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POST-MINE RECLAMATION OF NATIVE UPLAND COMMUNITIES

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POST-MINE RECLAMATION OF NATIVE UPLAND COMMUNITIES

FINAL REPORT

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DISCLAIMER

PERSPECTIVE

Steven G. Richardson – FIPR Reclamation Research Director

Xeric (dry) and mesic (intermediate between dry and wet) upland habitats in Florida are critical to the existence of several animal and plant species. Acreages of such lands have shrunk dramatically due to urban, agricultural and industrial development. Although phosphate mining causes a drastic disturbance of the land, it should be possible, with proper reclamation techniques, to reestablish native upland plant communities. An important goal of the FIPR reclamation research program is to gain a better understanding of the factors important to restoration of native habitats on phosphate mined lands and to develop methodology for accomplishing the rehabilitation of these habitats.

This project examined ten reclaimed sites of various ages and with different soil characteristics and different construction and planting techniques and then identified factors related to successful reestablishment of native upland plants or, conversely, invasion by exotic nuisance plants. The project also included two new field experiments.

In the first experiment, a revegetation technique that involves removing topsoil from a site to be mined and spreading it on a newly reclaimed site was modified. Because burning has been found to stimulate flowering and seed production in fire-adapted native plant communities, an innovative idea was tried. A donor site was burned and the plants were allowed to produce seed prior to removing the topsoil. Topsoil from the burned and unburned sites was then spread on sites with either overburden or sand tailings as the substrate.

In the second experiment, burning, disking and herbicide treatments were examined for control of competing vegetation prior to sowing a mixture of seeds collected from a native flatwoods/prairie site.

Two additional ongoing projects, "Development of Seed Sources and Establishment Methods for Native Upland Reclamation" (USDA Natural Resources Conservation Service, FIPR Project 96-03-120) and "Managing Weed Competition and Establishing Native Plant Communities on Reclaimed Phosphate Mined Land in Florida" (FIPR staff, FIPR Project 98-03-134), are providing additional information on reestablishing native plants on reclaimed lands and controlling exotic weeds. Related research conducted by the University of Florida, "Ecology, Physiology, and Management of Cogongrass (*Imperata cylindrica*)" has been published (FIPR Publication 03-107-140, 1997).

In addition, the Proceedings of the 17th Annual National Meeting of the American Society for Surface Mining and Reclamation, June 11-15, 2000, Tampa, Florida (ASSMR, Lexington, Kentucky), includes several papers on upland reclamation on phosphate mined lands in Florida.

ABSTRACT

Native upland communities are now being recognized as vital ecosystems worthy of restoration; however, scientific data on upland reclamation is lacking. This study examined soil properties that were influential in successful reclamation of native upland taxa, as well as establishment of undesirable aggressive grasses. Two field experiments were also implemented: a topsoil augmentation experiment and a site preparation experiment.

Matching moisture regimes between a reclaimed site and the targeted vegetative community was significant in determining the success of a reclamation site. Topsoiling was a successful method for transferring a viable seed bank to a reclaimed area. However, recruitment from the seed bank was more successful if the moisture regime at the reclaimed site closely matched the moisture regime from the donor site.

Aggressive grasses are problematic because they enter a site quickly, expand, and compete with perennial natives. Aggressive grasses grew successfully in a wide range of soil conditions but were frequently associated with a higher soil pH and higher soil fertility. Soil fertility and soil moisture were important factors in influencing aggressive grasses; however, there was roughly an equal chance that aggressive grasses would establish on a random basis irrespective of soil and site conditions.

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Without the assistance and dedication of John Kiefer, the topsoil augmentation study would not have been possible. Jeff Dodson was also invaluable in implementing the site preparation study. We thank Peter Wallace for his suggestions on vegetation monitoring. We are also grateful to Jay Udelhoven and Susan Elfers who helped us retrieve documents from the South Florida Water Management District. There were several individuals that assisted in field data collection, and in particular we wish to thank Josh Boan, Dawn Lucas, Martin Sandquist, Elena Chavez, Karen Garren, and Joni Wagner. In addition, we thank Josh Boan and Jackie Page for assistance with the laboratory analyses, and Scott Sheridan for his work in formulating the database and creating the summary tables and statistical analyses used in the report. We may have inadvertently omitted other people who should have been acknowledged, and we apologize for any such omissions.

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EXECUTIVE SUMMARY

Native upland communities are now being recognized as vital ecosystems worthy of restoration, but unlike wetland reclamation, data on techniques and methodology for upland soil reclamation has not been compiled and synthesized, much less evaluated for success. Numerous soil reconstruction procedures for upland communities have been tried, yet there has been little coordination or monitoring to determine which techniques are most successful. This study evaluated--through a large monitoring effort of ten existing reclaimed sites combined with two field experiments—soil properties that were influential in successful reclamation of native upland taxa. Also investigated were soil conditions that favor growth and establishment of undesirable aggressive grasses such as cogongrass, natalgrass, and bahiagrass.

After consulting with reclamation specialists from phosphate industries, state agencies, and private companies, ten reclamation sites were selected from 22 sites examined. Site selection criteria included presence of native herbaceous species, lack of disturbance such as cattle grazing or mowing, and known history of construction and planting methods. Nine of the ten sites are located in central Florida in the tricounty area of Polk, Hillsborough, and Hardee Counties, while the tenth site is located in Hamilton County in north Florida.

Two field experiments were also implemented: a topsoil augmentation experiment, and a site preparation experiment. The topsoil augmentation study evaluated the efficacy of transferring flatwoods seeds and plant parts in topsoil from unmined pine flatwoods. Part of the pine flatwoods was burned the summer prior to topsoil transfer to stimulate seed production of fire-dependent species such as wiregrass (*Aristida beyrichiana*). This study allowed comparison of vegetation in topsoil from burned and unburned flatwoods, thick and thin layers of topsoil, and overburden and sand tailings soil. The effects of topsoil were evaluated by comparing vegetation in topsoil plots to vegetation in control plots with no topsoil. The site preparation experiment was designed to investigate two site preparation methods--disking only, and burn/disking--disking their efficacy in removing weedy vegetation and preparing the site for direct seeding.

A wide range of soil physical and chemical properties was recorded at the ten reclamation sites. The soil types were generally overburden and/or sand tailings, with topsoil added to several sites. One site, Noralyn South, contained clay slurry, and clay mixture with sand tailings. Overburden showed the highest variability in soil texture, soil color, and soil chemical parameters. Overburden tended to be intermediate in soil parameter concentrations as compared to other soil types, with two exceptions—higher P concentrations and lower Zn concentrations were recorded in overburden soils. As expected, sand tailings were nutrient-poor and droughty compared to the other soil types. In contrast, clay and clay slurry increased the soil nutrients and moisture index of sand tailings. Topsoil enhanced soil properties in sand tailings by decreasing pH and increasing total N and total C.

Soil parameters (bulk density, pH, total N, total C, Mehlich 3 extractable nutrients--P, K, Ca, Mg, Zn, Mn, Cu, Fe, Na, CEC, soil compaction, and moisture index) and plant species or plant groups (native, exotic, aggressive, weedy, pioneer, characteristic, wiregrass, lovegrasses, scrub species, wetland species) were compared to determine relationships between both desirable and undesirable plant taxa and soil parameters. The native upland species in almost all cases were present because they were successfully introduced to the site and in some cases were reseeded. The fact that these desirable natives have persisted at the reclamation sites for 5 to 10 years suggests that these species or plant groups are somewhat adapted to a wide range of soil conditions inherent at reclaimed mine sites.

Aggressive grasses are a group of exotic perennial grasses, such as cogongrass, bahiagrass, natalgrass, bermudagrass and torpedograss, that are most problematic at upland restoration sites because they enter a site quickly during a weedy phase, expand their territory quickly, and persist in competition with perennial natives. Aggressive grasses grew successfully in a wide range of soil conditions, but were frequently associated with a higher soil pH and higher soil fertility than the desirable taxa. Soil fertility and soil moisture were important factors in influencing aggressive grasses; however, our study suggests that there is roughly an equal chance that aggressive grasses will establish on a random basis irrespective of soil and site conditions. Therefore, it is important to control the surrounding weed population prior to planting, and establish vegetation as quickly as possible before a weed population establishes. This was exemplified in the site preparation field experiment.

Comparisons among soil parameters and vegetation were also conducted within each of the ten reclamation sites. Several correlations were identified between desirable or undesirable vegetation and soil chemical and physical characteristics such as soil type, horizon thickness, and moisture holding capacity. In many cases, increased moisture holding capacity from thick overburden soils, high clay content, or thin sand tailings was correlated with the presence of undesirable aggressive grasses in habitats that were targeted for xeric (scrub and sandhill) communities. The reverse pattern was observed in more mesic communities. The drier portions of mesic communities such as where thicker sand occurred over overburden appeared to also be related to the presence of aggressive grasses.

Matching moisture regimes between a reclaimed site and the targeted vegetative community was perhaps the factor most frequently encountered in evaluating the success of a reclamation site with respect to native vegetation. If a xeric scrub or sandhill community was targeted to be reclaimed, then the soils should be droughty sand tailings with low moisture holding capacity and low fertility. Topsoiling has been demonstrated as a successful method for transferring a viable seed bank to a reclaimed area. However, recruitment from the seed bank appeared to be more successful if the moisture regime at the reclaimed site closely matched the moisture regime from the donor site. In order to closely match moisture conditions, topsoil removed from a xeric scrub or sandhill donor site should be added to droughty sand tailings. Conversely, topsoil removed from a mesic flatwoods or hydric flatwoods should be added to a sandy or loamy overburden. These observations were exemplified at several of our study sites, namely Estech, Gopher Hills, and Hardee Lakes, and were confirmed by the topsoil augmentation study. The topsoil augmentation study produced several interesting results. Transfer of topsoil resulted in a high species richness of desirable species at both the overburden and sand tailings site at the end of the first growing season. A higher density and coverage of desirable species persisted through the end of the second growing season at the overburden site but not at the sand tailings site. The sand tailings site contained a high weed cover in adjacent areas which presumably contributed to a heavy cover of natalgrass and torpedograss during the second year. A more favorable moisture regime at the overburden site presumably contributed to not only more successful germination, but to more successful establishment of mesic flatwoods species. The effect of an extreme drought experienced in 1998 was more pronounced on the droughty sand tailings soils than the overburden soils.

Significant vegetation differences were recorded between plots that received topsoil from a burned flatwoods and plots that received topsoil from an unburned flatwoods. Wiregrass was more frequently associated with topsoil from burned flatwoods, whereas saw palmetto (*Serenoa repens*) was more frequently associated with topsoil from unburned flatwoods. A similar pattern occurred for two witchgrass species in the *Dichanthelium* genus. *Dichanthelium aciculare* was more prevalent in the burned plots while *D. portoricense* was more common at the unburned plots. Thickness of topsoil affected some species, however this effect was not as pronounced as those from burning, soil type, or year.

The site preparation field study did not yield results as clear as the topsoil augmentation study. Undesirable weedy and aggressive species reemerged after both disking and burning/disking treatments. The site had a heavy cover of weedy species for several years prior to project initiation, and these species maintain a large number of seeds in the seed bank. Neither disking nor burning/disking were sufficient to reduce the emergence of weedy and aggressive species. Additionally, the winter and spring of 1997 was extremely droughty and there was little germination of the native grass and forb seeds.

INTRODUCTION

Mining of phosphate in central and northern Florida has involved more than 66,800 ha (165,000 acres) (Marion 1986), and a far greater area will be mined in the future. While much of this land was being used for agricultural production prior to mining, and much will be reclaimed for that purpose after mining, there remains a need for development of techniques for reclaiming native upland communities.

The 1978 state law (Florida Statutes, Chapter 378) requiring reclamation of all lands mined after 1975 recognized the values of native ecosystems, such as the provision of habitat for fish and wildlife. Reclamation requirements were given in DNR rules (Chapter 16C-16, Florida Administrative Code) stating, in addition to numerous physical requirements for reclamation projects, that wetlands had to be reclaimed to cover at least the same amount of land as they covered prior to mining, and *a minimum of 10% of upland areas had to be replanted with a variety of indigenous hardwoods and conifers.* To date, little research has been conducted on these upland portions of the reclamation schemes. Uplands have not received the same degree of legal protection as wetlands, but are now being recognized as vital ecosystems worthy of restoration.

In the 20 years since passage of the 1978 law, vast areas of wetlands and uplands have been reclaimed by mining companies in northern and central Florida. Significant acreage of reclaimed uplands has been reclaimed for agricultural purposes rather than as native upland communities. There now exists a relatively large array of upland reclamation sites that have employed a variety of reclamation techniques ranging in intensity from planting only a few canopy species and assuming that other suitable species will volunteer, direct seeding ground cover and scrub species, to application of donor topsoil coupled with supplemental planting. In all, numerous revegetation procedures for upland communities have been tried, yet there has been little coordination and monitoring to determine which techniques are most successful.

Several obstacles hinder the successful reclamation of native upland communities. First, encroachment of exotic aggressive grasses such as cogongrass, natalgrass, and bahiagrass can quickly reverse any attempts at establishing native upland taxa. The Florida Institute of Phosphate Research (FIPR) has recognized this as a significant problem and recently funded a research study *Ecology, Physiology, and Management of Cogongrass* (*Imperata cylindrica*) (Shilling et al. 1997) to address these concerns. That study has increased our understanding of cogongrass biology, physiology, plant-herbicide interactions, and management practices aimed at controlling cogongrass. Additional studies to address control of aggressive grasses are being conducted which will significantly increase our knowledge of reclaiming upland communities.

Another major obstacle in reclamation of native upland communities is to provide enough native seed to meet the state’s reclamation and land management needs. FIPR is again funding a research study with the U.S. Natural Resource Conservation Service (NRCS) to identify the hardiest seed sources and develop the technology for harvesting native seed plots. Currently, there are no commercial seed sources for native Florida upland species, and the logistics for obtaining seed are complicated at best. Many native taxa produce a low quantity of seed, have low seed viability, and may undergo an initial dormancy. Traditional mechanical seeding implements are often ineffective as the native seeds are light and chaffy.

Once native plants have been introduced to a reclaimed site, either by seeding, planting, or topsoiling, they are generally poor competitors with aggressive non-native grasses. Native xeric scrub and sandhill species typically grow slowly and are well adapted to the stressful conditions of low moisture and low fertility inherent in xeric soils. Low coverage combined with bare ground and open spaces are natural attributes of xeric communities. Flatwood species cover a wide range of moisture regime from scrubby flatwoods to hydric flatwoods. As moisture increases, native ground cover grows denser and some of the weedy aggressive grasses are not as competitive. Some non-native perennial grasses that we identified as aggressive grasses, on the other hand, are very opportunistic, fast-growing, and probably adapted to a wide range of reclaimed soil conditions.

Reclamation of upland communities has been attempted by the phosphate industry, but unlike wetland reclamation, data on techniques and methodology for upland reclamation has not been compiled and synthesized. This study evaluates soil properties to determine which soil parameters influence successful reclamation of native upland taxa, as well as favor the growth and establishment of undesirable aggressive grasses. With systematic and detailed monitoring, vegetative parameters are correlated with soil properties. We also attempt to identify reclamation conditions that favor the often slow-growing upland species, while excluding the aggressive grasses. The specific objectives for this study were as follows:

- Review and analyze existing information on soils, vegetation and hydrology for phosphate-reclaimed uplands
- With assistance from industry, examine existing upland reclamation sites which have a documented history of specific construction and planting techniques. Select eight to ten sites for further investigations
- At the selected sites, collect, synthesize, and evaluate information on soils, vegetation and hydrology based on systematic and detailed sampling
- Identify construction-related and soils-related parameters critical for the successful construction and establishment of native upland communities
- Implement a field experiment to assess the effects of transferring topsoil from a burned and unburned flatwoods to an overburden and a sand tailings site
- Implement a field study to assess the effects of disking and burning for site preparation prior to direct seeding.

POST-MINE RECLAMATION SAMPLING STUDY

POST-MINE RECLAMATION SAMPLING STUDY

METHODOLOGY

Site Selection

Reclamation specialists from phosphate industries, state agencies, and private companies were consulted to obtain information regarding sites that were mined and reclaimed to native upland plant communities. A total of 22 potential study sites were identified and evaluated in the field to determine suitability for this study. Criteria used for site selection included presence of native herbaceous species, lack of disturbance (such as cattle grazing or mowing), and known history of construction and planting methods. Ten sites were selected for this study (Table 1). Nine sites are located in the tri-county area of Polk, Hillsborough, and Hardee Counties, and the tenth site is located in Hamilton County (Figure 1). These sites were selected based on the criteria listed above, as well as to allow comparison of specific variables such as overburden vs. sand tailing, topsoil augmentation vs. no topsoil augmentation, and young sites vs. older sites. Each study site is described below. Project location maps for all project sites are provided in Appendix A.

Hundreds of plant species were encountered during this project and are listed in Appendix B. In this report, plant species are referenced by common name for the most commonly encountered species such as cogongrass (*Imperata cylindrica*), natalgrass (*Rhynchelythrum repens*), bahiagrass (*Paspalum notatum*), torpedograss (*Panicum repens*), hairy indigo (*Indigofera hirsuta*), and wiregrass (*Aristida beyrichiana*). Other less common plant species are generally reported by their scientific name so that the exact species is clear. Other plants are reported by both their common names and scientific names. At the risk of being inconsistent, this convention for reporting plant species should impart clarity on the exact plant species being addressed, while allowing the report to read smoothly.

Bald Mountain. This 200-acre site was reclaimed in the early 1990s by creating a hill of sand tailings, then capping the tailings with roughly 3 to 12 inches of overburden. Twelve 1-acre plots were left uncapped to provide natural openings. A road pulverizer-mixer with 18 inch radii blades set every few inches apart thoroughly mixed the soil into a looser consistency. The reclamation plan for Bald Mountain consisted of restoring 100 acres of sand scrub habitat and 65 acres of sandhill habitat.

Planting began in January 1993 with hydroseeding 130 pounds of partridge pea (*Chamaecrista fasciculata)*, 50 pounds of another partridge pea *(Chamaecrista nictitans* var. *aspera)*, 158 pounds of seed from over 17 species of forbs and grasses hand-collected from a sandhill and scrub in fall of 1992, and 27 pounds of hand-collected seed from the previous year. Additional planting occurred in August-October 1993 with 65 species of sandhill and 41 scrub species totaling 139,000 plants grown in the nursery by The Natives, Inc. (Bissett 1995a).

Table 1. Location and Characteristics of the Study Sites.

Site Name	Industry	Industry's designation	R, T, S[†]	Latitude, Longitude	Topsoil Applied	Age (Years)[‡]	Substrate[§]
Bald Mountain	IMC-Agrico	IMC-KC-LB(2)	23E, 31S, 18	N27^{0} 47.18', W82^{O} 02.77'	No	4	ST with OB cap
Best-of-the-West	IMC-Agrico	IMC-NP-SWB(1)	24E, 30S, 22	N27^{0} 51.50' , W81^{0} 54.51'	Yes	11	OB
Estech Topsoil Site	Estech	Parcel 188	25E, 32S, 05	N27^{0} 42.56', W81^{O} 44.25'	Yes	6-7	OB
Gopher Hills	IMC-Agrico	AGR-FG-SP(14)	23E, 32S, 23	N27^{0} 40.62', W81^{O} 50.65'	Yes	2-4	ST on OB
Hardee Lakes	IMC-Agrico	AGR-FG-PC(1)	23E, 33S, 02	N27^{0} 38.24', W81^{O} 54.29'	Yes	6-7	OB
Margaret Gilbert	IMC-Agrico	BP-L-SP(2a)	22E, 31S,10	N27^{0} 47.74', W82^{O} 05.72'	No	12	OB and ST
Noralyn South	IMC-Agrico	IMC-N-5	25E, 30S, 29	N27^{0} 50.26', W81^{O} 50.20'	No[¶]	15	ST amended with clay
PCS Site	PCS	PCS-SC-86(1)	14E, 01S, 02	N30^{0} 25.55', W82^{O} 53.40'	Yes	4-5	OB
16-Acre Direct Seed Site	IMC-Agrico	AGR-FG-PC(2)	23E, 32S, 32	N27^{0} 44.39', W81^{O} 55.71'	No	3	OB and ST mixture with OB cap
Wildlife Corridor	Cargill	SP-12	24E, 32S, 20	N27^{0} 39.44', W81^{O} 50.22'	No	8-11	OB and ST

R = Range, T = Township, S = Section
[‡] Years calculated to 1997 (when vegetation and soil analyses began)
[§] OB = Overburden, ST = Sand Tailing
[¶] Parts of the site received topsoil, but topsoil was not present in our quadrats.

