species present.

% Exotics 2 is the number of individuals of exotic species compared to the total number of individuals of all species.

a high number of exotics in these plots, exotics provided the majority of the cover. In study plot 2 Schinus terebinthifolius dominated the canopy while in plot 3 Schinus terebinthifolius, Ardisia solanacea and Psidium guajava provided the majority of the cover. Plot 13 had Ardisia solanacea and Schinus terebinthifolius as the dominant canopy species while in plot 15 Alternanthera philoxeroides provided most of the cover. Plots 13 and 15 had dominant exotic species and also exhibited the two lowest diversity and evenness values of all study plots.

Canopy Height and Litter Cover

Tree height data for all study plots are presented in Table 7. As would be expected the tallest trees usually occurred in study plots that have been abandoned for longer periods of time. Tree heights ranged from 2.0 m to 9.4 m. Of the 17 study plots with trees, five had mean tree heights less than 3.0 m, four had mean tree heights between 3.0 m and 4.0 m, five had mean tree heights between 4.0 m and 5.0 m, two had mean tree heights between 5.0 m and 6.0 m, and one plot had a mean tree height greater than 6 m.

Percent litter cover, which includes dead plant material, is also presented for all study plots in Table 7. The mean percentages of litter cover varied from 11.8% to 97.9%.

Hydrology

Results of hydrological censuses are reported in Table 8. Study plots 1, 4, 9, and 10 were not flooded at any time. These study plots were areas that were occupied by pineland before farming.

TABLE 7. Mean tree height and percentage litter cover for each study plot.

Plot No.	n	Tree Height (m) Mean ± S.D. (range)	Litter Cover (%) Mean ± S.D. (range)
1	50	5.0 ± 0.96 (2.0 - 6.4)	97.9 ± 3.80 (95.0 - 100.0)
2	49	2.6 ± 0.49 (2.0 - 3.8)	59.9 ± 27.62 (20.0 - 98.0)
3	62	4.1 ± 1.14 (2.0 - 7.4)	39.7 ± 24.05 (5.0 - 90.0)
4	19	2.2 ± 0.14 (2.0 - 2.6)	36.6 ± 20.00 (5.0 - 65.0)
5	48	4.8 ± 1.38 (2.3 - 7.8)	60.6 ± 20.18 (25.0 - 90.0)
6	11	5.9 ± 2.65 (2.4 - 9.0)	62.1 ± 29.70 (20.0 - 100.0)
7	0	--	25.0 ± 23.87 (5.0 - 75.0)
8	33	3.9 ± 1.85 (2.0 - 8.7)	89.3 ± 14.24 (50.0 - 100.0)
9	45	3.3 ± 1.10 (2.0 - 5.7)	87.3 ± 13.31 (50.0 - 98.0)
10	82	3.0 ± 0.91 (2.0 - 5.6)	69.4 ± 28.67 (10.0 - 98.0)
11	4	2.3 ± 0.18 (2.1 - 2.5)	41.5 ± 25.19 (5.0 - 90.0)
12	0	--	44.4 ± 21.05 (10.0 - 85.0)
13	17	4.1 ± 1.67 (2.0 - 8.7)	52.2 ± 28.11 (5.0 - 85.0)
14	89	4.5 ± 1.63 (2.0 - 7.5)	80.2 ± 1[illegible].73 (40.0 - 100.0)
15	109	2.9 ± 0.52 (2.0 - 4.2)	24.5 ± 27.74 (3.0 - 90.0)
16	23	4.8 ± 1.95 (2.1 - 7.7)	94.9 ± 3.97 (83.0 - 99.5)
17	28	6.1 ± 1.99 (3.1 - 9.4)	96.4 ± 3.71 (85.0 - 99.8)
18	0	--	46.3 ± 20.45 (0.0 - 75.0)
19	8	2.6 ± 0.58 (2.0 - 5.9)	36.9 ± 25.01 (5.0 - 85.0)
20	73	3.0 ± 0.92 (2.0 - 5.9)	88.6 ± 11.55 (50.0 - 97.0)
21	0	--	11.8 ± 10.08 (3.0 - 45.0)

TABLE 8. Summary of hydrological data during the seven month wet season from April to October during 1978 and 1979.

Plot No.	% Time flooded during wet season	% Area flooded Mean ± S.D.	Water depth (mm) Mean ± S.D.
1	0	--	--
2	27	60.2 ± 45.9	65.6 ± 51.5
3	4	22.5 ± 9.6	45.7 ± 12.7
4	0	--	--
5	8	23.1 ± 14.9	41.7 ± 28.1
6	27	53.4 ± 40.4	38.1 ± 38.0
7	42	69.1 ± 41.1	85.4 ± 71.8
8	27	46.4 ± 20.7	73.2 ± 40.3
9	0	--	--
10	0	--	--
11	31	87.4 ± 32.4	108.3 ± 62.7
12	54	84.2 ± 76.7	57.4 ± 41.5
13	38	63.0 ± 42.2	77.0 ± 61.9
14	65	43.3 ± 34.7	66.7 ± 81.6
15	38	50.3 ± 18.5	86.9 ± 83.1
16	38	69.9 ± 41.6	81.0 ± 55.2
17	42	47.0 ± 38.5	61.5 ± 48.0
18	46	59.1 ± 34.3	60.2 ± 45.1
19	69	85.1 ± 17.9	83.1 ± 44.7
20	15	41.1 ± 41.2	62.8 ± 63.6
21	46	89.0 ± 25.7	71.7 ± 33.7

The percentages of time during the wet season that each study plot was flooded was calculated based on bimonthly visits during the seven month wet season from April to October. Plot 19, which was inundated for more of the wet season than other plots, was covered with water 69% of the wet season. The area covered by standing water varied with water depth and local topography. When water depth was relatively high, 100% of the area of some plots were inundated. Water depth was greatest (108.3 mm) in Plot 11.

Community Structure, Agricultural History, Soil Type and Hydrology

Results of Mann Whitney U tests showing the relationship of rockplowing, furrowing, soil type, standing water, time of abandonment and shade (canopy/no canopy) on aspects of community structure are summarized in Table 9. With the exception of canopy absence there were no significant relationships ($p > 0.05$) of these parameters on the number of species, diversity (H'), evenness (e) or percentage of exotics. Figure 7 illustrates that species richness is greater when no canopy exists ($p < 0.01$).

The Effects of Exotic Species

The effects of the number of exotic species and the number of exotic individuals on total species richness, evenness (e) and diversity (H') in all study plots is presented in Table 10. The number (presence or absence) of exotic species does not affect richness, diversity, or evenness ($p > 0.05$). Species richness decreases as the percentage of exotics, calculated as the number of exotics divided by the total number of species, increases ($p < 0.05$)

TABLE 9. Results of Mann Whitney U tests comparing study plots for rockplowing/nonrockplowing, rockdale loam/marl, furrows/no furrows, standing water/no standing water, early (1940, 1950)/late (1960, 1970) abandonment, and canopy/no canopy.

	Rockplow	Furrows	Soil Type	Standing Water	Time of Abandonment	Canopy/No Canopy
Species Richness	n.s.	n.s.	n.s.	n.s.	n.s.	*
Diversity (H')	n.s.	n.s.	n.s.	n.s.	n.s.	*
Evenness (e)	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
% Exotics 1	n.s.	n.s.	n.s.	n.s.	n.s.	n.s.
% Exotics 2	n.s.	n.s.	n.s.	n.s.	n.s.	*

* $.01 < p < .05$
n.s. = no significant difference.
% Exotics 1 is the percentage of the number of exotic species compared to the total number of species present.
% Exotics 2 is the number of individuals of exotic species compared to the total number of individuals of all species.

