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VEGETATION SURVEY OF PEN BRANCH WETLANDS (U)

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SUMMARY

A survey was conducted of vegetation along Pen Branch Creek at SRS in support of K-Reactor restart. Plants were identified to species by overstory, understory, shrub, and groundcover strata. Abundance was also characterized and richness and diversity calculated. Based on woody species basal area, the Pen Branch delta was the most impacted, followed by the sections between the reactor and the delta. Species richness for shrub and groundcover strata were also lowest in the delta. No endangered plant species were found. Three upland pine areas were also sampled.

1.0 INTRODUCTION

In support of K Reactor restart, this report summarizes a study of the wetland vegetation along Pen Branch. Reactor effluent enters Indian Grave Branch and then flows into Pen Branch and the Pen Branch Delta. All of these areas were sampled (Figure 1-1). The headwater areas of Pen Branch were also sampled, including an upland area of pine woods (sites HD, HE, and HF). These latter sites are representative of the watershed communities of Pen Branch. For comparison purposes, the lower corridor and delta of Four Mile Creek were also sampled (sites DA, D in Figure 1-1).

2.0 BACKGROUND INFORMATION

The following background information is largely extracted from Wike et al. (1989).

2.1 Pen Branch Physiography

Pen Branch drains an area of 91 km^2 and is approximately 16 km long. In its headwaters, Pen Branch is a largely unperturbed blackwater stream, similar to the headwater reaches of Four Mile Creek. Above the confluence with Indian Grave Branch discharge is approximately 0.1 m^3/sec. Thermal effluent from K Reactor joins Pen Branch via Indian Grave Branch and accounts for over 90% of the stream volume (approximately 11.4 m^3/sec total discharge). The reactor cooling water originates from the Savannah River and changes the water quality as well as the temperature and flow regimes in Pen Branch (Firth et al., 1986).

Pen Branch discharges into the Savannah River Floodplain swamp rather than flowing directly into the Savannah River. Where it discharges into the swamp, it has formed a delta where temperatures typically range from 25 to 40°C above ambient (Wike et al., 1989). The flow from Pen Branch spreads over the delta and continues through the swamp as shallow sheet flow until entering the lower reaches of Steel Creek through which it discharges into the Savannah River. When the Savannah River inundates the floodplain swamp, Pen Branch flows along the northern border of the swamp and crosses the Steel Creek Delta. When the Savannah River is not flooding, the Pen Branch flow enters the Steel Creek channel downstream from the swamp. By the time Pen Branch discharges into Steel Creek, its temperature is near ambient, due to dilution and cooling in the swamp.

2.2 Pen Branch Corridor and Delta History

In 1951, the Savannah River swamp and Pen Branch corridor had a closed canopy forest. In 1954, K Reactor began discharging thermal effluent to Pen Branch. The discharge volume (approximately 2.8 m^3/s) and temperature were low. However, canopy change in the corridor was visible as early as 1955 and 1956 in the aerial photographs. About 11 hectares of bottomland hardwood forest along the corridor were partially defoliated by May 1955. Since discharge temperatures were relatively low, flooding from reactor effluents was probably the major cause of damage. Reactor discharge temperatures began a steady rise during 1955 and 1956, and by the end of March 1956, 54 ha along the corridor had been affected. By 1961, canopy defoliation was apparent throughout the corridor (113 ha)

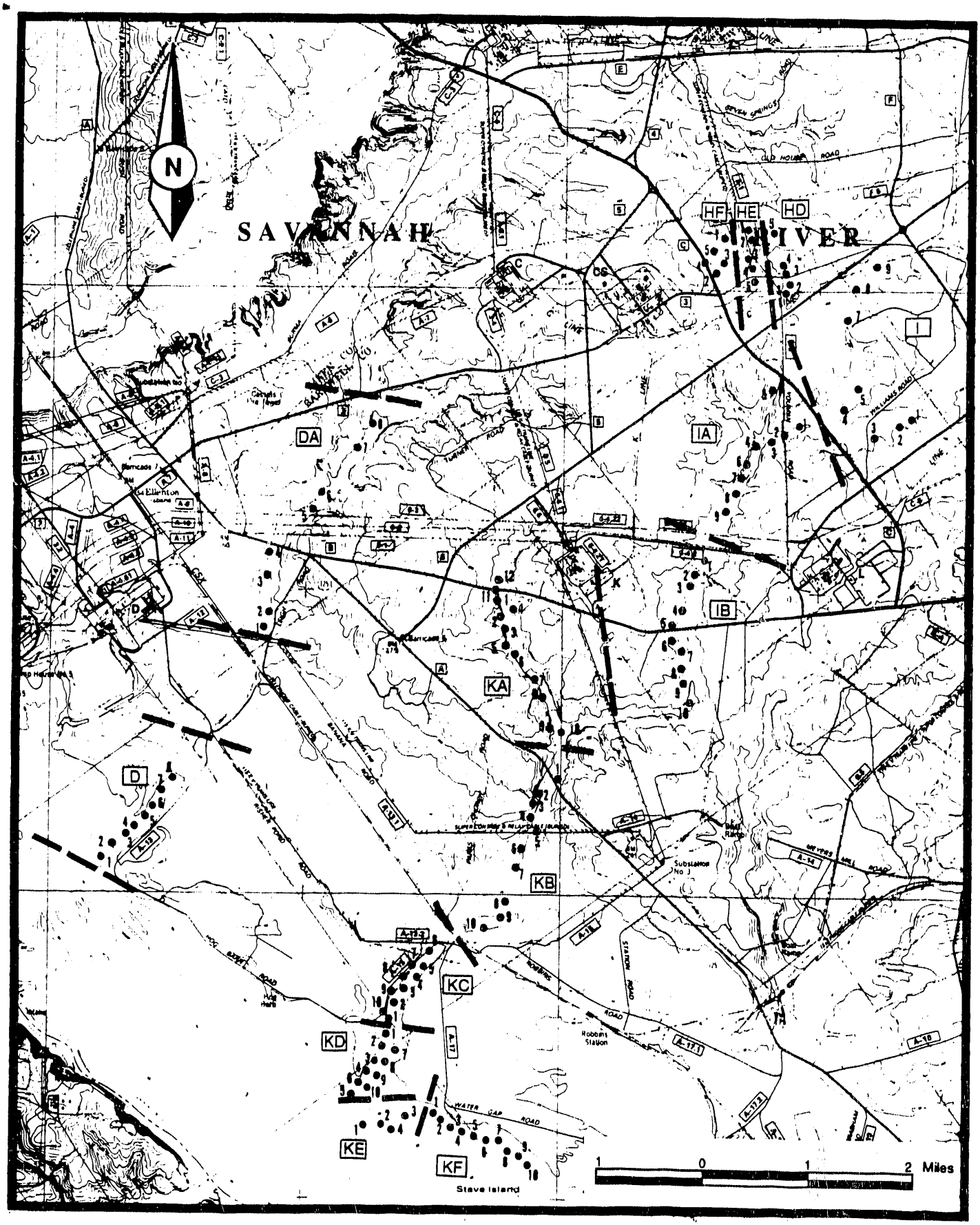

Figure 1-1. Map of Sampling Locations

and had reached the Savannah River swamp (4.5 ha). Most of the trees were affected, probably due to the increasing temperatures ($\bar{x}$ = 65°C) and flows ($\bar{x}$ = 9.6 m^3/s). During the next five years, the Pen Branch Corridor impact area stabilized (116 ha). At the same time, a delta formed in the swamp at a rate of 9 ha/yr, and reached a size of 51 ha by 1966. Average flow (11.2 m^3/s) and temperature (64°C) remained relatively high (Christensen et al., 1984).

In 1965, an experimental program resulted in lower K-Reactor power levels, and discharge temperatures were reduced to 53°C by 1966. The delta expansion rate also decreased to 1.6 ha/yr. Reduced power operations and discharge temperatures continued through 1974 when SRS began an energy conservation program in all reactor areas. Since less cooling water was used, K-Reactor discharges dropped an average of 20 cfs . However, delta growth accelerated to 6.6 ha/yr after 1973 despite the reduced flows and temperatures. After 1979, reactor power levels began to return to higher levels. Effluent temperatures increased ($\bar{x}$ = 65°C) and the Pen Branch Delta growth continued. In 1985, the impact zone was about 152 ha and was expanding at a rate of about 4 ha/yr (Christensen et al., 1984; Tinney et al., 1986).

As of 1985, approximately 245 ha of forested wetlands were impacted by thermal discharges from K Reactor. Defoliated canopy is visible in both the stream floodplain (93 ha) and SRS swamp (152 ha). The Pen Branch Delta continues to expand at a rate of 4 to 5 ha/yr, whereas no additional wetlands losses are expected in the stream corridor (Tinney et al., 1986).

Much of the recent swamp canopy loss near Pen Branch Delta has been occurring in the southeasterly direction, adjacent to the upland terrace along the Savannah River swamp (Sharitz et al., 1986; Christensen et al., 1986; Jensen et al., 1987). Over the years, cypress-tupelo canopy has been replaced by open water and willow. The historic aerial photographs, aerial multispectral scanner vegetation maps and ground observations from 1981-1985 have confirmed these changes. Recent EG&G thermal infrared surveys have shown that during river flooding, thermal effluents from both Four Mile Creek and Pen Branch are channeled along the northeast bank of the swamp away from the river (Shines and Tinney, 1983). River flooding seems to correlate with the southeastern progression of the Pen Branch Delta. From 1966 to March 1973, the southeastern "tail" changed little. Spring flooding frequency and duration were also low during this period. After 1973, the "tail" began to increase in size along with springtime flooding frequency. The channeling of thermal effluents during the spring and summer growing season may be occurring when the cypress-tupelo forest is most sensitive, resulting in increased mortality (Sharitz et al., 1986). The post-1973 increase in flooding intensity may have caused the increase in the delta expansion rate from 1.7 to 6.6 ha/yr, while reactor discharge temperatures and flows remained relatively constant (Christensen et al., 1984).

2.3 General Wetland Patterns

Interpretation of the present baseline vegetation survey necessitates comparison to predisturbance conditions, especially for the lower portion of Pen Branch where heated reactor effluent has killed trees. The following historical and background discussion is largely taken from Wike et al. (1989).

The composition of the SRS Savannah River swamp forest has been extensively examined. Summaries of the wetland community structure are given below from studies by Repaske (1981), Whipple et al. (1981); and Smith et al. (1981, 1982). Additional areas of the swamp were sampled in 1983 and 1984 (Mackey, 1987). Standard vegetation sampling techniques were used in these studies (Mueller-Dombois & Ellenberg, 1974). These data provided information on density, size class (relative basal area), and importance values of woody species distributed throughout disturbed and relatively undisturbed portions of the SRS Savannah River Swamp.

The data were analyzed using standard plant community analysis procedures. Importance values were calculated using relative density and relative dominance (basal area). Detrended correspondence analysis ordination was employed to array the data along axes calculated using the importance values of the plant species (Hill, 1979a; Smith et al., 1981, 1982). This technique grouped the wetland communities along gradients that can be interpreted to reflect plant community responses to environmental perturbations (Hill & Gauch 1980). A two-way indicator species analysis was then used to separate the data into major plant community types, based upon importance of dominant woody species (Hill, 1979b). Comparisons of species arrays or groupings and community types with environmental characteristics provided an indication of the major environmental variables responsible for woody species distribution in the SRS swamp (Mackey, 1987).

The ordination of woody plant communities developed using this detrended correspondence analysis (DCA) is given in Figure 2-1. Sample sites occurring in close proximity on DCA axes 1 and 2 show greater similarity in species importance than do sites located at greater distances from each other along these axes. Each site was assigned a relative value of 1 to 3 on a hydrologic scale (1=deeply and continuously flooded, 2=shallowly and continuously flooded, 3=occasionally flooded) and on a perturbation scale (1=tree mortality characteristic of natural swamp, 2=low perturbation with slight tree mortality, 3=high perturbation and high tree mortality). A comparison of these scalars with the data shown in Figure 2-1 shows that the swamp forest communities are distributed along two major environmental axes: a water depth or hydrologic regime gradient and a perturbation or disturbance gradient. Quadrats symbolized by squares or triangles show no perturbation or low levels of perturbation. Those symbolized by circles are highly disturbed and contain no or almost no species representative of the original swamp forest. Open symbols represent sites occurring in areas where there is only occasional flooding. Partially darkened or completely darkened symbols represent quadrats sampled at shallow or deeply flooded sites (Mackey, 1987).

The two-way indicator species analysis (Hill, 1979b) separates the swamp forest into the major wetlands community types (Figure 2-2). Deciduous bottomland hardwood forests occur in areas that are slightly elevated and better drained and that are flooded only occasionally during the year. These communities are dominated by a mixture of oak species (Quercus nigra, Q. laurifolia, Q. michauxii, Q. lyrata) as well as red maple (Acer rubrum), sweetgum (Liquidambar styraciflua), ash (Fraxinus caroliniana and F. americana), and other hardwood species. The species composition of the understory appears to be controlled by the wetness of the substrate. Sweet bay (Magnolia virginiana), tulip poplar (Liriodendron tulipifera), and hollies (Ilex spp.) are found in drier localities, while red bay (Persea borbonia) and ironwood (Carpinus caroliniana) occur in stands with longer periods of soil saturation. Smilax spp. and other woody vines are common (Mackey, 1987).

The deciduous swamp forest, which occurs in deeper water and on continuously flooded sites is characterized by two canopy dominants: bald cypress (Taxodium distichum) and water tupelo (Nyssa aquatica). The understory is typically sparse and is composed of ash, bald cypress, occasional black gum (Nyssa sylvatica), water tupelo, red maple, and water elm (Planera aquatica). Most saplings are restricted to stumps, logs, or accumulated sediments and debris at the bases of the trees. The ground cover is limited in the swamp forest by continuous flooding and low light penetration through the canopy. In areas of slow current, duckweed (Lemna spp. and Spirodela spp.), waterweed (Egeria densa), and coontail (Ceratophyllum demersum) are found. St. John's wort (Hypericum spp.), Virginia willow (Itea virginica), false nettle (Boehmeria cylindrica), and woody vines such as poison ivy (Toxicadendron radicans) and pepper-vine (Ampelopsis arborea) occur in the understory on stumps and fallen logs (Mackey, 1987).

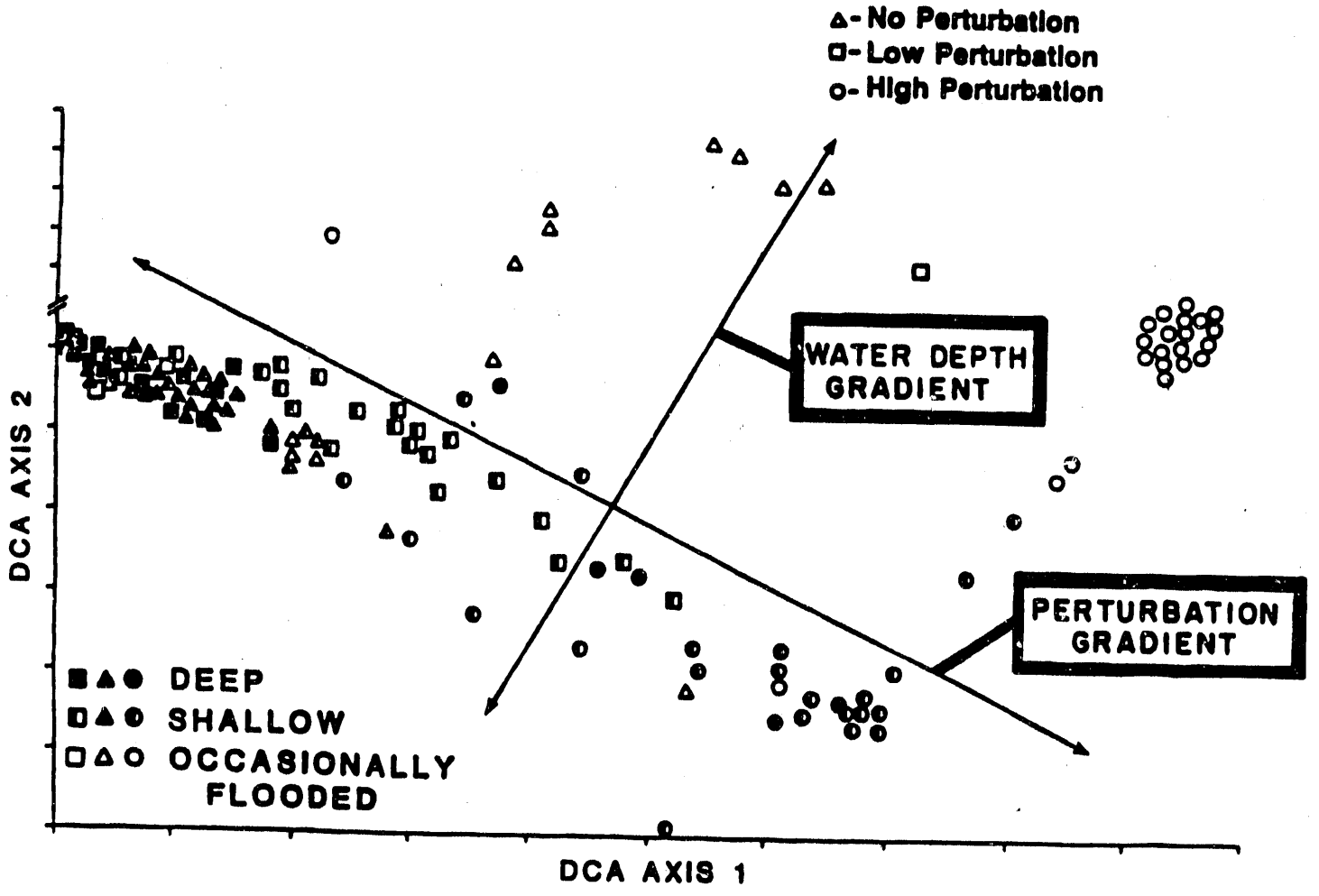

Figure 2-1. Detrended Correspondence Analysis (DCA) Ordination of Forested and Shrub Dominated Sites in the SRS Savannah River Swamp (source: Gladden et al., 1985)

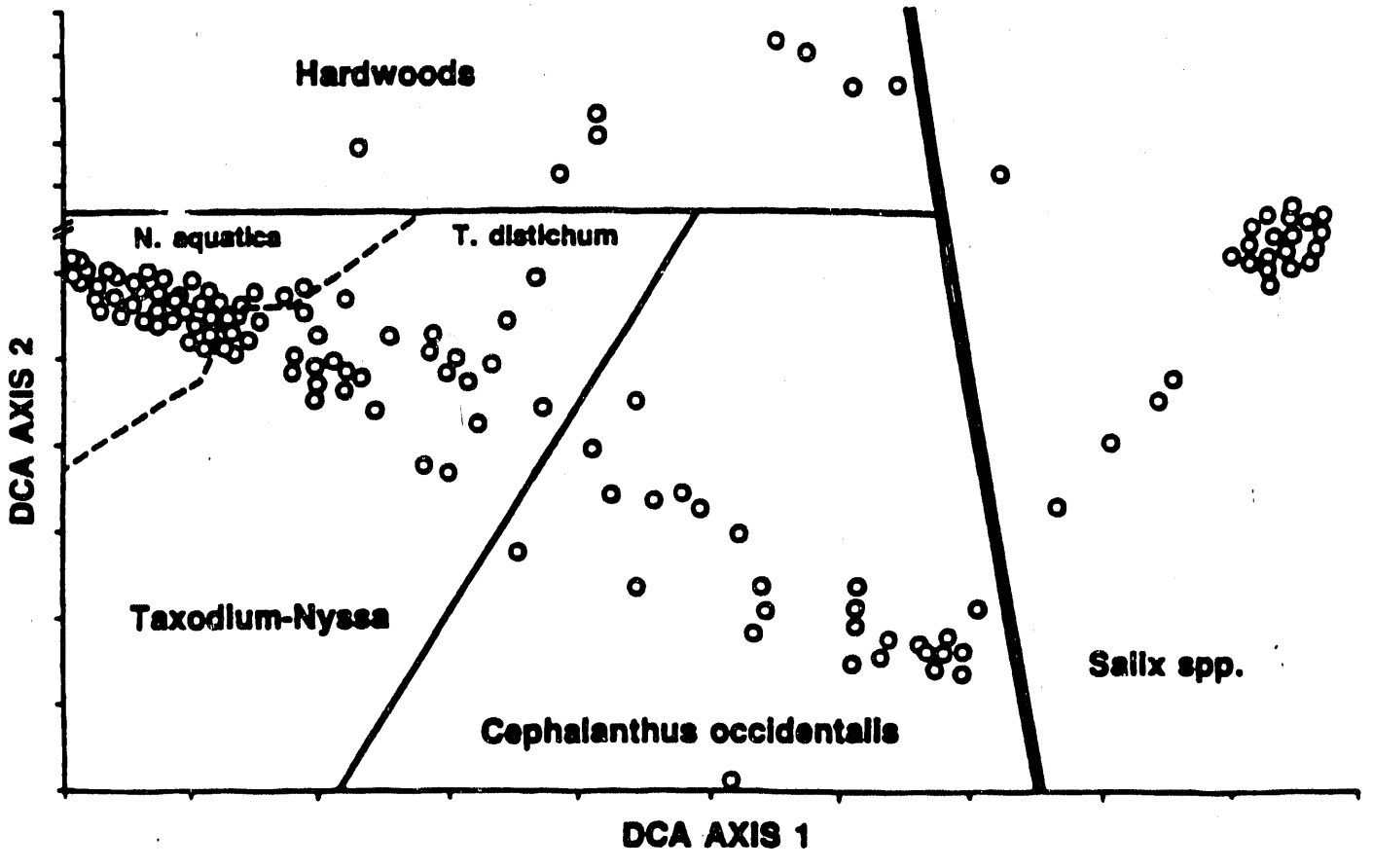

Figure 2-2. Two-Way Indicator Species Analysis of the SRS Savannah River Swamp Forest Data Indicated on DCA Ordination (source: Gladden et al., 1985)

Woody plant community types occurring in the most highly disturbed areas are dominated by successional shrub species, such as willow (Salix spp.) and buttonbush (Cephalanthus occidentalis). These scrub-shrub communities occur where the original swamp forest has been eliminated, but where water temperatures are not too high to preclude the growth of woody species.