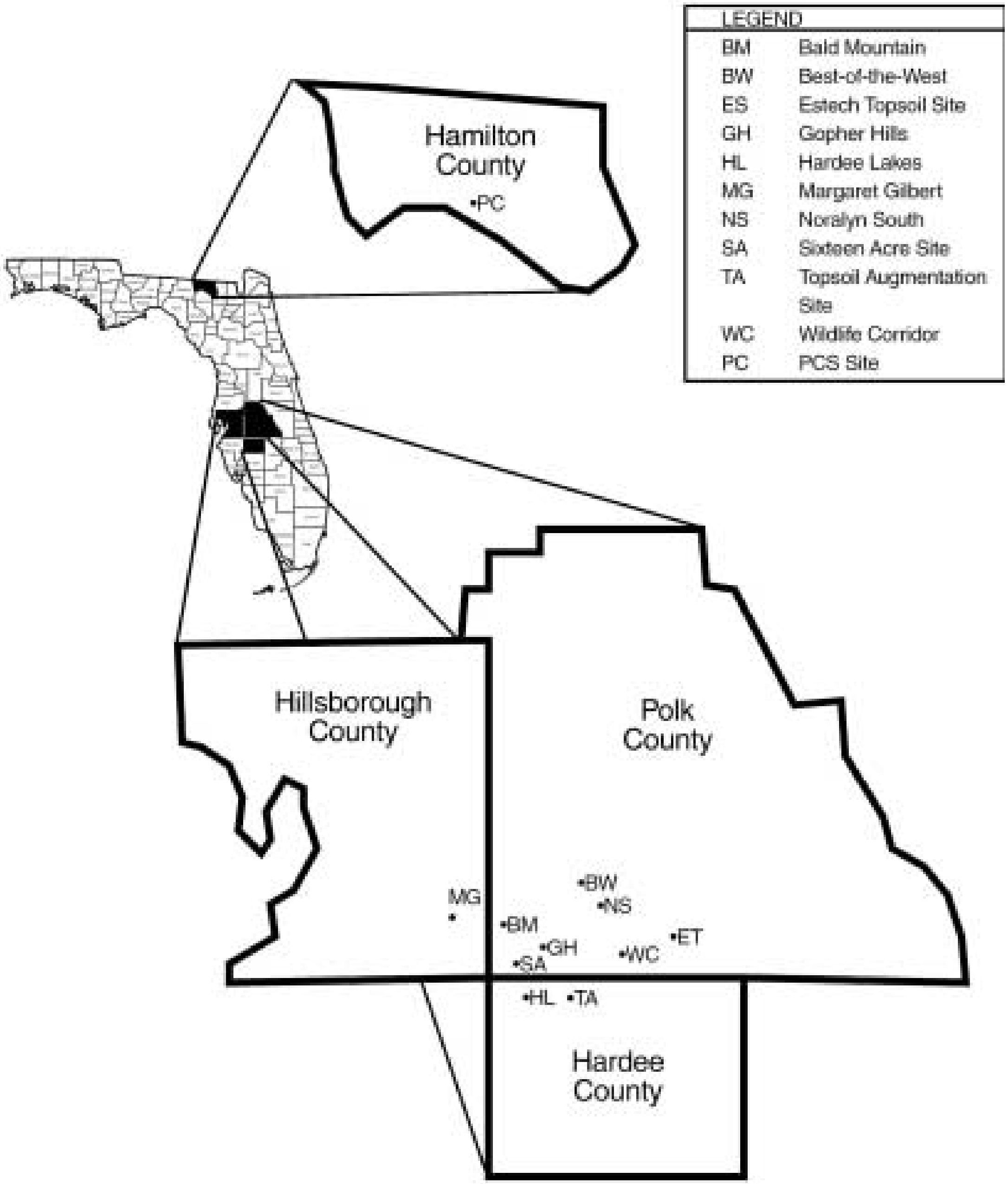

Figure 1. General Location of Study Sites.

Early observations in April 1994 showed that over 95% of the planted species had survived the first winter. Many forbs and grasses flowered and produced seed the same fall as they were planted. Several factors were thought to have contributed to the early success, including mixing a thin layer of overburden with sand tailings. Vegetation planted on sand tailings and mixed overburden/sand tailings areas had high survival rates. Highest mortality occurred on exposed sand tailings slopes that contained no overburden. Mortality was also high on areas with thick overburden, and it appeared that thicker overburden layers promoted greater initial weed growth. The exotic grass cogongrass had begun to establish in several areas by the first spring after planting.

In 1997, Bald Mountain continued to have high survival of planted scrub and sandhill species. Many of these species have reproduced and spread, including wiregrass, *Sporobolus junceus, Eragrostis elliottii, Polygonella robusta, Sorgastrum secundum,* and *Aristida gyrans*. Cogongrass, natalgrass, and hairy indigo had encroached some areas, and has allowed us to compare soil factors between native desirable vegetation zones and aggressive weedy vegetation zones. Despite this encroachment, Bald Mountain showed early signs of successful upland reclamation. It is interesting to note that the one-acre plots that were left uncapped and therefore contain only sand tailings have relatively few weeds or seedlings from initial hydroseeding. They are now colonizing with native grass and forbs. *Polygonella robusta*, for example, has reseeded in heavy drifts.

Best-of-the-West. This 156-acre reclaimed upland that is located just west of the Noralyn Mine in southwestern Polk County (Figure 1). Only the southwestern corner of this site is typically referred to as Best-of-the-West, however for our study the entire site is referred to as Best-of-the-West. This site was reclaimed in 1985 and 1986 by applying topsoil to a matrix of overburden. Topsoil was removed from a nearby donor xeric oak scrub, xeric oak sandhill, palmetto prairie, and small marsh and applied to a thickness of one foot or less. Large portions of the 156-acre site have been reclaimed to xeric scrub communities. A high density of sand live oak *(Quercus geminata),* sand pine (*Pinus clausa),* and longleaf pine *(Pinus palustris)* are present. The oaks sprouted from the transferred topsoil, whereas the pines were planted during reclamation. Many herbaceous species have established, including *Schizachyrium stoloniferum, Panicum anceps, Solidago fistulosa, Helianthemum corymbosum, Andropogon glomeratus, Tephrosia chrysophylla, Eragrostis elliottii*, and *Polygonella polygama*.

A population of the threatened scrub jay has established at the Best-of-the-West site and represents the first reported scrub jay use on a mine reclamation site (King et al. 1992). Gopher tortoises have successfully been relocated to this site on several occasions. Several small populations of the threatened Florida mouse were relocated to the Best-of-the-West site from 1996 through 1998. This site represents one of the best examples of successful upland reclamation as evidenced by the diversity of native xeric species and successful colonization of endemic wildlife species.

Estech Topsoil Site. This small, roughly 2-acre site is referred to by Estech as Parcel 188. It is located east of Fort Meade and was reclaimed in 1990 and 1991. Topsoil was removed from a nearby scrubby flatwoods and applied at an approximately 6-inch depth to cover an overburden soil. Slash pine (*Pinus elliottii)* were then planted at the site in February 1991. Seeds and propagules of many native flatwood and scrubby flatwood species transferred in the topsoil and have successfully colonized the site. These species include wiregrass, *Schizachyrium stoloniferum*, *Galactia elliottii*, *Pityopsis graminifolia* var. *tracyi, Chamaecrista fasiculata, Euthamia tenuifolia,* and *Elephantopus elatus*. Patches of cogongrass and bahiagrass are present, which allowed comparison of soil properties between zones of desirable species and zones of weedy aggressive grasses.

Gopher Hills. This 300-acre site is one of the younger sites reclaimed to scrub, scrubby flatwoods, and flatwoods. It is located at IMC-Agrico's Ft. Green Mine in southwestern Polk County (Figure 1). Sand tailings were applied over an overburden soil, with a variable thickness of both substrates. Topsoil was applied in August 1993. The tops of both hills were then planted with scrubby flatwoods species in the fall of 1995. Reclamation has been an ongoing process since the inception of this project, with partial burning and disking in 1996 to remove natalgrass and other weedy species, and direct seeding in 1997 with seed collected from a burned dry prairie in Okeechobee County.

The study quadrats were established along both hills that were topsoiled and planted with scrubby flatwoods species. The Site Preparation Field Experiment, which is presented at the end of this report, was also conducted at this site, and is located along the intermediate elevations that were burned, disked, and direct seeded. Although this is quite a young site, many topsoil areas are successfully supporting desirable native species such as *Schizachyrium stoloniferum, Helianthemum corymbosum, Galactia elliottii, Paspalum setaceum, Dichanthelium portoricense,* and *Sorgastrum secundum*, as well as exotic species such as natalgrass, cogongrass, and bahiagrass. As is the case with most reclaimed upland sites, nuisance and exotic species are problematic at this site.

Hardee Lakes. This 8-acre site was reclaimed in 1990 by applying roughly 1 foot (30 cm) of topsoil from a nearby flatwoods to an overburden matrix. Clearly this site has resulted in a successfully reclaimed flatwoods, as evidenced by a high cover and rich diversity of native species, including wiregrass, *Schizachyrium stoloniferum*, *Paspalum setaceum, Sorghastrum secundum, Solidago striata*, *Scleria ciliata*, and *Andropogon glomeratus* var. *glaucoposis*. In many areas, *Schizachyrium stoloniferum* forms a dense mat and out-competes most other species. Many sweetbay *(Magnolia virginiana)* saplings have sprouted at the lowest elevations, and by 1998 had grown up to 6 to 8 feet tall. Exotic and nuisance species are present but are not as abundant as most of the other reclaimed upland sites. Hardee Lakes represents the wettest of the 10 study sites.

Margaret Gilbert Site. Located in southeast Hillsborough County, this 100-acre site was reclaimed to a sand scrub community in 1985. During reclamation, several small areas were either planted with scrub species or seeded four times over a 2-year period with native scrub species including many rare species. We were able to locate one planted area and one seeded area for this investigation. These two study areas are located next to a scrub island that was left unmined to facilitate a natural source for scrub seed and wildlife habitat.

Quadrats were established to primarily measure groundcover vegetation that had reproduced and spread from the original planting and seeding. Both planted and seeded sites have shown a high degree of success, and probably best typify a reclaimed scrub community. Some of the species present include *Polygonella polygama, Polygonella fimbriata* var. *robusta, Chrysopsis floridana, Liatris laevigata, Liatris chapmanii, Liatris ohlingerae, Balduina angustifolia, Paspalum setaceum, Yucca filamentosa,* and several lichens in the genera *Cladonia* and *Cladina*.

The planted and seeded sites are located very close to the unmined scrub island, and as a result, we questioned whether they were mined and reclaimed, or just cleared and replanted. We compared the soils (both physical horizonation and chemical parameters) in the unmined scrub island with adjacent soils in the study plots. Because this site was a research project (Gilbert unpublished), detailed notes were taken during construction and reclamation. Although the soil profiles appeared nearly identical, chemical differences in pH, Ca, Mg, Zn, Fe, Mn, Na, and Ca suggested that the planted and seeded areas had indeed been mined and reclaimed. The detailed notes from the initial study substantiated this finding that the study plots did represent mined areas.

Noralyn South. This 127-acre site was reclaimed in 1983, and represents one of the first attempted upland reclamation projects following phosphate mining in central Florida. Together with the Best-of-the-West site, the Noralyn South site is the subject of published reports on upland reclamation in central Florida (King et al. 1992). This site originally served as a clay settling pond, and was drained of surface water and then filled with sand tailings. When some xeric trees were planted, they suffered from sand blasting, so phosphatic clays with only 18-20% solids were spread over the soil with scrapers and bulldozers. After the clays had dried sufficiently, the clays were disked into the top 6 to 8 inches of sand. This restoration technique was rather unique to the industry. At a nearby site, IMC actually pumped a clay slurry over the sand tailings, let it dry and then disked it in. In 1981 topsoil from a xeric habitat at west Noralyn was spread in test plots of approximately 0.25 acres in size. Because we were able to locate only a few of the topsoil pockets, we did not include topsoil areas in the study quadrats. The site was fertilized and planted with native trees and the exotic bahiagrass to form a grass understory.

Isolated patches of desirable species were observed during our 1997 field survey and included *Eragrostis spectabilis, Eragrostis elliottii*, *Garberia heterophylla, Bulbostylis ciliatifolia*, *Licania michauxii, Opuntia humifusa,* and *Polygonella polygama*. However, the majority of the understory is colonized by the aggressive grasses cogongrass, bahiagrass, and natalgrass. Over 200 tortoises were released at Noralyn South between 1982 and 1988. The site is now dotted throughout by active tortoise burrows, thus indicating a thriving population of gopher tortoises. A small population of the threatened Florida mouse was also relocated to this site in 1998.

PCS Site. This site differs from the other nine sites in that it is the only site located in north Florida. The PCS site was mined in the mid-1980s and reclaimed with an overburden matrix. A few inches of topsoil were added in strips four to five years later. The site was then planted with bare root seedlings of pines and hardwoods at a density of 650 trees per acre. The site has since revegetated, and by 1997 had a thick cover of herbaceous and woody species. Common species included *Andropogon glomeratus* var. *glaucopsis, Andropogon virginicus, Solidago canadensis* var. *scabra,* bahiagrass, *Gelsemium sempervirens, Agalinis purpurea, Solidago fistulosa, Euthamia tenuifolia, Rhus copallina, Toxicodendron radicans, Baccharis halimifolia,* and *Rubus cuneifolius*. The planted trees appeared healthy and have grown to a height of six feet or more.

Sixteen-Acre Site. This 16-acre site, located in southwest Polk County, was the first large-scale effort to direct seed wiregrass. The site was reclaimed in the early 1994 with an overburden and sand tailings mixture. The site was then covered with a roughly 6-inch overburden cap. Seeds of wiregrass and associated species were collected from a burned dry prairie in Okeechobee County and spread on the site. The wiregrass-dominated prairie was burned in June and the seeds were harvested in late November 1994. Grasses, sedges, and wild flowers were collected with the wiregrass. The seed was dried, bagged, and hauled to the 16-acre site where it was spread using a mulch blower. Just before the seed was spread, a cultipacker was used on the freshly graded site to create a 1-inch deep groove that would catch the seed and minimize seed loss through wind dispersal. The cultipacker was then driven over the site to help work the seed into the top 1 inch of soil.

A mulching experiment was conducted at the time of seeding to determine if mulch would increase germination by stabilizing seeds and retaining moisture from rainfall. Half of the site was mulched during the initial seeding with a bahiagrass mulch that was free of weeds and seeds, and the entire 16 acres was then rolled. We decided to also test this mulching hypothesis by locating half of our study quadrats in mulched areas and half in unmulched areas. Prior to our study, the site was monitored at three, six, and nine months after direct seeding to document germination of wiregrass and other species (Bissett 1995b). Over 40 species of grasses, sedges, and wildflowers that were collected had successfully established. Nine months after seeding, approximately ten native plants other than wiregrass and approximately 20 wiregrass occurred per square meter. This is four times the average of 5 per square meter reported by Clewell (1989) from various wiregrass systems. Bissett (1995b) found more wiregrass seedlings as well as more exotic and invasive seedlings in the mulched areas (wiregrass: 29 seedlings/m^2; invasives: 67 seedlings/m^2) as compared to the unmulched areas (wiregrass: 12 seedlings/m^2; invasives: 16 seedlings/m^2). Surface soil cracking has occurred on parts of this site during dry spells, and hard compacted soils were thought to limit germination in these areas. The cracking and compaction is suggested to be a result of the clayey overburden cap. We noticed this surface cracking and apparent compaction, however our penetrometer tests failed to document highly compacted soils.

Wildlife Corridor. This 58-acre site was reclaimed in 1986 through 1992 as a forested upland wildlife corridor. The matrix is primarily overburden material, but also contains a nonuniform layer of sand tailings either above or below the overburden matrix.

Many woody plant species considered beneficial to wildlife species were planted at the site, including saw palmetto *(Serenoa repens),* summer hawthorn (*Crataegus flava*), persimmon (*Diospyros virginiana*), scrub plum (*Prunus geniculata*), red mulberry (*Morus rubra),* paw-paw (*Asimina obovata*), American beautyberry (*Callicarpa americana*), gallberry (*Ilex glabra*), blackhaw (*Viburnum obovatum*), and coralbean (*Lonicera sempervirens*). There were no ground cover species, either native or exotic, planted at the wildlife corridor site. Site monitoring two years after planting showed good survival of planted species in areas with low weed competition (Bissett unpublished).However, in the ensuing years, undesirable species such as cogongrass, bahiagrass, natalgrass, and hairy indigo have spread extensively and limited cover of desirable species. We hypothesized that one or more soil properties were favoring these monostands of nuisance and exotic species. To test this hypothesis, we compared soils in areas of high cover of cogongrass, low cover of cogongrass, high cover of natalgrass, and low cover of natalgrass to soils which support desirable native species.

Quadrat Selection

Distinct vegetation zones were identified at each study site and included high cover of desirable species (HD), high cover of weedy species (HW), low cover of desirable species (LD), and low cover of weedy (LW) species. Desirable species were those species indicative of healthy scrub, sandhill, scrubby flatwoods, mesic flatwoods, and hydric flatwoods communities. Although some desirable species are more prevalent in recently disturbed areas, they do persist in mature ecosystems though perhaps in reduced numbers. All desirable species were later listed as pioneer or characteristic species. Weedy species encompassed two vegetation categories; true weedy species that quickly colonize severely disturbed sites but do not persist in mature ecosystems (and can be either native or exotic), and aggressive species that quickly colonize a disturbed site but will persist in a stable system. Appendix B lists all plant species documented in our study plots and their vegetation category.

Typically, three elongated quadrats were nonrandomly located in each vegetation zone at each study site. Some study sites did not support all four broad vegetation zones in sufficient numbers to replicate the quadrats. The quadrats were generally located in areas where vegetation reseeded or emerged from a nearby seed source, rather than in distinctly planted areas. The schematic in Figure 2 depicts a hypothetical quadrat configuration by vegetation zones, and Appendix C summarizes quadrat information from all 10 study sites. At some sites, we expanded our sampling protocol to include stands of species monocultures. For example, some areas contained stands exclusively of cogongrass, bahiagrass, natalgrass, or *Schizachyrium stoloniferum*. In those cases, we constructed replicate quadrats in the monostands to test the hypothesis that certain soil parameters promote colonization of undesirable species, or in the case of the *Schizachyrium stoloniferum*, support colonization of this desirable flatwoods species. One special case is the 16-acre site where half the site was mulched and the other half unmulched. To investigate the effects of mulching on vegetation cover and soil parameters, sampling quadrats were replicated three times in each vegetation community in both the mulched and unmulched areas.