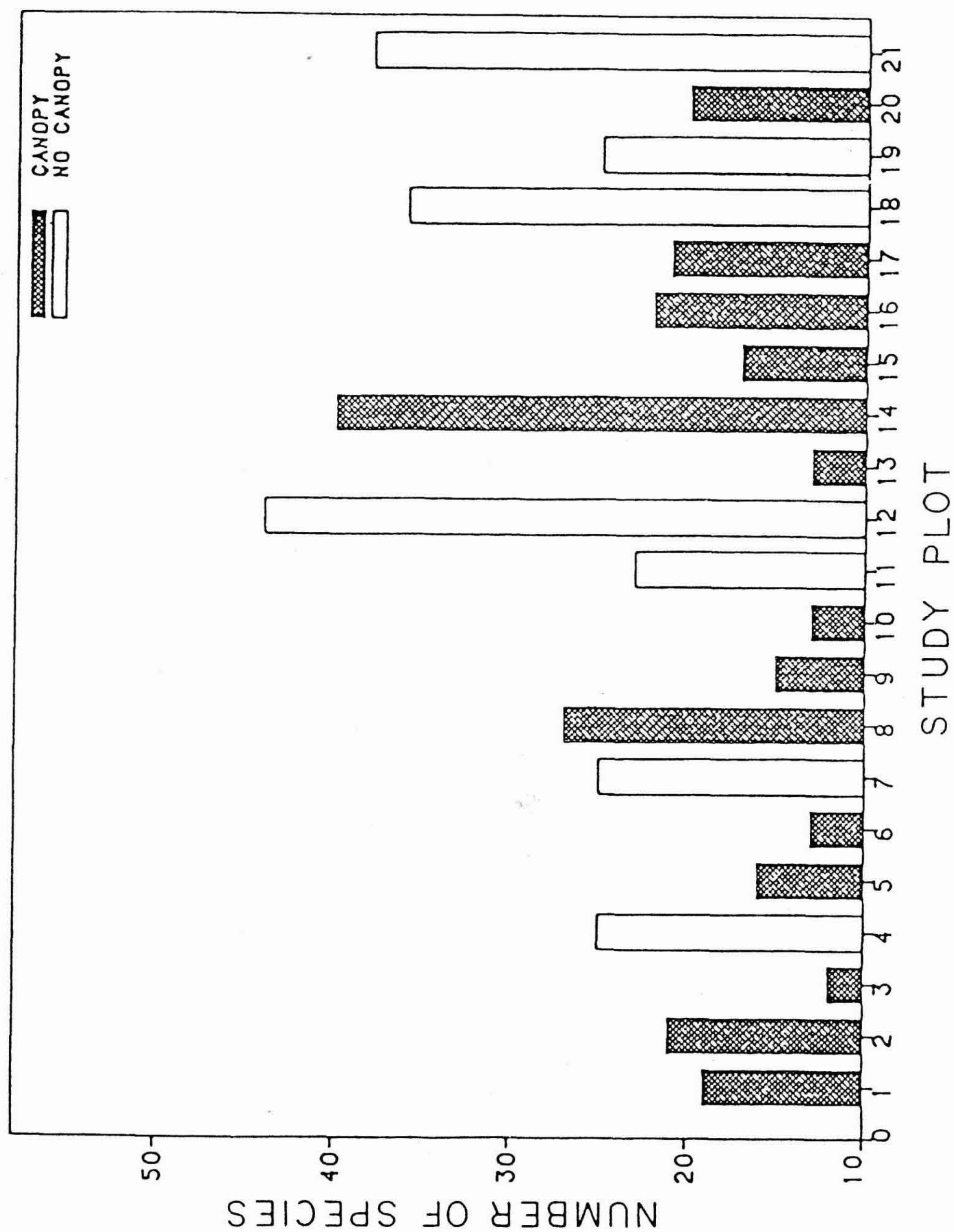

FIGURE 7. The relationship between canopy presence or absence and the number of species.

TABLE 10. Summary of linear regression analyses.

X	Y	Significance level	r
Number of exotic species	Richness	n.s.	-0.14
Number of exotic species	Evenness	n.s.	-0.20
Number of exotic species	Diversity	n.s.	-0.14
% exotics 1	Richness	0.05	-0.48
% exotics 1	Evenness	n.s.	-0.10
% exotics 1	Diversity	n.s.	-0.30
% exotics 2	Richness	0.01	-0.58
% exotics 2	Evenness	0.05	-0.53
% exotics 2.	Diversity	0.001	-0.64

n.s. = no significant difference ($p < 0.05$).

% exotics 1 is the percentage of the number of exotic species compared to the total number of species present.

% exotics 2 is the number of individuals of exotic species compared to the total number of individuals of all species.

(Fig. 8). Species richness, evenness, and diversity decrease as % Exotics 2 increases (Figs. 9, 10, 11).