Willow dominated scrub-shrub communities tend to occur on sand bars or on occasionally flooded sites; whereas, buttonbush dominated communities represent the early successional invasion of deeper water sites (Gladden et al., 1985). The understory of the buttonbush community is comprised of nonpersistent emergent wetland species such as hydrolea (Hydrolea quadrivalvis), aneilema (Aneilema keisak), waterpepper (Polygonum hydropiperoides), water purslane (Ludwigia palustris), and arrowhead (Sagittaria latifolia). Climbing hemp (Mikania scandens) and pepper-vine also occur (Gladden et al., 1985). Herbaceous vegetation in the willow community is often sparse due to the dense canopy. Small patches of herbs include redtop panicgrass (Panicum agrostoides), waterpepper, false nettle, St. John's wort, sensitive fern (Onoclea sensibilis), climbing hemp, and pepper-vine (Gladden et al., 1985).

There has been considerable revegetation in Pen Branch corridor and delta due to shutdown of K Reactor since 1988. Wetland vegetation grows very rapidly and has quickly colonized exposed substrates that are no longer exposed to flooding and thermal stress. These changes are documented in section 4.

Projection of these revegetation changes very far into the future is problematic. Ideally one would expect an eventual return of the delta to pre-thermal cypress-tupelo or bottomland hardwood swamp. However, the large size of the disturbed areas and the altered substrates and hydrology mean the expected successional trends may be altered. Seed sources for cypress and tupelo may be inadequate, for example. Large stands of willow and buttonbush may hinder climax forest regeneration. Current information allows us to point out these factors but not to quantify them.

3.0 MATERIALS AND METHODS FOR FIELD WORK

3.1 Field Methods

Quadrats were established in wetlands along Pen Branch and Four Mile Creek by Dames & Moore field crews during July and August 1990 to determine vegetation composition and characteristics. Complete data and photographs are provided in Dames & Moore (1990). Each site was surveyed to ensure that the plot would characterize the wetland areas. After selection of the site for each sample plot, a brief characterization of the area was made in the field journal or on the ground cover data sheet. The plot was then established in a rectangular shape of 20 m x 25 m, with all azimuths being recorded on field data sheets. Modifications of the plot shape were necessary in some cases to ensure that the sampling area remained within the designated area; however, the 500 m^2 sampling area size was retained (e.g., a 10 m x 50 m plot might be established).

In opposing corners of each plot, 1 m^2 and 25 m^2 plots were established for characterization of the ground cover and shrub/understory layers, respectively (Figure 3-1).

The materials used for marking each site consisted of a section of PVC pipe (approximately 1-7 m long) which was painted with pink florescent spray paint or flagged with pink flagging. The PVC pipe was driven into the ground in each corner of the plot, with exposed pipe extending at least 1.0 m above the ground. The plot was also staked with a .7 m section of metal rebar to ensure that each site was permanently marked. All sites were then tagged with an aluminum tag to identify the plot number.

One 500 m^2 plot was used to characterize the overstory (tree) vegetation. To meet the criteria for overstory vegetation, woody plants had to be greater than 61.0 cm in height and greater than or equal to 10.0 cm diameter at breast height (dbh). Diameter at breast height quantifies the diameter of a tree at the standard height of 1.5 meters. The measurement of dbh is used to determine basal area to establish overstory vegetation dominance. All trees which met the above requirements and were located within the plot boundaries, or partially within, were measured and identified to species.

Two 5 x 5 m plots were established in opposing corners within the 20 m x 25 m plot for sampling the shrub layer and understory vegetation. The criterion for understory vegetation was all woody plants greater than 61.0 cm in height and greater than or equal to 2.5 cm dbh and less than 10.0 cm dbh. The shrub stratum contains all woody plants and vines greater than 61.0 cm in height vertically or climbing and less than 2.5 cm dbh (while this criterion is used to define the stratum, actual field measurements of diameter were taken 5.0 cm above the ground on the largest stem). A tree caliper was used to measure the diameter of the vegetation, which was recorded in inches as the standard unit of measurement on the data sheets and converted to centimeters during data analyses.

Two 1 m^2 plots were sampled in opposing corners of the 20 m x 25 m quadrat, nested within the 5 m shrub/understory plots, to examine the ground cover vegetation. Ground cover vegetation consists of all woody plants less than 61.0 cm in height and all herbaceous plants of any height. All plant species which met the criterion for ground cover vegetation within the 1 m^2 plots were assigned a numerical value indicative of percent cover for that plot. The following table (Radford et al., 1974) shows cover values.

Cover 0*	-	Cover less than 1%
Cover 1	-	Cover 1% to 5%
Cover 2	-	Cover 5% to 12.5%
Cover 3	-	Cover 12.5% to 25%
Cover 4	-	Cover 25% to 50%
Cover 5	-	Cover 50% to 100%

*Cover 0 was used instead of the + for individuals that have a cover less than 1%.

Two specimens of each species documented within each plot were collected when first observed. Both specimens were pressed and then dried in a herbarium dryer. One specimen was identified, labeled, and mounted for archiving. The second specimen will remain in the Dames & Moore Herbarium for future reference. In addition, a species list of all the vascular flora occurring within the 20 m x 25 m plots was compiled to show species that may not have fallen into the nested subplots (Appendix A). Species were identified according to Godfrey et al. (1981a,b) and Radford et al. (1978, 1987).

Tree height was measured using a clinometer to ascertain the average overstory height. Three readings were taken at each plot, then averaged to determined the approximate tree height.

Absence of overstory within the assigned sampling area determined the need to use the linear transect method (Figure 3-2). The linear transect provides a more thorough characterization of the ground cover and the shrub/understory strata than is possible using the quadrat method. The transects were set up on a 20 meter straight line azimuth with five, 1 meter square plots being spaced at intervals of 5 meters on alternating sides of the transect. The two, 25 square meter plots were located on either end of the 20 meter transect.

All linear transects were marked with a section of PVC pipe driven into the ground, extending at least 1 meter above the ground, located on either end of the transect. A 2-foot section of metal rebar was used as a permanent marker. Aluminum tags were attached to the rebar to identify each plot.

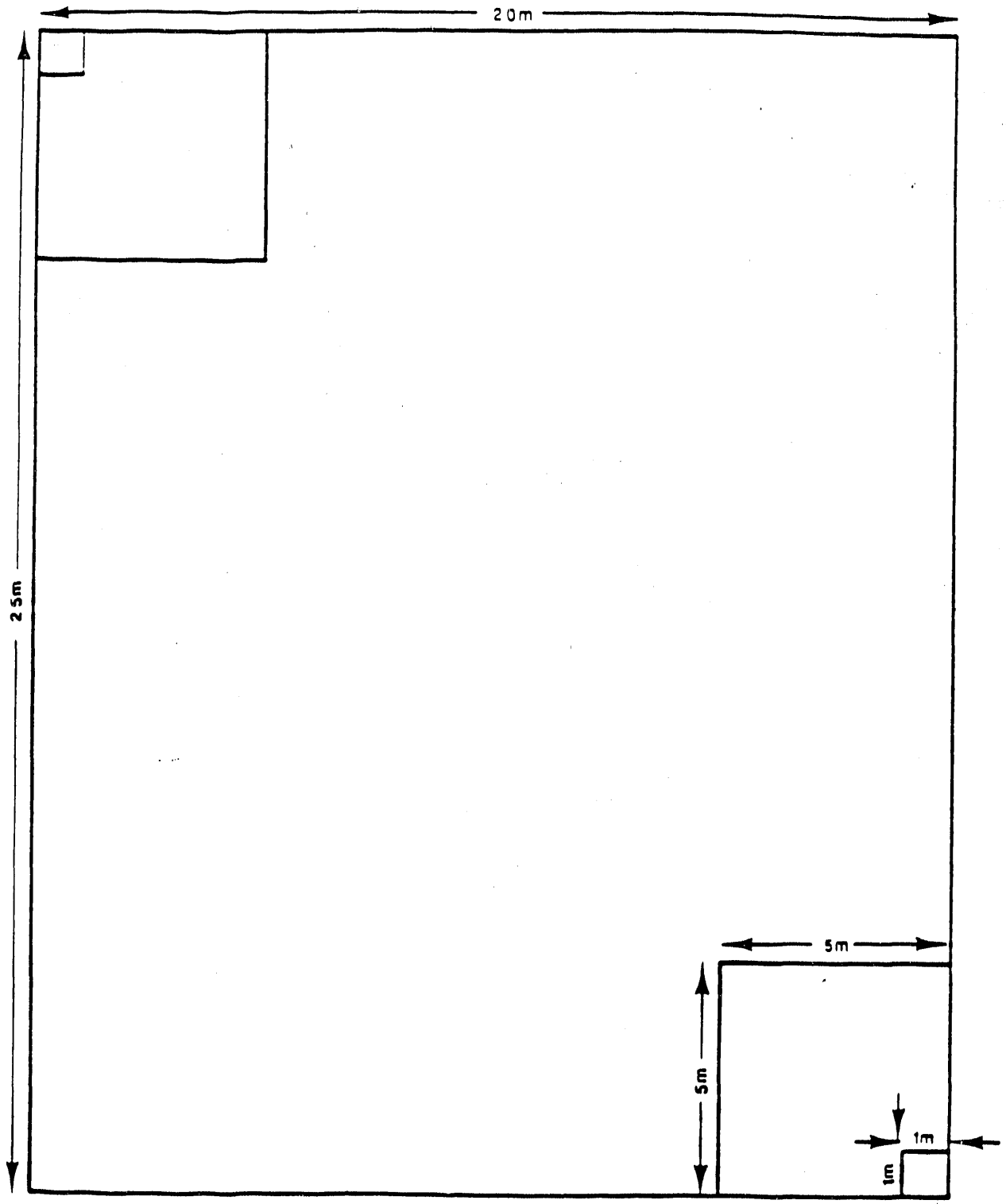

Figure 3-1. Plot Layout for Quadrat Sampling

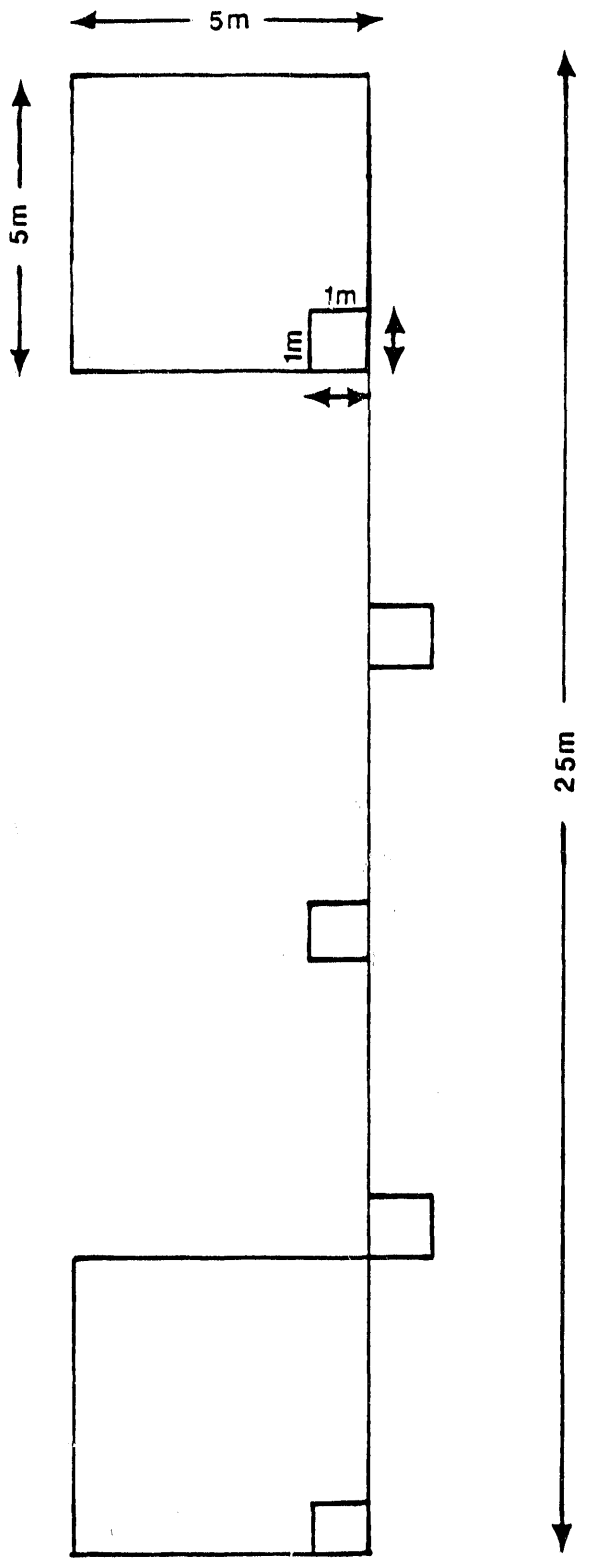

Figure 3-2. Plot Layout for Transect Sampling

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The methods for sampling the ground cover and shrub/understory vegetation in the linear transects were identical to the methods utilized in doing the quadrat plots.

Sampling adequacy within a site was determined by use of the species area curve. The species area curve is designed to indicate the point at which statistically sufficient sampling has been accomplished within a given study area. Cain (1938) states that sampling is adequate when a 10% increase in sample area results in an increase of species equaling 10% (or less) of the total species identified to that point. Some sites were sampled more intensively than this method would indicate in order to increase precision and obtain a more complete species census. Plots for species area analyses are presented in Dames & Moore (1990).

3.2 Analytical Methods

3.2.1 Overstory, Understory, and Shrub Layer Vegetation

Quantitative data were collected from each of the individual quadrat locations for the overstory, understory, and shrub layer strata. The type of data collected for each of these strata was identical and consisted of the individual species identification and the diameter (in inches) measured at breast height for trees in the field. From these data, the following information was derived based on Phillips (1959):

$$\text{Total Density (individuals/plot)} = \frac{\text{Number of individuals}}{\text{Number of plots sampled}}$$

Total density refers to the number of individuals per plot recorded by species, which is a direct measure of the individual species abundance within the sampling area. For a particular stratum, all plots are a standard size, so comparisons on a per plot basis are equivalent to comparisons on a per unit area basis.

$$\text{Relative Density} = \frac{\text{Number of individuals per species x 100}}{\text{Number of individuals of all species}}$$

Relative density is derived from the total density just described and is a representation of the percentage of the individuals which consist of an individual species.

$$\text{Total Frequency} = \frac{\text{Number of plots in which the species occurs}}{\text{Number of plots sampled}}$$

Total frequency is the number of times an individual species is recorded from within a given number of quadrats or transects. Commonly the term "frequency of occurrence" is used for this concept. Conceptually, frequency can be considered a measure of abundance and is related in concept to density. However, frequency gives no indication of the cover or biomass of individual plant species within a given measurement area.

$$\text{Relative Frequency} = \frac{\text{Frequency of individual species x 100}}{\text{Sum of frequencies of all species}}$$

The relative frequency measurement is the total frequency converted to a percentage which is normalized for the individual study area.

$$\text{Total Dominance} = \frac{\text{Total basal area of one species}}{\text{Number of plots}}$$

Total dominance is commonly measured by cover or by basal area. For this study, basal area was selected as the measure of dominance that would provide the most useful data concerning the structural characteristics of the individual vegetation stands surveyed. The total dominance is the collected

individual basal area values per tree from within an individual species, standardized to a set plot size. Basal area is expressed in cm^2 for this program. From a plant ecology perspective, the total dominance value is a measure of the success or the "influence" that a given tree species has when compared to other species from within the same measured area. Frequently, important tree species are evaluated on the basis of their dominance characteristics.

$$\text{Relative Dominance} = \frac{\text{Total basal area of one species x 100}}{\text{Total basal area of all species}}$$

In a manner similar to that noted for relative density and relative frequency, relative dominance is the absolute dominance term expressed as a percentage. The relative dominance percentage indicates the portion of the entire sampling population that consists (in terms of basal area) of the different species that are measured within the transect or quadrat.

Importance Value (I.V.) = Relative Density (%) + Relative Frequency (%) + Relative Dominance (%)

The importance value (I.V.) is useful for the evaluation of site vegetation because it combines the three principal measures of the vegetation taken from each of the study sites, namely the density, frequency, and dominance of the plant species. The I.V. uses the relative values (percentages) obtained for each of the three measurement parameters and results in a numerical value that can range from 0 to 300 depending on the individual site and the mix of species observed. Generally, the higher the I.V. for the individual species, the greater the influence which the species exerts on the study site based on the competition for available nutrients, water, and sunlight. In addition, the I.V. is an indication of the success of the individual species within a specific study site relative to all other species.

In addition to the above numerical results tabulated for the SRS site data, several other statistical measures were determined from the data to provide further insight into the dynamics of the species interactions. The two measures are species richness and species diversity. These concepts are briefly described as follows:

$$\text{Species Richness} = \frac{S-1}{\text{Log}(N)}$$

where: S = Total number of taxa in all sampling units, and
N = Total number of individuals.

This index of species richness was originally proposed by Margalef (1968), and has been extensively used by botanists since. The richness index will vary with sample size, and assumes a functional relationship between S and N. In essence, the richness index is a "species-area" relationship and commonly can be plotted as an approximately straight line if the relationship used is the number of species recorded against the logarithm of the area.

$$\text{Species Diversity} = 1 - \Sigma \frac{[n_i (n_i-1)]}{N (N-1)}$$

where: n_i = number of individuals in taxa i, and
N = total of all individuals

This is Simpson's diversity index (1949) which represents the probability of picking two organisms at random that belong to different taxa. This index, the complement of Simpson's original measure, ranges from 0.0 (low diversity) to almost 1.0.