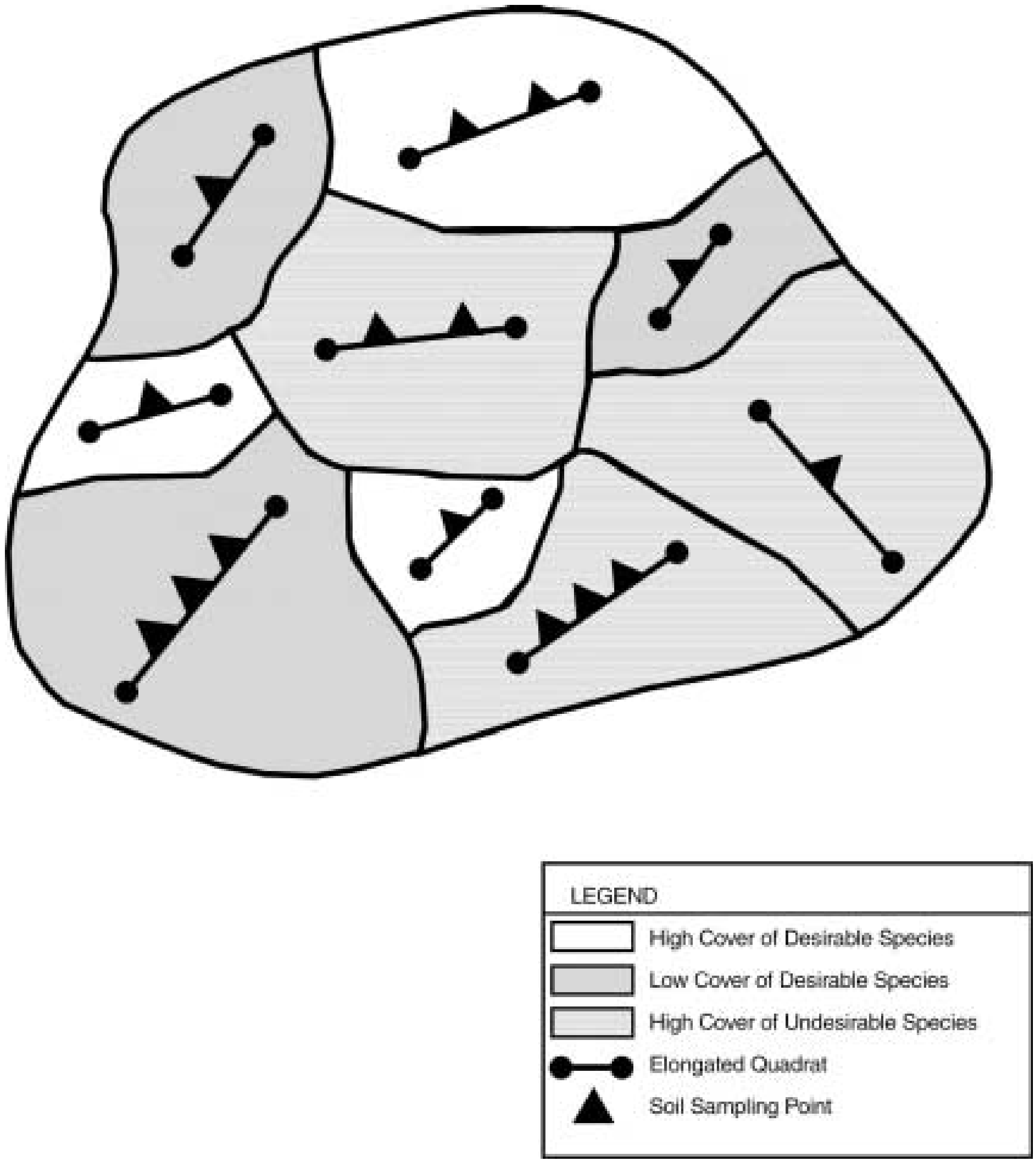

Figure 2. Schematic of Vegetation Zones at Hypothetical Study Site Showing Quadrat Layout and Soil Sampling Points.

Vegetation Characterization

Vegetation monitoring followed methods outlined by Ecosystem Research Corporation (ERC 1992). Quadrat lengths varied, and ranged from 10 to 80 feet depending on extent of the vegetation community being characterized. Each quadrat was 2 feet wide, and the length was divided into continuous 10-foot intervals. The 10-foot intervals were further divided into ten 1′ x 2′ intervals (Figure 3). Species cover was determined on the basis of percent cover of each species within each 10′ x 2′ cover interval. Seven vegetation cover categories were assigned to estimate ranges of percent cover that were visually discernible (Table 2). In addition, frequency was determined by species on the basis of occurrence within each 1′ x 2′ interval. Therefore, a maximum value of 10 was possible for each 10-foot interval. The following vegetation parameters as outlined by ERC (ERC 1992) were then calculated for each individual quadrat, each vegetation zone at each site, and each vegetation zone for all sites combined.

Total Frequency: Total number of 1′ x 2′ intervals where the species occurred.

Relative Frequency: Total number of 1′ x 2′ intervals where the species occurred divided by the total number of 1′ x 2′ intervals.

Frequency of Cover Category Value Assigned: Total number of cover intervals in which the species was present in the designated cover range (i.e., 1-7). The maximum value that can be obtained is equal to the number of 10′ intervals in the quadrat.

Total Quadrat Area Probable Percent Cover Range: Probable percent cover range of the species as calculated over the total quadrat area, where

Total % cover range =

$$\Sigma \frac{[(\text{frequency in each cover range}) \times (\text{minimum/average/maximum value for each range})]}{\text{total number of cover intervals in the quadrat}}$$

Comprehensive analyses of the data was performed using the average value for each range.

Total Occurrence Area Probable Percent Cover Range: Probable percent cover range of the species as calculated over the total cover interval area only where the species occurred, where

Occurrence % cover range =

$$\Sigma \frac{[(\text{frequency in each cover range}) \times (\text{minimum/average/maximum value for each range})]}{\text{total number of cover intervals where the species occurred}}$$

Frequency Rank: Numerical rank of the species within the plot based on frequency of occurrence. A rank of 1 indicates the plant occurred more frequently than any other plant.

Cover Rank: Numerical rank of the species within the plot based on percent cover displayed by the species. A rank of 1 indicates the plant covered more area than any other plant.

Percent cover of bare ground was also estimated along with the vegetation at each quadrat so that an accurate measure of the extent of community establishment is recorded over time. Bare ground is present in almost all ecosystems to some extent and is particularly important in native scrub or sandhill systems, regardless of age. Bare ground is functionally defined as all ground surface not covered by some form of live vegetation when viewed from above. Litter was not measured separately, but was considered as bare ground.

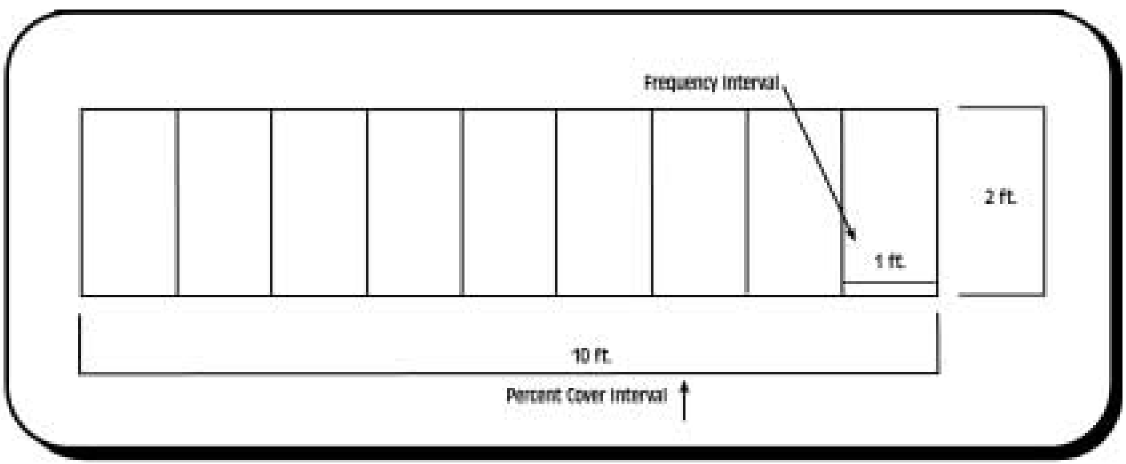

Figure 3. Schematic Diagram of Quadrat Configuration (Source: ERC 1992).

Table 2. Vegetation Cover Categories, Associated Cover Ranges, and Mid-point of Cover Range.

Category	Cover Range (%)	Mid-Point of Cover Range
0	0	0
1	<1	0.5
2	1-10	5
3	10-30	20
4	30-50	40
5	50-70	60
6	70-90	80
7	90-100	95

Source: ERC 1992.

Following collection and entry of the field data into the computer, a specially written program was used which analyzed the data line by line (species by species) for each quadrat and provided a statistical summary of the data. The resulting *basic* data analysis thus yielded a very thorough assessment of the developing community and allowed for detailed tracking of the migration of herbaceous vegetation.

Following calculation of the *basic* summary statistics as shown above, a set of *pooled* calculations were then made by further analyzing the data after first merging the summary statistics for individual quadrats based on treatments, communities, or whatever other logical grouping was present. For instance, in the case of the Bald Mountain dataset, quadrats have been established in three types of vegetation communities: high desirable-low weedy (HD/LW), low desirable-low weedy (LD/LW), high weedy-low desirable (HW/LD), and low weedy-low desirable (LW/LD). These designations were later simplified to HD (high desirable), LD (low desirable), HW (high weedy) and LW (low weedy) categories. The frequency and cover statistics were therefore merged to create four single “pooled” quadrats encompassing these four community types.

In the case of frequency, either total frequency or relative frequency could have been used. Since the individual quadrats are of varying lengths, the total possible number of frequency intervals for a given-pooled category would vary. Therefore, if total frequency was used, then some sort of weighting factor would have been needed to account for the different sample sizes. Using relative frequency solved this problem since it is calculated as the total number of occurrences (one occurrence per 1′ x 2′ square) divided by the total possible number of frequency intervals (1′ x 2′ squares). Each species was then ranked (within its pooled grouping) on the basis of relative frequency.

For percent cover, the parameter "Total Quadrat Area Probable Percent Cover--Average" (see above) was used. The *average* of this parameter for each species within each pooled grouping was then calculated and each species ranked on the basis of pooled average percent cover. By using both frequency and cover data in the pooled analyses, a two dimensional approach to evaluating each species was taken. Some taxa may be highly ranked because of widespread occurrence (high frequency) while others may simply be highly ranked due to dense coverage over smaller areas (high average cover). This two-dimensional approach aids in identifying these trends solely within the vegetation datasets without regard to soil conditions.

The *basic* statistical analysis described above was also used as the framework for more detailed statistical comparisons (regression analyses, Waller-Duncan test; etc.). The *basic* parameters described above were merged with the soils datasets and the resultant data used to analyze vegetation-soils interactions. While these higher level tests constitute the major statistical analyses for the project, the *pooled* analyses of vegetation data described above provided a quick, easy-to-comprehend ancillary overview of the vegetation data summarized across the various "treatments" at each site. These pooled vegetation data have been presented in Appendix D for each of the 10 reclaimed upland sites.

Vegetation Categories

Our initial vegetation categories included four broad groups: high cover of desirable species; low cover of desirable species; high cover of weedy species; and low cover of weedy species. These broad categories were important for characterizing soil parameters in distinctly different vegetative communities. It became necessary during data analysis to further subdivide the vegetation in order to determine if certain soil types or soil properties could predict these specific vegetation groups.

Geroud Wilhelm developed an approach to vegetation monitoring in northeastern Illinois that eventually became known as the Floristic Quality Assessment (Swink and Wilhelm 1979). Coefficients of conservation were assigned to each species using a scale of 0 to 10, with 0 indicating an introduced species and rare plants ranging up to 10. Variations of this system have been used throughout the Midwest (Nachlinger and Reese 1996), and are now being implemented in the west and southeast (Reese et al. 1994).

A Floristic Natural Quality Assessment Index (FQAI) for flora in the Upper Lakes Basin Watershed of south central Florida was prepared for the Southwest Florida Water Management District (Bridges and Reese 1996). This report provided a "Coefficient of Community" system, with values ranging from 0 for introduced species up to 12 for rare or unusual species. We compared the plant species and their Coefficient of Community values listed by Bridges and Reese with species identified in our study, and found close agreement between their species listings and values we thought were indicative of aggressive, weedy, pioneer, and characteristic species. In some instances, there was disagreement over species origin. Our view of pioneer species was more easily related to disturbed systems undergoing restoration rather than mature systems evaluated by Bridges and Reese. For example, using their scale from 0 to 12, they probably rated wiregrass as a 4 because of its dominance in a natural system, but we would consider it in the characteristic rather than pioneer category because it does not spread easily into disturbed areas or reseed easily. *Aristida gyrans,* which they assigned a 5, we frequently find reseeding readily in disturbed or restoring systems and we would call it a pioneer species.

After reviewing these above studies, we devised a modified floristic species classification system based on species type and species origin. This modified classification system might compare to a 10 point FQAI as follows:

Aggressive and Exotic Weedy Species	0
Native Weedy Species	1-2
Pioneer Species	2-5
Characteristic Species	4-10

The definitions for the species type and species origin are as follows:

Type

Aggressive	Species that out-compete weedy species and sometimes will even out-compete characteristic species of stable ecosystems; these species are not native.
Weedy	Species that depend on unnatural[1] or severe disturbances to become established
Pioneer	Species that readily reseed in unnatural[1] or severely disturbed areas but persist and are characteristic of mature ecosystems also.
Characteristic	Species that are found in mature ecosystems

Origin

Native	Species native to this region
Exotic	Species native to another continent or another region, but not to this region

Each species was assigned a type and origin designation based on the above definitions. The new vegetation type and origin categories were again compared to soils to determine if either plant origin or plant type categories favored a specific soil or certain soil chemical parameters. In the above modified classification system, only exotic species were considered aggressive. We also tended to give the benefit of doubt to questionable native species, as we felt there should be documented proof on species introduction. Only species encountered in the course of our study are included in Appendix B.

After the origin and type data were analyzed, we once again divided the vegetation into specific categories to determine if specific soil parameters could predict these more finely divided plant groups. The new groups represent plants that occur in specific ecosystems or different levels of disturbance. A list of plant species and their corresponding category designation is provided in Appendix B.

The first group, aggressive grasses, is a group of exotic perennial grasses that are most problematic in upland restoration. These species enter a site quickly during the weedy phase, expand their territory rapidly, and persist in competition with perennial natives. The most frequently encountered aggressive grasses included cogongrass, natalgrass, bahiagrass, bermudagrass, and to a lesser extent torpedograss.

Wiregrass was chosen as the second category as it is a native characteristic species that is dominant in sandhills and flatwoods, two major upland ecosystems. Wiregrass is also considered a keystone species, in that it is an indicator of the overall health and quality of these two ecosystems. Three lovegrasses comprise the lovegrass group. These lovegrasses typify pioneer species, or species found in mature ecosystems but which readily reseed into disturbed areas. This group flowers the first season and readily reseeds. They have the potential to be good competitors against aggressive species while allowing the slower-growing characteristic species to become established. The last two categories, scrub species and wetland species, were an attempt to sort out the moisture extremes of upland systems. Species selected in the scrub category are usually found only in scrub soils. Conversely, the wetland category is comprised of species typically listed as facultative wetland or obligate by the U.S. Army Corps of Engineers (Environmental Laboratory 1987) or Florida Department of Environmental Protection (State of Florida 1994), and are representative of a wetter moisture regime.

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[1]Unnatural or severe disturbances are caused by such means as bulldozing, disking, herbiciding, animal digging, severe long-term flooding followed by recession of water, etc., which open up areas of soil to new colonization. Natural changes due to fire or fire exclusion or changes in hydrology are not considered here. Therefore, species such as wax myrtle *(Myrica cerifera)* colonizing flatwoods, or oaks colonizing sandhills indicate a shift in ecosystems because of changes in natural events which can be reversed by natural events.

The species contained in the new groupings are as follows:

Aggressive Grasses	Includes cogongrass (*Imperata cylindrica*), natalgrass (*Rhynchelytrum repens*), bahiagrass (*Paspalum notatum*), bermudagrass (*Cynodon dactylon*) and, torpedograss (*Panicum repens*).
Wiregrass	*Aristida beyrichiana*
Lovegrasses	Includes *Eragrostis elliottii, E. rafracta*, and *E. spectabilis.*
Scrub Species	Includes the following species usually found only in scrub soils: *Polygonella polygama, Chrysopsis floridana*, *Cladina evansii, Cladina subtenuis, Cladina leporina, Garberia heterophylla, Liatris chapmanii, Liatris ohlingerae, Nolina brittoniana, Persea humilis*, and *Balduina angustifolia*.
Wetland Species	Includes the following species: *Agalinis purpurea, Amphicarpum muhlenbergianum, Andropogon glomeratus* var. *glomeratus, A. glomeratus* var. *glaucopsis, A. glomeratus* var. *hirsutior, Blechnum serrulatum, Carex verrucosa, Celtis laevigata, Centella asiatica, Chaptalia tomentosa, Coreopsis floridana, Ctenium aromaticum, Cyperus brevifolius, C. globulosus, C. odoratus, C. polystachyos, C. surinamensis, Elyonurus tripsacoides, Fimbristylis dichotoma, F. puberula, Hydrocotyle umbellata, Iva microcephala, Juncus dichotomus, J. effusus, J. scirpoides, Lindernia grandiflora, Ludwigia maritima, L. peruviana, Panicum hemitomon, P. repens, P. tenerum, Persea palustris, Pluchea rosea, Polygonum hydropiperoides, P. punctatum, Rhynchospora fascicularis, R. plumosa, Salix caroliniana, Solidago elliottii, S. stricta, Thelypteris dentata, Xyris ambigua*, and *X. caroliniana*.

Soil Profile Characterization and Sampling

Soils were characterized along each quadrat at approximately 30-foot intervals and were classified as either topsoil, sand tailings, overburden, or mixtures of these soils. Topsoil is typically a light gray to dark gray fine sand that was removed from the surface of an unmined donor site. The gray material indicates organic material that accumulated before the topsoil was transferred. Topsoil at the Best-of-the-West site was removed from a native scrub and sandhill community, and is a much lighter gray color than the darker gray topsoil at the Hardee Lakes site that was removed from a wet mesic flatwoods. Sand tailings by definition are sand that was separated from the phosphate matrix or ore as the ore was processed. Sand tailings are typically fine sand, but unlike topsoil are white in color and resemble beach sand. Frequently, small black dots containing phosphate ore are present in the white sand tailings. Overburden by definition is all the soil that lies above the phosphate matrix, and is therefore the most variable matrix in terms of texture and color. Overburden ranges from sand to sandy clay loam, to clay, and can be yellow, orange, tan, brown, or any combination of these colors. Concretions, mottles, and pockets of clay are commonly found in overburden.

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Soil profiles were described by depth, thickness, color, texture, and mottling of each soil type within the upper 30 cm of soil (Appendix E). Generally, only one soil profile was described along short quadrats (≤30 feet long). At least two soil profiles were described for quadrats greater than 30 feet, unless the soils were uniform along the quadrat, and then only one profile was described. Unlike undisturbed soils, soil profiles in a reclaimed landscape can be quite variable over a short distance.

One intact soil core (30-cm depth) was collected at every 30-foot interval along each quadrat using a soil probe. Frequently, two or more soils were encountered in the 30-cm soil sample, such as topsoil and overburden, topsoil and sand tailings, or sand tailing and overburden. In these cases, a subsample of soil was collected from each soil type. Where no notable changes in soil type, color, or texture occurred within the upper 30-cm, then a surface sample (0-15 cm) and a subsurface sample (15-30 cm) of soil were collected from each soil profile. All samples were placed in plastic bags, labeled, and taken to the Soils Laboratory, Soil and Water Science Department at the University of Florida in Gainesville, Florida, for analyses of chemical parameters.