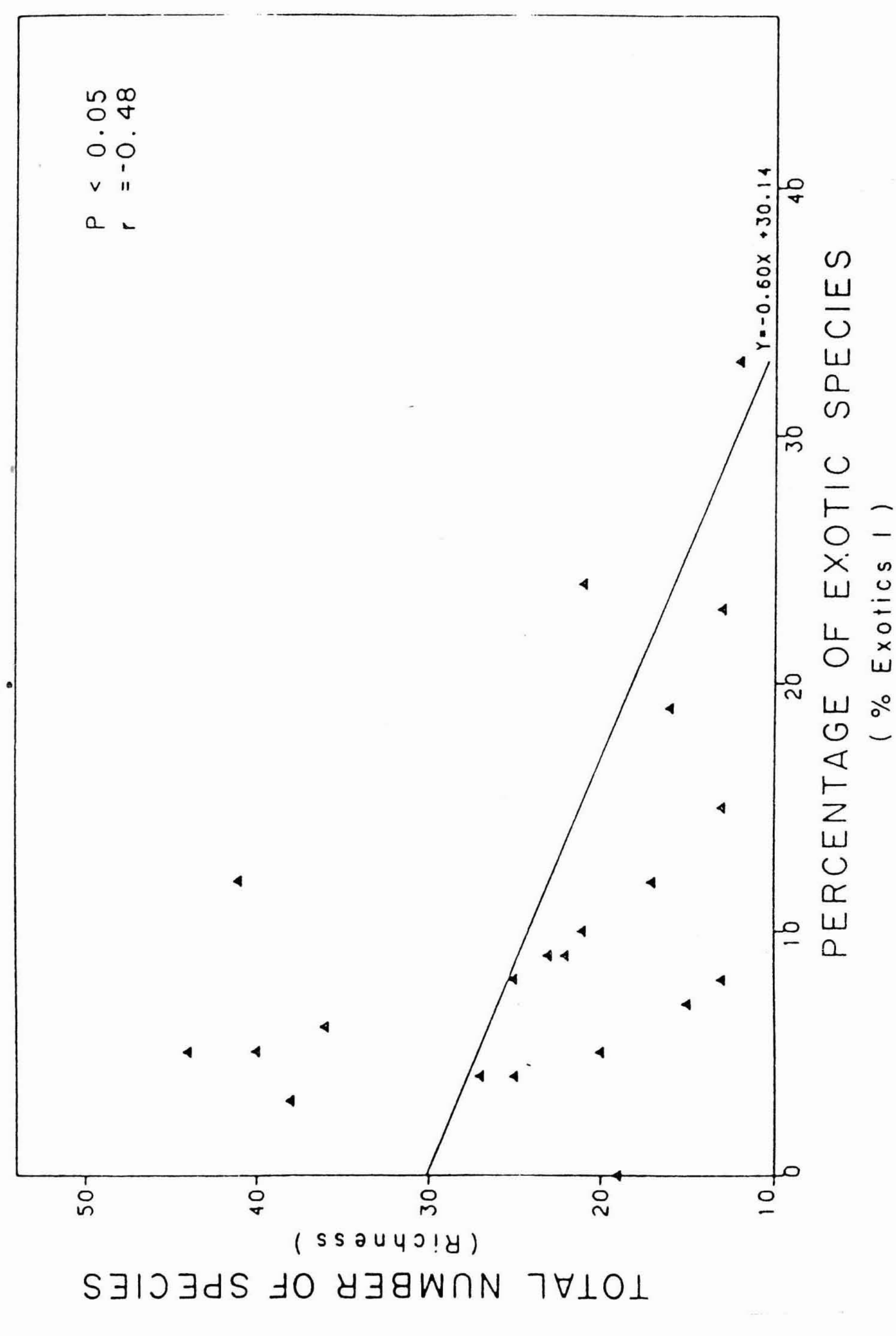

FIGURE 8. Linear regression of percentage of exotic species against total number of species (df = 19).

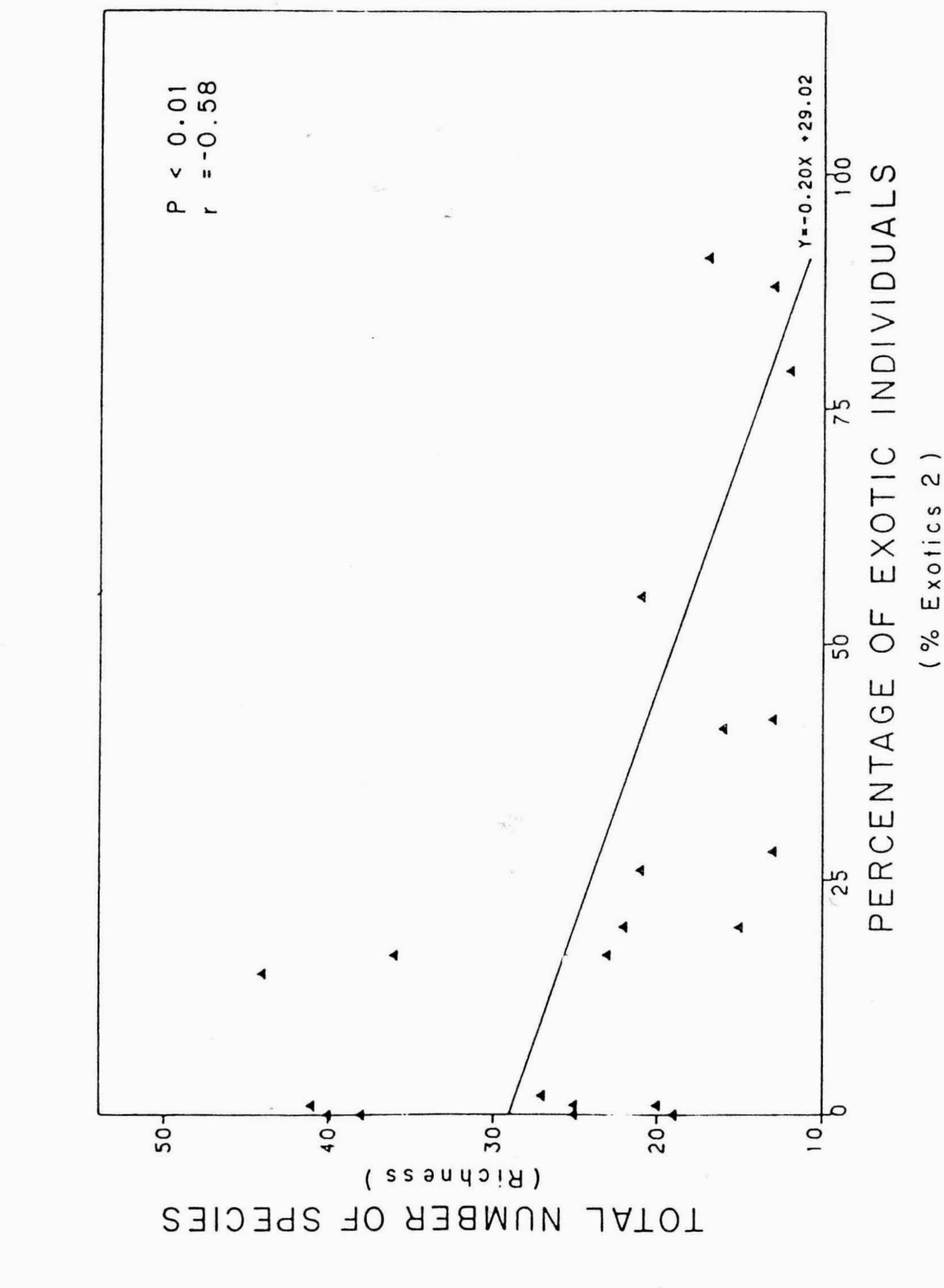

FIGURE 9. Linear regression of percentage of exotic individuals against total number of species (df = 19).