3.2.2 Ground Cover Vegetation

Quantitative data were collected from each of the individual transect locations for the ground cover stratum. The data collected for the ground cover stratum were obtained using the microplot-quadrat method (using 1 m^2 plots). Individual ground cover species were identified from the microplots and an indication of the relative cover was made using the Braun-Blanquet method (Phillips, 1959). Using this method, individual plant species occupying a percentage of the microplot are recorded on the field sheets showing their percent cover as a Braun-Blanquet cover abundance value ranging from 1 to 5. The following indices were computed.

$$\text{Total Frequency} = \frac{\text{Number of plots at which the species occurs}}{\text{Number of plots sampled}}$$

Vegetation frequency is the number of times that an individual species is recorded from within a given number of individual sampling points. Total frequency is the actual number of points at which a species is found to occur for a given number of sample points. Thus, the total frequency is an absolute value derived directly from the field data sheets.

$$\text{Relative Frequency} = \frac{\text{Frequency of individual species x 100}}{\text{Sum of frequencies of all species}}$$

The relative frequency measurement is the total frequency value converted to a percentage that is normalized of the individual study area.

$$\text{Total Dominance (Cover)} = \frac{\text{Cover (in\%) for each species}}{\text{Number of plots}}$$

Plant dominance is frequently measured by cover. The total dominance (cover) is the collected individual cover values per species, divided by the number of plots sampled. Cover was computed as the midpoint cover value for each cover class.

$$\text{Relative Dominance (Cover)} = \frac{\text{Domiance of the species x 100}}{\text{Sum of dominances of all species}}$$

The relative dominance (cover) term is expressed as a percentage. The relative dominance percentage indicates the portion of the entire sampling population that consists (based solely on cover) of the different species within the microplot sampling area.

Importance Value (I.V.) = Relative Frequency (%) + Relative Dominance (%)

The importance value (I.V.) concept as applied to the ground cover vegetation is based on two plant measures: frequency (occurrence) and dominance (cover). The I.V. uses the relative values (percentages) obtained for both measurement parameters and results in a numerical value that can range from 0 to 200, depending on the individual site.

For the ground cover stratum, it is necessary to modify the richness and diversity calculations. Because individuals were not counted but only presence and cover, the variable N in the richness calculation can not be number of individuals. Instead, it is calculated as the number of species x plot occurrences. For example, if five species each occurred on each of seven plots, then N = 5 x 7. This still somewhat overestimates richness because most species on a given plot are represented by many individuals. For diversity, n_i = % cover of species i and N = total % cover over all species and plots. With these substitutions, the same formulas are used as before.

4.0 RESULTS

In this section a site by site and stratum by stratum description is given of the vegetative composition. Table 4-1 summarizes site attributes by stratum. Full data is located in Appendix Tables A-1 through A-7. Flora for SRS are listed in Table A-8. Relative values can be computed from these tables. Section 5 covers comparisons between sites. Sites DA and D are comparison sites on Four Mile Creek Delta. Sites HD, HE, and HF are reference upland watershed sites.

4.1 DA Area

DA Area begins approximately 300 feet north of Banana Road and extends north to the confluence of Four Mile Creek and an unnamed tributary entering from the east (Figure 1-1). This sampling area has been dissected by several transmission line rights-of-way, and by Road 125. The DA Area is located within the Sunderland Terrace subregion of the Pleistocene Coastal Terraces. There is a change of approximately 20 feet in elevation, from 125 feet msl to 145 feet msl, over the 2.75-mile-stretch of study area.

A total of eight sample plots were established and sampled in DA Area (Figure 1-1). Leigh Road, Road 3, Road 125, and a logging road, which extends off Turner Road, were used to access the area.

A total of 76 plant species were documented within the sampling area. The species area curve indicated that sampling was sufficient with the completion of the fifth plot.

Overstory Stratum

Eight plots were analyzed to sample the overstory vegetation for DA Area. Within the overstory stratum, a total of 93 individuals were measured representing a total of 10 distinct species. The entire sampling area had a diversity of 0.84, which represents a moderately diverse flora, and a richness of 4.32. Basal area was 7,326 cm^2/500 m^2 and density was 12 stems/500 m^2. The average canopy height for DA Area was 66 feet.

The species with the greatest I.V. was yellow poplar (Liriodendron tulipifera), with an I. V. of 62.02, followed by sweet gum (Liquidambar styraciflua) (56.1), black gum (Nyssa sylvatica) (52.0), and bald cypress (Taxodium distichum) (36.69).

Sweet gum had the highest relative density (29.0%) and yellow poplar had the highest relative dominance (23.7%).

Understory Stratum

A total of 16 subplots were sampled for the characterization of the understory stratum within DA Area. The area is moderately diverse with a diversity of 0.75 and a richness of 5.07. There were 11 different species among the 94 individual specimens measured for the understory stratum. Basal area was 907 cm^2/500 m^2 and density was 115 stems/500 m^2.

Tag alder (Alnus serrulata) had the highest I.V. (75.62) followed by red maple (Acer rubrum) (61.0), wax myrtle (Myrica cerifera) (54.29), and sweet gum (34.25).

The most frequently occurring species within the entire sampling area were red maple and wax myrtle with a relative frequency of 18.5%. Red maple had the highest relative dominance with 29.7% and tag alder had the greatest relative density with 40.43%.

Table 4-1. Vegetation Summary Data (1 of 2)

	DA	D*	I	IA	IB	KA	KB	KC	KD*	KE*	KF	HD	HE	HF
Overstory														
No. Plots	8	8	8	9	10	12	10	10	4	4	10	5	5	5
Richness	4.32	*	3.21	5.59	6.77	5.69	3.85	3.46	*	*	1.17	2.79	2.35	3.90
Diversity	0.84	*	0.62	0.83	0.80	0.86	0.80	0.79	*	*	0.58	0.32	0.60	0.77
Basal Area+	7,326	0	13,502	13,887	15,658	5,145	4,464	2,544	0	0	6,775	11,735	11,291	12,109
Density++	12	0	19	24	23	11	6	5	0	0	5	28	27	23
Understory														
No. Plots	16	16	16	18	20	24	20	20	20	8	20	10	10	10
Richness	5.07	3.20	6.41	8.70	9.24	6.83	6.67	4.16	1.91	a	1.73	2.81	4.26	2.71
Diversity	0.75	0.65	0.89	0.88	0.90	0.86	0.67	0.61	0.45	a	0.24	0.43	0.69	0.61
Basal Area	907	263	2,322	1,591	820	1,677	2,467	839	524	46	238	2,536	2,700	2,745
Density	115	93	135	99	55	70	126	84	123	3	54	119	88	140
Shrub Layer														
No. Plots	16	16	16	18	20	24	20	20	20	8	20	10	10	10
Richness	8.84	4.20	13.93	13.39	14.97	10.56	2.92	5.37	4.50	1.70	1.54	6.31	7.17	4.72
Diversity	0.85	0.68	0.92	0.93	0.90	0.92	0.52	0.80	0.74	0.69	0.59	0.74	0.81	0.76
Basal Area	557	915	364	360	476	208	271	176	334	56	443	176	206	303
Density	500	173	325	529	460	240	554	164	278	38	396	222	126	168

Table 4-1. Vegetation Summary Data (Contd 2 of 2)

	DA	D*	I	IA	IB	KA	KB	KC	KD*	KE*	KF	HD	HE	HF
Groundcover														
No. Plots	16	40	23	18	20	42	41	44	50	20	29	10	10	10
Richness	60.56	28.45	23.05	30.59	27.81	41.72	40.01	30.94	24.80	14.56	25.84	10.59	13.64	10.54
Diversity	0.95	0.94	0.92	0.94	0.94	0.96	0.95	0.89	0.92	0.89	0.93	0.83	0.87	0.90

* No vegetation present in this stratum.
\+ $cm^2/500m^2$
a) Only a single individual present
++ $Stems/500m^2$

Shrub Layer Stratum

A total of 24 species were sampled within the 16 subplots in the DA Area shrub layer stratum. The stratum contained an extremely diverse assemblage of vegetation (diversity of 0.85) and a richness of 8.84. Basal area was 557 $cm^2/500\ m^2$ and density was 500 stems/500 m^2.

The highest I.V. for the area was tag alder with a value of 71.3, followed by wax myrtle with a value of 68.08, and Virginia willow (Itea virginica) with a value of 34.67.

The species with the highest relative density for the shrub sampling layer in the DA Area was tag alder which accounted for 25.0%. Wax myrtle had the highest relative dominance, at 19.75%.

Wax myrtle was the most frequently occurring species within the DA Area shrub layer stratum with a relative frequency of 15.79%; a total of 79 individuals of this species were measured within the study area.

Ground Cover Stratum

The DA sampling area ground cover was measured from a total of 28 subplot locations. A total of 441 individuals of 61 species were recorded from this area, for a diversity of 0.94 and a richness of 60.56. The species with the highest relative dominance for the DA ground cover stratum was marsh dewflower (Murdania keisak) with a value of 17.76%. Woolgrass (Scirpus cyperinus) had a relative dominance of 9.30%. The remainder of the species recorded accounted for percentage values less than 7.0% of the dominance. Murdania was the most frequently occurring species for this sampling area, accounting for 7.5% of the relative frequency. The next most frequently occurring species was red maple with a relative frequency of 5.0%. Cutgrass (Leersia oryzoides) and woolgrass shared the next highest frequency of occurrence, each with a relative frequency of 4.5%.

The species with the highest I.V. for the DA sampling location was Murdania with an I.V. of 22.36. Woolgrass (13.82) and cutgrass (9.8) were the other dominant species recorded from this sampling area.

4.2 D Area

The sampling area designated as D Area begins at Risher Pond Road and extends south to the delta region on Four Mile Creek (Figure 1-1). The site is located approximately 1.25 miles southeast of D-Area facilities and 1.5 miles northeast of the confluence with the Savannah River. D Area is situated within portions the Sunderland Terrace and the Wicomico Terrace subregions of the Pleistocene Coastal Terraces and ranges in elevation between 95 feet msl to 85 feet msl.

Eight plots were sampled within D Area (Figure 1-1). The plots were spaced approximately 0.1 mile apart. An odometer was used to mark the distances between plots while traveling parallel to the sample area on Hog Barn Road.

Sixty-eight species occurred within the D Area sampling plots. Analysis of the species area curve shows the sampling to be sufficient after the completion of eight plots.

Overstory Stratum

No overstory vegetation was found to occur in D Area as all sampling sites were within the braided streams area of the Four Mile Creek floodplain. All overstory vegetation had long since been removed from the area due to the upstream thermal effluent release from the reactors. Many dead snags, which were mainly bald cypress (Taxodium distichum), now occupy the delta region of Four Mile Creek.

Understory Stratum

The understory stratum for D Area yielded a diversity value of 0.65 over the 16 subplots which were sampled. There were a total of seven different species within the sampling area, comprising the 75 individuals measured for a moderate diversity of 0.65 and a low richness of 3.20. The sampling site within D Area consisted mainly of emergent community types. Basal area was 263 cm^2/500 m^2 and density was 93 stems/500 m^2.

Tag alder (Alnus serrulata) was the dominant species based on the I.V., comprising 109.5 percentage points of the possible 300. Black willow (Salix nigra) was also well represented with an I.V. of 79.9 in the D sampling area. Both the tag alder and black willow had a relative frequency of 23.08%. Tag alder had the greatest relative dominance (41.14%) and had the greatest relative density (45.3%).

Shrub Layer Stratum

Ten species were measured within the D Area shrub layer stratum of Four Mile Creek. A total of 16 subplots were sampled with 139 individuals being measured. The shrub layer stratum had a moderate diversity of 0.68 and a moderate richness of 4.20. Basal area was 915 cm^2/500 m^2 and density was 173 stems/500 m^2.

Based on I.V., the dominant species was black willow (116.6) followed by tag alder (103.75) and bay berry (Myrica heterophylla) (28.63).

Black willow had the highest relative frequency value (25.8%) with 53 individuals recorded within the shrub layer. Black willow also had the highest relative dominance (52.7%). Tag alder had a relative density of 41.01%.

Ground Cover Stratum

Within the D sampling area at SRS, a total of 40 ground stratum microplots were measured. A total of 72 individual species were recorded from the field program in this location, for a high diversity of 0.94 and a richness of 28.45. The species with the greatest dominance for the area was cutgrass (Leersia oryzoides) with a relative dominance of 15.93%. The next species in descending order of dominance was climbing hempweed (Mikania scandens) with a relative dominance of 9.24%. False nettle (Boehmeria cylindrica) and tear-thumb (Polygonum sagittatum) were the remaining dominant species with relative dominance values of 7.35% and 6.98%, respectively.

The species with the greatest frequency of occurrence for the D Area ground cover stratum were, in descending order, climbing hempweed (7.99%), false nettle (7.35%), knotweed (Polygonum punctatum) (6.39%) and tear- thumb (Polygonum sagittatum) (5.43%). The species with the highest I.V.'s closely follow the results obtained for the relative frequency: cutgrass (21.04), climbing hempweed (17.23), false nettle (15.32), tear- thumb (12.41), and knotweed (12.35).

4.3 I Area

I Area is located in the upper reaches of the Pen Branch drainage basin. This area has not been impacted from thermal effluent from the reactors; however, several other forms of alteration exist within the sampling plot areas. The most extensive change has been brought about due to logging practices throughout the eastern fork of Pen Branch and new construction approximately 1000 feet south of the junction of Road 3 and Road F. Also contributing to the alteration of I Area are the many roads (gravel and logging) and a railway track which runs through the area. The western fork of Pen Branch has been relatively undisturbed from SRS functions.

I Area sampling plots are located on Pen Branch approximately 500 feet southwest of Road F and

extend in a southwest direction for approximately 1.5 miles to Road C (Figure 1-1). This section of Pen Branch is within the Aiken Plateau subregion of the Upper Coastal Plain province and ranges in elevation from 300 feet msl down to 200 feet msl.

Access to the site was gained through use of Williams Road, the railroad track right-of-way, and the many logging roads which run throughout the area.

A total of eight plots were sampled in I Area (Figure 1-1). There were a total of 58 species documented during sampling of the I Area. Analysis of the species area curve indicates sampling of the vegetation was sufficient to characterize the species diversity of the area after the completion of sample plot 3.

Overstory Stratum

A total of 151 specimens of 8 species were sampled within the 8 overstory stratum sampling plots (diversity of 0.62 and richness of 3.21). Basal area was 13,502 $cm^2/500\ m^2$ and density was 19 stems/500 m^2.

Black gum (Nyssa sylvatica) had the greatest basal area coverage with 9747 sq cm/500 m^2 giving a relative dominance value of 72.19%. Sweet gum (Liquidambar styraciflua) had 2020 sq cm/500 m^2 of basal area coverage to rank second with a relative dominance of 14.96%. The other 6 species occurring in the sampling plots combined for the remaining 12.85 percentage points of the relative dominance calculation. The average height of the overstory canopy was 75 feet.

Black gum also had the greatest importance value with a total of 153.19 points of the possible 300. Following black gum, in descending order of I.V., were sweet gum (54.24), red maple (Acer rubrum) (30.36), and American holly (Ilex opaca) (29.53).

Both sweet gum and black gum were found in five of the eight plots sampled for a relative frequency of 22.73%. Red maple was in four of the plots for a relative frequency of 18.18%. The highest relative density was recorded for black gum (58.28%).

Understory Stratum

I Area understory vegetation had a high diversity of 0.89 and a richness of 6.41. A total of 107 individual specimens of 13 species were sampled. Basal area was 2,322 $cm^2/500\ m^2$ and density was 135 stems/500 m^2.

American holly had a relative dominance of 39.21%. Sweet gum was next with a relative dominance of 19.91%. According to the importance value, American holly was again the dominant species with an I.V. of 77.72, followed by sweet gum at 53.05, and black gum at 33.32.

American holly also had the greatest relative density and relative frequency with 22 specimens giving a R. D. of 20.56% and seven plot occurrences giving a R.F. of 17.95%.

Shrub Layer Stratum

A total of 276 individual specimens of 35 species were measured within the 16 plots sampled in the I Area shrub layer. The area had a high diversity with a value of 0.91 and a richness of 13.93. Basal area was 364 $cm^2/500\ m^2$ and density was 325 stems/500 m^2.

Tag alder (Alnus serrulata) had the highest importance value with a value of 48.50. Other species with high importance values were sweet gum, red bay (Persea borbonia), American holly, sweet bay, and red maple.

Two species, sweet gum and American holly, held the highest relative frequency with each having seven plot occurrences for a relative frequency of 8.97%. Virginia willow (Itea virginica) and sweet bay followed with relative frequencies of 7.69% and 6.41%, respectively. Tag alder had 44 individuals for a relative density of 15.94%.

Tag alder had the greatest relative dominance with a value of 28.71% more than double the dominance of any of the other species present within the site.

Ground Cover Stratum

The I Area ground cover stratum was highly diverse. A total of 52 species were found to occur within the 23 plots sampled, yielding a high diversity index value of 0.92 and a richness of 23.05.

Royal fern (Osmunda regalis) had the highest importance value with a total of 19.37 points of a possible 200. A species of blackberry (Rubus sp.) was second with a tally of 16.68 points. Woolgrass (Scirpus cyperinus) was third with 13.79 and fourth was St. John's wort (Hypericum sp.) with 12.40 points.

Netted chain-fern (Woodwardia areolata) had the highest frequency of occurrence with seven sample plots being occupied for a relative frequency of 4.29%. Royal fern followed with a relative frequency of 3.68%. There were six species each found in five plots for a relative frequency of 3.07%.

The species that was most dominant within I Area ground cover was royal fern with a relative dominance of 15.69%. Royal fern was followed by blackberry (13.0%), round-leaf catbriar (Smilax rotundifolia) (10.73%), St. John's wort (9.95%), and sedge (Carex sp.) (5.57%).

4.4 IA Area

IA Area is located south of I Area on Pen Branch and a tributary entering from the north. Beaver dam construction to the northeast of Youman Road has promoted excessive ponding of water. This ponding in turn has caused the vegetation to develop to a dense scrub/shrub growth. Other than the beaver dam construction, the area consists of a Palustrine/bottomland hardwood system.

IA Area begins south of Road C and continues south to approximately 2000 feet north of Road 6-4.2 (Figure 1-1). Youman Road runs parallel to the tributary and crosses Pen Branch approximately 500 feet above the confluence with the tributary. This sampling area is located within the Aiken Plateau subregion of the Upper Coastal Plain province. The elevation of the upper section of IA Area is 200 feet msl and drops to 175 feet msl at the southernmost portion of the sampling area.

Sampling of the vegetation in IA Area was accomplished with nine sampling plots (Figure 1-1). Youman Road was primarily utilized for access to the sampling area. Other access routes included old logging roads.

There were a total of 82 species documented within the nine sampling plots in IA Area. The species area curve shows adequate sampling of the vegetation in the area after the fifth plot was completed.

Overstory Stratum

A total of 212 individual specimens were measured representing 14 distinct species in the overstory vegetative stratum of IA Area for a diversity of 0.83 and a richness of 5.59. Basal area was 13,887 $cm^2/500\ m^2$ and density was 24 stems/500 m^2.

The most dominant species based on the importance value was black gum (Nyssa sylvatica) with a value of 71.66. Following black gum, in descending order of importance, were sweet gum

(Liquidambar styraciflua) (54.26), red maple (Acer rubrum) (52.12), yellow poplar (Liriodendron tulipifera) (39.49), and American holly (Ilex opaca) (29.57). The average canopy height for the overstory in IA Area was 61 feet.

Three species (black gum, red maple, and sweet gum) had individuals appearing in each of the nine subplots for a relative frequency of 16.98%. These three also had the highest relative densities (black gum = 23.58%; red maple = 21.7%; sweet gum = 18.87%) within IA Area.

Black gum had the greatest relative dominance at 31.09%. Yellow poplar and sweet gum followed with a relative dominance of 22.03% and 18.41%, respectively.