Soil Analyses. Total weight and volume of each soil sample was recorded for bulk density calculations as soon as the samples were brought to the laboratory. The pH was determined on all samples (1:2 soil:water). Subsamples from each soil sample were oven-dried at 105^{o} C for a minimum of 24 hours for moisture content determination. Bulk density of all soil samples were then calculated based on the oven-dried weight. The samples were dried, pulverized, and passed through a 2-mm sieve, and analyzed for total C, total N, and available nutrients. Total C and N were measured using a Carlo Erba CNS Analyzer (Carlo Erba, Milan, Italy).

Available P, K, Ca, Mg, Zn, Mn, Cu, Fe, and Na were extracted using the Mehlich III procedure (Mehlich 1984). The extracting solution was ammonium nitrate in an ammonium fluoride/EDTA mixture, and the resulting mixture acidified with an acetic acid/nitric acid solution to maintain a pH of 2.5. The elements were analyzed using an inductively coupled argon plasma (ICAP) emission spectrometer.

Cation exchange capacity (CEC) was determined on surface soils. The cation exchange sites were saturated with Na by equilibrating a subsample with 0.4 M NaOAc-0.1 M NaCl solution (pH 8.2) in 60% ethanol. The Na-saturated soil was then extracted with 0.5 M $MgNO_3$ solution (Rhoades 1982) to determine total exchangeable Na. Total Na in the extract, which represents CEC of the soil, was analyzed using an atomic absorption spectrophotometer. Soil chemistry raw data are provided in Appendix F.

Soil compaction was assessed for all sites using a recording penetrometer (DELMI Machine and Instrument Co., 123 Shafter Ave., Shafter, CA 93263) with a penetrating point consisting of a 30-degree circular cone and a base area of 1.29 cm^2 (Vazquez et al. 1989). Penetrometer readings were measured in duplicate under existing moisture conditions for each quadrat and are provided in Appendix G.

Texture analyses were conducted on selected soil samples (Appendix H) using Day's (1965) method for particle size analysis. Moisture index was visually assessed at each quadrat based on soil type and vegetation characteristics. The visual assessment of the vegetation was based on species present, their dominance in the quadrat, and the type of community in which they were most likely to be found. This was a subjective assessment by the botanist. The moisture index was based on a 1 to 5 scale, with 1 being the driest and 5 the wettest. For example, if a quadrat contained plant species indicative of a scrub community and also sandy, droughty soils, then the quadrat was assigned a moisture index of 1.0. If it contained both scrub and sandhill species, and sandy, droughty soils, it was assigned a moisture index of 1.5. The moisture index in general corresponded to the follow vegetation communities:

1 = Scrub
2 = Sandhill
3 = Scrubby flatwoods
4 = Mesic flatwoods
5 = Hydric flatwoods

Statistical Analyses

Preliminary data analysis consisted of computations of arithmetic averages and variances. One-way classification linear models (Littell et al. 1991; Sokal and Rolhf 1969a) were utilized to examine differences in soil parameter values across soil types and vegetation classes as previously defined. Where significant differences in average soil parameters were observed, a Waller-Duncan K-ratio t-test (k set at 100 which is equivalent to a 95% type I error rate) was used to indicate significant differences in class means (Waller and Duncan 1969; SAS Institute Inc. 1989). Levene's test (Levene 1960) was used to examine the data for heterogeneity of variance. Heterogeneity of variance and nonnormality were within ranges acceptable for normal-based analysis of variance procedures.

The probable percent cover range measurements computed for specific vegetation types were summed within a transect to produce a total cover index for vegetation within a vegetation class, e.g., aggressive species. Since much of the vegetation overlaps, it is quite common to find the total cover index extend beyond 100%. This precluded the use of a standard transformation, such as the square root of the arcsine of the total cover index as a proportion, in the statistical analysis. Examination of the distribution of total cover indicated acceptable normality so untransformed data were used in most analyses. As a check, analyses were also performed with log transformed values, but this transformation had little effect on the conclusions. One-way and two-way classification linear models and associated multiple comparison procedures of the same type used for the soil's parameter analyses were also used to compare differences in total cover index.

RESULTS AND DISCUSSION

Soil Physical and Chemical Characteristics

We described soil physical characteristics to a depth of 30 cm within each vegetation quadrat at all 10-study sites and found high variability in soil texture, soil color, soil moisture index, and mottling within and among sites. Soil type also varied considerably, and included sand tailings, overburden, topsoil, and multiple combinations of these substrates. Horizon depths varied from very thin layers to layers exceeding 30cm. Numerous combinations of soil types were encountered within the upper 30cm; however, only seven soil combinations were documented with sufficient frequency to conduct meaningful statistical tests. These seven soil types are included in subsequent analyses, and include overburden, sand tailings, sand tailings on overburden, sand tailings/clay mixture, sand tailings/clay slurry mixture, topsoil, and topsoil on overburden. Soil profile descriptions are provided in Appendix E and raw soil chemistry data are provided in Appendix F.

Chemical parameters in soils also exhibited a high degree of variability. Overburden, which by definition includes all soil above the phosphate ore, visually contained the highest variability in soil physical properties. Similarly, chemical parameters in overburden were quite variable. This is best exemplified in the five study sites that contained overburden (Table 3). Of the 14 soil parameters, we detected a significant difference in all soil parameters except total C and N among the five sites. When comparing soil parameters in overburden to soil parameters in other soils, we found overburden to be intermediate in value compared to other soils (Table 4). However, two patterns were detected in overburden; first that P concentrations were significantly higher, and second, that Zn concentrations were significantly lower than most of the other soils.

Table 3. Variability in Soil Properties of Overburden Material From Five Reclaimed Sites.

Soil Properties	Site‡				
	PC	WC	HL	MG	SA
pH	5.32^{B}	6.01^{A}	5.91^{A}	5.17^{B}	6.06^{A}
C, % (NS)	0.93^{A}	1.08^{A}	1.06^{A}	0.47^{A}	0.39^{A}
N, % (NS)	0.04^{A}	0.05^{A}	0.05^{A}	0.03^{A}	0.01^{A}
Ca, mg kg^{-1}	1149^{A}	660^{B}	523^{B}	259^{B}	612^{B}
Mg, mg kg^{-1}	190^{A}	113^{AB}	56^{B}	22^{B}	76^{B}
K, mg kg^{-1}	71^{A}	12^{BC}	31^{B}	16^{BC}	8^{C}
P, mg kg^{-1}	187^{B}	274^{AB}	350^{A}	174^{B}	386^{A}
Zn, mg kg^{-1}	0.56^{B}	0.86^{AB}	0.73^{AB}	1.02^{A}	0.48^{B}
Cu, mg kg^{-1}	0.71^{A}	0.23^{B}	0.24^{B}	0.33^{AB}	0.17^{B}
Mn, mg kg^{-1}	1.8^{AB}	0.86^{C}	1.1^{BC}	2.3^{A}	0.40^{C}
Fe, mg kg^{-1}	110^{A}	33^{BC}	81^{AB}	30^{C}	76^{ABC}
Na, mg kg^{-1}	24^{A}	17^{AB}	10^{B}	13^{B}	15^{B}
CEC, cmol kg^{-1}	28^{A}	24^{AB}	25^{AB}	14^{B}	28^{A}
Moisture Index	4.0^{A}	2.9^{B}	4.0^{A}	2.4^{B}	3.2^{AB}

Note: These Are Mean Values from 9 to 24 Quadrats at Each Site.

† Mean values for a given soil parameter followed by the same letter are not significantly different ($p < 0.05$) within a row of data.

‡ PC = PCS site in N. Florida
WC = Wildlife Corridor
HL = Hardee Lakes
MG = Margaret Gilbert
SA = Sixteen Acres
NS = Not Significant

Table 4. Characteristics of Soil Matrices[†] for the Surface Horizon.[‡]

Matrix Characteristics	OB	ST	ST/OB	ST/CLF	ST/CS	TS	TS/OB
pH	5.88^{B}	5.80^{B}	6.16^{B}	6.85^{A}	7.04^{A}	5.09^{C}	4.99^{C}
C, %	0.67^{BC}	0.28^{C}	0.43^{C}	0.40^{C}	0.45^{C}	1.26^{A}	1.22^{A}
N, %	0.03^{AB}	0.02^{AB}	0.01^{B}	0.02^{AB}	0.02^{AB}	0.04^{AB}	0.05^{A}
Ca, mg kg^{-1}	661^{B}	299^{C}	280^{C}	996^{A}	1066^{A}	318^{C}	219^{C}
Mg, mg kg^{-1}	96^{BC}	12^{D}	25^{D}	135^{AB}	177^{A}	42^{CD}	18^{D}
K, mg kg^{-1}	18.0^{A}	8.05^{A}	10.7^{A}	14.1^{A}	16.7^{A}	17.4^{A}	13.5^{A}
P, mg kg^{-1}	312^{A}	135^{C}	226^{B}	289^{AB}	313^{A}	81^{C}	57^{C}
Zn, mg kg^{-1}	0.65^{C}	0.81^{C}	0.59^{C}	1.39^{B}	2.45^{A}	0.86^{C}	1.41^{B}
Cu, mg kg^{-1}	0.27^{A}	0.21^{A}	0.16^{A}	0.30^{A}	0.32^{A}	0.20^{A}	0.21^{A}
Mn, mg kg^{-1}	0.88^{B}	1.47^{B}	0.57^{B}	3.30^{A}	3.55^{A}	1.36^{B}	2.81^{A}
Fe, mg kg^{-1}	$64A^{B}$	22^{C}	16^{C}	78^{A}	81^{A}	44^{BC}	58^{AB}
Na, mg kg^{-1}	16.6^{AB}	15.6^{BC}	20.5^{A}	20.0^{AB}	17.5^{AB}	11.9^{C}	11.6^{C}
CEC, cmol kg^{-1}	25.7^{BCD}	13.8^{E}	19.9^{CDE}	48.9^{A}	30.3^{BC}	32.8^{B}	18.8^{ED}
Moisture index	3.15^{A}	1.38^{D}	1.90^{CD}	2.40^{BC}	3.33^{A}	3.02^{AB}	2.25^{C}

Note: These are mean values from multiple transects at 10 study sites.

† OB = Overburden
ST = Sand tailings
ST/CL = Sand tailings with clay
ST/CS = Sand tailings/clay slurry mixture
ST/OB = Sand tailings/overburden mixture
TS = Topsoil
TS/OB = Topsoil/overburden mixture

‡ Mean values for a given soil parameter followed by the same letter are not significantly different ($p < 0.05$) within a row of data.

Sand tailings, which by definition is sand that was separated from phosphate ore as the ore was processed, exhibited similar soil chemical properties to sand tailings/overburden. Both straight sand tailings and sand tailings/overburden can be characterized as nutrient poor and droughty soils, as evidenced by a significantly lower total C, total N, Ca, Mg, Zn, Fe, CEC, and moisture index (Table 4). Mislevy and Blue (1981a, 1981b, 1981c) found that although low in several nutrients, organic matter, and water retention capacity, sand tailings contain no phytotoxic substances. Adding sand tailings to a clay or clay slurry produced significantly higher pH, Ca, Mg, P, Zn Mn, Fe, CEC, and moisture index. Like sand tailings, clays also contain no phytotoxic substances, although they are low in organic matter, high in P, K, Ca, and Mg, and contain marginal concentrations of Mn, Cu, Zn, and Fe (Mislevy et al. 1989). Bromwell and Carrier (1989) reported higher CEC for phosphatic clay and sand/clay mixtures compared to sand tailings. Mehlich I extracts in their study showed high concentrations of Ca, Mg and P similar to high concentrations of these ions in the Mehlich III extracts in the current studies. Bromwell and Carrier (1989) concluded that due to low concentrations of micronutrients, corrective applications of micronutrients may be required for growing crops in soils derived from phosphatic clay. Topsoil and topsoil on overburden enhanced soil properties by decreasing pH, increasing total C, and increasing total N (Table 4). The addition of topsoil also resulted in a significantly lower Ca, Mg, P, Na, and CEC.

Penetrometer Readings and Soil Compaction. Penetrometer readings were obtained for assessing soil compaction at each quadrat and at each site. Soil is compacted when soil particles are pushed closer together, increasing the mass per unit volume. This occurs when a weight on the soil surface, such as large earthmoving equipment, causes the soil particles to rearrange themselves. The degree of compaction that occurs is highly influenced by soil water content, i.e., compaction increases with increasing soil water content (Singer and Munns 1996). Based on a review of literature, Graetz et al. (1997) concluded that a penetrometer reading < 20 kg cm^{-2} is critical for root penetration and/or root elongation in agricultural soils. Thus, penetrometer pressure readings greater than 20 kg cm^{-2} would suggest that soils are compacted sufficiently to impair root growth. Based on this, we assumed that 20 kg cm^{-2} is also the critical value for root growth in upland reclaimed soils.

Penetrometer readings were made under *in situ* soil moisture conditions, which in our case was nearly always under dry conditions. It is well known that soil moisture conditions affect soil resistance to the penetrometer probe, i.e., resistance decreases with increasing moisture content (Pachepsky et al. 1998). In some studies, the soil has been moistened prior to making the penetrometer readings (Mushinsky and McCoy 1996). However, this represents a condition that occurs for relatively short periods under natural conditions and generally only during the wet season. Therefore, we concluded that making the measurements under relatively dry conditions would more closely represent conditions as they exist in the field.

There was high variability in penetrometer readings within sites, and sometimes even within a single quadrat, presumably due to the heterogeneous nature of the soil matrix, as well as the loading due to earthmoving equipment used in the reclamation process. Two penetrometer graphs from each site revealed several trends. Penetrometer readings exceeding 20 kg cm^{-2} were often measured within the upper 30 cm of the soil (Figures 4A-4E), suggesting that many reclaimed soils were sufficiently compacted in the root zone to impair root growth. Soil resistance tended to increase with soil depth, even when the soil matrix remained unchanged. Topsoil and sand tailings tended to produce the lowest soil resistance, whereas overburden frequently produced higher soil resistance. Mushinsky and McCoy (1996) found that soil compaction tended to be greater for sand tailings/overburden mixtures than for sand tailings at depths of 7.5 to 22.5 cm. Often, soil resistance increased abruptly when the soil matrix changed from topsoil to overburden. Penetrometer readings by soil depth for each site are provided in Appendix G.

Our experience in measuring soil resistance suggests that compaction is prevalent in many of the reclaimed soils. Although overburden material appeared to be the most subject to compaction, compaction was observed in all types of reclaimed soil. In observing the moving (hauling, spreading, leveling) of soil during the reclamation process it was apparent that much of the soil compaction may be caused by the extensive travel of heavy equipment over the soil. It has been shown that compaction may persist for many years after the compaction event (Gameda et al. 1994) indicating that this condition will not be resolved by time alone. This raises the question of how to minimize compaction within the reclaimed soil profile. The reclamation process must involve movement and manipulation of the soil material, and therefore compaction will occur. One solution might be to incorporate a deep subsoiling operation into the reclamation process, making it the last operation in the soil preparation process.

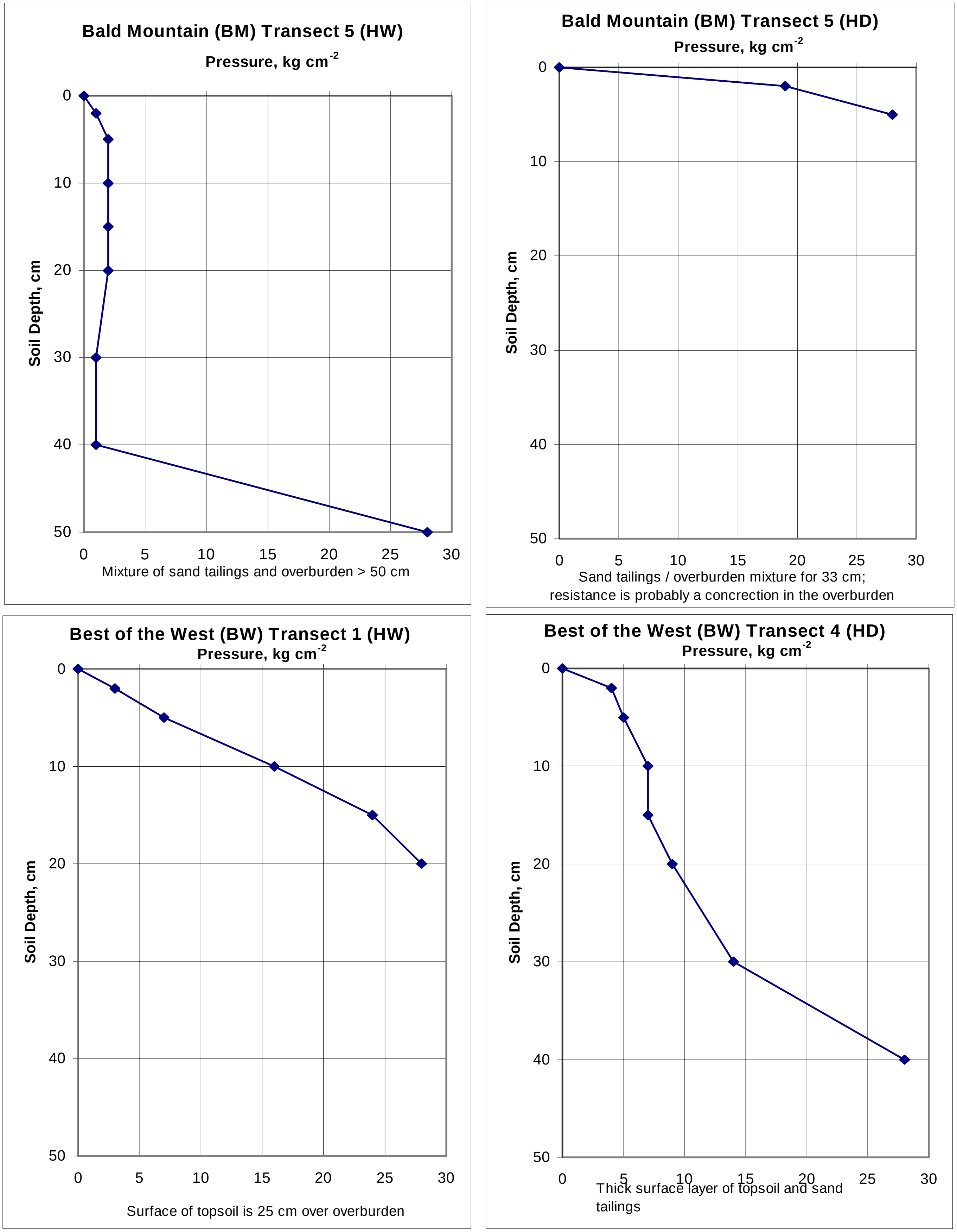

Figure 4A. Penetrometer Readings for Selected Soils in Phosphate-Mined Sites.