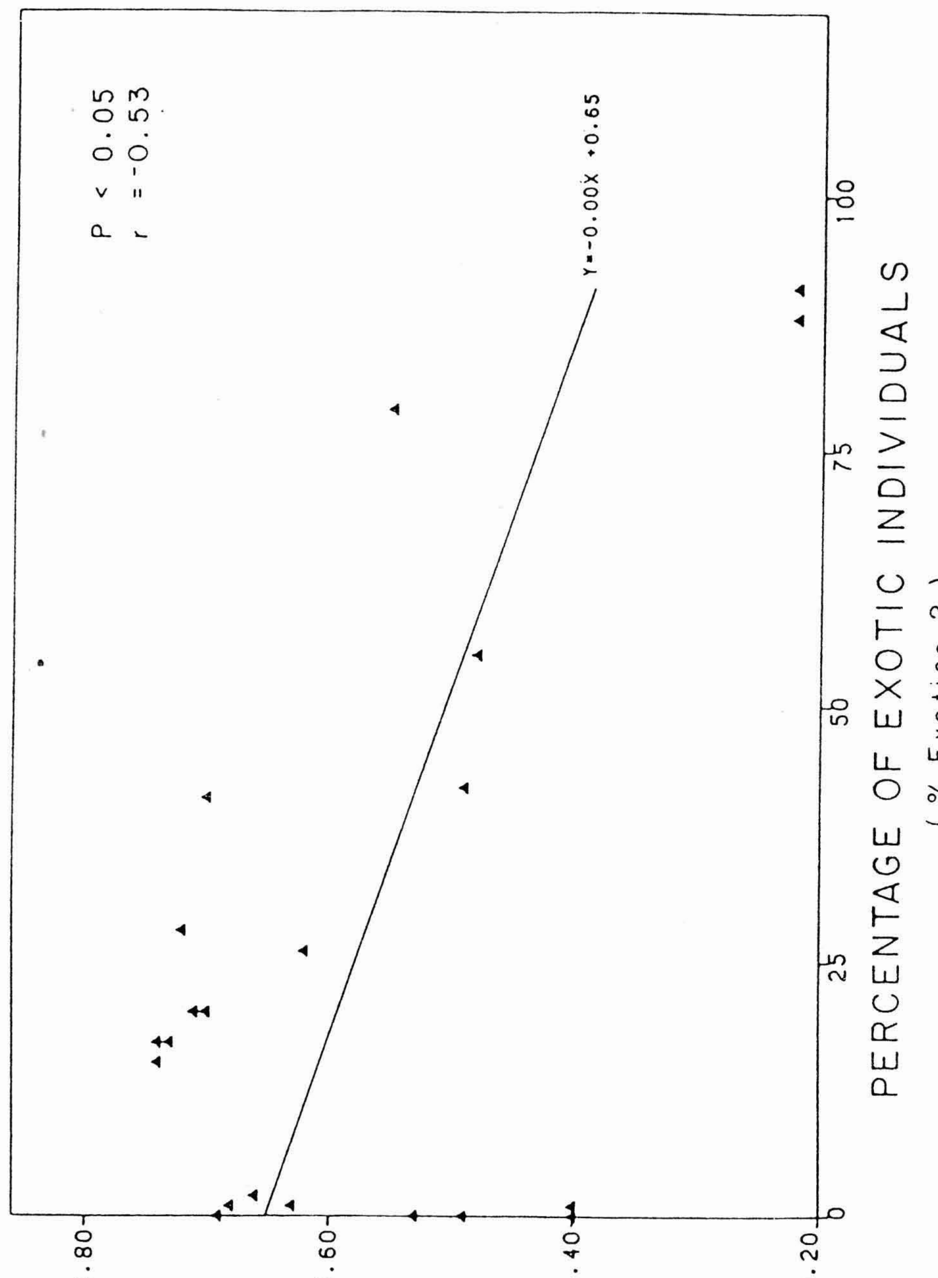

FIGURE 10. Linear regression of percentage of exotic individuals against species evenness (df = 19).

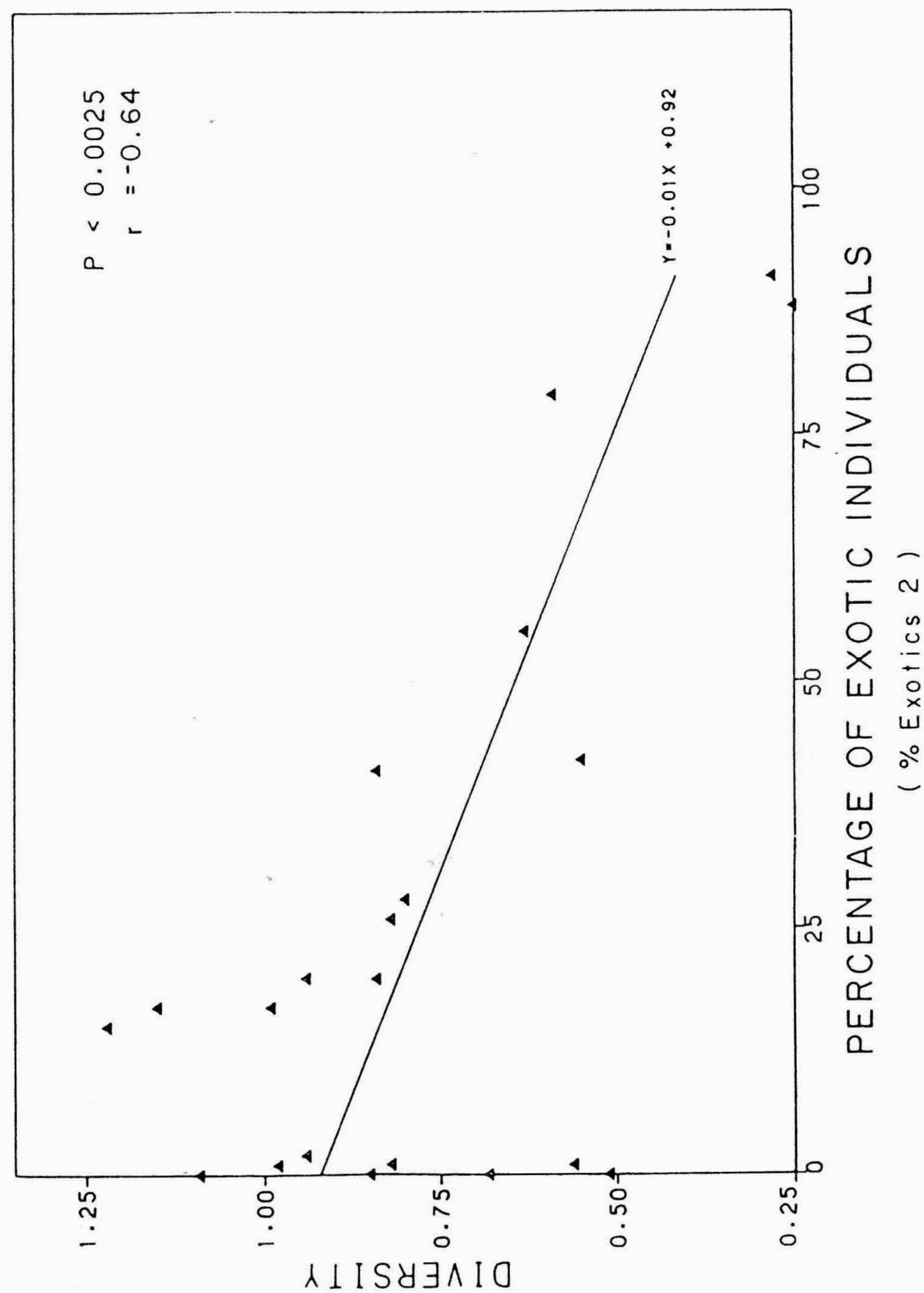

FIGURE 11. Linear regression of percentage of exotic individuals against species diversity (df = 19).

ACKNOWLEDGEMENTS

I am particularly grateful to my major advisor, Dr. D. F. Austin, whose persistent guidance and cooperation allowed me to complete my thesis. I am grateful to Drs. R. Adams, T. Sturrock and M. Boss for their advice and critical input.

I am thankful to Dr. L. Loope and Dr. G. Hendrix of the South Florida Research Center, Everglades National Park, for providing me the research position that gave me the opportunity to perform the study. I appreciate the field assistance from N. Urban, L. McNabb, R. Bruckbauer, and R. Russell. G. Avery provided invaluable assistance in plant identification.

I am indebted to M. McMahon, Dr. F. Mazzotti, and N. Gillies for their numerous suggestions and assistance.

Special thanks is due to J. Cowart of Environmental Science and Engineering, Inc., and to Metcalf and Eddy, Inc., for allowing the flexibility in my employment status to complete my thesis.

I am indebted to B. Bohnsack for typing the manuscript and A. Lewis for graphics preparation.

I am thankful to my fellow graduate studies, J. Jones and C. Nauman.

nearly pure stands with Myrica, Ilex, and Persea slowly colonizing. In general, findings of this study confirm these predicted trends.

The vegetation in the Hole-in-the-Donut provides the opportunity to evaluate and predict successional trends. The present mosaic in the study site with the exception of the western portion of the Donut and along the Old Ingraham Highway does not resemble the pre-farming vegetation mosaic which was dominated by prairie. The existing communities on abandoned farmland in the Donut consist of a mixture of successional assemblages including early successional stages (less than ten years after abandonment), which have been thoroughly described by Hilsenbeck (1976) and Loope and Dunevitz (1981), as well as older successional associations. These older successional associations were most intensively inventoried in the present study. Study sites considered as early successional assemblages in the present study are typified as Baccharis-Boehmeria Subforest and Baccharis Forest. Study sites considered as older successional assemblages are typified as Myrica Forest, Schinus-Baccharis Subforest, Mixed Psidium Forest, Schinus Forest, Ludwigia-Graminoid Association, Ilex-Myrica Forest, Myrica-Schinus Forest, Baccharis Glade, Mesic Prairie, Mixed Successional Forest, Ilex Forest, Mixed Furrowed Prairie, and Early Successional Glade. Each of these associations has been characterized in the study plot descriptions.