Understory Stratum

IA Area understory stratum vegetation was highly diverse (diversity of 0.87 and richness of 8.70) with 90 individuals of 18 distinct species being measured within the 18 subplots. Basal area was 1,591 cm^2/500 m^2 and density was 99 stems/500 m^2.

Tag alder (Alnus serrulata) had the highest importance value at 55.60. In descending order of importance, tag alder was followed by American holly (50.9), red maple (41.77), and water oak (Quercus nigra) (31.41).

American holly had the highest relative dominance at 23.13%. American holly was followed by tag alder (17.54%), red maple (16.77%), and iron wood (Carpinus caroliniana) (10.19%).

The most frequently occurring species within the 18 sampling plots was red maple with specimens occupying six of the plots for a relative frequency of 15.0%. Tag alder had five plot occurrences for a relative frequency of 12.5% and was followed by American holly, water oak, and iron wood with four plot occurrences each. Tag alder had the greatest relative density with a value of 25.56%.

Shrub Layer Stratum

IA Area shrub layer vegetation recorded an extremely high diversity with a value of 0.93 and a richness of 13.39. A total of 488 specimens representing 37 species were measured within the 18 sampled plots. Basal area was 360 cm^2/500 m^2 and density was 529 stems/500 m^2.

Arrow wood (Viburnum dentatum) represented 70 of the 488 individuals within the area for a relative density of 14.34%. Virginia willow (Itea virginica) followed with 58 individuals giving a relative density of 11.89% and possumhaw (Viburnum nudum) was third with 52 individuals giving a relative density of 10.66%.

Arrow wood was the most frequently occurring species, with 11 occurrences within the sampling plots for a relative frequency of 9.02%. Arrow wood was followed by American holly, red maple, Virginia willow, and possumhaw each having specimens in 8 of the 18 plots for a relative frequency of 6.56%.

Arrow wood also had the highest value of importance with an I.V. of 40.95. Possumhaw followed with 29.01, then came tag alder (28.86), Virginia willow (24.28), and American holly (19.21).

Relative dominance was highest for arrow wood (17.59%) and possumhaw (11.79%).

Ground Layer Stratum

The diversity for the ground layer stratum in IA Area was an extremely high 0.94. Richness was 30.59. A total of 70 species were identified within the 18 plots surveyed. Seven of the species held plot coverages and occurrences significant enough to rank high in the data analyses. The most

dominant species was giant bamboo (Arundinaria gigantea) with a relative dominance of 17.93%. Poison ivy (Toxicodendron radicans) and bushy seedbox (Ludwigia alternifolia) were second with a relative dominance of 6.13%. Climbing hydrangea (Decumaria barbara) was third (5.0%) and netted chain-fern (Woodwardia areolata) was fourth (4.98%).

Red maple, giant bamboo, climbing hempweed (Mikania scandens), and netted chain-fern all occupied nine plots each for a relative frequency of 5.0%. Climbing hydrangea occurred in eight plots for a relative frequency of 4.44%.

Giant bamboo possessed the greatest importance value with a total of 22.93 of the possible 200 points. Climbing hempweed and netted chain-fern were second with a total of 9.98 points, and climbing hydrangea was third with a total of 9.44 points.

4.5 IB Area

IB Area begins south of Road 6-4.2 and traverses Road B, then extends .75 mile south, terminating where Pen Branch begins to flow to the west (Figure 1-1). This section of Pen Branch is located within the Brandywine Terrace subregion of the Pleistocene Coastal Terraces and ranges from 165 feet msl to 145 feet msl in elevation.

IB Area has been crossed by several roads and power line rights-of-way. The crossings seem to be well culverted (in one instance the crossing was bridged) and have not altered the water flow extensively. There are a few impacts (e.g., sediment loss, thick successional vegetative growth) on the wetlands on the southeastern portion of Pen Branch (IB Area) due to logging. There is a thick layer of alluvial deposits along the levee of Pen Branch in the lower half of the IB Area. This section of Pen Branch has a high content of tannic acid from the decaying organic matter (i.e., leaves) which causes an orange tint to develop in the water.

A total of 10 plots were established and sampled within IB Area (Figure 1-1). Access routes to the sampling sites were by way of Road B, Road 6-4.2, and an unnamed road which joins the power line right-of-way entering from the northeast.

A total of 85 species were measured within the vegetative strata of the 10 plots that were sampled in IB Area. Analysis of the species area curve shows that sampling was sufficient after the fifth sampling plot.

Overstory Stratum

The overstory vegetation in IB Area yields a diversity of 0.80 and a richness of 6.77 for the 10 plots sampled. A total of 230 individual specimens were measured representing the 17 species of the area. The average canopy height of the overstory in IB Area was 66 feet. Basal area was 15,658 $cm^2/500\ m^2$ and density was 23 stems/500 m^2.

The 36 individuals of yellow poplar (Liriodendron tulipifera) gave a relative dominance of 27.27%. Almost twice (63) the number of black gum (Nyssa sylvatica) specimens were measured to yield a lower basal area coverage (relative dominance of 23.74%). Two other species, red maple (Acer rubrum) (relative dominance of 21.03%) and sweet gum (Liquidambar styraciflua) (relative dominance of 18.20%) had high basal area coverages.

The highest importance value for IB Area overstory was black gum (68.44). Closely following were red maple (66.34), sweet gum (52.90), and yellow poplar (52.54).

Black gum held the highest relative density with a value of 27.39% while red maple held the highest relative frequency with 10 occurrences for a value of 19.23%.

Understory Stratum

The IB Area understory vegetative stratum was a highly diverse assemblage of vegetation with a diversity of 0.90 and a richness of 9.24. A total of 17 species comprised the 54 individuals measured within the 20 subplots in the area. Basal area was 820 cm^2/500 m^2 and density was 55 stems/500 m^2.

Red maple had the highest importance value with a value of 81.16. Following red maple, in descending order of importance, were arrow wood (Viburnum dentatum) (46.64), water oak (Quercus nigra) (18.92), sweet gum (18.15), box-elder (Acer negundo) (17.89), and winged elm (Ulmus alata) (16.46).

The highest frequency of occurrence was for red maple which occurred in nine of the 20 subplots for a relative frequency of 25.71%. The next most commonly occurring species within the sampling plots of IB Area understory layer were arrow wood, which occupied five plots (relative frequency of 14.29%), and water oak which occupied three plots (relative frequency of 8.57%).

The most dominant species was red maple with a relative dominance of 35.08%. All other species had total basal area coverage significantly lower than red maple.

Arrow wood had a relative density of 22.22% and was closely followed by red maple with a relative density of 20.37%.

Shrub Layer Stratum

A total of 20 subplots were sampled in IB Area for shrub layer vegetation. There were 460 individuals of 41 species recorded for a diversity of 0.89 and richness of 14.97. Basal area was 476 cm^2/500 m^2 and density was 460 stems/500 m^2.

Ninety-seven of these individuals were recorded from Virginia willow (Itea virginica) for a relative density of 20.64%. Arrow wood closely followed with a relative density of 17.87%. The highest importance values were recorded for arrow wood, Virginia willow, red maple, and sweet gum.

Virginia willow had a relative frequency of 10.94%. Following Virginia willow were arrow wood (8.59%), red bay (Persea borbonia) (7.81%), and American holly (Ilex opaca) and sweet gum, each at 7.03%.

Ground Layer Stratum

A total of 62 species occurred within IB Area ground layer for a diversity of 0.94 and richness of 27.81. Poison ivy (Toxicodendron radicans) had the highest importance value for the 20 plots sampled with a value of 19.08. Netted chain-fern (Woodwardia areolata) followed with an importance value of 18.31 and climbing hydrangea (Decumaria barbara) was third with a value of 13.78.

Poison ivy also had the highest frequency of occurrence with individuals occupying 14 of the 20 plots sampled for a relative frequency of 8.97%. Closely following poison ivy was netted chain-fern which was found in 11 plots for a frequency of 7.05%. Red maple and climbing hydrangea both were in nine plots and had a relative frequency of 5.77%.

Netted chain-fern had the highest relative dominance with a value of 11.26%. Following netted chain-fern were poison ivy, an unidentified fern, climbing hydrangea and muscadine (Vitis rotundifolia).

4.6 KA Area

KA Area is located on Indian Grave Branch, a 2.5-mile-long tributary to Pen Branch. Indian Grave Branch drainage can be characterized as having steep, incised banks with a flow approximately 15 feet to 20 feet wide.

The sampling plots located on Indian Grave Branch begin approximately 1000 feet north of Road B and extend south to the confluence of Pen Branch (Figure 1-1). Due to the steep banks within this sampling area, the configuration of the quadrats was sometimes altered to accommodate the floodplain (e.g., a 10 m x 50 m instead of a 20 m x 25 m quadrat). The KA Area is located within the Brandywine terrace subregion of the Pleistocene Coastal Terraces. The elevation ranges from 170 feet msl to 135 feet msl from the northernmost plot to the terminal end of the study area at the confluence with Pen Branch.

Twelve plots were sampled within the KA Area (Figure 1-1). A logging road which runs parallel to Indian Grave Branch between Road B and Road 125 was used to gain access to the sampling sites. A total of 99 species were identified during the sampling of the 10 sample plots in KA Area. After the completion of the seventh plot, sampling of the vegetation was complete according to the analysis of the species area curve.

Overstory Stratum

A total of 12 plots were sampled in KA Area for vegetation occurring within the overstory stratum. There were 128 specimens of 13 species occurring within the sample plots (diversity of 0.86 and richness of 5.69). The average height of the overstory canopy was 62 feet. Basal area was 5,145 $cm^2/500\ m^2$ and density was 11 stems/500 m^2.

The importance value was the greatest for yellow poplar (Liriodendron tulipifera) (71.58). Yellow poplar was followed, in descending order of importance, by black gum (Nyssa sylvatica) (49.92), red maple (Acer rubrum) (43.56), sweet gum (Liquidambar styraciflua) (38.10), and loblolly pine (Pinus taeda) (20.65).

The most dominant species occurring within the sample plots were yellow poplar, with a relative dominance of 37.48%, and black gum, with a relative dominance of 15.82%. All other species had a relative dominance of less than 12%.

Black gum, yellow poplar, and sweet gum each occupied 5 of the 12 plots for a relative frequency of 16.13%. Red maple occupied four plots (relative frequency of 12.9%) and red bay (Persea borbonia) was measured within three plots (relative frequency of 9.68%).

Red maple was the most dense species within the sampling plots with a relative density of 21.09%. Following red maple in relative density were black gum and yellow poplar (17.97%), sweet gum (12.5%), and sycamore (Plantanus occidentalis) (10.94%).

Understory Stratum

The diversity for KA Area understory vegetation was 0.85. A total of 80 individual specimens, representing 14 species, were measured within the 24 sampling plots. Basal area was 1,677 $cm^2/500\ m^2$ and density was 70 stems/500 m^2.

American holly (Ilex opaca) had the highest importance value of the 14 species (62.99). Following American holly were sweet gum (57.68), redbay (41.51), and tag alder (Alnus serrulata) (25.77). American holly also held the greatest relative density (27.50%) for the KA Area understory stratum.

Sweet gum was the most frequently occurring species in the sampling areas with 9 out of 24 plots containing this species (relative frequency of 21.95%). The most dominant species was red bay with 11 individuals having a relative dominance of 20.44%.

Shrub Layer Stratum

The KA Area shrub stratum had an extremely high diversity (0.92) and a high richness (10.56). A total of 292 specimens representing 27 species were measured. Basal area was 208 cm^2/500 m^2 and density was 240 stems/500 m^2.

American holly had the greatest relative dominance at 28.46%. The next highest was tag alder with relative dominance of 10.89%.

Red bay had the greatest relative density with a value of 15.75% and was followed by American holly (11.99%) and sweet bay (Magnolia virginiana) (10.96%). Tag alder had the highest relative frequency with seven plot occurrences yielding a value of 10.89%.

American holly had an importance value of 49.42. Other species with significant importance values were tag alder (29.80) and red bay (29.19).

Ground Layer Stratum

KA Area ground layer vegetation had an extremely high diversity of 0.96 and a richness of 41.72. A total of 105 species were recorded within the 42 plots that were sampled in the area. Soft rush (Juncus effusus) had the highest importance value with a value of 17.39. Following soft rush, in descending order of importance, were netted chainfern (Woodwardia areolata) (12.4), dogfennel (Eupatorium capillifolium) (8.81), and cutgrass (Leersia sp.) (6.44).
Soft rush had the highest relative dominance with a value of 12.89% and dogfennel had the highest relative frequency at 5.14%.

4.7 KB Area

KB Area begins approximately 100 feet north of Road 125 (A) and extends for approximately 3 miles south just beyond a western turn in Pen Branch (Figure 1-1). This sampling area is located within the Sunderland Terrace subregion of the Pleistocene Coastal Terraces and ranges in elevation from 135 feet to 115 feet msl.

KB Area begins in a section of Pen Branch that may be characterized as similar to KA Area. For approximately 1 mile, the sampling area has steep banks leading down to the floodplain of the creek. From this point, the topography surrounding Pen Branch flattens out. Due to the flat terrain, the surface runoff contributing to Pen Branch flows as wide sheets of water rather than being confined to small intermittent tributaries. One plot held little water during sampling; however, upon returning to that area following an overnight rain, the ground throughout the area was inundated with approximately 10 inches of water.

There were 10 plots sampled in KB Area (Figure 1-1). Road 125 (A), Road A-13.1, and several logging roads off Road A-15 were used to access the area for sampling.

A total of 88 species were recorded in the 10 plots sampled in KB Area. Analysis of the species area curve shows that sampling of the vegetation was sufficient after the completion of the third plot.

Overstory Stratum

The overstory vegetation for KB Area had a diversity of 0.80 and a richness of 3.85 with eight species occurring within the 10 sampled plots. The average canopy height of the overstory vegetation was 70 feet. Basal area was 4,464 cm^2/500 m^2 and density was 6 stems/500 m^2.

Twenty-three of the 66 individuals measured within the plots were red maples (Acer rubrum), yielding a relative density of 34.85% for that species. Black gum (Nyssa sylvatica) had 14 individuals (relative density of 21.21%) and yellow poplar (Liriodendron tulipifera) had 11 individuals (relative density of 16.67%) occurring in the plot. Ash (Fraxinus sp.), with only 6 individuals, had a relative dominance of 32.81%. Black gum had a relative dominance of 22.95% and yellow poplar had a relative dominance of 20.70%.

Yellow poplar, red maple, and sweet gum (Liquidambar styraciflua) all occurred in 3 of the 10 sampling plots for a relative frequency of 20.00%. Black gum occurred twice for a relative frequency of 13.33%. All other species were found in only one plot.

Of the possible 300 points for the importance values, red maple had the highest tally with 70.58. Black gum was next with 57.49 points and was closely followed by yellow poplar with 57.37 points. Other importance values worth mentioning were ash (48.57) and sweet gum (32.17).

Understory Stratum

KB Area was moderately diverse (diversity of 0.67 and richness of 6.67) in its vascular flora with 126 specimens of 15 species being measured within the 20 subplots. Basal area was 2,467 cm^2/500 m^2 and density was 126 stems/500 m^2.

Wax myrtle (Myrica cerifera) was the dominant species with a relative dominance of 65.89%. The next highest relative dominance was 14.65% for red maple. All other species had a relative dominance of less than 6%.

Wax myrtle had the highest importance value for the area with a value of 149.23 points of the possible 300. Following wax myrtle was black willow (Salix nigra) (16.60), tag alder (Alnus serrulata) (15.83), and sweet gum (13.47).

Wax myrtle also had the greatest relative frequency with specimens being measured in half the plots (relative frequency of 28.57%). Red maple occurred in six of the sampling plots for a relative frequency of 17.14% and black willow was found in four plots for a relative frequency of 11.43%. The highest relative density was wax myrtle with a value of 54.76%.

Shrub Layer Stratum

There were 20 plots sampled for shrub layer vegetation within KB Area for a moderate diversity of 0.51 and a very low richness of 2.92. A total of 554 individuals representing only nine species were measured for basal area coverage. Basal area was 271 cm^2/500 m^2 and density was 554 stems/500 m^2.

The 375 specimens of black willow yielded relative dominance of 35.66%. Wax myrtle relative dominance was 28.72% while the 49 individuals of tag alder combined for a relative dominance of 16.45%.

Black willow, red maple, and wax myrtle all occurred within 7 of the 20 sampling plots for a relative frequency of 17.95%. There were five plots in which sweet gum occurred and four plot occurrences of yellow poplar. Relative density was the greatest for black willow with a value of 67.69%.

Black willow had the highest importance value with a value of 121.3. Following black willow, in descending order of importance, were wax myrtle (59.84), tag alder (38.12), red maple (29.61), and sweet gum (16.22).

Ground Cover Stratum

KB Area ground cover stratum had very diverse flora within the 41 plots sampled with a diversity of 0.95 and richness of 40.01. There were a total of 101 species found within these sample plots. The highest importance value was obtained by false nettle (Boehermia cylindrica) with an importance value of 17.51. Woolgrass (Scirpus cylindrica) was next with 14.22, followed by jewel weed Impatiens capensis) (12.62), climbing hempweed (Mikania scandens) (10.49), and marsh dewflower (Murdannia keisak) (10.45).

False nettle had the greatest relative frequency with 24 occurrences yielding a value of 7.59%. Climbing hempweed followed with a relative frequency of 6.01%. Woolgrass was third with a relative frequency of 4.11%.

Woolgrass had the highest relative dominance with a value of 10.11%. Following woolgrass were false nettle (relative dominance 9.92%), jewel weed (relative dominance of 9.45%), and marsh dewflower (relative dominance of 8.23%).

4.8 KC Area

KC Area is located on Pen Branch beginning south of Road A-13.2 (Risher Pond Road) and extending for approximately .75 mile south (Figure 1-1). This sampling area is located within the Sunderland Terrace subregion of the Pleistocene Coastal Terraces. This stretch of Pen Branch drops only 10 feet in elevation through the sampling area, beginning at 100 feet msl in elevation and dropping to 90 feet msl at the southernmost plot.

KC Area is dominated by scrub/shrub growth and has a series of braided streams which run parallel to Pen Branch. Within the braided streams are many islands on which thrive thick masses of ground cover vegetation (persistent emergent). Nonpersistent emergent vegetation also is well represented in the area.

Ten plots were sampled within KC Area (Figure 1-1). Hog Barn Road running parallel enabled easy access to most of the sites on the west side of Pen Branch while an unnamed side road off Road A-17 (visible on aerial photography) was used to access the east side of Pen Branch.

A total of 76 species were documented while sampling the vegetational strata in the 10 plots of KC Area. The species area curve shows sampling to be sufficient after the fifth plot.

Overstory Stratum

The overstory vegetation in the KC sampling area was moderately diverse (diversity of 0.79 and richness of 3.46) with 54 measured specimens representing seven species. The average canopy height for the 10 plots in the KC Area overstory was 64 feet. Basal area was 2,544 $cm^2/500\ m^2$ and density was 5 stems/500 m^2.

Sweet gum (Liquidambar styraciflua) and black gum (Nyssa sylvatica) each had 16 individuals occurring within the 10 plots sampled for a relative density of 29.63%. The most dominant species was black gum (relative dominance 37.24%).

Sweet gum had the highest importance value (78.63) and was closely followed by black gum (77.98). Two species, red maple (Acer rubrum) and sweet gum, occurred in two of the 10 plots sampled for a relative frequency of 22.22%. The remaining five species had a relative frequency of 11.11%.

Understory Stratum

A total of 20 plots were sampled within KC Area for understory vegetation. These 20 plots held 84 individuals that met the criterion as understory vegetation. A total of nine species occurred within this area, yielding a diversity of 0.61 and richness of 4.16. Basal area was 839 cm^2/500 m^2 and density was 84 stems/500 m^2.

The dominant species, according to the importance value, was black willow (Salix nigra) with a value of 148.60 of the possible 300 points. Following black willow, from highest to lowest value, was black gum (34.38), tag alder (Alnus serrulata) (33.85), buttonbush (Cephalanthus occidentalis) (21.42), and American holly (Ilex opaca) (20.94).