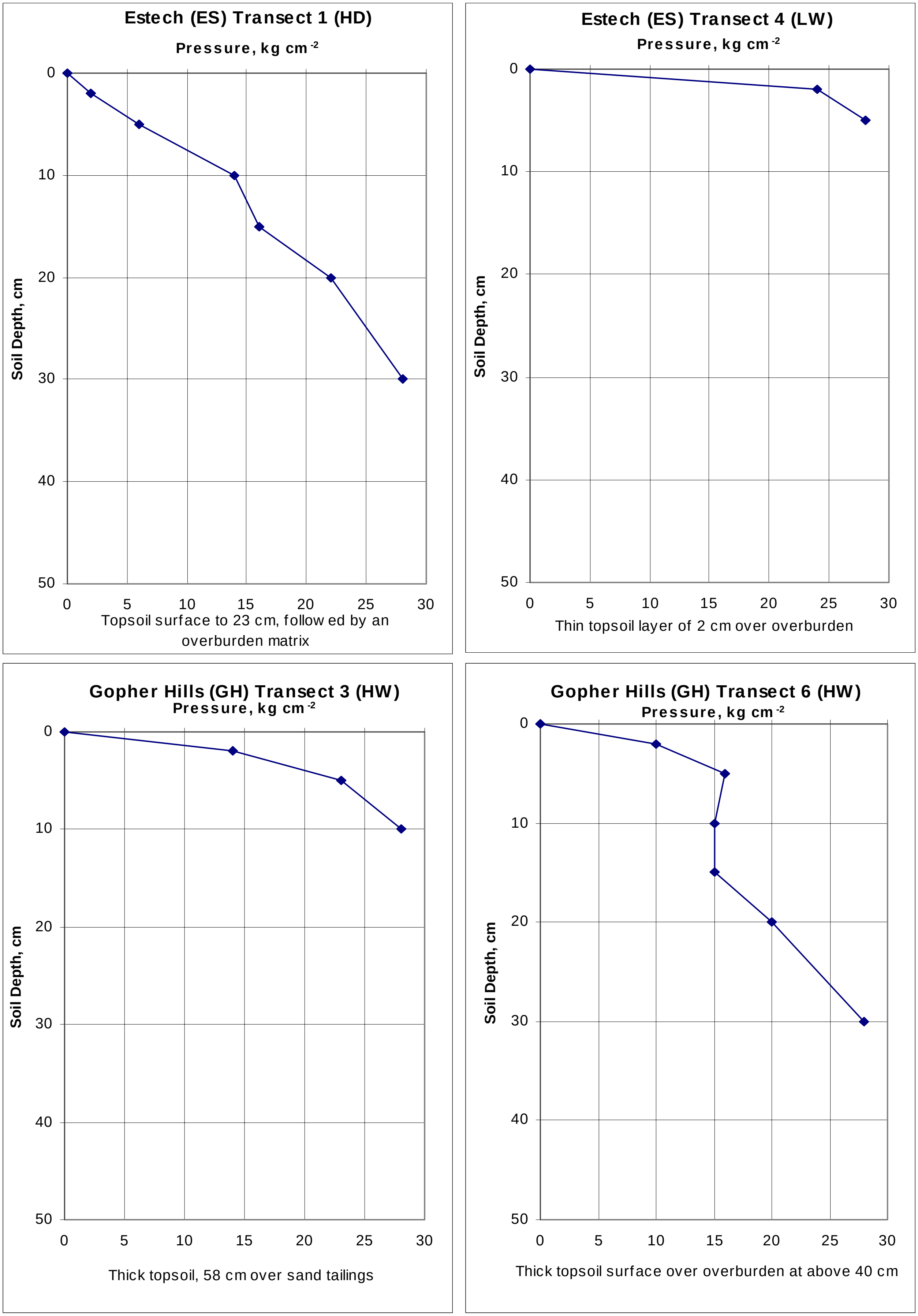

Figure 4B. Penetrometer Readings for Selected Soils in Phosphate-Mined Sites.

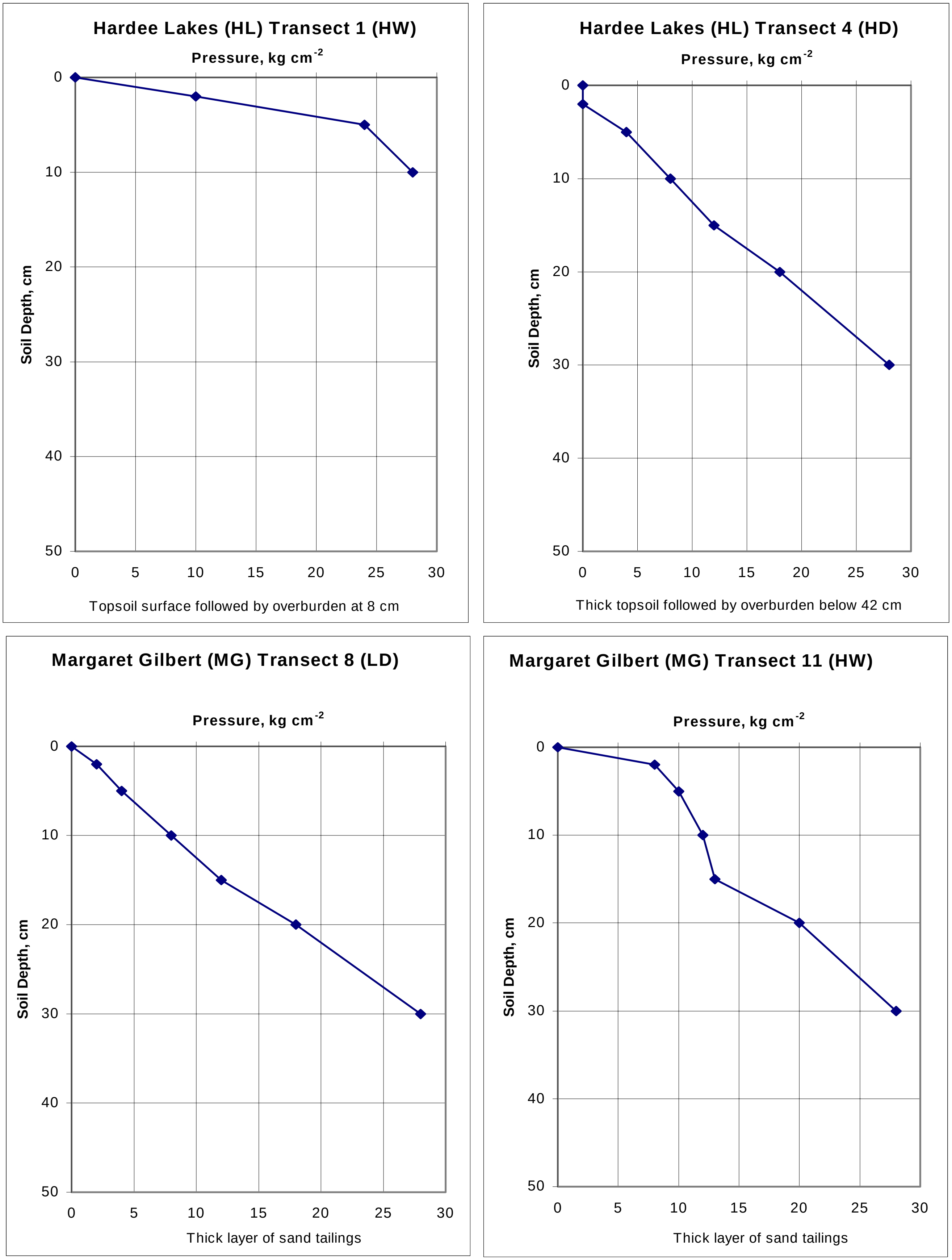

Figure 4C. Penetrometer Readings for Selected Soils in Phosphate-Mined Sites.

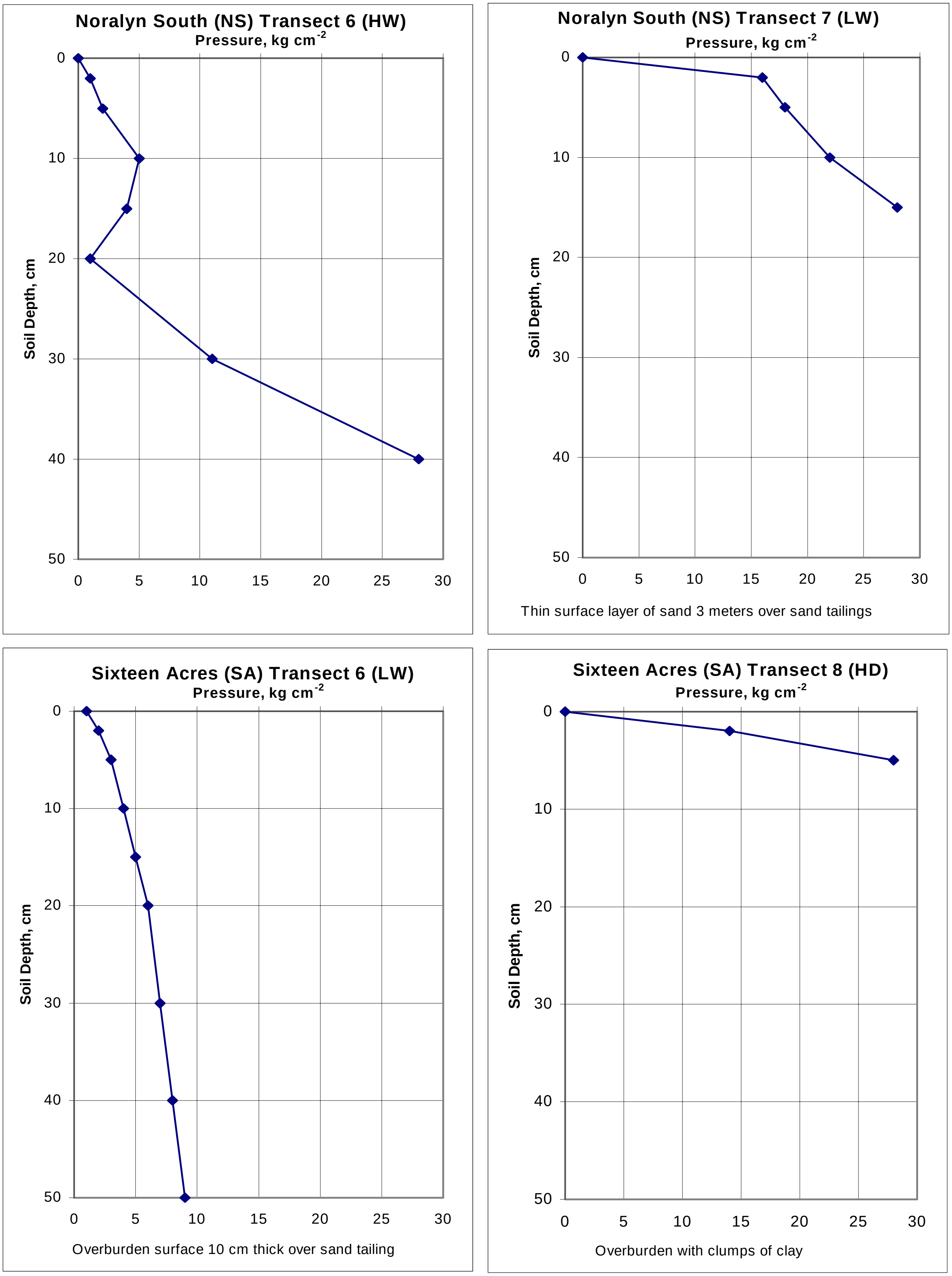

Figure 4D. Penetrometer Readings for Selected Soils in Phosphate-Mined Sites.

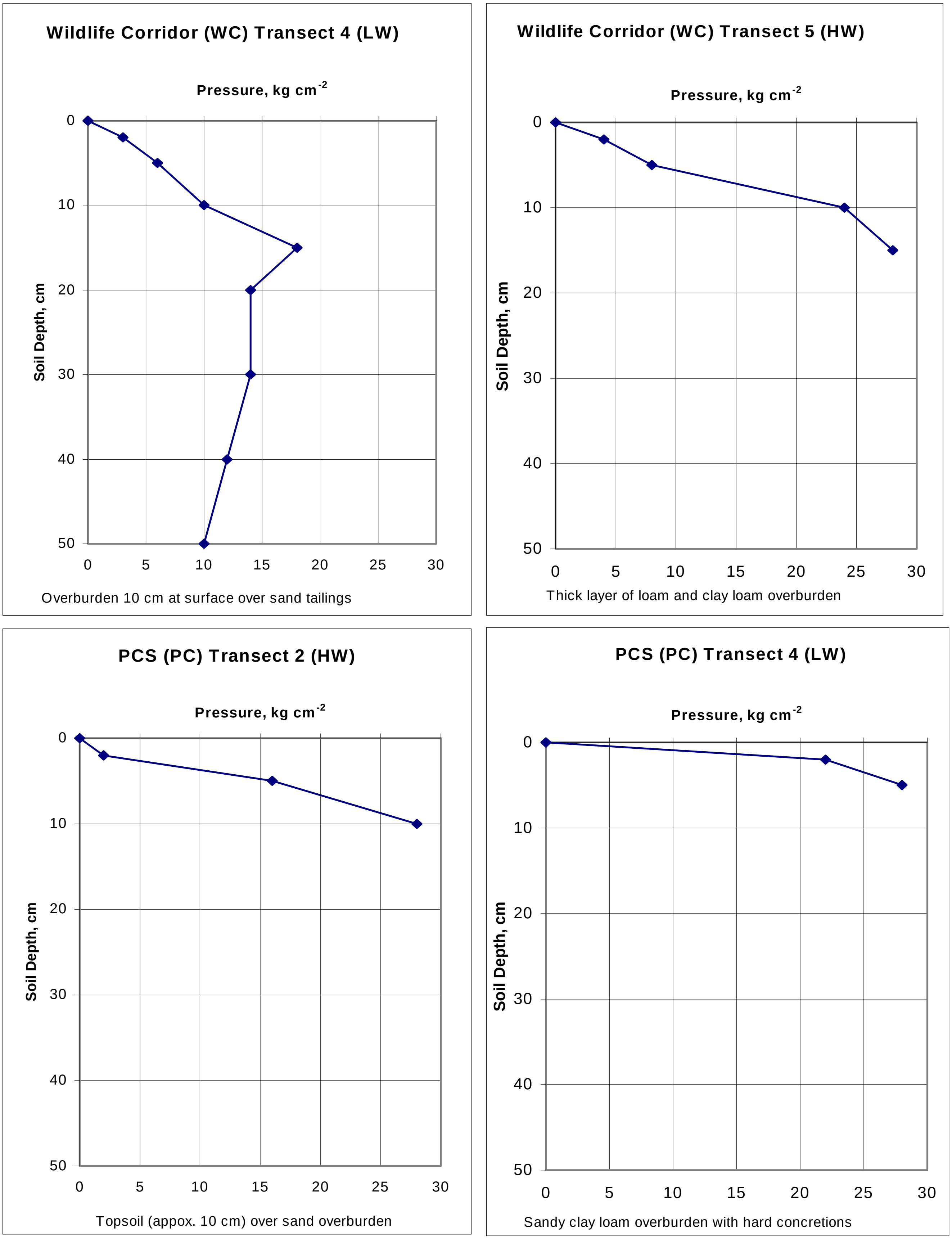

Figure 4E. Penetrometer Readings for Selected Soils in Phosphate-Mined Sites.

Soil Moisture. Using a scale of 1 to 5 based on vegetative and soil characteristics, a soil moisture index value was assigned to each quadrat at each site. The lowest value of 1 represented the driest habitat, which equated to a scrub community, and 5 represented the wettest habitat, which equated to a hydric flatwoods. A comparison was made to determine how the moisture index changed between soils with a single soil type and soils comprised of two different soil types within the upper 30-cm.

The soil moisture index did not change significantly between a soil type of overburden and an overburden on sand tailings (Table 5). Intuitively, the addition of sand tailings to an overburden soil (especially an overburden soil with high clay content) should lead to drier conditions, which would be indicative of a lower soil moisture index. This was the pattern observed at Bald Mountain, where sand tailings generally supported scrub and sandhill species. However, when overburden occurred together with sand tailings, nonscrub, and nonsandhill species such as aggressive grasses and weedy species tended to occur. The fact that we detected no significant difference in moisture index value between overburden and overburden on sand tailings soils is probably because the comparison included both sandy and clayey overburden, and variable thicknesses of both overburden and sand tailings. This variability in soil texture and soil thickness led to a high variability in soil moisture index of overburden on sand tailings, which resulted in no significant difference in moisture index between overburden and overburden on sand tailings.

Table 5. Comparison of Moisture Index of a Single Soil Type vs. a Double Soil Type Within the Surface 30 cm.

OB	OB-ST	TS	TS-OB	TS	TS-ST
3.38^{A}	3.0^{A}	2.9^{B}	3.8^{A}	3.5^{A}	2.71^{B}

Notes: This information is pooled from 10 survey sites.

Mean values for the moisture index within a single soil/double soil comparison, followed by the same letter, are not different according to a Waller-Duncan K-ratio t-test of means with K set to 100 (approximate 0.05 type I error rate). The comparisons are OB vs. OB-ST, TS vs. TS-OB and TS vs. TS-ST.

OB = Overburden
ST = Sand tailings
TS = Topsoil
OB-ST = Overburden on sand tailings
TS-OB = Topsoil on overburden mixture
TS-ST = Topsoil on sand tailings

The addition of topsoil to overburden resulted in a significantly higher soil moisture index (wetter soils) as compared to a thick horizon of only topsoil (Table 5). Conversely, the addition of topsoil to sand tailings resulted in a significantly lower soil moisture index (drier soil) as compared to a thick (>30 cm) horizon of only topsoil. These observations are critical when transferring topsoil from a donor site to a reclaimed site consisting of either overburden or sand tailings. The primary objective in transferring topsoil is to transfer a viable seed bank to the reclamation area. Recruitment from the seed bank will be more successful if the moisture index from the topsoil donor site is closely matched to the moisture index of the reclamation area. In order to closely match the moisture index, topsoil removed from a scrub or sandhill donor site should be added to sand tailings. Conversely, topsoil removed from a mesic flatwoods or hydric flatwoods should be added to a sandy overburden. And if the reclamation area consists of a mixture of sand tailings and overburden, then the topsoil could come from a sandhill, scrubby flatwoods, or mesic flatwoods. These observations were exemplified at several of our study sites, namely Estech, Gopher Hills, Hardee Lakes, and especially the topsoil augmentation study, where closely matching the moisture regime at the reclamation site with the moisture regime from the topsoil donor site produced a higher density and diversity of native species that were more successful at out-competing the aggressive grasses. Correctly matching topsoil from a donor site to a recipient site was also noted earlier during reclamation of N-West (our Best-of-the-West site) where King et al. (1992) noted that the key to scrub restoration was having the right community mulch (topsoil) matched to the right reclamation setting. In that case, topsoil from an oak scrub donor site was applied to a dry sandy overburden soil to successfully produce xeric oak species.

Relationship Between Plant Taxa and Soil Characteristics

Desirable and Weedy Vegetation Groups. The original broad vegetation categories of high cover of desirable species (high desirable—HD), low cover of desirable species (low desirable—LD), high cover of weedy species (high weedy—HW), and low cover of weedy species (low weedy—LW) were compared to soil types to determine if desirable and undesirable vegetation groups favor a specific soil type. The seven soil types used in this comparison were overburden, sand tailings, sand tailings/clay mixture, sand tailings/clay slurry mixture, sand tailings on overburden, topsoil, and topsoil on overburden. A list of all plant species documented in this study and their corresponding category designation is provided in Appendix B. The quadrats were subjectively located to replicate the four vegetation categories (when present) at each site. This nonrandom method was employed to ensure that all vegetation extremes (high desirable and high weedy) were adequately sampled. However, due to this nonrandom methodology, we have exercised caution when interpreting the data.

The high desirable vegetation group occurred on five of the seven soils and was quite variable among the five soils (Table 6). Average percent cover of the high desirable vegetation group was highest on overburden and topsoil, and lowest on sand tailings. The low desirable vegetation group was represented on four of the seven soils, and showed low variability. The high weedy vegetation group was well represented on all seven-soil types, which is not surprising since weedy species are so ubiquitous and problematic at reclaimed upland sites. These results are somewhat misleading in that only the Noralyn South site had sand tailings/clay slurry and sand tailings/clay soils. This site also was originally planted in bahiagrass, so it stands to reason that these two soils would be heavily weighted towards the high weedy and low weedy vegetation groups. The low weedy vegetation group did not display any high variability in average percent cover on the six soils in which it was recorded. As mentioned earlier, the above observations are an artifact of the nonrandom manner in which the quadrats were located. These data do not imply mean percent cover of the four vegetation groups for each soil type; a more random field protocol would be needed to answer those questions.