The vegetation associations described as successional forest and represented by groups A and B in the cluster analysis shown in Figure 5 are either dominated by a mix of canopy species or by one to two species. Forest dominance by species does not appear to be due to a result of differences in farming history, hydrological differences or substrate variations, but most likely seed storage or proximity to a seed source. The presence of dominant canopy species in each size class (Table 3) in the study plots indicates that the successional forests are maintaining themselves. These successional forest assemblages, referred to by Alexander and Crook (1973), Ewel et al. (1982), and Loope and Dunevitz (1981) are likely final stages in secondary succession.

The two associations described as subforest and represented as group C in the cluster analysis shown in Figure 5 occur on sites that were abandoned in the 1960's and 1970's. Although other study sites abandoned at about the same time support forest associations, the species complement of Plot 2 (Schinus-Baccharis Subforest) and Plot 4 (Baccharis-Boehmeria Subforest) of group C suggest that forest associations also will eventually dominate these sites. The reasons for the more retarded ecosystem development at these sites is not apparent. Based on species composition, Baccharis Glade, like the subforest associations, seem to represent an intermediate step in the successional process. This association however, more closely resembles the original prairie than the subforests that occupy former prairie and pineland.

The study plots typified as Mesic Prairie, Mixed Furrowed Prairie and Early Successional Glade represented by cluster group D (Fig. 5) resemble the pre-farming prairie more than other study plots. The Mesic Prairie and Mixed Furrowed Prairie have been undisturbed since the 1940's. The Early Successional Glade, previously occupied by successional forest, but bulldozed in the early 1970's, has a species complement resembling plots that have been relatively undisturbed. The species composition and distribution in Plot 7 typified as *Ludwigia*-Graminoid Association most closely resembles a sere described by Egler (1952) which he suggests may revert to a sawgrass prairie as a result of fire. The management treatment used on this relatively small area has altered the successional pattern. The untreated adjacent area where Plot 3 is located remains occupied by forest.

The presence of *Baccharis* spp. or *Ludwigia octovalvis* in all study plots that have no canopy suggests that future development into successional forest is likely. Potential exceptions are study Plots 12 (Mesic Prairie) and 18 (Mesic Prairie) which both resemble the original prairie community. The presence of *Baccharis* which is not routinely common in the surrounding prairie suggests that farming disturbance has initiated some subsequent succession. These plots have been abandoned since 1940 and the substrate has not been subsequently aerated or disturbed. It is understandable, therefore, that the rate of succession in these plots is very slow and edaphic conditions as well as relative distance to successional forest seed sources may inhibit further succession. Other plots that were abandoned in the same time period but were proximal to seed sources of successional species eventually became dominated by successional forest.

Before farming, the vegetation of the Donut was 80% prairie, 7% glade, 2% ponds, 9% slash pine community (Pinus elliotti var. densa) with the rest either hammock or bayhead (Hilsenbeck, 1976; Resources Management, 1976).

The community structure of the successional vegetation studied exhibits a different species complement than the surrounding communities or the communities which originally occupied the area. Olmsted, Loope and Rintz (1980) report that Muhlenbergia prairies in the Taylor Slough area adjacent to the Donut are composed of nearly 100 plant species. Long (1974) reports 172 species occupy wet prairies in southern Florida. Loope et al. (1979) report that the pineland shrub understory in the Long Pine Key area is composed of 30 to 40 species and an herbaceous understory of 100 species. Olmsted, Loope and Hilsenbeck (1980) report 200 vascular plant species in hammocks nearly half of which are trees and shrubs. A preliminary checklist of vascular plants in the Donut (Krauss 1979) includes over 260 species. These include species that commonly occur in the surrounding pinelands, hammocks, prairies, and glades. Although the species composition in all the successional study plots totalled 139, only eleven species occur in the canopy of all plots. Fifty-one species occur in the intermediate size class, many being primarily herbaceous rather than shrubs.

In the successional assemblages inventoried, where canopy development has occurred, species richness is low. The time required for forest development is not necessarily related to the time of agricultural abandonment. Successional assemblages with vertical stratification that includes a canopy have lower species richness. Loope and Dunevitz (1981) report a tentative increase in shrubby vegetation in areas abandoned between 1973 and 1975. They also report an increase of Schinus five years after abandonment with a nearly twenty-fold increase between 1977 and 1978. Assuming that this is representative of all past farming, non-forested assemblages in the Donut, the area dominated by successional forest will gradually increase while species richness will decrease.

The ecology of Schinus terebinthifolius and its role in the Donut has been studied by Ewel et al. (1982). Although Schinus is the most abundant exotic species in the Donut, the combined effect of all exotic species has been evaluated. As the frequency of exotics increase, species richness, evenness, and diversity decreases.

Schinus was first noted in the Royal Palm area in Everglades National Park in the 1940's (Bancroft, 1973). It became a component of post-farming successional forests. Because of the extremely aggressive nature of Schinus and its established presence in the Donut, areas that are now dominated by shrubs and subforest assemblages will probably become dominated by Schinus forests similar to Plots 5 and 6 (Schinus Forest). The only sites that will become mixed successional forests are probably those in which other successional forest species establish before Schinus.

Since the release from farming, successional forest and the seres leading to it have become new components in the vegetational history of the Donut. In fact, successional forest is a relatively new community in southern Florida. Prior to the introduction of exotics, literature describing southern Florida communities (Davis, 1943; Egler, 1952; Craighead, 1971) did not mention this type of successional association. The results of this research together with the findings of Ewel *et al*. (1982), Hilsenbeck (1976), and Loope and Dunevitz (1981) indicate that the defined successional assemblages should be considered a community, together with other historical communities such as hammocks, pinelands, and prairies, in the southern Florida ecosystem. This community is most appropriately termed Successional Forest. It is characterized by a well-developed canopy with low species richness and variable composition that is self-maintaining.

The specific composition and environmental qualities of a site are not the defining characters. Successional Forests occur with varying disturbance history. In the Donut, the Successional Forest canopies are composed of a mix or dominance by the following species: *Schinus terebinthifolius*, *Psidium quava*, *Persea borbonia*, *Myrsine quianensis*, *Ilex cassine*, *Baccharis halimifolia*, and *Myrica cerifera*. Outside of Everglades National Park, Successional Forest may be dominated by exotic or native species including: *Melaleuca quinquenervia*, *Casuarina equisetifolia*, *Laguncularia racemosa*, and *Albizzia lebbeck*.

CONCLUSIONS

1. The findings of this study generally confirm the successional trends predicted by Hilsenbeck (1976) and Loope and Dunevitz (1981).

2. With limited exceptions, post-farming vegetation patterns do not resemble the prefarming vegetation mosaic.

3. Vegetation dominance does not appear to be a result of differences in farming history, hydroperiod or substrate variation.

4. If present community relationships persist, as the frequency of exotics increase, species richness, evenness and diversity will decrease.

5. Successional forest is a relatively new community in southern Florida and should be considered in a context along with communities such as hammocks, pinelands and prairies.

6. It is likely that the area occupied by successional forest will gradually increase while species richness will gradually decrease.

7. Successional forests are likely final stages in secondary succession after farming.

ACKNOWLEDGEMENTS

I am particularly grateful to my major advisor, Dr. D. F. Austin, whose persistent guidance and cooperation allowed me to complete my thesis. I am grateful to Drs. R. Adams, T. Sturrock and M. Boss for their advice and critical input.