The species with the highest frequency of occurrence within KC Area was black willow with a relative frequency of 38.10%. Tag alder had a relative frequency of 14.29% and three other species had a relative frequency of 9.52%.

Black willow had the greatest relative density (60.71%) and relative dominance (49.79%) with tag alder following in relative density (10.71%) and black gum following in relative dominance (18.91%).

Shrub Layer Stratum

The diversity for KC Area shrub layer was 0.80 with 171 individual specimens of 13 species being measured. Richness was 5.37. Basal area was 176 cm^2/500 m^2 and density was 164 stems/500 m^2.

Black willow had the greatest importance value for the area at 84.42. Black willow was followed by tag alder (57.92), buttonbush (50.80), and sweet bay (Magnolia virginiana) (36.41).

Tag alder held the greatest relative frequency with specimens occurring in 8 of the 20 subplots for a frequency of 22.86%. Following tag alder were black willow and buttonbush with relative frequencies of 17.14%.

Black willow was the dominant species with 60 individuals having a relative dominance of 33.19%. Buttonbush had 27 individuals with a relative dominance of 17.87% while tag alder had 30 individuals with a relative dominance of 17.54%.

The relative density for black willow was 35.09% and was followed by buttonbush (15.79%) and tag alder (17.54%).

Ground Cover Stratum

A total of 44 plots were sampled for ground cover vegetation in KC Area. There were 78 species documented within the area for a diversity of 0.89 and richness of 30.94. False nettle (Boehmeria cylindrica) was the dominant species in measures of relative dominance (25.68%) and relative frequency (12.66%) for the highest measurement of importance (38.34). Fireweed (Erechtites hieracifolia) had the next highest importance value with a total of 12.68 points. The second highest relative dominance was recorded for woolgrass (Scirpus cylindrica) with a value of 14.40%. Two species, fireweed and woolgrass, were second in relative frequency with a value of 6.82%.

4.9 KD Area

KD Area begins adjacent to KC Area to the north and extends down into the marsh of the Savannah River floodplain for approximately 500 feet (Figure 1-1). The six plots on the west side of Pen Branch were measured with a car odometer and spaced approximately 1.5 miles apart. An unnamed road off of Hog Barn Road was used to access the west side. The remaining four plots were located along previously established survey transects on the east side of Pen Branch.

KD Area is similar to KC Area in vegetative growth due to the braided streams/ islands occurring within the broad floodplain of the flat topography. Many dead trees occupy the lower section of KD Area (delta region of Pen Branch) and woody debris from a previously forested area is scattered throughout the sampling site. The loss of the overstory has resulted in a thick scrub/shrub and persistent emergent growth which required the use of machetes to establish the linear transects for the vegetative sampling.

KD Area is located in the Sunderland Terrace subregion of the Pleistocene Coastal Terraces. Elevation ranges from 85 feet msl to 80 feet msl. There were a total of 10 plots sampled within this area (Figure 1-1).

There were a total of 61 species sampled from KD Area. Sampling of the vegetation was shown to be sufficient by the species area curve after the fifth plot.

Overstory Stratum

No overstory vegetation was measured within KD Area. All sampling plots were located in the wide floodplain of the lower section of Pen Branch. The area once was well forested; however, it now contains many dead snags of black gum (Nyssa sp.) and bald cypress (Taxodium distichum).

Understory Stratum

Only five distinct species comprised the 123 specimens measured within the 20 plots of KD Area understory sampling stratum. The diversity for this area was a low 0.44 with a low richness of 1.91. Basal area was 524 cm^2/500 m^2 and density was 123 stems/500 m^2.

Black willow (Salix nigra) was the dominant species as measured by importance value with a total tally of 213.51 out of a possible 300 points. This dominance of the importance value was due to the high values for relative frequency, relative dominance, and relative density. Black willow had a relative dominance of 79.25%. There were 13 plots in which this species occurred for a relative frequency of 61.90%. The relative density for black willow was 72.36%.

Buttonbush (Cephalanthus occidentalis) had the next highest importance value with a value of 41.56 and also ranked second in frequency with four plot occurrences for a relative frequency of 19.05%. Loblolly pine (Pinus taeda) was second in relative density with one specimen having a total basal area coverage of 51.9 sq cm for a value of 9.90%.

Shrub Layer Stratum

The shrub layer vegetative stratum in KD Area held a total of 279 measured specimens of 12 species. The area was moderately diverse in the shrub layer flora with a diversity of 0.74 and a richness of 4.50. Basal area was 334 cm^2/500 m^2 and density was 278 stems/500 m^2.

Black willow dominated the stratum in all categories of analysis by having 124 individuals occurring in 15 of the 20 plots sampled. The relative dominance for black willow was 83.18%, much higher than the next highest measurement of relative dominance. Black willow also had the greatest relative frequency (44.12%) and density (44.44%) in the sampling area.

The importance value for KD Area was highest for black willow (importance value of 171.74 of a possible 300). Another importance value worth mentioning is buttonbush with a value of 36.95.

The dominance of black willow within this area shows its opportunistic ability to colonize a disturbed wetland. This thick growth of black willow was also noted within creek floodplains that have been cleared for utility crossings along Pen Branch and Four Mile Creek. The crossings constitute high disturbance due to the total clearing of the vegetation, leaving space for successional stages to develop.

Ground Layer Stratum

The ground layer stratum for KD Area held a very diverse flora for the 50 subplots sampled (diversity of 0.92 and richness of 24.80). False nettle (Boehmia cylindrica) occurred in 43 of the plots for a relative frequency of 12.39%, a relative dominance of 20.92%, and an overall importance value of 33.31. Fireweed (Erechtites hieracifolia) followed with a total of 31 plot occurrences for a relative frequency of 8.93%, a relative dominance of 10.39%, and an importance value of 19.32. The third highest in all categories was dogfennel (Eupatorium capillifolium), occupying 26 plots and having a relative frequency of 7.49%, a relative dominance of 8.19%, and an importance value of 15.69.

4.10 KE Area

KE Area is merely an extension of KD Area into the delta. The area is located within parts of the Sunderland Terrace and Wicomico Terrace subregions of the Pleistocene Coastal Terraces. The elevation of the sampling area is approximately 80 feet msl. There were four plots sampled within the study site (Figure 1-1).
KE Area is located within the delta region of the confluence of Pen Branch and the Savannah River floodplain. The area is dominated by persistent and non- persistent vegetation with a soft substrate that is inundated with water. Located to the east of KE Area is a boardwalk constructed and used by the Savannah River Ecology Lab (SREL) for research within the marsh. Little shrub and understory vegetation was observed in the area and no overstory stratum was sampled.

A total of 31 plant species were documented within the Pen Branch delta region of the Savannah River swamp (KE Area). According to the species area curve, more sampling is required to establish the diversity of the area; however, sampling was discontinued after the fourth plot due to budget restrictions.

Overstory Stratum

There was no overstory vegetation occurring within the KE sampling area.

Understory Stratum

Only one individual occurred in KE Area which met the criterion for understory stratum vegetation. The species, wax myrtle (Myrica cerifera), had a basal area of 18.3 sq cm. No other calculations could be made due to the absence of other data.

Shrub Layer Stratum

The shrub layer vegetation for KE Area consisted of 15 individual specimens representing three species for a diversity of 0.68 and a very low richness of 1.70. Basal area was 56 cm^2/500 m^2 and density was 38 stems/500 m^2.

The three species occurring within the area were: black willow (Salix nigra); buttonbush (Cephalanthus occidentalis); and wax myrtle. The highest importance value was recorded for black willow with a value of 130.34 and was followed by buttonbush (92.47) and then wax myrtle (77.19).

Buttonbush had the highest relative frequency (50.0%). Black willow had the greatest relative density for the area (46.67%) while both wax myrtle and buttonbush had a density of 26.67%.

Black willow, based on relative dominance, was the most dominant of the three species at 50.34%. Wax myrtle was next at 33.86%, followed by buttonbush at 116.67%.

As with KD Area, KE Area has had unnatural disturbances to the area due to the loss of the overstory. Also, additional sediment dumping in the delta region from increased sediment loss upstream has been a factor which may alter the vegetation. Once again, black willow appears to be well suited to colonize the disturbed area.

Ground Cover Stratum

A total of 20 plots were sampled in the KE Area, which had a diversity of 0.89 and a richness of 14.56. There were 34 species measured within this stratum.

Broad-leaf arrowhead (Sagittaria latifolia) had the greatest importance value with a tally of 30.06 points of a possible 200. Broad-leaf arrowhead was followed by river seedbox (Ludwigia leptocarpa) (26.9), cattail (Typha latifolia) (18.37), and beggar tick (Bidens frondosa) (16.1).

Broad-leaf arrowhead had the highest relative dominance with a value of 19.79% and highest relative frequency with a value of 10.27%. River seedbox was second in these two categories with a relative frequency of 9.19% and a relative dominance of 17.71%. Third was cattails with a relative frequency of 8.11% and a relative dominance of 10.26%.

4.11 KF Area

KF Area begins east of the boardwalk and extends for approximately 1.25 miles to the east (Figure 1-1). A small logging road off Water Gap Road was used to access the site. Plot intervals were set at approximately 0.1 mile as measured by a car odometer. A total of 10 plots were sampled within KF Area (Figure 1-1). The sampling area is located within the Wicomico Terrace subregion of the Pleistocene Coastal Terraces and resides at an elevation of 80 feet msl.

KF Area runs along the wetland/upland boundary east of the Boardwalk and north of Stave Island. All plots were sampled within the wetland area and were placed at equal intervals. This was done to show the transition of the vegetation as distance increased from the flowing water of Pen Branch into the marsh. The area is dominated with persistent and nonpersistent emergent vegetation. To the east, there was an increase in mature bald cypress trees (Taxodium distichum) and the density of seedlings and saplings greatly increased.

There were 77 species documented within the 10 sampling plots in KF Area. Analysis of the species area curve shows sampling of the area for vegetation to be sufficient with the completion of the fourth sampling plot.

Overstory Stratum

Very little overstory was found in the natural swamp of the Savannah River floodplain (KF Area). Only three species occurred, having a total of 51 individuals that were measured for dbh. The diversity for the overstory vegetation was a moderate 0.57. Richness was 1.17, the lowest encountered for any

strata or site. The average canopy height of the sparse overstory vegetation was measured at 78 feet. Basal area was 6,775 $cm^2/500\ m^2$ and density was 5 stems/500 m^2.

Bald cypress, water tupelo (Nyssa aquatica), and black gum (Nyssa sylvatica) were the three species occupying this area. Bald cypress had over twice the basal area coverage (4251 $cm^2/500\ m^2$) as water tupelo (2088 $cm^2/500\ m^2$) and almost 10 times the basal area of black gum (436 $cm^2/500\ m^2$).

All values were highest for bald cypress, followed by water tupelo and then black gum. The importance values, in descending order from the highest to lowest, were 181.28 for bald cypress; 84.3 for water tupelo; and 34.42 for black gum. The relative frequency for bald cypress was 63.64% with both of the Nyssa spp. having a frequency of 18.18%. Bald cypress had a relative density of 54.9% and a relative dominance of 62.75%, both far higher than the value for the other two species in KF Area. The overstory vegetation became progressively more dense as distance from the mouth of Pen Branch increased.

Understory Stratum

A total of 54 individuals representing 4 distinct species were measured within the understory stratum of KF Area. The area has an extremely low diversity with a value of 0.23 and a low richness of 1.73. Basal area was 238 $cm^2/500\ m^2$ and density was 54 stems/500 m^2.

Out of the possible 300 importance value points, wax myrtle (Myrica cerifera) had the greatest value with 202.18 points. Black Willow (Salix nigra) followed with a value of 51.82.

Wax myrtle was the most frequently occurring species with 47 individuals, giving a relative frequency of 58.33%. Wax myrtle also had the highest relative dominance (56.81%).

Shrub Layer Stratum

KF Area shrub layer vegetation, as with the overstory and understory vegetation, was represented by only a few species (5); however, there were 396 individuals measured within the sampling plots. The diversity was only a moderate 0.59 and the richness a very low 1.54. Basal area was 443 $cm^2/500\ m^2$ and density was 396 stems/500 m^2.

As with the understory stratum, wax myrtle was the dominant species with a relative dominance of 56.16% and an importance value of 134.31. Following the wax myrtle was buttonbush (Cephalanthus occidentalis) with a relative dominance of 37.72% and an importance value of 113.92.

Buttonbush was the most frequently occurring species with a relative frequency of 35.29%. Wax myrtle had the highest relative density (48.74%) and was followed by buttonbush (40.91%).

Analysis of the density of the vegetative growth of KF Area understory stratum shows wax myrtle to be much better established than the other three species occurring in the sampling area. As previously described, the KF Area occurs within the floodplain of the Savannah River. The plot is located just below the wetland/upland boundary of the floodplain and remains inundated with water for a great portion of the growing season. The area sampled is undergoing succession from a persistent/ nonpersistent vegetative community to a palustrine/forested wetland. The dense growth of the natural successional communities could be compared to KD and KE Area successional trends in the disturbed community. With hydrology (inundation) and soils being similar, the vegetational succession in the disturbed area has been dominated by black willow, while the wax myrtle appears to be far better at colonizing the undisturbed, naturally changing areas.

Ground Cover Stratum

A total of 68 species were sampled within the KF Area ground cover stratum. The diversity for this area was an extremely high 0.93. Richness was 25.84. Marsh dewflower (Murdannia keisak), a highly successful introduced plant, held the highest importance value with a tally of 21.28 points out of a possible 200. Following closely were broad-leaf arrowhead (Sagittaria latifolia) (18.48), cattail (Typha latifolia) (15.36) and false nettle (Boehermia cylindrica) (15.34).

False nettle occurred in 21 of the 29 sampling plots for a relative frequency of 7.66%. Broad-leaf arrowhead was next with 20 plot occurrences for a relative frequency of 7.30% and was followed by marsh dewflower with a relative frequency of 6.20%.

Marsh dewflower had a relative dominance of 15.08% for the highest rating for dominance in the KF ground cover stratum. Following, in descending order of dominance, were broad-leaf arrowhead (11.18%), cattail (10.25%), and false nettle (7.68%).

4.12 HD Area

HD Area consisted of sampling in some areas which were inundated with water as well as sampling in an upland pine/oak xeric forest. When possible, sites which contained mesic or hydric soil conditions were sampled; however, much of the sampling within this area was conducted in the dryer areas.

The sample area is located northeast of Road C-6 adjacent to C Line of the SRS railway system. There were five plots sampled within HD Area (Figure 1-1). The area is located in the Aiken Plateau subregion of the Upper Coastal Plain province and lies at 300 feet msl in elevation.

The many roads which traverse the site were used to gain access to the area. Other than logging and past road construction, the area seemed to be free from impact associated with SRS operations. One plot (HD-4) appeared to be on an old home site.

A total of 31 species were documented during the sampling of the vegetational strata within the five sampling plots in HD Area. Analysis of the species area curve for the area shows sampling of the vegetation to be sufficient after the completion of the fifth sampling plot.

Overstory Stratum

The overstory stratum for HD Area had a low diversity of 0.32 for the seven species found within the five plots. This was the lowest diversity of any site overstory. Richness was 2.79. The average overstory canopy height for HD Area was 66 feet. Basal area was 11,735 cm^2/500 m^2 and density was 28 stems/500 m^2.

A total of 116 individuals of the overstory total of 141 individuals were loblolly pine (Pinus taeda). Except for relative frequency (35.71%), computed parameters were much higher for the loblolly pine than for any other species. The relative density was 82.27% and the relative dominance was 89.85%. The summation of these values yields an importance value of 207.83 of a possible 300 points for the loblolly pine. One other species, black cherry (Prunus serotina), occurred in more than one plot (relative frequency of 28.57%).

Understory Stratum

HD Area understory had a low diversity of 0.42 and a richness of 2.81 with a total of 60 individuals of six different species occurring. Basal area was 2,536 cm^2/500 m^2 and density was 119 stems/500 m^2.

Loblolly pine dominated the understory with an importance value of 199.31 points, based on a relative density of 75.0%, a relative dominance of 71.37%, and a relative frequency of 52.94%.

Black cherry (Prunus serotina) had the second highest relative dominance, at 12.47%, and, along with water oak (Quercus nigra) and wax myrtle (Myrica cerifera), had a relative frequency of 11.76%. Wax myrtle had the second greatest relative density with a value of 10.0%, followed by water oak (6.67%).

Shrub Layer Stratum

The 14 species measured within the 10 plots in HD Area shrub layer produced a diversity of 0.73 and a richness of 6.31. A total of 115 individuals were sampled, with loblolly pine dominating three of the four statistical parameters. Basal area was 176 $cm^2/500\ m^2$ and density was 222 stems/500 m^2.

Loblolly pine had the greatest importance value (76.41), relative frequency (20.69%), and relative dominance (33.11%), and the second greatest relative density (22.61%).

A species of Lespedeza (Lespedeza sp.) had the second highest importance value (70.35%) and relative dominance (14.79). Lespedeza also had the highest relative density (45.22%).

Ground Cover Stratum

The ground cover stratum for HD Area had a diversity of 0.83 within the 10 plots sampled. This site, along with HF area, had the lowest ground cover stratum richness at 10.59. Yellow honeysuckle (Lonicera japonica) had the highest importance value, at 45.96, followed by a species of blueberry (Vaccinum sp.) (28.88), yellow jasimine (Gelsemium sempervirens) (20.0), and loblolly pine and black cherry (13.36 each).

Yellow honeysuckle had the greatest relative dominance, with a value of 31.67%, followed by blueberry (relative dominance of 24.12%). Yellow jasmine and yellow honeysuckle each occurred in 3 of the 10 plots for the highest frequency of occurrence (relative frequency of 14.29%).

4.13 HE Area

HE Area is located west of Road C-6 and approximately 1000 feet north of C Line of the SRS railway system. Road C-6 and Road C-5 were used to access the site. The five sampling plots in the area are located within the Aiken Plateau subregion of the Upper Coastal province and are at an elevation of 300 feet msl (Figure 1-1).

HE Area is located in a mature, upland pine forest with a subcanopy consisting of scattered hardwoods. Evidence of logging (i.e., grown over logging roads) is recognizable on the site. The area has a gently sloping terrain with xeric soil conditions. The vegetation in all strata sampled was characteristic of this upland environment, quite different from that found in the Four Mile Creek and Pen Branch sampling areas.

There were 40 plant species measured within the five sampling plots in HE Area. By analyzing the species area curve, sampling is shown to be statistically sufficient after the fifth plot.

Overstory Stratum

The diversity for the HE Area overstory was a moderate 0.59. Richness was 2.79. The average height of the canopy in this sampling area is 69 feet. A total of 133 individual specimens of six species were measured within the five plots. Basal area was 11,291 $cm^2/500\ m^2$ and density was 27 stems/500 m^2.

Slash pine (Pinus elliotti) had a relative dominance of 67.18%. This species had a total of 69 specimens recorded and a relative density of 51.88%. Slash pine had the highest importance value with 144.06 out of a possible 300 points.

Loblolly pine (Pinus taeda) was the only species which occurred in all five of the plots, with a relative frequency of 31.25%; loblolly ranked second in relative dominance (23.76%) and relative density (35.34%) for an importance value of 90.34. Black cherry (Prunus serotina) and slash pine were second in relative frequency, with a value of 25.0%.

Understory Stratum

A total of 44 specimens of eight different species were measured in the 10 understory stratum plots of HE Area for a diversity of 0.69. Richness was 4.26. Basal area was 2,700 cm^2/500 m^2 and density was 88 stems/500 m^2.

Loblolly pine had the greatest importance value at 118.29. Following loblolly pine, in descending order of importance, were slash pine (102.14), and black cherry (29.97).

Loblolly pine was found in 6 of the 10 plots sampled and had a relative frequency of 33.33%. The second highest frequency of occurrence was slash pine, with specimens being recorded in four of the plots and a relative frequency of 22.22%. Black cherry had a relative frequency of 16.67%. All other species were found in only one plot and had a relative frequency of 5.56%.