Table 6. Average Percent Cover of Desirable and Weedy Vegetation Groups for Each Soil.

Vegetation Grouping†	Soil‡						
	OB	ST	ST/CL	ST/CS	ST/OB	TS	TS/OB
HD	111.1^{A}	49.3^{C}	—	—	51.2^{C}	107.2^{A}	82.5^{A}
LD	84.0^{AB}	56.0^{AB}	—	—	43.3^{B}	97.1^{A}	—
HW	112.2^{A}	109.9^{A}	75.6^{A}	87.8^{A}	87.0^{A}	107.8^{A}	100.1^{A}
LW	79.2^{A}	70.9^{A}	72.6^{A}	—	65.9^{A}	91.3^{A}	88.7^{A}

† HD = High Cover of Desirable Species
LD = Low Cover of Desirable Species
HW = High Cover of Weedy Species
LW = Low Cover of Weedy Species

Species Origin and Species Type Vegetation Groups. When analyzing species origin (native, exotic) and species type (aggressive, weedy, pioneer, characteristic) data in the modified floristic species classification system, we found native species occurred at a greater percent cover on topsoil and topsoil on overburden soil types (Table 7). In general, native species will only be present where they have been successfully introduced, either by topsoiling, direct seeding, or planting. These data reflect specific site conditions where native species were successfully introduced, such as topsoiling at the Hardee Lakes and Estech sites (overburden sites) which produced a high cover of native species. Native species demonstrated the lowest average percent cover on sand tailings/clay and on sand tailings/clay slurry, the soil types found only at the Noralyn South site. Noralyn South was seeded in bahiagrass, which is an aggressive grass that has formed a monostand throughout much of the site. Exotic species favored the wetter substrates of sand tailings/clay slurry and sand tailings/clay, again an artifact of site construction where the exotic species bahiagrass was planted on these two soil types at the Noralyn South site. Native groundcover at Noralyn South not introduced by planting, seeding or topsoiling was extremely minimal. Although the whole site was seeded, native species (and not the bahiagrass) were generally located at the top of mounds which may have been drier and had less clay since the clay settled into the lower reaches of the site.

Aggressive species such as cogongrass, bahiagrass, and natalgrass had a significantly higher vegetative cover on sand tailings/clay and sand tailings/clay slurry matrices, and a significantly lower cover on straight sand tailings (Table 7). Weedy species such as dogfennel (*Eupatorium capillifolium*) and crabgrass (*Digitaria* sp.) exhibited the highest average percent cover on overburden and lowest cover on topsoil, topsoil on overburden, and sand tailings/clay. The same caution mentioned above applies here; that bahiagrass was planted on sand tailings/clay slurry and sand tailing/clay, so these two matrices are expected to be heavily weighted towards exotic and aggressive species.

Pioneer species such as *Andropogon virginicus* var. *virginicus*, *Paspalum setaceum*, *Solidago fistulosa*, and *Polypremum procumbens* favored topsoil, topsoil on overburden, and overburden over the other soils (Table 7). Pioneer species are opportunistic, adaptable, and if successfully introduced, can out compete or displace weedy species. Pioneer species were successfully introduced to the topsoil sites (Hardee Lakes), topsoil on overburden sites (Best-of-the-West, Estech, Hardee Lakes, PCS sites), and overburden sites (Sixteen Acres, PCS sites), and have therefore exhibited a high percent cover on these three soil types. Similarly, characteristic species such as wiregrass, *Panicum anceps*, and *Schizachyrium stoloniferum* favored topsoil and topsoil on overburden over the other soil types, again because they were successfully introduced to these sites during reclamation.

Specific Vegetation Groups. Average percent cover of the specific vegetation groups (wiregrass, lovegrasses, scrub species, legumes, wetland species, aggressive grasses) were calculated for each soil types to illustrate relative occurrence of each plant group for each soil type (Table 8). Preference of individual aggressive grasses for soil type is also illustrated in Table 8. Additionally, soil parameters were recorded for each vegetation group and compared between the desirable plants (wiregrass, lovegrasses, scrub species, wetland species) and undesirable plants (aggressive grasses, aggressive grasses + weedy species). Mean concentration of each soil parameter is provided in Appendix I for the aggressive grasses and in Appendix J for the other plant groups.

Wiregrass. (*Aristida beyrichiana*) was recorded on three of the seven soils; overburden, sand tailings/overburden, and topsoil. These soil types represent the sites where wiregrass was originally introduced during reclamation, and include Bald Mountain (planted), Estech (topsoiled), Gopher Hills (topsoiled and planted), Hardee Lakes (topsoiled), and Sixteen Acres (direct seeded). Average percent cover of wiregrass was low, and ranged from 5.77 at the overburden sites to 0.59 at the sand tailings/overburden sites (Table 8). The low average percent cover of wiregrass not only reflects its slow-growing nature, but also suggests that it is sparsely represented at the above five sites.

Table 7. Average Percent Cover of Species by Origin and Species Type Vegetation Categories for Each Soil.

		Soil‡						
Vegetation grouping	n	OB (n=47)	ST (n=17)	ST/CL (n=5)	ST/CS (n=3)	ST/OB (n=10)	TS (n=37)	TS/OB (n=10)
Species Origin								
Native	127	42	34	17	3.3	28	70	60
Exotic	125	54	24	61	87	36	39	33
Species Type								
Aggressive	115	36	22	59	87	25	40	34
Weedy	107	29	13	9	—	17	7	10
Pioneer	117	20	10	2	3	13	32	23
Characteristic	117	21	26	7	—	10	37	33

‡ ST = Sand tailings
ST/CL = Sand tailings/Clay
ST/CS = Sand tailings/Clay Slurry
ST/OB = Sand tailings/Overburden
TS = Topsoil
TS/OB = Topsoil/Overburden

Note: Mean values of average percent cover within each vegetation grouping followed by the same letter are not significantly different according to a Waller-Duncan K-ratio t-test of means with K set to 100 (approximate 0.05 type I error rate).

Table 8. Average Percent Cover of Specific Vegetation Groups for Each Soil.

Vegetation Grouping	n	Soil†						
		OB (n=47)	ST (n=17)	ST/CL (n=5)	ST/CS (n=3)	ST/OB (n=10)	TS (n=37)	TS/OB (n=10)
Vegetation class on an ecosystem basis								
Wiregrass	34	6.01^{A}	-	-	-	0.590^{A}	3.59^{A}	-
Lovegrass	25	0.21^{AB}	4.19^{A}	-	-	3.44^{AB}	0.32^{AB}	1.00^{AB}
Scrub Species	24	0.11^{B}	14.2^{A}	-	-	0.21^{B}	0.77^{B}	3.20^{B}
Legumes	105	22.1^{A}	3.95^{B}	2.10^{B}	-	12.5^{AB}	9.49^{AB}	2.57^{B}
Wetland Species	55	8.18^{A}	0.04^{A}	-	-	0.13^{A}	3.56^{A}	0.34^{A}
Aggressive Grasses	115	31.3^{BC}	20.8^{C}	58.9^{AB}	86.7^{A}	25.2^{BC}	30.3^{BC}	27.1^{BC}
Individual aggressive grasses								
Bahiagrass	131	14.2^{AB}	-	13.8^{AB}	11.0^{AB}	0.51^{B}	38.3^{A}	28.3^{AB}
Bermudagrass	54	0.46^{A}	-	3.02^{A}	-	-	0.34^{A}	-
Cogongrass	52	6.83^{B}	24.7^{B}	7.12^{B}	2.65^{B}	4.17^{B}	4.0^{B}	58.3^{A}
Natalgrass	186	8.73^{AB}	2.38^{B}	9.08^{AB}	7.12^{AB}	20.5^{A}	16.3^{AB}	-
Torpedograss	10	0.12^{A}	-	0.03^{A}	-	-	-	-

† OB = Overburden
ST = Sand tailings
ST/CL = Sand tailings/Clay
ST/CS = Sand tailings/Clay Slurry
ST/OB = Sand tailings/Overburden
TS = Topsoil
TS/OB = Topsoil/Overburden

Note: Mean values of average percent cover within each vegetation grouping followed by the same letter are not significantly different according to a Waller-Duncan K-ratio t-test of means with K set to 100 (approximate 0.05 type I error rate).

Establishment of wiregrass on reclaimed phosphate mined areas has been the focus of several recent reclamation studies (Bissett 1995b; Pfaff and Gonter 1996). Bissett implemented the first large-scale effort to direct seed wiregrass in 1994, which occurred at our Sixteen-Acre study site (Bissett 1995b). Many factors influence the viability and germination of wiregrass seed. For instance, seed viability varies widely depending on climatic conditions, burn strategy, and seed collection site (Pfaff and Gonter 1996). Parrott (1967) reported that viability of wiregrass seed is highly variable, and that one-year old seed germinated more quickly than new seed, thus suggesting some dormancy. A growing season burn from late April through July is needed to stimulate flower and seed production of this fire-dependent species (Platt et al. 1988). And care should be taken to collect seed from habitats with a similar moisture regime as the planting site, as there is some evidence that seed collected from flatwoods sites establish best on moist sites, and seed collected from sandhill sites establish best on drier sites (Pfaff and Gonter 1996).

Wiregrass, as with other desirable species, was present at five of the study sites primarily because it was successfully introduced to those sites during reclamation. The fact that wiregrass has persisted at those five sites for a relatively short time of 5 to 10 years suggests that this species is adapted to the wide ranging soil conditions inherent at reclaimed mine sites. Perhaps in this short time frame, wiregrass has responded more successfully towards certain soil parameters. To test this, we compared soil parameters at the five sites which supported wiregrass to determine if certain soil parameters favored wiregrass as compared to the undesirable species consisting of aggressive grasses and weedy species. Wiregrass tended to be more strongly associated with a lower soil pH, Ca, P, Na, and CEC, and a higher total C, total N, K, and moisture index than the aggressive grasses (Table 9A). Additionally, wiregrass was more strongly associated with a higher total C, total N, and moisture index than aggressive grasses + weedy species (Table 9B).

We ran a stepwise multiple regression to identify the best linear model that would relate certain variables (soil parameters, soil type, and site) to average percent cover of wiregrass. The best fit model (with estimated standard errors indicated below regression coefficients, all indicated model components significant at $p=0.05$ or greater), showed that P, Ca, and moisture index were the three soil parameters that best explained average percent cover of wiregrass.

Average percent cover of wiregrass =

$$\underset{\substack{(1.93)\\ \text{NS}}}{0.300} - \underset{\substack{(0.013)\\ *}}{0.0293(P)} - \underset{\substack{(0.0199)\\ *}}{0.00452(Ca)} + \underset{\substack{(0.612)\\ **}}{1.901\,(\text{Moisture Index})} + \underset{\substack{(2.364\text{x}10^{-3})\\ **}}{9.741\text{x}10^{-5}\,(P^2)}$$

In this model, these three soil parameters explained only 25.6% of the variability of wiregrass cover. The next variable, soil type, only explained 2.3% of the residual variability, and the third variable, site, explained 12.2% of the residual variability associated with wiregrass. Overall only 40.10% of the variability of wiregrass was explained by the best fit stepwise multiple linear regression that included soil parameters, soil type, and site. Since we monitored wiregrass cover mostly on reclaimed sites tending toward flatwoods conditions, this would weight the moisture index in that direction even though in natural systems, wiregrass grows from sloughs to sandhills.

Table 9A. Comparison of Soil Parameters† Associated with Wiregrass vs. Aggressive Grasses.

Soil Parameter	Neither Plant Group	Wiregrass	Aggressive Grasses	Both Plant Groups
pH	5.01^{B}	4.57^{B}	5.73^{A}	5.98^{A}
Total C (%)	0.99^{B}	1.73^{A}	0.69^{BC}	0.45^{c}
Total N (%)	0.03^{B}	0.05^{A}	0.02^{BC}	0.01^{C}
Ca (mg kg^{-1})	179.5^{B}	173.0^{B}	349.9^{AB}	554.8^{A}
Mg (mg kg^{-1})	31.5^{B}	41.2^{AB}	30.1^{B}	69.4^{A}
K (mg kg^{-1})	26.2^{A}	19.84^{A}	12.1^{B}	8.71^{B}
P (mg kg^{-1})	15.0^{C}	17.8^{C}	172.1^{B}	348.9^{A}
Na (mg kg^{-1})	13.7^{AB}	7.26^{B}	14.6^{A}	15.4^{A}
CEC (cmol kg^{-1})	18.47^{B}	22.65^{B}	36.6^{A}	28.0^{AB}
Moisture Index	3.7^{A}	4.00^{A}	2.51^{B}	3.01^{B}

Table 9B. Comparison of Soil Parameters† Associated with Wiregrass vs. Aggressive Grasses + Weedy Species.

Soil Parameter	Neither Plant Group	Wiregrass	Aggressive Grasses and Weedy Species	Both Plant Groups
Total C (%)	1.46^{A}	2.11^{A}	0.68^{B}	0.56^{B}
Total N (%)	0.04^{B}	0.07^{A}	0.02^{BC}	0.01^{C}
P (mg kg^{-1})	19.0^{B}	20.0^{B}	166.3^{AB}	314.6^{A}
Moisture Index	4.00^{A}	4.00^{A}	2.56^{B}	3.11^{AB}

Note: Mean values followed by the same letter are not significantly different for each row according to a Waller-Duncan K-ratio t-test of means with K set to 100 (approximate 0.05 type I error rate).

Only includes data from site Best-of-the-West, Estech, Gopher Hills, Hardee Lakes, and Sixteen Acres where wiregrass was present in quadrats.

Lovegrasses. The 3 desirable lovegrasses, *Eragrostis elliottii, E. refracta,* and *E. spectabilis* are important pioneer species because they have the potential to be good competitors against aggressive species while allowing the slower growing characteristic species to become established. The lovegrasses were recorded growing on five of the seven soils, and although not statistically significant, tended to favor sand tailings and sand tailings on overburden (Table 8). These soil types represent the six sites where the lovegrasses were originally introduced during reclamation, and include Bald Mountain (planted), Best-of-the-West (topsoiled), Gopher Hills (topsoiled and planted), Noralyn South (possibly spread from little topsoiling patches), PCS (topsoiled), and Sixteen Acres (direct seeded). Like wiregrass, the lovegrasses were recorded at a low average percent cover at these six sites.

When comparing lovegrasses to aggressive grasses we found few significant differences in soil parameters between the two groups of plants (Table 10A). The exceptions were that the lovegrasses tended to be more strongly associated with higher Mg and K concentrations than the aggressive grasses. We were unable to compare lovegrasses to aggressive grasses + weedy species, as there were no quadrats at the above six sites that supported the lovegrasses but did not include aggressive grasses + weedy species (Table 10B). In other words, every quadrat that contained lovegrasses also contained aggressive grasses and/or weedy species.

Table 10A. Comparison of Soil Parameters† Associated with Lovegrasses vs. Aggressive Grasses.

Soil Parameter	Neither Plant Group	Lovegrass	Aggressive Grasses	Both Plant Groups
Mg ($mg\ kg^{-1}$)	140.80^{A}	145.67^{A}	59.63^{B}	23.14^{B}
K ($mg\ kg^{-1}$)	54.82^{A}	49.47^{A}	13.07^{B}	9.94^{B}

Table 10B. Comparison of Soil Parameters† Associated with Lovegrasses vs. Aggressive Grasses + Weedy Species.

Soil Parameter	Neither Plant Group	Lovegrass‡	Aggressive Grasses and Weedy Species	Both Plant Groups
Total C (%)	3.02^{A}	—	0.73^{B}	0.65^{B}
Total N (%)	0.11^{A}	—	0.02^{B}	0.02^{B}

Note: Mean values followed by the same letter are not significantly different for each row, according to a Waller-Duncan K-ratio t-test of means with K set to 100 (approximate 0.05 type I error rate).

† Only includes data from site Best-of-the-West, Bald Mountain, Gopher Hills, Noralyn South, PCS, Sixteen Acres where lovegrasses were present in quadrats.

‡ There were no plots where lovegrass occurred without aggressive grasses or weedy species.

The best fit multiple regression that related soil parameters, soil type, and site to average percent cover of lovegrasses (with estimated standard errors indicated below regression coefficients, all indicated model components significant at *p=0.05* or greater) was:

Average percent cover of lovegrasses =

$$\underset{\substack{(1.511)\\ *}}{-3.609} - \underset{\substack{(0.137)\\ **}}{0.0681}(Mg) - \underset{\substack{(0.910)\\ **}}{3.329}(Zn) + \underset{\substack{(12.435)\\ *}}{30.587}(N) + \underset{\substack{(0.365)\\ *}}{0.777}(Mn) + \underset{\substack{(0.0476)\\ **}}{0.251}(pH^2) + \underset{\substack{(0.0000401)\\ **}}{1.71\times10^{-4}}(Mg^2)$$

The five soil parameters that best explained average percent cover of the lovegrasses were Mg, Zn, N, Mn, and pH, and these soil variables only explained 21.6% of the variability of lovegrass cover. The next variable, soil type, accounted for only 6.3% of the residual variability, and site explained 4.2% of the residual variability associated with the lovegrasses. Overall only 32.10% of the variability of the lovegrasses was explained by the best fit stepwise multiple linear regression that included soil parameters, soil type, and site. These data suggest that the lovegrasses are persisting, albeit in low coverage, based on location of introduction during the reclamation process, and not on factors associated with soils or site.

Scrub Species. Scrub species were documented at five of the study sites; Bald Mountain (planted), Best-of-the-West (topsoiled), Estech (topsoiled), Margaret Gilbert (seeded and planted), and Noralyn South (some from planting *Garberia*, maybe some from topsoil patches). Not surprisingly, scrub species demonstrated the greatest preference for straight sand tailings, and were recorded in low coverage on overburden, sand tailing on overburden, topsoil, and topsoil on overburden (Table 8). Scrub species, or those species found growing in the most xeric of conditions, were more strongly associated with a lower pH and P concentration, and higher total N and total C than aggressive grasses (Table 11A). Similarly, when compared to aggressive grasses + weedy species, scrub species occurred on lower pH and a higher total C, total N, and moisture index (Table 11B). Interestingly, scrub species were documented growing at a significantly higher moisture index (3.00) than aggressive grasses + weedy species (2.06), which equates in our methodology to moisture conditions of a scrubby flatwoods for the scrub species (3.0) and a sandhill (2.0) for the aggressive grasses + weedy species. This unexpected high value for the moisture index for scrub species is due to the low occurrence of scrub species in this particular analysis (n=2), and therefore is not truly representative of the moisture conditions required for scrub species. The data are from the Estech site, where eight of the nine quadrats had a moisture index of 3.0.

The best fit multiple regression that related soil parameters, soil type, and site to average percent cover of scrub species (with estimated standard errors indicated below regression coefficients, all indicated model components significant at *p=0.05* or greater) was:
Average percent cover of scrub species =

$$\underset{\substack{(3.746)\\ **}}{39.694} - \underset{\substack{(2.709)\\ **}}{21.94}\text{ (Moisture Index)} - \underset{\substack{(0.0627)\\ **}}{0.179}\,(pH^2) + \underset{\substack{(0.508)\\ **}}{3.380}\text{ (Moisture Index}^2)$$

Table 11A. Comparison of Soil Parameters† Associated with Scrub vs. Aggressive Grasses.

Soil Parameter	Neither Plant Group‡	Scrub	Aggressive Grasses	Both Plant Groups
pH	—	4.59[B]	5.67[A]	5.31[A]
Total C (%)	—	1.72[A]	0.53[B]	0.59[B]
Total N (%)	—	0.06[A]	0.02[B]	0.02[B]
P (mg kg^{-1})	—	13.67[B]	162.8[A]	108.32[A]

Table 11B. Comparison of Soil Parameters† Associated with Scrub vs. Aggressive Grasses and Weedy Species.