I am thankful to Dr. L. Loope and Dr. G. Hendrix of the South Florida Research Center, Everglades National Park, for providing me the research position that gave me the opportunity to perform the study. I appreciate the field assistance from N. Urban, L. McNabb, R. Bruckbauer, and R. Russell. G. Avery provided invaluable assistance in plant identification.

I am indebted to M. McMahon, Dr. F. Mazzotti, and N. Gillies for their numerous suggestions and assistance.

Special thanks is due to J. Cowart of Environmental Science and Engineering, Inc., and to Metcalf and Eddy, Inc., for allowing the flexibility in my employment status to complete my thesis.

I am indebted to B. Bohnsack for typing the manuscript and A. Lewis for graphics preparation.

I am thankful to my fellow graduate studies, J. Jones and C. Nauman.

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APPENDIX 1. Species composition in each study plot. Nomenclature is in accord with Avery and Loope (1980). (E = exotic species).

SPECIES	PRESENCE IN SIZE CLASS 1	2	3
PLOT 1			
Ardisia escallonioides	*	*	
Baccharis halimifolia	*	*	
Boehmeria cylindrica	*		
Bumelia salicifolia		*	
Forestiera segregata var. *pinetorum*		*	
Guettarda scabra		*	
Ilex cassine	*		
Ipomoea indica	*		
Metopium toxiferum		*	
Morinda royoc	*		
Myrica cerifera	*		*
Myrsine floridana		*	*
Nectandra coriacea		*	
Parthenocissus quinquefolia	*		
Passiflora suberosa	*		
Psidium longipes	*		
Psychotria sulzneri	*		
Tetrazygia bicolor	*	*	
Vitis munsoniana	*		
Total	13	9	2

SPECIES		PRESENCE IN SIZE CLASS 1	2	3
PLOT 2				
Andropogon glomeratus		*	*	
Baccharis halimifolia			*	*
Boehmeria cylindrica		*	*	
Cyperus ligularis	E	*	*	
Galium obtusum var. *floridanum*		*		
Hydrocotyle umbellata		*		
Ludwigia microcarpa		*		
Ludwigia octovalvis ssp. *octovalvis*		*	*	
Macroptilium lathyroides	E	*		
Mikania scandens		*		
Parthenocissus quinquefolia		*		
Phyla nodiflora	E	*		
Pluchea rosea			*	
Sarcostemma clausum	E	*		
Schinus terebinthifolius	E	*	*	*
Setaria geniculata		*		
Solidago sempervirens var. *mexicana*		*		
Spermacoce assurgens		*		
Verbena scabra		*		
Vicia acutifolia		*		
Vigna luteola		*		
Total		19	7	2

APPENDIX 1.

SPECIES		PRESENCE IN SIZE CLASS 1	2	3
PLOT 3				
Acrostichum danaeifolium		*	*	
Ardisia solanacea	E	*	*	
Hypericum hypericoides				
var. *hypericoides*			*	
Myrica cerifera				*
Myrsine floridana			*	*
Persea borbonia		*		
Boehmeria cylindrica			*	
Schinus terebinthifolius	E		*	
Thelypteris kunthii		*	*	
Trismeria trifoliata	E	*	*	
	Total	7	8	3
PLOT 5				
Acrostichum danaeifolium		*	*	
Ardisia solanacea	E	*		
Baccharis halimifolia		*	*	
var. *drummondiana*			*	
Boehmeria cylindrica			*	
Ilex cassine		*		
Myrica cerifera		*	*	
Myrsine floridana		*	*	*
Parthenocissus quinquefolia			*	

SPECIES		PRESENCE IN SIZE CLASS 1	2	3
PLOT 4				
Ambrosia artemisiifolia		*	*	
Ampelopsis arborea		*		
Andropogon glomeratus		*		
Baccharis halimifolia		*	*	*
Bidens alba		*	*	
Boehmeria cylindrica		*	*	
Chamaesyce hyssopifolia		*		
Commelina diffusa	E	*		
Diodia virginiana		*	*	
Eupatorium capillifolium		*		
Eupatorium coelestinum		*		
Galium obtusum var. *floridanum*		*		
Ludwigia octovalvis				
ssp. *octovalvis*		*	*	
Lythrum lineare		*	*	
Melothria pendula		*		
Mikania scandens		*		
Parthenocissus quinquefolia		*	*	
Psidium longipes			*	
Schinus terebinthifolius	E	*	*	
Sida acuta		*	*	
Spermacoce assurgens		*		
Spermacoce prostrata		*		
Thelypteris kunthii		*	*	

APPENDIX 1.

SPECIES		PRESENCE IN SIZE CLASS 1	2	3
PLOT 5 (Cont.)				
Persea borbonia				*
Psidium guajava	E		*	
Psychotria nervosa		*		
Cissus sicyoides		*		
Psidium guajava	E	*		*
Bidens alba		*		
Psychotria sulzneri		*		
Schinus terebinthifolius	E	*		
Thelypteris kunthii		*	*	
Toxicodendron radicans		*	*	
	Total	12	9	2
PLOT 7				
Ammannia latifolia		*		
Andropogon glomeratus		*	*	
Aster dumosus		*		
Aster tenuifolius		*		
Baccharis halimifolia			*	
Bacopa monnieri		*		
Boehmeria cylindrica		*	*	
Centella asiatica	E	*		
PLOT 4 (Cont.)				
Vigna luteola		*		
Vitis aestivalis		*		
	Total	24	12	1
PLOT 6				
Ardisia solanacea	E		*	
Boehmeria cylindrica		*	*	
Hydrocotyle umbellata		*		
Ilex cassine		*		
Myrica cerifera		*		
Myrsine floridana		*	*	
Parthenocissus quinquefolia		*		
Persea borbonia			*	
Psidium guajava	E	*	*	*
Psychotria sulzneri			*	
Schinus terebinthifolius	E	*	*	*
Thelypteris kunthii		*	*	
Toxicodendron radicans		*		
	Total	10	8	2
PLOT 8				
Acrostichum danaeifolium			*	
Ampelopsis arborea		*	*	

APPENDIX 1.

SPECIES		PRESENCE IN SIZE CLASS		
		1	2	3
PLOT 7 (Cont.)				
Cynoctonum mitreola		*		
Cyperus ligularis	E	*	*	
Cyperus surinamensis		*		
Dichromena colorata		*		
Diodia virginiana		*		
Eleocharis caribaea		*		
Erigeron quercifolius		*		
Eupatorium coelestinum		*		
Galium obtusum var. *floridanum*		*		
Hydrocotyle umbellata		*		
Juncus megacephalus		*	*	
Ludwigia alata		*		
Ludwigia microcarpa		*		
Ludwigia octovalvis ssp. *octovalvis*		*	*	
Ludwigia repens		*		
Lythrum lineare		*	*	
Mikania scandens		*		
Muhlenbergia filipes		*		
Panicum bartowense		*		
Phyla nodiflora	E	*		
Pluchea odorata		*	*	
Proserpinaca palusris var. *palustris*		*		
Rhynchosia minima	E	*		
Setaria geniculata		*		

SPECIES		PRESENCE IN SIZE CLASS		
		1	2	3
PLOT 8 (Cont.)				
Baccharis halimifolia		*	*	*
Boehmeria cylindrica		*	*	
Crinum americanum		*		
Eugenia axillaris		*		
Eupatorium coelestinum		*		
Habenaria odontopetala		*		
Hypericum hypericoides var. *hypericoides*		*		
Hyptis alata var. *stenophylla*		*	*	
Ilex cassine		*	*	*
Kosteletzya virginiana			*	
Metopium toxiferum				*
Mikania scandens		*		
Myrica cerifera		*	*	*
Myrsine floridana		*	*	*
Panicum joorii		*		
Parthenocissus quinquefolia		*		
Persea borbonia		*	*	*
Psychotria sulzneri		*	*	
Schinus terebinthifolius	E	*	*	*
Tetrazygia bicolor			*	
Thelypteris kunthii		*	*	
Toxicondendron radicans		*	*	
Vitis munsoniana		*		
Zeuxine strateumatica	E	*		
Total		22	15	7

APPENDIX 1.