Slash pine had the highest relative density (40.91%) and the second highest relative dominance with a value of 39.01%. Loblolly pine had the greatest relative dominance (46.32%) and was second with a relative density of 38.64%.

Shrub Layer Stratum

HE Area shrub layer held a high diversity of 0.81, with 65 specimens of 14 distinct species sampled within the 10 plots. Richness was 3.17. Basal area was 206 cm^2/500 m^2 and density was 126 stems/500 m^2.

Wax myrtle (Myrica cerifera) had the highest statistical values of all the species in the HE Area shrub layer, as follows: relative frequency of 15.38%; relative dominance of 25.74%; relative density of 38.46%; and an importance value of 79.58.

Chickasaw plum (Prunus angustifolia) led in three of the categories with the following values: importance value of 43.37; relative dominance of 22.60%; and a relative density of 16.92%. Three species [slash pine, American holly (Ilex opaca), and water oak (Quercus nigra)] shared the second highest relative frequency with values of 11.57%. Slash pine also had the third highest measures of the following: importance value of 38.93, relative dominance of 16.62%, and relative density of 10.77%.

Ground Layer Stratum

The diversity of the ground layer stratum of HE Area was 0.87. Richness was 13.64. A total of 23 species were measured and recorded within the 10 plots that were sampled. Yellow honeysuckle (Lonicera japonica) and Virginia creeper (Parthenocissus quinquefolia) each occurred in 10 of the plots for a relative frequency of 9.76%. Virginia creeper had the greatest relative dominance with a value of 28.66%, followed by muscadine (Vitis rotundifolia) (12.97%) and yellow jasmine (Gelsemium sempervirens) (10.99%).

4.14 HF Area

HF Area begins east of the junction of Road 3 and Road C and extends for approximately 500 feet to the northwest. This study site is located within the Aiken Plateau subregion of the Upper Coastal Plain Province. The five study plots are at the 300 foot msl elevation contour (Figure 1-1).

HF Area is composed of an immature upland pine forest of 15 to 20 years age. As the trees occur in a row formation and there is extensive growth of slash pine (Pinus elliotti), which is not endemic to the SRS, the area appears to have been planted. This sampling area is similar to HE Area but is more of a pine monoculture, though there are hardwoods within this study site. Ground cover is limited to hardy upland plant species such as Vaccinum spp. and Lespedezia spp. As with HE Area, the vegetation community in this study area is quite different from the sample areas of Four Mile Creek and Pen Branch.

A total of 23 species were documented within the five plots sampled in the HF Area. Analysis of the species area curve shows the sampling to be sufficient after the completion of the fourth plot.

Overstory Stratum

HF Area had a total of 113 individuals of nine different species measured for dbh. The average height for the overstory canopy was 71 feet. The diversity for the five plots sampled was 0.76. Richness was 3.90. Basal area was 12,109 cm^2/500 m^2 and density was 23 stems/500 m^2.

Loblolly pine (Pinus taeda) had a relative dominance of 32.36%. Sweetgum (Liquidambar styraciflua) followed with a relative dominance of 21.85%. Third highest was red maple (Acer rubrum) with a relative dominance of 17.57%.

Red maple was documented in three of the five plots for the highest relative frequency (23.08%). Loblolly pine and sweet gum had two plot occurrences for a relative frequency of 15.38%. The other six species were each found in only one of the five plots sampled.

Loblolly pine had the highest importance value of the nine species with a value of 72.52. Following loblolly pine were red maple (68.96) and sweet gum (66.44).

Understory stratum

A total of 70 individual specimens from six different species were measured and recorded from the 10 understory plots sampled within HF Area. The vegetation had a diversity of 0.61. Richness was 2.71. Basal area was 2,745 cm^2/500 m^2 and density was 140 stems/500 m^2.

Sweet gum had a total of 140.73 importance value points of a possible 300. Following sweet gum was red maple (115.46). Sweet gum and red maple each occupied seven plots for a relative frequency of 38.89%. All other species occurred in only one plot.

Sweet gum had the greatest relative dominance with a value of 56.12% and a relative density of 45.71%. Red maple had a relative dominance of 33.71% and a relative density of 42.86%.

Shrub Layer Stratum

The shrub layer stratum for HF Area had a diversity of 0.76 with 10 species occurring within the 10 plots sampled. Richness was 4.72. Basal area was 303 cm^2/500 m^2 and density was 168 stems/500m^2.

Red maple had the highest importance value with a total of 98.85 points. Following red maple, in descending order, were sweet gum (82.64), wax myrtle (Myrica cerifera) (42.15), and loblolly pine (26.9).

Sweet gum was documented in 6 of the 10 plots for a relative frequency of 23.08%. Red maple was second with five occurrences yielding a relative frequency of 19.23%. Loblolly pine occurred in four plots for a relative frequency of 15.38%.

Red maple had the greatest relative density (37.04%) and relative dominance (42.59%). Sweet gum followed with a relative density of 27.16% and a relative dominance of 32.40%.

Ground Layer Stratum

The HF Area ground layer stratum had a highly diverse flora (diversity of 0.90). Richness was 10.54, lowest of all sites for this stratum. A total of 17 species were found within this area. The most dominant of these species was yellow honeysuckle (Lonicera japonica) with a relative dominance of 23.63%. White-leaf catbriar (Smilax gluaca) was second with a relative dominance of 12.92% and tied for third were round-leaf catbriar (Smilax rotundifolia), poison ivy (Toxicodendron radicans), and peppervine (Ampelopsis arborea), each with a relative dominance of 8.09%.

Round-leaf catbriar and yellow honeysuckle were each found in four plots for a relative frequency of 12.12%. Peppervine, round-leaf catbriar, and poison ivy all were in three plots for a relative frequency of 9.09%.

The highest importance value was computed for yellow honeysuckle (35.75), followed by white-leaf catbriar (25.04), and three species (poison ivy, round-leaf catbriar, and peppervine) with importance values of 17.18.

5.0 DISCUSSION

Because of past disturbances which removed the overstory in areas of Pen Branch affected by reactor effluent, growing conditions are excellent for typical pioneer plant species. Except in areas of deep water, the vegetation over much of the corridor and delta has responded vigorously to the recent reactor outage, producing chest high herbaceous growth and thickets of woody growth that require a machete to traverse. These sites generally approach 100% cover. The exact species composition depends on substrate and chance colonization events, but generally follows the pattern described in Section 2 of this report.

In Figure 5-1 the successional status of the various sites is summarized based on basal area of woody components of the vegetation. The upstream, relatively untouched portions of Pen Branch (I, IA, IB) have a high total woody basal area of around 16,000 $cm^2/500\ m^2$, slightly greater than the pine upland areas (HD, HE, HF). In these mature stands the bulk of the basal area is comprised of large trees. In Indian Grave Branch (KA) and the corridor (KB and KC), however, the total woody basal area is one-half to one-third that in the upstream areas and the understory size class makes up nearly a third of the total. This indicates advanced secondary succession with many young trees and large shrubs. The Four Mile Creek corridor (DA) is very similar in aspect, but with a greater percentage of larger trees. In the delta (KD and KE) there is a complete lack of larger trees and only a few smaller trees. The Four Mile Creek understory basal area is five times that in Pen Branch (262 $cm^2/500\ m^2$ in D vs 52 and 46 $cm^2/500\ m^2$ in KD and KE, respectively). Shrub basal area in D (915 $cm^2/500\ m^2$) is similarly much greater than KD (334 $cm^2/500\ m^2$) or KE (56 $cm^2/500m^2$). Woody species strata diversity and richness values are lower in the deltas (D and KD, KE, KF) as well as in the corridors (KB and KC) for some strata. Groundcover layer species richness values are not affected except in the wettest delta site (KE). The Pen Branch delta thus remains the most heavily impacted and is at a very early successional stage.

No threatened, rare, or endangered plants were found on any of the sites sampled. This is not too surprising because on heavily disturbed sites the species that typically colonize are very common and widely distributed species such as willow and cattail rather than rare types. The upland stands sampled, (HD, HE, HF) would also not be expected to have any rare species because most rare plants at SRS are found in mesic to wet habitats.

Figure 5-2 shows the relative composition of dominant overstory vegetation in the upstream portions of Pen Branch. As one proceeds downstream from I to IA to IB, the composition changes largely by the increase in red maple and tulip tree, decreasing the strong dominance of black gum in I.

In the areas affected by thermal effluent (KA, KB, KC) tulip tree is progressively lost down-gradient and total basal area decreases (Figure 5-1), but otherwise the proportions of the dominant species are similar to IA and IB. Comparison to Four Mile Creek below C reactor (site DA) also shows a similar composition to the unimpacted midreaches of Pen Branch (IA and IB) except that cypress is present in Four Mile Creek. It is notable that no cypress was found in any of the Pen Branch plots, as this indicates that a lack of cypress seed source may inhibit regeneration of the delta area.

Comparison of the delta areas is problematic because all trees have been killed in these areas. Based on the shrub layer, the two deltas (D and KD plus KE) are very similar, being dominated by willow and tag alder in D and willow and buttonbush in KD and KE. The two delta ground cover strata, however, are very diverse, with species composition changing every few feet. Four Mile delta is dominated by climbing hempweed, false nettle, and tear-thumb compared to KD area at Pen Branch which is dominated by false nettle, fireweed, and dogfennel. KE area has wetter-site species, being dominated by broad-leaf arrowhead, river seedbox, and cattail. All of these are subject to change based on time since disturbance and minor changes in hydrology due to reactor operations.

Table 5-1. Woody Total Basal Area

	Basal Area* ($cm^2/500m^2$)													
	DA	D	I	IA	IB	KA	KB	KC	KD	KE	KF	HD	HE	HF
Overstory	7,326	0	13,502	13,887	15,658	5,145	4,464	2,544	0	0	6,775	11,735	11,291	12,109
Understory	907	263	2,322	1,591	820	1,677	2,467	839	524	46	238	2,536	2,700	2,745
Overstory + Understory	8,233	263	15,824	15,869	16,479	6,822	6,931	3,381	524	46	713	14,271	13,991	14,854
Shrub Layer	557	915	364	360	476	208	271	176	334	56	443	176	206	303

* Summed over all species

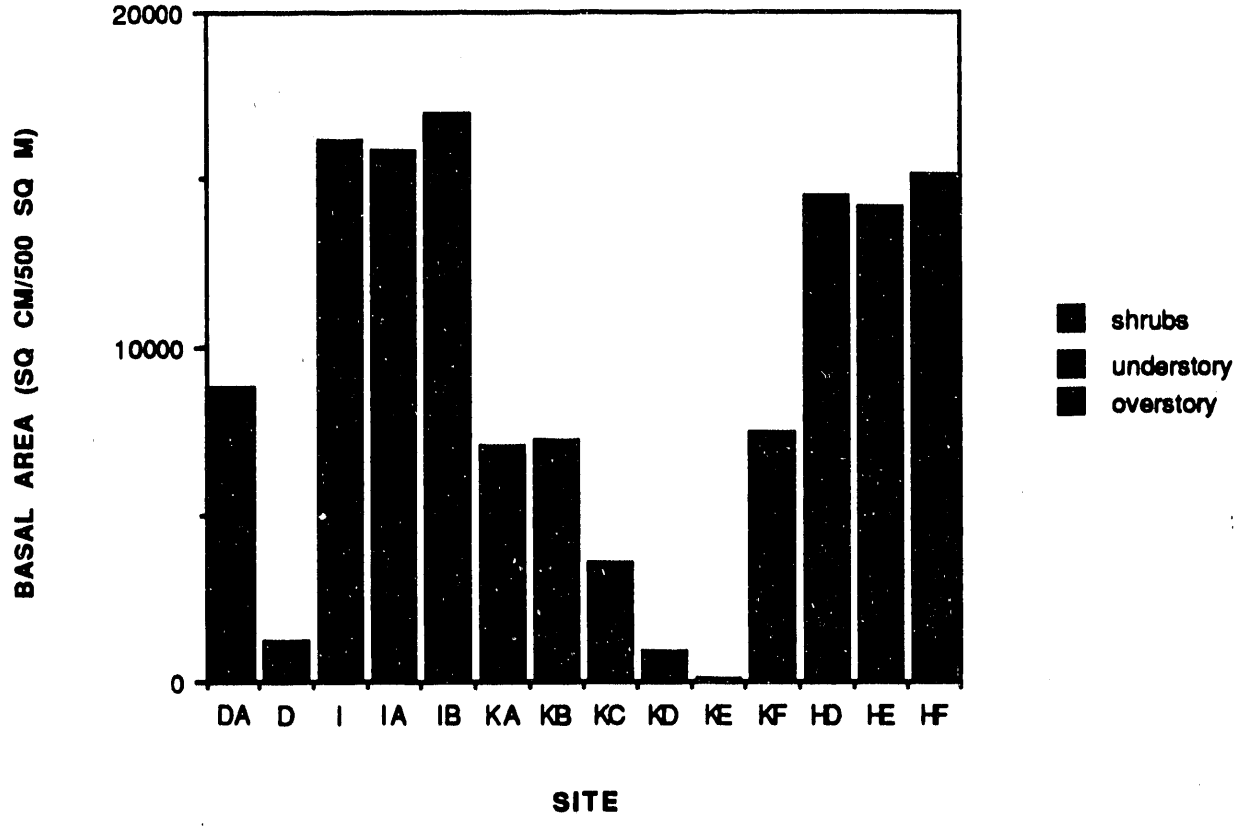

Figure 5-1. Successional Status of Study Locations

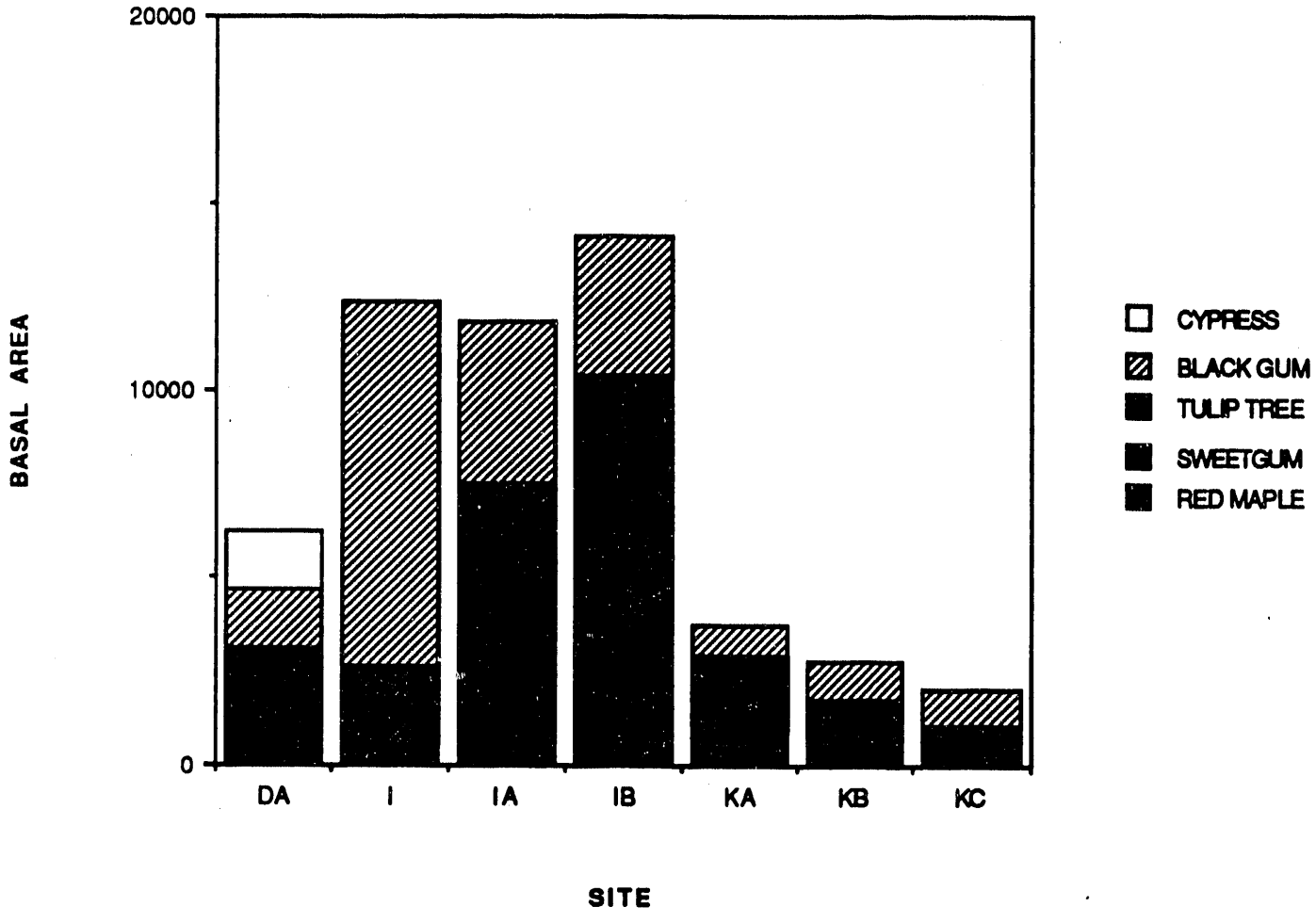

Figure 5-2. Overstory Composition in Pen Branch Corridor and Lower Portion of Four Mile Creek.