Soil Parameter	Neither Plant Group‡	Scrub	Aggressive Grasses and Weedy Species	Both Plant Groups
pH	—	4.47[B]	5.67[A]	5.25[AB]
Total C (%)	—	3.02[A]	0.53[B]	0.63[B]
Total N (%)	—	0.11[A]	0.02[B]	0.02[B]
Moisture Index	—	3.00[A]	2.06[B]	1.55[B]

Note: Mean values followed by the same letter are not significantly different for each row according to a Waller-Duncan K-ratio t-test of means with K set to 100 (approximate 0.05 type I error rate).

† Only includes data from sites Best-of-the-West, Bald Mountain, Estech, Margaret Gilbert, and Noralyn South where scrub species were present in quadrats.

‡ There were no quadrats at the above sites where neither plant group occurred.

Only two soil parameters were used in the linear regression model that best explained average percent cover of the scrub species, and included moisture index and pH. These soil variables explained a relatively high amount of variability at 48.0%. The next variable, soil type, accounted for 10.2% of the residual variability, and site explained 25.9% of the residual variability associated with the scrub species. Overall, a high of 84.1% of the variability of scrub species was explained by the best fit stepwise multiple linear regression model that included soil parameters, soil type, and site. These data suggest that unlike the lovegrasses, the presence and coverage of scrub species is influenced more strongly by soil parameters, soil type, and site.

Wetland Species. Wetland species were surprisingly found at seven of the 10 study sites; Bald Mountain, Best-of-the-West, Gopher Hills, Hardee Lakes, PCS, Sixteen Acres, and Wildlife Corridor. They were also found on five of the seven soil types, with low average percent cover on all soils (Table 8). Although not significantly different from the other soil types, wetland species occurred primarily on overburden (7.85%) with the second highest average percent cover on topsoil (3.56). The species we designated as wetland, which are listed in the Methods Section and in Appendix B, are specified as facultative wetland or obligate by the U.S. Army Corps of Engineers (Environmental Laboratory 1987) or Florida Department of Environmental Protection (State of Florida 1994). In many cases the wetland species were associated with the wetter extremes of reclaimed upland communities such as mesic and hydric flatwoods, however they were also found in reclaimed landscapes where overburden impedes water movement, creating seeps or areas with a parched water table. For example, *Andropogon glomeratus* var. *glomeratus and A. glomeratus* var. *hirsutior* are frequently found in reclaimed upland communities. And although *Celtis laevigata* (sugarberry) is listed as a wetland species by the U.S. Army Corps of Engineers, it is more typically associated with upland communities rather than wetland communities in Florida.

When comparing wetland species to aggressive grasses, wetland species were more strongly associated with a lower soil pH and P concentration and a higher K, Cu, and moisture index (Table 12A). Wetland species tended more strongly than aggressive grasses + weedy species to grow at a lower pH and P concentration, and a higher total C, total N, and moisture index (Table 12B). Consistent in both of these comparisons is the preference of wetland species over the undesirable species of aggressive grasses and weedy species to a lower soil pH, lower P concentration, and higher moisture index.

The best fit multiple regression that related soil parameters, soil type, and site to average percent cover of wetland species (with estimated standard errors indicated below regression coefficients, all indicated model components significant at *p=0.05* or greater) was:

Average percent cover of wetland species =

$$6.737 - 0.040(\text{Mg}) + 0.0188(\text{P}) - 10.737(\text{Moisture Index}) + 3.017(\text{Moisture Index}^2) + 3.457(\text{Cu}^2)$$

6.737	- 0.040(Mg)	+ 0.0188(P)	- 10.737(Moisture Index)	+ 3.017(Moisture Index²)	+ 3.457(Cu²)
(3.797)	(0.010)	(0.00435)	(3.097)	(0.576)	(1.335)
NS	**	**	**	**	*

Table 12A. Comparison of Soil Parameters† Associated with Wetland Species vs. Aggressive Grasses.

Soil Parameter	Neither Plant Group	Wetland Species	Aggressive Grasses	Both Plant Groups
pH	5.14^{B}	4.76^{B}	5.70^{A}	5.80^{A}
Total C (%)	0.92^{AB}	1.46^{A}	0.89^{AB}	0.64^{B}
K (mg kg^{-1})	32.42^{A}	41.20^{A}	11.38^{B}	12.84^{B}
P (mg kg^{-1})	84.20^{BC}	67.60^{C}	190.07^{AB}	269.21^{A}
Zn (mg kg^{-1})	1.10^{A}	0.66^{B}	0.90^{AB}	0.59^{B}
Cu (mg kg^{-1})	0.24^{AB}	0.43^{A}	0.20^{B}	0.19^{B}
CEC (cmol kg $^{-1}$)	24.26^{B}	24.94^{B}	24.47^{B}	33.28^{A}
Moisture Index	3.04^{B}	3.91^{A}	2.30^{C}	3.12^{B}

Table 12B. Comparison of Soil Parameters† Associated with Wetland Species vs. Aggressive Grasses + Weedy Species.

Soil Parameter	Neither Plant Group‡	Wetland Species	Aggressive Grasses and Weedy Species	Both Plant Groups
pH	—	4.64^{B}	5.63^{A}	5.69^{A}
Total C (%)	—	2.17^{A}	0.90^{B}	0.68^{B}
Total N (%)	—	0.07^{A}	0.04^{B}	0.02^{B}
P (mg kg^{-1})	—	19.00^{B}	177.16^{A}	249.30^{A}
CEC (cmol kg $^{-1}$)	—	21.21^{B}	24.44^{B}	32.61^{A}
Moisture Index	—	3.78^{A}	2.41^{C}	3.22^{B}

Note: Mean values followed by the same letter are not significantly different for each row, according to a Waller-Duncan K-ratio t-test of means with K set to 100 (approximate 0.05 type I error rate).

† Data only from sites Best-of-the-West, Bald Mountain, Gopher Hills, Hardee Lakes, PCS, Sixteen Acres, and Wildlife Corridor where wetlands species were present in quadrats.

‡ There were no quadrats at the above sites where neither plant group occurred.

Four soil parameters were used in the linear regression model that best explained average percent cover of the wetland species, and included Mg, P, moisture index, and Cu. These soil variables explained a relatively high amount of variability at 44.8%. The next variable, soil type, accounted for only 2.1% of the residual variability, and site explained 8.1% of the residual variability associated with the wetland species. Overall, 55.0% of the variability of wetland species was explained by the best fit stepwise multiple linear regression model that included soil parameters, soil type, and site. These data suggest that there is roughly an equal chance that wetland species will occur based on soils and site, and an equal chance that wetland species will occur either randomly or respond to variables other than the soils and site measured in this study. It is probable that the underlying construction of the site such as hills and valleys of overburden disrupts normal drainage and pockets of wetter soils can be found on hill tops, slopes, even odd places such as upper shoulders where one would not normally expect wetlands in mined areas.

Aggressive Grasses. Aggressive grasses are highly adapted to a wide range of soil conditions and were recorded growing on all seven-soil types. Additionally, aggressive grasses were measured at a higher average percent cover on all seven soils as compared to the other plant categories (Table 8). Bahiagrass was planted on sand tailings/clay and sand tailings/clay slurry, which would partially explain why aggressive grasses were so prevalent on these two soil types. Aggressive grasses showed the least preference for straight sand tailings, however they grew at a higher percent cover on straight tailings as compared to the other plant groups (Table 8). Because aggressive grasses are so ubiquitous and problematic at upland reclaimed sites, we examined these grasses in greater detail, both as a group and individually, to determine whether aggressive grasses favored soil parameters over the desirable vegetation groups such as wiregrass, lovegrasses, scrub species, and wetland species.

When summarizing the above comparisons of soil parameters between specific plant categories (wiregrass, lovegrasses, scrub species, wetland species) and aggressive grasses, several patterns emerged. First, aggressive grasses were associated with a higher pH than all four-plant groups, and this difference was significant for three of the four plant groups (wiregrass, scrub species, wetland species). Second, aggressive grasses grew on soils with a significantly higher P concentration than all plant groups except lovegrasses. And third, aggressive grasses favored a statistically significantly higher K concentration than all plant groups except scrub species.

The best fit multiple regression that related soil parameters, soil type, and site to average percent cover of aggressive grasses (with estimated standard errors indicated below regression coefficients, all indicated model components significant at *p=0.05* or greater) was:
Percent cover of aggressive grasses =

$$-63.973 + 19.632(Mn) + 115.579(Cu) + 38.928(\text{Moisture Index}) - 2.701(Mn^2) - 5.526(\text{Moisture Index}^2) - 0.0143(K^2)$$

Standard error	(16.574)	(4.780)	(29.574)	(13.091)	(90.785)	(2.474)	(0.00326)
Significance	**	**	**	**	**	*	**

Four soil parameters were used in the linear regression model that best explained average percent cover of the aggressive grasses, species, and included Mn, Cu, moisture index, and K. These soil variables explained 31.1% of the cover of aggressive grasses. The next variable, soil type, accounted for 7.0% of the residual variability, and site explained 7.4% of the residual variability associated with aggressive grasses. Overall, 45.5% of the variability of aggressive grasses was explained by the best fit stepwise multiple linear regression model that included soil parameters, soil type, and site. These data suggest that, similar to wetland species, there is roughly an equal chance that aggressive grasses will occur based on soils and site, and an equal chance that aggressive grasses will occur either randomly or respond to variables other than the soils and site variables, measured in this study.

Because this category called aggressive grasses includes a diverse group of species, they are best considered individually. Bahiagrass, for example, was seeded onto several sites and natalgrass is usually found growing at a much lower moisture index such as is found on sand tailings or soils of scrub or sandhills.

Cogongrass. Cogongrass is becoming one of the most troublesome weeds in nonagricultural areas in Florida, and could perhaps be considered one of the most problematic weeds in previously mined areas that have been reclaimed to upland communities. In a recent study on *Ecology, Physiology, and Management of Cogongrass (Imperata cylindrica)*, Shilling et al. (1997) found that cogongrass is spread from site to site by wind-blown seeds. Once seedlings are established, the plant then spreads out rapidly via rhizomes. These rhizomes contain large reserves and can provide quick regrowth following burning, tillage, mowing, or herbicide treatment.

We found that cogongrass grew in luxuriant levels in most all soil conditions and in all soil types. Soil parameters were compared between cogongrass and other plant groups (wiregrass, lovegrasses, scrub species, wetland species) (Tables 13A-13C). In many cases, there were no significant differences between cogongrass and the other plant groups, or the sample size was too small to yield conclusive results. However, cogongrass tended more strongly than wiregrass to grow at a higher Zn, Mn, and CEC, and a lower Mg and moisture index (Table 13A). Cogongrass grew on soils with a significantly higher CEC than scrub species (Table 13B) and a lower CEC and moisture index than wetland species (Table 13C).

Qualitative observations at the study sites suggested that in certain places soil physical characteristics may have promoted cogongrass, whereas at other sites, there were no obvious factors to explain its presence. For example, at Bald Mountain, the three high weedy plots which contained the highest cover of cogongrass (and natalgrass), contained the thickest layer of overburden, or had clay clumps at the surface of the soil. We surmised that the increased water holding capacity at these three plots may have favored cogongrass over the targeted sandhill and scrub species that were planted. At the Noralyn South site, thick cogongrass patches appeared to be associated with a higher clay content. And at the Wildlife Corridor site, thick cogongrass patches tended to be associated with thicker overburden and thinner sand tailings, whereas the thinner cogongrass patches appeared to be growing on thinner overburden and thicker tailings. Contrary to these observations, we saw no obvious physical differences at the Estech site in soils with thick cogongrass patches or soils that lacked cogongrass. A possible scenario for cogongrass establishment is that seeds blow into a site, the plants become established more quickly in the slightly wetter (upland) soils that have a higher clay content, the seedlings out compete the few upland species that are present, the cogongrass spreads vigorously from rhizomes, and then establishes a population in surrounding areas through opportunistic spreading rather than preference for specific soil conditions.

Table 13A. Comparison of Soil Parameters[†] Associated with Cogongrass vs. Wiregrass.

Soil Parameter	Neither Species	Cogongrass	Wiregrass	Both Species
Ca (mg kg^{-1})	301.1^{B}	435.5^{AB}	493.2^{A}	-
Mg (mg kg^{-1})	26.9^{B}	38.9^{B}	64.9^{A}	-
P (mg kg^{-1})	153.7^{B}	181.1^{AB}	295.6^{A}	-
Zn (mg kg^{-1})	0.64^{AB}	0.73^{A}	0.53^{B}	-
Mn (mg kg^{-1})	0.72^{AB}	0.87^{A}	0.47^{B}	-
Fe (mg kg^{-1})	33.1^{B}	39.0^{AB}	61.7^{A}	-
CEC (cmol kg $^{-1}$)	34.4^{AB}	37.2^{A}	27.1^{B}	-
Moisture Index	2.66^{B}	2.47^{B}	3.18^{A}	-

Table 13B. Comparison of Soil Parameters[†] Associated with Cogongrass vs. Scrub.

Soil Parameter	Neither Species	Cogongrass	Scrub	Both Species
CEC (cmol kg $^{-1}$)	18.02^{AB}	24.75^{A}	14.97^{B}	11.13^{B}
Moisture Index	2.05^{B}	2.09^{B}	1.55^{B}	3.00^{A}

Table 13C. Comparison of Soil Parameters† Associated with Cogongrass vs. Wetland Species.

Soil Parameter	Neither Plant Group	Cogongrass	Wetland Species	Both Plant Groups
CEC (cmol kg $^{-1}$)	24.7^{BC}	23.4^{C}	30.7^{B}	37.2^{A}
Moisture Index	2.40^{B}	2.43^{B}	3.32^{A}	3.02^{A}

Note: Mean values followed by the same letter are not significantly different for each row, according to a Waller-Duncan K-ratio t-test of means with K set to 100 (approximate 0.05 type I error rate).

† Only includes data from Best-of-the-West, Bald Mountain, Estech, Gopher Hills, Noralyn South, and Wildlife Corridor where cogongrass was present in quadrats.

Table 14A. Comparison of Soil Parameters† Associated with Bahiagrass vs. Wiregrass.

Soil Parameter	Neither Plant Group	Bahiagrass	Wiregrass	Both Plant Groups
pH	5.68^{AB}	5.55^{AB}	5.35^{B}	5.92^{A}
Total C (%)	0.78^{AB}	1.04^{A}	1.02^{A}	0.52^{B}
Total N (%)	0.03^{AB}	0.04^{A}	0.03^{AB}	0.01^{B}
Ca (mg kg^{-1})	321.13^{B}	371.24^{AB}	398.96^{AB}	511.28^{A}
Mg (mg kg^{-1})	33.29^{B}	36.77^{B}	51.32^{AB}	69.30^{A}
K (mg kg^{-1})	13.52^{AB}	14.83^{A}	13.57^{AB}	9.16^{B}
P (mg kg^{-1})	155.46^{B}	163.75^{B}	210.21^{AB}	313.86^{A}
Zn (mg kg^{-1})	0.75^{AB}	0.79^{A}	0.65^{AB}	0.51^{B}
Mn (mg kg^{-1})	1.01^{AB}	1.29^{A}	0.61^{B}	0.55^{B}
Fe (mg kg^{-1})	31.87^{B}	53.61^{AB}	53.98^{AB}	62.83^{A}
Moisture Index	2.37^{B}	3.04^{A}	3.12^{A}	3.20^{A}

Table 14B. Comparison of Soil Parameters† Associated with Bahiagrass vs. Lovegrass.

Soil Parameter	Neither Plant Group	Bahiagrass	Lovegrass	Both Plant Groups
Fe (mg kg^{-1})	62.45^{AB}	73.19^{A}	34.25^{B}	45.97^{AB}
Moisture Index	2.55^{B}	3.08^{A}	2.12^{C}	3.33^{A}

Note: Mean values followed by the same letter are not significantly different for each row, according to a Waller-Duncan K-ratio t-test of means with K set to 100 (approximate 0.05 type I error rate).

† Includes data from all sites except Best-of-the-West, where bahiagrass was present in quadrats.

Table 14C. Comparison of Soil Parameters† Associated with Bahiagrass vs. Scrub.

Soil Parameter	Neither Plant Group	Bahiagrass	Scrub Species	Both Plant Groups
pH	5.99^{A}	5.92^{A}	5.40^{AB}	5.19^{B}
Ca (mg kg^{-1})	441.4^{A}	537.2^{A}	306.7^{AB}	128.1^{B}
Na (mg kg^{-1})	16.99^{AB}	17.80^{A}	13.22^{B}	13.74^{AB}
CEC (cmol kg^{-1})	25.76^{A}	27.55^{A}	18.37^{B}	12.93^{B}
Moisture Index	2.20^{B}	2.68^{A}	1.65^{C}	1.58^{C}

Table 14D. Comparison of Soil Parameters† Associated with Bahiagrass vs. Wetland Species.

Soil Parameter	Neither Plant Group	Bahiagrass	Wetland Species	Both Plant Groups
P (mg kg^{-1})	169.90^{B}	207.13^{AB}	183.19^{AB}	283.75^{A}
Zn (mg kg^{-1})	0.98^{A}	0.70^{AB}	0.64^{B}	0.57^{B}
Fe (mg kg^{-1})	42.47^{B}	32.29^{B}	47.78^{AB}	72.09^{A}
CEC (cmol kg^{-1})	24.36^{B}	24.74^{B}	31.77^{A}	31.77^{A}
Moisture Index	2.34^{C}	2.69^{B}	3.13^{A}	3.41^{A}

Note: Mean values followed by the same letter are not significantly different for each row, according to a Waller-Duncan K-ratio t-test of means with K set to 100 (approximate 0.05 type I error rate).

† Includes data from all sites except Best-of-the-West, bahiagrass was present.

Bahiagrass. Like cogongrass, bahiagrass is widespread at almost all of the reclaimed mined sites. We recorded bahiagrass at nine of the 10 study sites. Bahiagrass was not documented in any of our study quadrats at the Best-of-the-West site, however, it could be present at that site as well. Bahiagrass is opportunistic and will colonize open disturbed areas from stolons spread in the original site formation and possibly by seed dropped by birds. Though we could not find documentation, it is known that germination is improved by scarifying (Duke 1983). Bahiagrass is adapted to a wide range of moisture conditions and can be found on well-drained upland soils as well as poorly drained flatwoods soils. Its deep root system enables it to tolerate drought conditions, however it is equally tolerant of poorly drained conditions (Chambliss 1996). We have observed thick bahiagrass stands growing on sites other than our study sites where overburden contained high clay content, and resulted in surface saturation for extended periods of time. Bahiagrass is a popular pasture grass with Florida ranchers as it tolerates a wide range of soil conditions, it has the ability to produce moderate yields on soils of very low fertility, it easily establishes from seed, it withstands close grazing, it is resistant to encroachment of weeds, and it is relatively free from damaging insects (except mole crickets) and diseases (Chambliss 1996). These characteristics enable bahiagrass to quickly establish at reclaimed mine sites and then spread and out compete slower growing desirable native species. Bahiagrass also has the ability to accumulate and store a supply of mineral nutrients and carbohydrate reserves in its stolons and roots, which allows it to be competitive on low-fertility soils. Bahiagrass was found growing under a wide range of soil conditions, with few significant differences in soil parameters between bahiagrass and other plant groups. Bahiagrass tended to be more strongly associated with a higher Mn concentration than wiregrass (Table 14A), and a higher Fe concentration and moisture index than lovegrasses (Table 14B), and a higher Na concentration, CEC, and moisture index than scrub species (Table 14C). Compared to wetland species, bahiagrass favored a lower CEC and lower moisture index (Table 14D).