SPECIES		PRESENCE IN SIZE CLASS 1	2	3
PLOT 7 (Cont.)				
Sisyrinchium miamiense		*		
Solidago sempervirens var. mexicana		*		
Spermacoce tetraquetra		*		
Spilanthes americana		*		
Trismeria trifoliata	E		*	
Vicia acutifolia		*		
Vigna uteola		*		
Zeuxine strateumatica	E	*		
	Total	38	9	0
PLOT 9				
Andropogon glomeratus		*		
Baccharis glomeruliflora		*	*	*
Bidens alba		*	*	
Bumelia salicifolia		*		
Ludwigia octovalvis ssp. octovalvis		*		
Metopium toxiferum		*		
Morinda royoc			*	
Myrica cerifera		*	*	*
Parthenocissus quinquefolia		*		
Psychotria sulzneri			*	

SPECIES		PRESENCE IN SIZE CLASS 1	2	3
PLOT 10				
Andropogon glomeratus		*		
Baccharis halimifolia		*	*	*
Boehmeria cylindrica		*	*	
Eupatorium coelestinum		*	*	
Hypericum hypericoides var. hypericoides		*		
Ilex cassine		*		*
Myrica cerifera			*	*
Myrsine floridana		*		*
Psychotria sulzneri			*	
Schinus terebinthifolius	E	*	*	*
Spermacoce assurgens		*		
Thelyptens kunthii		*	*	
Vitis aestivalis		*		
	Total	11	7	5
PLOT 12				
Andropogon glomeratus		*	*	
Baccharis halimiflora		*	*	
Bacopa monnieri		*		
Boehmeria cylindrica			*	
Centella asiatica	E	*		
Cirsium horridulum		*		

APPENDIX 1.

SPECIES		PRESENCE IN SIZE CLASS 1	2	3
PLOT 9 (Cont.)				
Schinus terebinthifolius	E	*	*	*
Spermacoce assurgens		*		
Tetrazygia bicolor		*		
Thelypteris kunthii			*	
Vitis munsoniana		*		
	Total	12	7	3
PLOT 11				
Acacia pinetorum			*	
Andropogon glomeratus		*	*	
Baccharis halimiflora		*	*	*
Caperonia casteneifolia		*		
Cyperus ligularis		*		
Dichromena colorata		*		
Diodia virginiana		*		
Erigeron quercifolius		*		
Eupatorium capillifolium			*	
Eupatorium coelestinum		*	*	
Ludwigia octovalvis ssp. octovalvis		*		
Ludwigia microcarpa		*		
Lythrum lineare			*	
Melanthera angustifolia		*		

SPECIES	PRESENCE IN SIZE CLASS 1	2	3
PLOT 12 (Cont.)			
Cladium jamaicensis	*	*	
Crinum americanum	*		
Dichromena colorata	*		
Diodia virginica	*		
Erianthus giganteus	*		
Erigeron quercifolius	*		
Eupatorium coelestinum	*	*	
Eupatorium mikaniodes		*	
Hydrocotyle umbellata	*		
Hyptis alata var. stenophylla	*	*	
Ilex cassine	*		
Ipomoea sagittata	*		
Juncus megacephalus	*		
Justicia angusta	*		
Kosteletzya virginica	*	*	
Lobelia glandulosa	*		
Ludwigia microcarpa	*		
Ludwigia octovalvis ssp. octovalvis	*		
Lythrum lineare	*		
Melanthera angustifolia	*		
Mikania scandens	*		
Muhlenbergia filipes		*	
Myrica cerifera		*	

APPENDIX 1.

SPECIES		PRESENCE IN SIZE CLASS 1	2	3
PLOT 11 (Cont.)				
Mikania scandens		*		
Phyla nodiflora	E	*		
Phyllanthus caroliniensis ssp. *saxicola*		*		
Polygonum hydropiperoides		*		
Sarcostemma clausum	E	*		
Schinus terebinthifolius	E		*	
Spermacoce assurgens		*		
Teucrium canadense var. *hypoleucum*		*	*	
Verbena scabra		*	*	
Vigna luteola		*		
	Total	20	9	1
PLOT 13				
Ampelopsis arborea		*		
Ardisia solanacea	E	*	*	
Baccharis halimifolia			*	*
Crinum americanum		*		
Ilex cassine		*		*
Myrica cerifera				*
Myrsine floridana		*	*	*
Psychotria sulzneri		*	*	

SPECIES		PRESENCE IN SIZE CLASS 1	2	3
PLOT 12 (Cont.)				
Panicum caerulescens		*		
Passiflora suberosa		*		
Phyla nodiflora	E	*		
Pluchea rosea		*		
Proserpinaca palustris var. *palustris*		*		
Rhyncospora microcarpa		*		
Scoparia dulcis		*		
Setaria geniculata		*		
Sisyrinchium miamiense		*		
Solidago leavenworthii		*		
Solidago sempervirens var. *mexicana*		*		
Spermacoce assurgens		*		
Teucrium canadense var. *hypoleucum*		*		
Thelyptens kunthii		*		
	Total	40	9	0
PLOT 14				
Acrostichum danaeifolium			*	
Andropogon glomeratus		*	*	
Annona glabra				*

APPENDIX 1.

SPECIES		PRESENCE IN SIZE CLASS 1	2	3
PLOT 13 (Cont.)				
Salix caroliniana		*		*
Schinus terebinthifolius	E	*		*
Thelypteris kunthii		*		
Vitis aestivalis		*		
Vitis munsoniana		*		
Total		11	4	6
PLOT 15				
Alternanthera philoxeroides	E	*		
Andropogon glomeratus		*	*	
Baccharis halimifolia		*	*	*
Boehmeria cylindrica var. drummondiana		*		
Commelina diffusa	E	*		
Cyperus surinamensis			*	
Erechtites hieracifolia var. hieracifolia		*		
Erigeron quercifolius		*		
Galium obtusum var. floridanum		*		
Guettarda elliptica		*		
Ludwigia octovalvis ssp. octovalvis		*	*	
Myrica cerifera		*		

SPECIES		PRESENCE IN SIZE CLASS 1	2	3
PLOT 14 (Cont.)				
Ardisia solanacea	E	*	*	
Aster caroliniensis		*		
Baccharis halimifolia		*	*	*
Boehmeria cylindrica		*		
Chrysobalanus icacco		*		
Cladium jamaicensis		*	*	
Crinum americanum		*		
Dichromena colorata		*		
Diodia virginica		*		
Eupatorium coelestium		*		
Hyptis alata			*	
Ilex cassine		*	*	*
Ipomoea sagittata		*		
Justicia angusta		*		
Kosteletzya virginica			*	
Ludwigia alata		*		
Ludwigia microcarpa		*		
Ludwigia octovalvis ssp. octovalvis		*	*	
Ludwigia spathulifolia		*		
Metopium toxiferum			*	
Mikania scandens		*		
Myrica cerifera		*		
Myrsine floridana		*	*	

APPENDIX 1.