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APPENDIX A

Table A-1. Overstory Basal Area (1 of 2)

	Basal Area ($cm^2/500\ m^2$)													
	DA	D*	I	IA	IB	KA	KB	KC	KD*	KE*	KF	HD	HE	HF
Acer rubrum	503		572	1867	3293	492	702	403						2127
Acer saccharum var. leucoderme			13											
Alnus serrulata				14										
Carpinus caroliniana				165								54		
Celtis laevigata					20									
Cephalanthus occidentalis					33									
Fraxinus pennsylvanica				441	41		1465	208						
Ilex opaca			715	635	271	16		13						
Liquidambar styraciflua	884		2020	2557	2850	487	137	681						2646
Liriodendron tulipifera	1739		17	3060	4271	1929	924							
Magnolia virginica	325		63	17	52	50	70							
Myrica cerifera						7								
Nyssa aquatica					573						2088			
Nyssa sylvatica	1529		9747	4318	3717	814	1025	947			436	116		1479
Persea borbonia	20				21	99								
Pinus echinata													127	
Pinus elliottii													7585	
Pinus palustris												375		

Table A-1. Overstory Basal Area (Contd 2 of 2)

	Basal Area ($cm^2/500\ m^2$)													
	DA	D*	I	IA	IB	KA	KB	KC	KD*	KE*	KF	HD	HE	HF
Pinus taeda	393			182		615		52				10543	2682	3918
Platanus occidentalis	293				268	483								16
Prunus serotina					18							301	538	
Quercus falcata													328	
Quercus laurifolia				46	15									33
Quercus lyrata						7								
Quercus marilandica												59		
Quercus michauxii				28										
Quercus nigra	78		355	504	29	74							31	16
Quercus phellos						72								636
Quercus sp.														1238
Quercus stellata var. margarettae												287		
Salix nigra				53			133	240						
Taxodium distichum	1562										4251			
Ulmus alata					137									
Ulmus americana					49		8							
Total	7326	0	13502	13887	15658	5145	4464	2544	0	0	6775	11735	11291	12109

* No overstory at these sites

Table A-2. Overstory Density (1 of 2)

	Density (Trees/500 m^2)													
	DA	D*	I	IA	IB	KA	KB	KC	KD*	KE*	KF	HD	HE	HF
Acer rubrum	1.38		1.50	5.11	6.00	2.25	2.30	0.70						6.40
Acer saccharum var. leucoderme			0.13											
Alnus serrulata				0.11										
Carpinus caroliniana				0.89								0.20		
Celtis laevigata					0.10									
Cephalanthus occidentalis					0.10									
Fraxinus pennsylvanica				0.89	0.10		0.60	0.80						
Ilex opaca			2.00	3.67	0.90	0.08		0.10						
Liquidambar styraciflua	3.38		3.13	4.44	4.00	1.33	0.60	1.60						6.60
Liriodendron tulipifera	2.13		0.13	1.44	3.60	1.92	1.10							
Magnolia virginica	0.63		0.38	0.11	0.30	0.25	0.30							
Myrica cerifera						0.08								
Nyssa aquatica					0.40						1.80			
Nyssa sylvatica	1.88		11.00	5.56	6.30	1.92	1.40	1.60			0.50	0.40		2.20
Persea borbonia	0.13				0.20	0.58								
Pinus echinata													0.20	
Pinus elliottii													13.8	
Pinus palustris												1.00		

Table A-2. Overstory Density (Contd 2 of 2)

	Density (Trees/500 m^2)													
	DA	D*	I	IA	IB	KA	KB	KC	KD*	KE*	KF	HD	HE	HF
Pinus taeda	0.38			0.11		0.58		0.10				23.20	9.40	5.60
Platanus occidentalis	0.75				0.20	1.17								0.20
Prunus serotina					0.10							1.40	2.80	
Quercus falcata													0.20	
Quercus laurifolia				0.11	0.10									0.20
Quercus lyrata						0.08								
Quercus marilandica												0.20		
Quercus michauxii				0.11										0.20
Quercus nigra	0.38		0.63	0.78	0.10	0.33							0.20	
Quercus phellos						0.08								0.60
Quercus sp.														0.60
Quercus stellata var. margarettae												1.80		
Salix nigra				0.22		0.20		0.50						
Taxodium distichum	0.63										2.80			
Ulmus alata					0.20									
Ulmus americana					0.30		0.10							
Total	11.6	0	18.9	23.6	23.0	10.9	6.4	5.4	0	0	5.1	28.2	26.6	23.0

*No overstory at these sites

Table A-3. Understory Basal Area (1 of 3)

	Basal Area ($cm^2/500\ m^2$)													
	DA	D	I	IA	IB	KA	KB	KC	KD	KE	KF	HD	HE	HF
Acer negundo					93									
Acer rubrum	269	9	36	267	287	114	361							925
Alnus serrulata	185	108	73	279	11	143	34	74						
Berchemia scandens					6									
Betula nigra							3							
Carpinus caroliniana			15	162		49								
Carya cordiformis							9							
Cephalanthus occidentalis							15	50	41		7			
Cornus amomum				12										
Cornus florida			31		43	103								
Cornus foemina							34							
Cornus stricta				23				7						
Diospyros virginiana				47										
Fraxinus pennsylvanica				56										15
Hibiscus militaris							1							
Ilex opaca	16		911	368	11	309	49	66						
Liquidambar styraciflua	99	14	463	96	72	264	94	3			1			1541
Liriodendron tulipifera	12		31		46	19								

Table A-3. Understory Basal Area (Contd 2 of 3)

	Basal Area ($cm^2/500\ m^2$)													
	DA	D	I	IA	IB	KA	KB	KC	KD	KE	KF	HD	HE	HF
Magnolia virginica	125		97			103		19						
Myrica cerifera	93	21				50	1625	43		46	135	135		20
Myrica heterophylla		51												
Nyssa sylvatica			362	4	31	143		159	10					8
Oxydendrum arboreum				43										
Persea borbonia	96		43	57	9	343	11							
Pinus elliottii												1810	1054	
Pinus taeda		12				4			52				1251	
Platanus occidentalis						29	6							
Prunus serotina												316	175	
Quercus alba												185		
Quercus laurifolia					19		71						26	
Quercus nigra	<1		94	146	24							64	23	235
Quercus phellos				3										
Quercus stellata													79	
Rhus copallina												26	6	
Rhus glabra			141											
Rhus sp.				7	11									
Salix nigra	8	48					30	418	415		95			

Table A-3. Understory Basal Area (Contd 3 of 3)

	Basal Area ($cm^2/500\ m^2$)													
	DA	D	I	IA	IB	KA	KB	KC	KD	KE	KF	HD	HE	HF
Sassafras albidum									6					
Sorbus arbutifolia			25											
Styrax americana				3										
Taxodium distichum	3													
Ulmus alata					66									
Ulmus americana					5		124							
Vaccinium arboreum													86	
Viburnum dentatum				2	83									
Viburnum nudum				16	3									
Vitis rotundifolia						4								
Total	907	263	2322	1591	820	1677	2467	839	524	46	238	2536	2700	2744

Table A-4. Understory Density (1 of 3)

	Density (Trees/500 m^2)													
	DA	D	I	IA	IB	KA	KB	KC	KD	KE	KF	HD	HE	HF
Acer negundo					2									
Acer rubrum	15	1	8	10	11	3	19							60
Alnus serrulata	48	43	13	26	1	5	11	9						
Berchemia scandens					1									
Betula nigra							1							
Carpinus caroliniana			3	6		<1								
Carya cordiformis							1							
Cephalanthus occidentalis							1	5	18		4			
Cornus amomum				2										
Cornus florida			1		2	2								
Cornus foemina							5							
Cornus stricta				2				2						
Diospyros virginiana				1										
Fraxinus pennsylvanica				4										
Hibiscus militaris							1							4
Ilex opaca	3		28	17	3	18	1	3						
Liquidambar styraciflua	10	1	24	3	2	16	5	1			1			64
Liriodendron tulipifera	1		4		2	2								

Table A-4. Understory Density (Contd 2 of 3)

	Density (Trees/500 m^2)													
	DA	D	I	IA	IB	KA	KB	KC	KD	KE	KF	HD	HE	HF
Magnolia virginica	5		11			5		2						
Myrica cerifera	30	1				3	69	6		3	47	12		4
Myrica heterophylla		5												
Nyssa sylvatica			10	1	3	4		5	11					2
Oxydendrum arboreum				2										
Persea borbonia	3		4	6	2	9	1							
Pinus elliottii													36	
Pinus taeda		6				1			1			90	34	
Platanus occidentalis						1	1							
Prunus serotina												4	6	
Quercus alba												4		
Quercus laurifolia					2		3						2	
Quercus nigra	1		6	12	4							8	2	6
Quercus phellos				1										
Quercus stellata													2	
Rhus copallina												1	2	
Rhus glabra			19											
Rhus sp.				2	2									
Salix nigra	1	36					5	51	89		2			

Table A-4. Understory Density (Contd 3 of 3)

	Density (Trees/500 m^2)													
	DA	D	I	IA	IB	KA	KB	KC	KD	KE	KF	HD	HE	HF
Sassafras albidum									4					
Sorbus arbutifolia			4											
Styrax americana				1										
Taxodium distichum	1													
Ulmus alata					3									
Ulmus americana					1		2							
Vaccinium arboreum													4	
Viburnum dentatum				1	12									
Viburnum nudum				1	1									
Vitis rotundifolia				1	1	1								
Total	115	93	135	99	55	70	126	84	123	3	54	119	88	140

Table A-5. Shrub Layer Basal Area (1 of 5)

Basal Area ($cm^2/500m^2$)

	DA	D	I	IA	IB	KA	KB	KC	KD	KE	KF	HD	HE	HF
Acer negundo					<1									
Acer rubrum	19	1	29	10	39	7	21	3						129
Alnus serrulata	192	367	111	51	2	23	45	32						
Amelanchier arborea				2	<1	2								
Baccharis halimifolia		4												
Berchemia scandens					8									
Bignonia capreolata									1					
Boehemeria cylindrica									17					
Carex amphibola	1													
Carex radiata			<1		1									
Carpinus caroliniana		<1	3	5	<1	13								2
Carya cordiformis														
Celtis laevigata					2									
Cephalanthus occidentalis	6	1			1		7	33	30	9	167			
Chenopodium ambrosioides	4													
Cornus florida			2		8									
Cornus foemina				12										
Cornus stricta	3													

Table A-5. Shrub Layer Basal Area (Contd 2 of 5)

Basal Area ($cm^2/500m^2$)

	DA	D	I	IA	IB	KA	KB	KC	KD	KE	KF	HD	HE	HF
Decumaria barbara	2					2								
Diospyros virginiana														
Erechtites hieracifolia		<1			5							4	12	
Euonymus americanus					<1	<1								
Eupatorium capillifolium									1					
Fraxinus pennsylvanica				14	1			1						
Gordonia lasianthus			<1											
Hibiscus militaris							1							
Ilex decidua			<1			<1								
Ilex glauca					2									
Ilex opaca	21		45	33	30	60		3					16	
Ilex vomitoria			2											
Itea virginica	47		12	22	17	11								
Lespedeza sp.												27		
Ligustrum sinensis					1									
Lindera benzoin				3	185									
Liquidambar styraciflua	17	1	33	5	42	8	11	6	1			3	1	98
Liriodendron tulipifera			<1	1	6	2								

Table A-5. Shrub Layer Basal Area (Contd 3 of 5)

	Basal Area ($cm^2/500m^2$)													
	DA	D	I	IA	IB	KA	KB	KC	KD	KE	KF	HD	HE	HF
Lyonia lucida	11		8	9										
Magnolia virginica	24		26	5	4	20		25						
Mikania scandens						1								
Morus rubra			2											
Myrica cerifera	181			<1		15	79	11	<1	19	249	25	53	44
Myrica heterophylla		42	4											
Nyssa sylvatica	3		1	9	2		9	1	1					5
Parthenocissus quinquefolia			<1			<1								
Persea borbonia	14		40	11	15	9								
Pinus elliottii													34	
Pinus palustris											<1			
Pinus taeda	<1	16	2	5	1	<1					6	60	6	12
Platanus occidentalis						13							47	
Prunus angustifolia												20		
Prunus serotina					1							3	11	
Quercus alba					1		<1					5		
Quercus laurifolia				3	2							9	5	5
Quercus lyrata	1			2										

Table A-5. Shrub Layer Basal Area (Contd 4 of 5)

Basal Area ($cm^2/500m^2$)

	DA	D	I	IA	IB	KA	KB	KC	KD	KE	KF	HD	HE	HF
Quercus nigra	1		6	17	9							7	17	3
Quercus phellos				1										1
Quercus stellata												13		
Quercus stellata var. margarettae													4	
Rhus copallina												<1		
Rhus glabra			16											
Rhus sp.				1	6									
Rubus sp.									1					
Salix nigra	3	482				2	98	61	278	28				
Sambucus canadensis	1			<1	1	1								
Sassafras albidum													<1	
Scirpus cyperinus									4					
Smilax glauca					<1									
Smilax laurifolia			2	10		12								
Smilax rotundifolia			1			<1								
Sorbus arbutifolia			1	<1	2									
Styrax americana				7	8									
Taxodium distichum	1										21			

Table A-5. Shrub Layer Basal Area (Contd 5 of 5)

	Basal Area ($cm^2/500m^2$)													
	DA	D	I	IA	IB	KA	KB	KC	KD	KE	KF	HD	HE	HF
Toxicodendron radicans	2		<1	2	<1									
Toxicodendron vernix					<1	<1								
Ulmus alata				8										4
Ulmus americana				<1	<1									
Viburnum dentatum				67	70	<1								
Viburnum nudum	3			45	4									
Viburnum rufidulum			11											
Vitis rotundifolia			6	<1		7								
Total	557	915	364	360	476	208	271	176	334	56	443	176	206	303

Table A-6. Shrub Layer (1 of 5)

	Density (stems/500m^2)													
	DA	D	I	IA	IB	KA	KB	KC	KD	KE	KF	HD	HE	HF
Acer negundo					1									
Acer rubrum	18	3	20	26	28	8	22	1						60
Alnus serrulata	125	71	55	53	6	24	49	30						
Amelanchier arborea				1	1	3								
Baccharis halimifolia		1												
Berchemia scandens					2									
Bignonia capreolata									4					
Boehemeria cylindrica									51					
Carex amphibola	3	8												
Carex radiata			1		2									
Carpinus caroliniana			5	11	1	10								
Carya cordiformis														10
Celtis laevigata					6									
Cephalanthus occidentalis	3	1			2		8	27	29	10	162			
Chenopodium ambrosioides	5													
Cornus florida					27									
Cornus foemina				11										
Cornus stricta	3													

Table A-6. Shrub Layer Density (Contd 2 of 5)

	Density (stems/500m^2)													
	DA	D	I	IA	IB	KA	KB	KC	KD	KE	KF	HD	HE	HF
Decumaria barbara	1					<1								
Diospyros virginiana		1			3							4	4	
Erechtites hieracifolia									3					
Euonymus americanus					1	<1								
Eupatorium capillifolium									20					
Fraxinus pennsylvanica				11	2			1						
Gordonia lasianthus			3											
Hibiscus militaris							2							
Ilex decidua			3			6								
Ilex glauca					2									
Ilex opaca	6		21	22	22	29		1					8	
Ilex vomitoria			3											
Itea virginica	91		24	64	97	27	7	6						
Lespedeza sp.												104		
Ligustrum sinensis					4									
Lindera benzoin				6	6									
Liquidambar styraciflua	16	1	40	8	55	13	12	14	2			2	2	44
Liriodendron tulipifera			3	2	5	3								

Table A-6. Shrub Layer Density (Contd 3 of 5)

	Density (stems/500m^2)													
	DA	D	I	IA	IB	KA	KB	KC	KD	KE	KF	HD	HE	HF
Lyonia lucida	30		5	14										
Magnolia virginica	28		19	6	3	18		20						
Mikania scandens						2								
Morus rubra			1											
Myrica cerifera	99			2		19	73	3	4	10	193	22	50	26
Myrica heterophylla		14	1											
Nyssa sylvatica	1		3	16	4		6	1	6					2
Parthenocissus quinquefolia			1			<1								
Persea borbonia	29		46	23	32	38								
Pinus elliottii													14	
Pinus palustris											1			
Pinus taeda	1	8	5	16	4	<1					10	52	6	12
Platanus occidentalis						11								
Prunus angustifolia												10	22	
Prunus serotina					1							10	6	
Quercus alba					2	3						4		
Quercus laurifolia				7	4							4	2	2
Quercus lyrata	1			6										

Table A-6. Shrub Layer Density (Contd 4 of 5)

	Density (stems/500m^2)													
	DA	D	I	IA	IB	KA	KB	KC	KD	KE	KF	HD	HE	HF
Quercus nigra	3		6	22	8							4	8	2
Quercus phellos				1										2
Quercus stellata														2
Quercus stellata var. margarettae												4	2	
Rhus copallina												2		
Rhus glabra			10											
Rhus sp.				12	8									
Rubus sp.									1					
Salix nigra	19	66				3	375	60	124	18				
Sambucus canadensis	3			1	5	<1								
Sassafras albidum													2	
Scirpus cyperinus									34					
Smilax glauca					1									
Smilax laurifolia			3	17		14								
Smilax rotundifolia			1			2								
Sorbus arbutifolia			1	2	4									
Styrax americana				16	10									
Taxodium distichum	1										30			

Table A-6. Shrub Layer Density (Contd 5 of 5)

	Density (stems/500m^2)													
	DA	D	I	IA	IB	KA	KB	KC	KD	KE	KF	HD	HE	HF
Toxicodendron radicans	4		3	8	2									
Toxicodendron vernix					1	2								
Ulmus alata				7										2
Ulmus americana				1	5									
Viburnum dentatum				78	84	<1								
Viburnum nudum	10			58	9									
Viburnum rufidulum			36											
Vitis rotundifolia			6	1		4								
Total	500	173	325	529	460	240	554	164	278	38	396	222	126	168

Table A-7. Ground Cover Stratum Species Presence (1 of 11)

	DA	D	I	IA	IB	KA	KB	KC	KD	KE	KF	HD	HE	HF
Acer rubrum	X	X	X	X	X	X	X	X	X		X			X
Acer negundo						X								
Aeschynomene indica										X	X			
Agalinis purpurea							X							
Alnus serrulata	X	X	X	X	X	X	X	X						
Alternathera philoxeroides						X			X	X				
Amelanchier arborea	X	X		X	X	X	X	X						X
Ammannia coccinea										X	X			
Ampelopsis arborea														
Andropogon virginicus							X							
Antennaria caroliniana				X	X	X								
Apios americana							X							
Aralia spinosa														
Aristolochia serpentaria	X			X	X									
Arundinaria gigantea			X		X	X		X						
Arundinaria gigantea				X										
Asplenium platyneuron													X	
Aster sp.		X		X	X	X	X						X	

Table A-7. Ground Cover Stratum Species Presence (Contd 2 of 11)

	DA	D	I	IA	IB	KA	KB	KC	KD	KE	KF	HD	HE	HF
Atherium asplenioides	X				X		X							
Azolla caroliniana										X				
Baccharis halimifolia			X			X			X					
Berchemia scandens			X		X									
Bidens discoidea									X					
Bidens frondosa	X	X		X		X		X	X	X	X			
Bignonia capreolata					X									
Boehemeria cylindrica	X	X		X	X	X	X	X	X	X	X			
Boehemeria scandens				X										
Botrychium sp.					X									
Brunnichia cirrhosa						X								
Carex amphibola	X		X			X								
Carex folliculata												X		
Carex joorii		X		X										
Carex radiata							X				X			
Carex rosea	X				X			X						X
Carpinus caroliniana				X										
Centrosema virginianum													X	

Table A-7. Ground Cover Stratum Species Presence (Contd 3 of 11)

	DA	D	I	IA	IB	KA	KB	KC	KD	KE	KF	HD	HE	HF
Cephalanthus occidentalis	X	X	X	X		X	X	X	X	X	X			
Chenopodium ambrosioides														
Cicuta maculata	X	X		X	X		X	X	X					
Clitoria mariana													X	
Coccululus carolinus						X								
Commelina virginica					X									
Cornus florida					X	X								
Crataegus sp.												X		
Cynodon dactylon	X				X		X							
Cyperus sp.	X	X	X	X	X		X	X	X	X	X			
Decodon verticillatus		X		X		X								
Decumaria barbara	X			X	X	X	X							
Desmodium toruosum													X	
Digitaria sanguinalis									X					
Diospyros virginiana		X	X											
Dulichium arundinaceum											X			
Eclipta alba							X	X		X	X			
Echinochola colonum											X			

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Table A-7. Ground Cover Stratum Species Presence (Contd 4 of 11)

	DA	D	I	IA	IB	KA	KB	KC	KD	KE	KF	HD	HE	HF
Echinochola crusgalli							X			X				
Eleocharis sp.			X				X							
Erechtites hieracifolia						X	X	X	X					
Erianthus giganteus						X	X							
Erigeron canadensis						X		X	X					
Eupatorium capillifolium	X	X	X	X			X	X	X		X			
Eupatorium perfoliatum		X	X	X										
Fraxinus pennsylvanica				X	X									
Gallium circaezans													X	
Gallium obtusum								X		X				
Gallium tinctorium	X	X		X				X	X		X			
Gelsemium sempervirens	X		X			X	X					X	X	X
Glyceria sp.						X		X						
Gordonia lasianthus						X								
Habenaria repens							X			X	X			
Habenaria sp.				X	X									
Hibiscus moscheutos							X							
Hydrangea quercifolia		X		X				X		X				

Table A-7. Ground Cover Stratum Species Presence (Contd 5 of 11)

	DA	D	I	IA	IB	KA	KB	KC	KD	KE	KF	HD	HE	HF
Hydrocotyle ranunculoides	X													
Hydrocotyle verticillata						X	X	X			X			
Hypericum mutilum	X					X	X	X	X		X			
Hypericum sp.		X	X	X		X	X	X	X		X			
Ilex glauca							X							
Ilex opaca			X	X	X	X								
Ilex vomitoria			X			X								
Impatiens capensis	X	X		X	X	X	X	X	X					
Itea virginica	X		X	X	X	X	X							
Juncus coriaceus				X							X			
Juncus effusus	X	X		X		X	X	X	X					X
Krigia sp.						X								
Lamaceae sp.						X								
Latuca canadensis		X		X		X								
Leersia oryzoides	X	X					X	X	X	X	X			
Leersia virginia				X										
Leersia sp.	X					X	X				X	X		
Lemna sp.						X								

Table A-7. Ground Cover Stratum Species Presence (Contd 6 of 11)

	DA	D	I	IA	IB	KA	KB	KC	KD	KE	KF	HD	HE	HF
Lespedeza cuneata		X						X					X	
Leucothoe axillaris							X							
Liquidambar styraciflua			X	X	X		X	X	X					X
Liriodendron tulipifera	X		X				X							
Lobelia cardinalis				X										
Lomialeae sp.						X								
Lonicera japonica	X		X	X	X							X	X	X
Ludwigia alternifolia	X	X	X	X		X	X	X		X	X			
Ludwigia decurrens							X		X	X	X			
Ludwigia glandulosa		X												
Ludwigia leptocarpa	X						X	X	X	X	X			
Ludwigia palustris				X							X			
Lycopodium sp.		X					X							
Lycopus rubellus				X	X		X		X		X			
Lyonia lucida	X		X	X		X								
Magnolia virginica			X		X	X		X						
Mimulus alatus		X		X										
Michella repens	X		X	X	X	X	X	X			X			
Mikania scandens	X	X	X	X		X	X	X	X	X	X			

Table A-7. Ground Cover Stratum Species Presence (Contd 7 of 11)

	DA	D	I	IA	IB	KA	KB	KC	KD	KE	KF	HD	HE	HF
Morus rubra														
Murdania keisak	X			X			X	X	X	X	X			
Myrica cerifera	X		X			X	X	X	X		X			X
Myrica heterophylla						X								
Myriophyllum brasiliense							X			X				
Nasturtium officinalis		X					X							
Nasturtium sp.		X						X						
Nyssa sylvatica				X	X				X					
Nyssa aquatica											X			
Obolaria virginica											X			
Oldenlandia uniflora							X							
Onoclea sensibilis				X	X		X	X	X					
Osmunda cinnamonea	X		X	X	X		X							
Osmunda regalis			X						X					
Oxydendrum arboreum							X							
Panicum sp.	X	X	X		X	X	X	X	X		X	X	X	
Panicum verrucosum						X	X		X					
Paronychia riparia	X						X				X			

Table A-7. Ground Cover Stratum Species Presence (Contd 8 of 11)

	DA	D	I	IA	IB	KA	KB	KC	KD	KE	KF	HD	HE	HF
Parthenocissus quinquefolia	X		X	X	X	X							X	X
Paspalum floridanum		X						X	X					
Paspalum urvillei	X						X		X					
Peltandra virginica		X		X		X	X							
Persea borbonia	X	X	X	X	X	X	X							
Pilea pumila				X		X								
Pinus taeda		X			X	X	X	X				X		
Platancs occidentalis						X								
Pluchea camphorata	X						X							
Poa autumnalis						X			X					
Polygonum hydropiperoides	X						X	X		X	X			
Polygonum punctatum	X	X				X	X	X	X	X	X			
Polygonum sagittatum	X	X				X	X	X			X			
Polygonum sp.					X		X	X						
Polypodium polypodioides					X									
Polypremum procumbens							X							
Prunus angustifolia													X	

Table A-7. Ground Cover Stratum Species Presence (Contd 9 of 11)

	DA	D	I	IA	IB	KA	KB	KC	KD	KE	KF	HD	HE	HF
Prunus serotina												X		
Quercus laurifolia							X							X
Quercus nigra	X		X	X		X		X						
Quercus phellos								X						X
Rhus copallina									X		X	X		
Rhus glabra			X											
Rhus sp.					X		X		X					
Rhynchospora sp.													X	
Robinia nana													X	
Rubus sp.	X	X	X		X	X	X	X			X	X	X	X
Sabal minor						X								
Sabatia calycina					X			X		X				
Sagittaria gigantea		X												
Sagittaria latifolia	X							X						
Sagittaria latifolia									X	X	X			
Sagittaria montevidensis		X												
Salix nigra	X	X				X	X	X	X	X	X			
Sassafras albidum											X			
Saururus cernuus								X			X			

Table A-7. Ground Cover Stratum Species Presence (Contd 10 of 11)

	DA	D	I	IA	IB	KA	KB	KC	KD	KE	KF	HD	HE	HF
Scirpus cyperinus	X	X	X			X	X	X	X	X	X			
Setaria sp.							X							
Smilax glauca	X				X							X	X	X
Smilax laurifolia				X	X	X	X	X						
Smilax rotundifolia			X	X	X									X
Smilax smallii												X		
Sphenoclea zeylandica							X			X	X			
Solidago gigantea	X					X	X	X	X					
Solidago sp.			X				X	X					X	
Taxodium distichum						X					X			
Thelypteris noveboracensis			X											
Toxicodendron radicans	X		X	X	X		X				X		X	X
Tradescantia sp.						X	X		X					
Tragia urens													X	
Triadenum sp.								X		X	X			
Triadenum walteri	X	X		X	X		X	X	X	X	X			
Typha latifolia	X	X				X		X	X	X	X			
Ulmus alata				X										

Table A-7. Ground Cover Stratum Species Presence (Contd 11 of 11)

	DA	D	I	IA	IB	KA	KB	KC	KD	KE	KF	HD	HE	HF
Urtica sp.						X								
Viburnum dentatum				X	X	X								
Viburnum nudum				X	X		X							
Viburnum rufidulum			X											
Violet sp.					X	X								
Vitis rotundifolia			X	X	X	X	X						X	X
Wisteria frutescens	X													
Woodwardia areolata	X		X	X	X	X	X	X						
Xyris sp.							X							

TABLE A-8. VASCULAR FLORA OF SRS

	LYCOPODIOPHYTA
Lycopodiaceae	Lycopodium sp. – clubmoss
	PTERIDOPHYTA
Aspidiaceae	Athyrium asplenoiodes – southern lady fern
	Onoclea sensibilis – sensitive fern
	Thelypteris noveboracensis – New York fern
Aspleniaceae	Asplenium platyneuron – ebony spleen wort
Blechnaceae	Woodwardia areolata – netted chain–fern
Ophioglossaceae	Botrychium sp. – grapefern
	Botrychium biternatum – southern grapefern
	Botrychium dissectum – common grapefern
Osmundaceae	Osmunda cinnamomea – cinnamon fern
	Osmunda regales – royal fern
Polypodiaceae	Polypodium polypodioides – resurrection fern
Pteridaceae	Cheilanthes tomentosa – wooly lip fern
	Pteridium aquilinium – bracken fern
Salviniaceae	Azolla caroliniana – mosquito fern
	GYMNOSPERMAE
Pinaceae	Pinus echinata – shortleaf pine
	Pinus elliottii – slashpine
	Pinus palustris – longleaf pine
	Pinus taeda – loblolly pine
Taxodiaceae	Taxodium distichum – bald cypress
	ANGIOSPERMAE
	DICOTYLEDONEAE:
Aceraceae	Acer negundo – box elder
	Acer rubrum – red maple
	Acer saccharum var. floridanum – southern sugar maple

TABLE A-8 (Continued)

	Acer saccharum var. leucoderme – chalk maple
Amaranthaceae	Alternanthera philoxeroides – alligator weed
Anacardiaceae	Rhus copallina – winged sumac
	Rhus glabra – smooth sumac
	Toxicodendron radicans – poison ivy
	Toxicodendron vernix – poison sumac
Apiaceae	Cicuta maculata – water hemlock
	Hydrocotyle ranunculoides – floating pennywort
	Hydrocotyle verticillata – whorled pennywort
Apocynaceae	Vinca sp. – periwinkle
Aquifoliaceae	Ilex glabra – inkberry
	Ilex decidua – possum haw, deciduous holly
	Ilex opaca – American holly
	Ilex sp. – holly
	Ilex verticillata – winter holly
	Ilex vomitoria – yaupon
Aralinaceae	Aralia spinosa – hercules club
Aristolochiaceae	Aristolochia sp. – birthwort
	Aristolochia serpentaria – Virginia snakeroot
	Hexastylis arifolia – wild ginger
Balsaminaceae	Impatiens capensis – jewelweed
Betulaceae	Alnus serrulata – tag alder
	Betula nigra – river birch
	Carpinus caroliniana – ironwood
Bignoniaceae	Bignonia capreolata – crossvine
Brassicaceae	Nasturtium officinale – watercress
	Nasturtium sp. –
Campanulaceae	Lobelia cardinalis – cardinal flower
	Lobelia elongata – elongated lobelia
	Sphenoclea zeylandica – chicken spike
Caprifoliaceae	Lonicera japonica – japanese honeysuckle
	Sambucus canadensis – elderberry

TABLE A-8 (Continued)

	Viburnum dentatum – arrowwood
	Viburnum sp.
	Viburnum nudum – possumhaw
	Viburnum prunifolium – black haw
	Viburnum rufidulum – bluehaw
	Viburnum sp.
Caryophyllaceae	Paronychia riparia –
Celastraceae	Euonymus americanus – strawberry bush
Chenopodiaceae	Chenopodium ambrosioides – mexican tea
Compositae	Antennaria caroliniana – pussy–toes
	Aster sp.
	Aster vimineus var. subdumosus
	Aster vimineus – small white aster
	Baccharis halimifolia – groundsel tree
	Bidens discoidea – swamp beggar ticks
	Bidens frondosa – devil's beggar ticks
	Bidens sp. – beggar ticks
	Bidens vulgata –
	Chrysanthemum segetum – ox–eye daisy
	Coreopsis sp.
	Eclipta alba – yerba de tajo
	Elephantopus tomentosus – elephant's foot
	Erechtites hieracifolia – fireweed
	Erigeron canadensis – horseweed
	Eupatorium capillifolium – dogfennel
	Eupatorium compositifolium – dogfennel
	Eupatorium perfoliatum – boneset
	Eupatorium rugosum – thoroughwort
	Eupatorium sp.
	Krigia sp.
	Latuca canadensis – wild lettuce
	Latuca sp.

TABLE A-8 (Continued)

	Mikania scandens - climbing hempweed
	Pluchea camphorata - marsh fleabane
	Solidago gigantea - goldenrod
	Solidago sp.
Commelinaceae	Tradescanthia sp. - spiderwort
Convolvulaceae	Cuscuta sp. - dodder
	Jacquemontia tamnifolia - hairy cluster-vine
Cornaceae	Cornus amomum - dogwood
	Cornus florida - flowering dogwood
	Cornus sp. - dogwood
	Cornus foemina - stiff dogwood
	Cornus stricta - swamp dogwood
Cruciferae	Nasturtium sp. -
	Nasturtium officinale - watercress
Ebenaceae	Diospyros virginiana - persimmon
Ericaceae	Leucothoe axillaris - leucothoe
	Lyonia lucida - fetter-bush
	Oxydendrum arboreum - sourwood
	Rhododendron sp. - azalea
	Rhododendron sp. - rhododendron
	Rhododendron viscosum - swamp azalea
	Vaccinium corymbosum - blueberry
	Vaccinium arboreum - sparkleberry
	Vaccinium sp.
	Vaccinium vacillans - blueberry
Euphorbiaceae	Euphorbia sp.
	Tragia urens
Fabaceae	Aeschynomene evenia
	Centrosema virginianum - butterfly pea
	Clitoria mariana - butterfly pea
	Desmodium tortuosum - beggars lice,
	Lespedeza cuneata - sericea

TABLE A-8 (Continued)

	Lespedeza sp. – sericea
	Wisteria frutescens – wisteria
Fagaceae	Carpinus caroliniana – iron wood
	Quercus alba – white oak
	Quercus bicolor – swamp white oak
	Quercus falcata – southern red oak
	Quercus laurifolia – laurel oak
	Quercus lyrata – overcup oak
	Quercus marilandica – blackjack oak
	Quercus michauxii – swamp chestnut oak
	Quercus nigra – water oak
	Quercus phellos – willow oak
	Quercus sp. – oak
	Quercus stellatia – post oak
	Quercus stellata var margarettae – scrubby post oak var MA
Gentianaceae	Obolaria virginica – pennywort
	Sabatia calycina – marsh pink
	Sabatia sp. – pink
	Sabatia stellaris
Halorrhagidaceae	Myriophyllum brasiliense – parrot feather
Hamamelidaceae	Liquidambar styraciflua – sweetgum
Hydrophyllaceae	Hydrolea quadrivalvis – water-pod
Hypericaceae	Hypericum mutilum – St. John's wort
	Hypericum sp. – St. John's wort
	Triadenum sp.
	Triadenum walteri
Juglandaceae	Carya sp. – hickory
Labiatae	Lycopus sp. – bugleweed
	Lycopus rubellus –taper-leaf bugleweed

TABLE A-8 (Continued)

Lauraceae	Lindera benzoin – spicebush
	Persea borbonia – red bay
	Sassafras albidum – sassafras
Leguminosae	Aeschynomene indica – joint vetch
	Apios americana – American potato bean
	Centrosema virginianum – butterfly pea
	Clitoria mariana – butterfly pea
	Desmodium tortuosum – beggars lice
	Lespedeza sp. – lespedeza
	Lespedeza cuneata – sericea
	Robinia nana – locust
	Wisteria frutescens – wisteria
Loganiaceae	Gelsemium sempervirens – yellow jessamine
	Polypremum procumbens
Lythraceae	Ammannia coccinea – toothcups
	Decodon verticillatus – water willow
Magnoliaceae	Liriodendron tulipifera – yellow poplar, tuliptree
	Magnolia virginica – sweet bay
Malvaceae	Hibiscus militaris – halberd–leaved marshmallow
	Hibiscus moscheuto – rose mallow
Menispermaceae	Cocculus carolinus – coralbeads
Moraceae	Morus rubra – red mulberry
Myricaceae	Myrica cerifera – wax myrtle
	Myrica heterophylla – bayberry
Nymphacaceae	Nymphaea odorata – water lily
Nyssaceae	Nyssa aquatica – water tergum
	Nyssa sylvatica – black gum
Oleaceae	Fraxinus caroliniana – water ash
	Fraxinus pennsylvanica – green ash
	Fraxinus sp. – ash

TABLE A-8 (Continued)

Onagraceae	Ludwigia alternifolia – bushy seedbox
	Ludwigia decurrens – primrose willow
	Ludwigia glandulosa – cylindric-fruit seedbox
	Ludwigia leptocarpa – river seedbox
	Ludwigia linearis – narrow leaf seedbox
	Ludwigia palustris – marsh seedbox
	Ludwigia sp. – seedbox
Orchidaceae	Habenaria repens – water-spider orchid
Oxalidaceae	Oxalis sp. – wood sorrel
Polygalaceae	Polygala rugelii – yellow milkwort
	Polygala lutea – orange milkwort
Polygonaceae	Brunnichia cirrhosa – ladies' eardrops
	Polygonum hydropiper – marshpepper smartweed
	Polygonum hydropiperoides – swamp smartweed
	Polygonum punctatum – dotted smartweed
	Polygonum sagittatum – arrow-leaf tearthumb
	Polygonum setaceum – swamp smartweed
	Polygonum sp. – smartweed
Primulaceae	Lysimachia sp. – loosestrife
Rhamnaceae	Berchemia scandens – supplejack
Rosaceae	Crataegus sp. – hawthorne
	Prunus angustifolia – chickasaw plum
	Prunus serotina – black cherry
	Rubus sp. – blackberry
	Sorbus arbutifolia – red chokeberry
	Sorbus melanocarpa – black chokeberry
	Sorbus sp. – chokeberry
Rubiaceae	Cephalanthus occidentalis – buttonbush
	Diodia virginiana – Virginia buttonweed
	Galium circaezans – wild licorice

TABLE A–8 (Continued)

	Galium obtusum – bluntleaf bedstraw
	Galium sp. – bedstraw
	Galium tinctorium – stiff marsh bedstraw
	Mitchella repens – partridge berry
	Oldenlandia uniflora – clustered bluet
Salicaceae	Salix nigra – black willow
Saururaceae	Itea virginica – virginia willow
	Saururus cernuus – lizard's tail
Saxifragaceae	Decumaria barbara – climbing hydrangea
Scrophulariaceae	Agalinis purpurea – large purple false–foxglove
	Lindernia sp. – false pimpernel
	Mimulus alatus – sharp–wing monkey flower
	Mimulus ringens
Styracaceae	Styrax americana – styrax
Theaceae	Gordonia lasianthus – loblolly bay
Ulmaceae	Celtis laevigata – hackberry
	Planera aquatica – planer–tree, water elm
	Ulmus alata – winged elm
	Ulmus americana – American elm
Umbelliferae	Cicuta maculata – water hemlock
	Hydrocotyle ranunculoides – floating pennywort
	Hydrocotyle verticillata – whorled pennywort
Urticaceae	Boehemeria cylindrica – false nettle
	Pilea pumila – clearweed
Verbenaceae	Callicarpa americana – beauty–berry
Violaceae	Viola sp. – Violet
Vitaceae	Parthenocissus quinquefolia – virginia creeper
	Ampelopsis arborea – peppervine
	Vitis cinerea – pigeon grape
	Vitis rotundifolia – muscadine

TABLE A-8 (Continued)

MONOCOTYLEDONEAE:

Alismataceae	Sagittaria latifolia – broad-leaf arrowhead
	Sagittaria montevidensis – giant arrowleaf
	Sagittaria sp.
Araceae	Peltandra virginica – duck potato
Arecaceae	Sabal minor – palmetto
	Serenoa repens – saw palmetto
Bromeliaceae	Tillandsia usneoides – spanish moss
Commelinaceae	Commelina virginica – day flower
	Murdannia keisak – marsh dewflower
	Tradescantia sp. – spiderwort
Cyperaceae	Carex amphibola – narrow-leaf sedge
	Carex digitalis – slender wood sedge
	Carex folliculata
	Carex janiesii
	Carex joorii – cypress swamp sedge
	Carex raiata
	Carex rosea
	Carex sp. – sedge
	Cyperis albomarginatus
	Cyperis sp.
	Cyperus sp. – flatsedge
	Cyperus albomarginatus – white-edge cyperus
	Cyperus strigosus – straw-color flatsedge
	Dulichium arundinaceum – three-way sedge
	Eleocharis sp. – spikerush
	Rhynchospora sp. – beakrush
	Rhynchospora corniculata – short-bristle beakrush
	Scirpus cyperinus – woolgrass
	Scirpus sp. – bulrush
Dioscoreaceae	Dioscorea villosa – wild yam

TABLE A-8 (Continued)

Gramineae	Andropogon sp. - broomsedge
	Andropogon virginicus - broomsedge
	Arundinaria gigantea - giant cane
	Chasmanthium sessiflorium - long-leaf spikegrass
	Cynodon dactylon - bermuda grass
	Digitaria sanguinalis - crab grass
	Echinochola sp.
	Echinochola colonum - jungle rice
	Echinochola crusgalli - barnyard grass
	Erianthus giganteus - plumegrass
	Festsuca sp. - fescu
	Glyceria sp. - manna grass
	Leersia sp. - cutgrass
	Leersia oryzoides - rice cutgrass
	Leersia virginia - whitegrass
	Panicum sp. - panic grass
	Panicum scoparium
	Panicum verrucosum - warty panic grass
	Paspalum sp.
	Paspalum floridanum - Florida paspalum
	Paspasum urvillei - vasey grass
	Poa autumnalis - autumn bluegrass
	Setaria sp. - foxtail grass
	Sphenopholis pennsylvanica - swamp wedgescale
Hydrocharitaceae	Egeria densa
	Elodea sp. - water weed
Juncaceae	Juncus coriaceus - leathery rush
	Juncus effusus - soft rush
	Juncus sp. - rush
	Luzula sp. - woodrush
Lemnaceae	Lemna sp. - duckweed
Liliaceae	Smilax sp. - catbrier

TABLE A–8 (Continued)

	Smilax glauca – catbriar
	Smilax laurifolia – bamboo catbriar
	Smilax rotundifolia – roundleaf catbriar
	Smilax sp. – catbriar
	Smilax smallii – lanceleaf greenbrier
Orchidaceae	Habenaria sp.
	Habenaria repens – water-spider orchid
Palmae	Sabal minor – dwarf palmetto
Typhaceae	Typha latifolia – cattail
Xyridaceae	Xyris sp. – yellow eyed grass

END

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