SPECIES		PRESENCE IN SIZE CLASS 1	2	3
PLOT 15 (Cont.)				
Phyllanthus amarus		*		
Pluchea rosea		*		
Sesbania exaltata			*	
Solidago sempervirens				
var. mexicana		*		
Thelypteris kunthii		*	*	
	Total	15	6	1
PLOT 17				
Acrostichum danaeifolium			*	
Ampelopsis arborea		*		
Ardisia solanacea	E	*	*	
Baccharis halimifolia		*	*	*
Boehmeria cylindrica				
var. drummondiana		*	*	
Diodia virginiana		*		
Eupatorium coelestinum		*		
Ficus aurea			*	
Hydrocotyle verticillata		*		
Hypericum hypericoides				
var. hypericoides			*	
Ilex cassine		*		*
Myrica cerifera			*	*
Myrsine floridana		*	*	*

SPECIES		PRESENCE IN SIZE CLASS 1	2	3
PLOT 14 (Cont.)				
Panicum hemitomon		*		
Parthenocissus quinquefolia		*		
Persea borbonia		*	*	*
Phyla nodiflora	E	*		
Pluchea rosea			*	
Proserpinaca palustris				
var. palustris		*		
Rhynchospora inundata		*		
Salix caroliniana		*		*
Solidago leavenworthii		*		
Teucrium canadense				
var. hypoleucum		*		
Thelypteris kunthii		*		
Tillandsia fasciculata		*		
Utricularia biflora		*		
Vigna luteola		*		
	Total	34	13	5
PLOT 16				
Ampelopsis arborea		*	*	
Ardisia solanacea	E	*	*	
Baccharis halimifolia		*	*	*
Boehmeria cylindrica		*	*	
Bumelia celastrina			*	

APPENDIX 1.

SPECIES		PRESENCE IN SIZE CLASS 1	2	3
PLOT 17 (Cont.)				
Panicum joorii		*		
Parthenocissus quinquefolia		*		
Persea borbonia		*	*	*
Psychotria sulzneri		*	*	
Salix caroliniana				*
Schinus terebinthifolius	E	*		*
Thelypteris kunthii			*	
Vitis aestivalis		*		
Total		14	11	7
PLOT 19				
Acrostichum danaeifolium			*	
Ammannia latifolia			*	
Andropogon glomeratus		*	*	
Baccharis halimifolia		*	*	*
Cephalanthus occidentalis		*		
Cladium jamaicensis		*	*	
Cyncotonum mitreola		*	*	
Dichromena colorata		*		
Eupatorium coelestinum		*		
Eustachys glauca			*	
Ilex cassine		*		
Justicia angusta		*		
Ludwigia alata		*		

SPECIES		PRESENCE IN SIZE CLASS 1	2	3
PLOT 16 (Cont.)				
Crinum americanum		*		
Hydrocotyle verticillata		*		
Hypericum hypericoides var. hypericoides		*	*	
Ilex cassine		*	*	*
Ludwigia octovalvis ssp. octovalvis			*	
Myrica cerifera		*	*	*
Myrsine floridana			*	
Parthenocissus quinquefolia		*		
Persea borbonia		*	*	*
Psychotria sulzneri		*	*	
Rhynchospora inundata			*	
Salix caroliniana			*	
Schinus terebinthifolius	E	*	*	
Teucrium canadense var. hypoleucum			*	
Thelypteris kunthii			*	
Toxicodendron radicans		*		
Vitis aestivalis			*	
Total		14	18	4

APPENDIX 1.

SPECIES		PRESENCE IN SIZE CLASS 1	2	3
PLOT 19 (Cont.)				
Lythrum lineare		*	*	
Magnolia virginiana			*	
Mikania scandens		*		
Myrica cerifera			*	*
Myrsine floridana			*	
Panicum hemitomon		*		
Pluchea rosea		*	*	
Proserpinaca palustris var. *palustris*		*		
Rhynchosia minima	E	*		
Rhynchospora inundata		*	*	
Salix caroliniana			*	*
Taxodium distichum		*		
	Total	21	14	3
PLOT 21				
Ambrosia artemisiifolia		*		
Ammannia latifolia		*		
Ampelopsis arborea		*		
Andropogon glomeratus		*		
Baccharis halimifolia		*		
Cynoctonum mitreola		*		
Cyperus surinamensis		*		

SPECIES		PRESENCE IN SIZE CLASS 1	2	3
PLOT 18				
Andropogon glomeratus		*	*	
Bacopa monnieri		*		
Baccharis halimifolia		*	*	
Boehmeria cylindrica			*	
Centella asiatica	E	*		
Cirsium horridulum		*		
Cladium jamaicensis		*	*	
Crinum americanum		*		
Cynoctonum mitreola		*		
Diodia virginiana		*		
Eupatorium coelestinum		*	*	
Eustachys glauca		*		
Hydrocotyle verticillata		*		
Hyptis alata var. *stenophylla*		*	*	
Ipomoea sagittata		*		
Kosteletzya virginiana		*		
Ludwigia alata		*		
Ludwigia microcarpa		*		
Ludwigia octovalvis ssp. *octovalvis*		*	*	
Lythrum lineare		*	*	
Melanthera angustifolia		*		
Mikania scandens		*		
Muhlenbergia filipes			*	

APPENDIX 1.

SPECIES	PRESENCE IN SIZE CLASS 1	2	3
PLOT 21 (Cont.)			
Dichromena colorata	*		
Eupatorium coelestinum	*		
Eustachys glauca	*		
Hydrocotyle umbellata	*		
Hyptis alata var. stenophylla	*		
Imperata brasiliensis	*		
Ipomoea sagittata	*		
Kosteletzya virginica	*		
Ludwigia alata	*		
Ludwigia microcarpa	*		
Ludwigia octovalvis ssp. octovalvis	*		
Ludwigia repens	*		
Lythrum lineare	*		
Melanthera angustifolia	*		
Mikania scandens	*		
Panicum caerulescens	*		
Panicum hemitomon	*		
Panicum polycaulon	*		
Persea borbonia	*		
Pluchea rosea	*		
Rhyncospora inundata	*		
Sabatia grandiflora	*		
Setaria geniculata	*		
Spermacoce prostrata	*		

SPECIES		PRESENCE IN SIZE CLASS 1	2	3
PLOT 18 (Cont.)				
Panicum hemitomom		*		
Panicum polycaulon		*		
Passiflora suberosa		*		
Phyla nodiflora	E	*		
Phyllanthus amarus		*		
	Total	25	9	0
PLOT 20				
Ampelopsis arborea		*	*	
Andropogon glomeratus		*		
Baccharis halimifolia		*	*	*
Boehmeria cylindrica			*	
Crinum americanum		*		
Cyperus surinamensis		*		
Dichromena colorata		*		
Galium obtusum var. floridanum		*		
Hydrocotyle umbellata		*		
Hyptis alata			*	
Ludwigia microcarpa		*		
Muhlenbergia filipes		*		
Myrica cerifera		*	*	*
Parthenocissus quenquefolia		*		
Persea borbonia		*	*	*
Phyla nodiflora	E	*		

APPENDIX 1.

SPECIES		PRESENCE IN SIZE CLASS 1	2	3
PLOT 21 (Cont.)				
Sporobolus domingensis		*		
Verbena bonariensis	E	*		
Vicia acutifolia		*		
Vigna luteola		*		
	Total	36	0	0

SPECIES		PRESENCE IN SIZE CLASS 1	2	3
PLOT 20 (Cont.)				
Polygonum hydropiperoides		*		
Proserpinaca palustris var. palustrius		*		
Ptilinium capillaceum		*		
Salix caroliniana			*	*
Toxicodendron radicans		*		
	Total	17	7	4