Natalgrass. Natalgrass is similar to cogongrass and bahiagrass in that it is ubiquitous and problematic at reclaimed upland sites. However, unlike cogongrass and bahiagrass which have a wide moisture tolerance, natalgrass appears to be less tolerant of wetter soils with a higher clay content. Natalgrass was recorded at all of our study sites except the two wettest sites, Hardee Lakes and PCS.

Overall, natalgrass was strongly associated with low fertility and droughty soils as compared to the other plant groups. Natalgrass grew in soils with a significantly higher pH and CEC, and a lower total C, total N, K concentration, CEC, and moisture index than wiregrass (Table 15A). When compared to the lovegrasses, natalgrass favored a significantly higher pH, and a lower K concentration and moisture index (Table 15B). Natalgrass appears to favor many of the same soil conditions as scrub and sandhill species and therefore is most problematic at sites reclaimed to scrub and sandhill communities. Our data support this observation by indicating that there were only two soil differences between plots with natalgrass and plots with scrub species (Table 15C). Natalgrass appeared to favor higher pH and P concentrations than scrub species. When compared to wetland species, natalgrass was more strongly associated with a higher pH, a lower K concentration, and predictably a lower moisture index (Table 15D). Therefore, natalgrass might intrude into those soil systems which have a high pH and a low moisture index.

Table 15A. Comparison of Soil Parameters† Associated with Natalgrass vs. Wiregrass.

Soil Parameter	Neither Plant Group	Natalgrass	Wiregrass	Both Plant Groups
pH	5.30^{B}	5.78^{A}	4.94^{B}	5.97^{A}
Total C (%)	0.84^{B}	0.68^{BC}	1.58^{A}	0.44^{C}
Total N (%)	0.03^{B}	0.02^{BC}	0.04^{A}	0.01^{C}
Ca (mg kg^{-1})	284.83^{B}	352.09^{AB}	281.33^{B}	544.09^{A}
Mg (mg kg^{-1})	28.17^{B}	30.37^{B}	51.33^{AB}	68.14^{A}
K (mg kg^{-1})	18.55^{A}	11.69^{B}	18.23^{A}	8.64^{B}
P (mg kg^{-1})	119.00^{B}	172.27^{B}	73.67^{B}	348.81^{A}
Mn (mg kg^{-1})	0.87^{A}	0.74^{AB}	0.52^{AB}	0.46^{B}
Na (mg kg^{-1})	10.62^{AB}	15.58^{A}	9.82^{B}	15.11^{A}
CEC (cmol kg^{-1})	24.25^{B}	38.15^{A}	22.92^{B}	28.17^{B}
Moisture Index	3.89^{A}	2.26^{C}	4.08^{A}	2.95^{B}

Table 15B. Comparison of Soil Parameters† Associated with Lovegrass vs. Natalgrass.

Soil Parameter	Neither Plant Group	Natalgrass	Lovegrass	Both Plant Groups
pH	5.08^{B}	5.75^{A}	5.22^{B}	5.84^{A}
Total C (%)	1.31^{A}	0.61^{B}	0.76^{B}	0.61^{B}
Total N (%)	0.05^{A}	0.02^{B}	0.02^{B}	0.02^{B}
Ca (mg kg^{-1})	735.3^{A}	466.4^{AB}	664.6^{A}	302.4^{B}
Mg (mg kg^{-1})	103.42^{A}	56.56^{AB}	104.00^{A}	20.84^{B}
K (mg kg^{-1})	38.36^{A}	10.64^{B}	35.98^{A}	9.22^{B}
Cu (mg kg^{-1})	0.45^{A}	0.18^{B}	0.26^{AB}	0.17^{B}
Fe (mg kg^{-1})	82.64^{A}	60.79^{AB}	60.46^{AB}	31.99^{B}
Moisture Index	3.55^{A}	2.60^{B}	3.64^{A}	2.27^{B}

Note: Mean values followed by the same letter are not significantly different for each row, according to a Waller-Duncan K-ratio t-test of means with K set to 100 (approximate 0.05 type I error rate).

† Includes data from all sites except Hardee Lakes and PCS, where natalgrass was present in quadrats.

Table 15C. Comparison of Soil Parameters† Associated with Natalgrass vs. Scrub Species.

Soil Parameter	Neither Plant Group	Natalgrass	Scrub Species	Both Plant Groups
pH	5.01^{B}	5.84^{A}	4.93^{B}	5.38^{AB}
P (mg kg^{-1})	105.83^{AB}	177.04^{A}	52.00^{B}	121.14^{AB}
CEC (cmol kg^{-1})	21.84^{A}	19.98^{AB}	16.19^{BC}	13.83^{C}
Moisture Index	2.57^{A}	1.92^{B}	1.94^{B}	1.38^{C}

Table 15D. Comparison of Soil Parameters† Associated with Natalgrass vs. Wetland Species.

Soil Parameter	Neither Plant Group	Natalgrass	Wetland Species	Both Plant Groups
pH	5.30^{B}	5.72^{A}	5.15^{B}	5.90^{A}
Total C (%)	0.98^{AB}	0.87^{AB}	1.20^{A}	0.54^{B}
K (mg kg^{-1})	23.86^{A}	11.16^{B}	31.06^{A}	9.93^{B}
P (mg kg^{-1})	131.70^{B}	189.95^{B}	136.50^{B}	291.88^{A}
Zn (mg kg^{-1})	1.07^{A}	0.89^{AB}	0.66^{B}	0.58^{B}
Mn (mg kg^{-1})	1.78^{A}	1.31^{AB}	1.05^{AB}	0.59^{B}
CEC (cmol kg^{-1})	26.29^{B}	23.81^{B}	25.87^{B}	35.47^{A}
Moisture Index	3.15^{B}	2.15^{D}	3.89^{A}	2.87^{C}

Note: Mean values followed by the same letter are not significantly different for each row, according to a Waller-Duncan K-ratio t-test of means with K set to 100 (approximate 0.05 type I error rate).

† Includes data from all sites except Hardee Lakes and PCS, where natalgrass was present.

Within Site Comparisons. Soil parameters were compared between plots with a high cover of weedy species (HW plots) and all other plots within each site to determine if specific soil parameters promoted high coverage of weedy species such as cogongrass, natalgrass, or bahiagrass. This analysis was performed separately for surface soils and subsurface soils. Two levels of statistical significance are reported; a high level of significance ($p < 0.01$), and a somewhat lower level of significance ($p = 0.05 - 0.01$). A total of 50 significant differences were found in soil parameters between HW plots and all other plots (Table 16). We were surprised to find a significant difference in such a high number of soil comparisons as the sample size for HW plots was typically only 3.

The HW plots in almost all cases were strongly associated with more fertile soils than plots with few to no weedy species (Table 16). The soil parameters that were detected more frequently in higher amounts in HW plots were total C, P, K, Mg, Fe, and micronutrients. These results are important in determining construction and management practices at reclaimed upland sites. As our data suggest, a higher concentration of soil nutrients promote high coverage of weedy species, particularly aggressive grasses. The addition of fertilizers, sewage sludge, or other soil amendments will probably favor these undesirable aggressive grasses, especially cogongrass and bahiagrass over native upland species. In native sandhill and scrub habitats, soil fertility and moisture content are typically low. The native species, especially characteristic species, are adapted to these "stressful" soil conditions, and consequently grow slowly. In reclaimed communities, these slow-growing native species are easily out competed by fast-growing aggressive grasses, especially in conditions of high soil nutrients and high soil moisture. Site specific patterns emerged between desirable and undesirable species during field data collection and statistical data analysis. These results are presented below on a site-by-site basis.

Bald Mountain. Bald Mountain was reclaimed by creating a hill of sand tailings and then capping the tailings with roughly three to 12 inches of overburden. Twelve one-acre plots were left with no overburden cap. The reclamation plan consisted of restoring 100 acres of sand scrub habitat and 65 acres of sandhill habitat. Seeds of many native species collected from scrub and sandhill habitats were spread on the site. Nursery-grown sandhill and scrub species were also planted at Bald Mountain. In 1997, four years after seeding and planting, we found high survival of scrub and sandhill species at this relatively new site. Many of these species have reproduced and spread, including *Sporobolus junceus, Eragrostis elliottii, Polygonella robusta, Sorgastrum secundum, Aristida beyrichiana,* and *Aristida gyrans.* Many of these species have tended to reseed in the open areas (where no overburden was spread and mixed in) where there is little to no competition by natalgrass.

Encroachment of cogongrass, natalgrass, and hairy indigo has occurred in some areas, and were represented in our three HW quadrats. Qualitatively, we observed that two of the HW quadrats contained the thickest layer of overburden/sand tailing mix (61 cm at BM-2; 81 cm at BM-9), and the third HW quadrat exhibited a moderate thickness of overburden/sand tailings mix (25 cm at BM-6) with concretions present (soil profile in Appendix E). We surmised that the thicker layer of overburden/sand tailing mix at BM-2 and BM-9 increases the moisture holding capacity and perhaps even the nutrient capacity sufficiently to favor aggressive grasses (cogongrass in this case) over the desired sandhill or scrub species. When comparing soil parameters between the three HW quadrats and all other plots, we found that the HW quadrats contained a significantly higher total N and K concentration (Table 16). These data suggest that a thicker overburden surface horizon at the HW quadrats may not only result in a higher water holding capacity, but also a higher fertility level as well.

Table 16. Comparison of Soil Parameters Between Plots with High Cover of Weedy Species (HW) and All Other Plots. Comparison Shown Are Only for Observations Where a Statistical Difference Occurred (*P* < *0.05*). Page 1 of 2.

Site	Soil Parameter	Soil Location	HW† Plots	All other Plots (HD, LD, LW)†	Level of Significance‡
Bald Mountain	Total N (%)	Surface	0.018	0.008	*
	K (mg/kg^{-1})	Surface	16.8	8.2	**
Estech	Total N (%)	Surface	0.092	0.053	*
	Fe (mg kg^{-1})	Subsurface	130.25	99.44	*
Gopher Hills	Mg (mg kg^{-1})	Surface	51.8	22.8	**
	K (mg kg^{-1})	Surface	19.5	11.6	**
	Zn (mg kg^{-1})	Surface	1.01	0.61	**
	Cu (mg kg^{-1})	Surface	0.21	0.17	*
	Total C (%)	Subsurface	0.989	0.40	*
	Mg (mg kg^{-1})	Subsurface	49.4	14.5	**
	Fe (mg kg^{-1})	Subsurface	69.3	34.0	*
Hardee Lakes	pH	Surface	5.54	4.59	**
	Total C (%)	Surface	0.62	1.69	*
Margaret Gilbert	Bulk Density (g cm^{-3})	Surface	1.04	1.56	*
	Total C (%)	Surface	0.47	0.31	*
	Ca (mg kg^{-1})	Surface	259.0	75.0	**
	Mg (mg kg^{-1})	Surface	21.5	5.5	*
	P (mg kg^{-1})	Surface	173.6	60.0	**
	Fe (mg kg^{-1})	Surface	29.6	19.8	*
	Micronutrients	Surface	2393	1053	**
	Moisture Index	Surface	2.5	1.0	**
	Cation Exchange Capacity(cmol kg^{-1})	Surface	15.1	10.4	**
	Moisture (%)	Subsurface	4.93	1.35	*
	Bulk Density (g cm^{-3})	Subsurface	1.43	1.03	*
	Total C (%)	Subsurface	0.30	0.129	**
	Ca (mg kg^{-1})	Subsurface	227.8	37.3	**
	Mg (mg kg^{-1})	Subsurface	19.1	2.5	*

Table 16. Comparison of Soil Parameters Between Plots with High Cover of Weedy Species (HW) and All Other Plots. Comparison Shown Are Only for Observations Where a Statistical Difference Occurred ($P < 0.05$). Page 2 of 2.

Site	Soil Parameter	Soil Location	HW† Plots	All other Plots (HD, LD, LW)†	Level of Significance‡
Margaret Gilbert	K (mg kg^{-1})	Subsurface	12.6	4.1	**
	P (mg kg^{-1})	Subsurface	179.5	36.1	**
	Zn (mg kg^{-1})	Subsurface	0.57	0.40	*
	Cu (mg kg^{-1})	Subsurface	0.442	0.190	*
	Mn (mg kg^{-1})	Subsurface	0.596	0.180	*
	Fe (mg kg^{-1})	Subsurface	32.25	10.69	*
	Micronutrients	Subsurface	2455	647	**
	Cation Exchange Capacity (g cm^{-3})	Subsurface	15.1	10.4	**
Noralyn South	Fe (mg kg^{-1})	Surface	87.25	37.06	*
	Micronutrients	Surface	4278	3244	*
	Moisture Index	Surface	3.0	1.6	**
	P (mg kg^{-1})	Surface	321	249.9	*
PCS	pH	Surface	4.93	5.35	*
	Total C (%)	Surface	1.81	0.70	**
	Micronutrients	Surface	2608	3728	*
	Bulk Density	Subsurface	1.36	1.0	*
	P (mg kg^{-1})	Subsurface	76.7	228.2	*
	Micronutrients	Subsurface	1948	4095	**
Sixteen Acres	Total C (%)	Surface	0.49	0.35	**
	Total N (%)	Surface	0.0153	0.0080	**
	Ca (mg kg^{-1})	Subsurface	900.8	534.0	**
	K (mg kg^{-1})	Subsurface	7.87	4.94	*
	P (mg kg^{-1})	Subsurface	450.0	320.1	*
	Zn (mg kg^{-1})	Subsurface	0.81	0.52	*
	Cu (mg kg^{-1})	Subsurface	0.335	0.130	**
	Mn (mg kg^{-1})	Subsurface	0.72	0.49	*
	Micronutrients	Subsurface	5659	4069	*

Note: Surface and subsurface depths vary with the soil profile (Appendix F).

† HD = Plots with high cover of desirable species
HW = Plots with high cover of weedy species
LD = Plots with low cover of desirable species
LW = Plots with low cover of weedy species

‡ * $p = 0.05 - 0.01$
** $p < 0.01$

Best-of-the-West. This site was reclaimed in 1985 and 1986 by applying topsoil to overburden. Topsoil was removed from a nearby donor xeric oak scrub, xeric oak sandhill, palmetto prairie, and small marsh and applied at a thickness of one foot or less. Many herbaceous species established from the topsoiling, including *Schizachyrium stoloniferum, Panicum anceps, Solidago fistulosa, Helianthemum corymbosum, Andropogon glomeratus, Tephrosia chrysophylla, Eragrostis elliottii,* and *Polygonella polygama.*

We selected four vegetation categories when locating the vegetation and soil monitoring quadrats at the Best-of-the-West site; high weedy (HW), low cover of weedy species, high cover of desirable nonscrub species, and high cover of scrub species. Qualitatively, we found that soil physical properties appeared to overlap between the HW, low cover of weedy species, and high cover of desirable nonscrub species with regards to thickness of topsoil, color of topsoil, and depth to overburden. However, two of the three quadrats (BW-4, BW-11) with high cover of scrub species tended to occur on the driest soils that contained light gray topsoil on top of a sandy topsoil or sand tailings subsurface soil. The third quadrat (BW-12) contained a thick topsoil layer (26 cm) over a brown fine sand overburden. Conversely, the other quadrats all contained topsoil on top of overburden, with the overburden exhibiting a higher content of loam and clay, and often with concretions. Overall, it appeared that the three quadrats with high cover of scrub species exhibited the driest soils, and in physical appearances, resembled native scrub or sandhill soils more closely than the other nine quadrats.

This site, as well as Noralyn South, was studied extensively after construction to evaluate reclamation techniques on upland reclamation (King et al. 1992). One conclusion of the study was that the best way to restore an oak scrub would be to spread chopped oak scrub topsoil over sand tailings. This is what we observed at two of the quadrats which exhibited high cover of desirable scrub species. Two of the plots (BW-4 and BW-11) contained a deep surface layer of light gray fine sand topsoil over a subsurface layer of either topsoil or sand tailings. This site also demonstrates the need to match the hydrologic regime between a donor topsoil site and the recipient reclaimed site, as the apparent driest quadrats are the quadrats that supported high cover of scrub species. Surprisingly, we found no significant differences in any of the soil parameters between HW plots and all other plots at the Best-of-the West site.

Estech Topsoil Site. This site was reclaimed in 1990 and 1991 by removing topsoil from a nearby scrubby flatwoods and applying it at an approximately 6-inch depth to cover an overburden soil. Seeds and propagules of many native flatwood and scrubby flatwood species transferred in the topsoil, and have successfully colonized the site.

Qualitatively, we saw no obvious differences in vegetation patterns as related to soil physical properties such as topsoil thickness, topsoil color, overburden color, and overburden texture. We hypothesized that establishment of cogongrass at this site was probably more influenced by distribution of seed rather than specific soil properties. The cogongrass then apparently spread out to create patches, and this spread was more of an opportunistic occurrence that was irrespective of soil physical properties.

The first growing season probably has a profound effect on the vegetative community that establishes, especially at topsoil sites. In fact, initial moisture conditions can favor certain species during the first growing season. The seeds that establish early have an advantage in availability of nutrients, space, and moisture to establish themselves. If these early-established plants are tolerant of a wide range of soil conditions, as is the case with aggressive species such as cogongrass, bahiagrass, or even the desirable creeping blue stem (*Schizachyrium stoloniferum*) or beaked panicum (*Panicum anceps*), then their spread can occur irrespective of soil conditions.

Soil nutrient parameters were similar between the HW plots and all other plots at the Estech site. The only differences detected were that HW plots were more closely associated with a high total N in the surface layer and a high Fe concentration in the subsurface layer than the other less weedy plots (Table 16).

Gopher Hills. This site is one of the younger sites that was reclaimed to scrub, scrubby flatwoods, and flatwoods by applying sand tailings over overburden. The thickness of both the sand tailings and overburden vary across the site. Topsoil was added to the site in 1993, and the tops of both hills were planted with scrubby flatwoods species in 1995. Although this is a young site, many topsoil areas are successfully supporting desirable native species such as *Schizachyrium stoloniferum, Helianthemum corymbosum, Galactia elliottii, Paspalum setaceum, Dichanthelium portoricense,* and *Sorgastrum secundum.*

Qualitatively, a pattern between soil physical properties and desirable species was observed at Gopher Hills that is opposite to the pattern observed at Bald Mountain and Best-of-the-West. At the latter two sites, the drier soil profiles appeared to promote desirable (scrub) species, whereas at the Gopher Hills site, the wetter soil profiles tended to promote desirable (flatwoods) species. The three plots with high cover of desirable species contained either a thick (66 cm) layer of dark topsoil (GH-12) or topsoil on top of overburden (GH-1 and GH-8) (Appendix E). The majority of the weedy plots, both high weedy and low weedy, contained topsoil on top of sand tailings, generally with little or no overburden. This observation again reinforces the need to match the hydrologic regime between the topsoil donor site and the recipient site. The overburden at Gopher Hills improved water retention and created a hydrologic regime more similar to a flatwoods site than the droughty sand tailings. The flatwoods species present in the topsoil have an increased chance of survival when they are transferred to an recipient site, such as one with overburden soils that is similar to the hydrologic conditions from which they were removed.

Several differences in soil nutrient properties were detected between the HW plots and all other plots at the Gopher Hills site. The HW plots contained a significantly higher Mg, K, Zn, and Cu concentration in the surface layer, and a significantly higher total C, Mg, and Fe concentration in the subsurface layer than the other less weedy plots (Table 16). Our data suggest that at the Gopher Hills site, the weedy species were more abundant at a somewhat drier soil with a higher concentration of specific soil nutrients. However, the selected quadrats were on the south hill, which had many wetter characteristics perhaps because the underlying overburden was shaped to hold water.

Hardee Lakes. Hardee Lakes was reclaimed in 1990 by applying roughly 1 foot (30 cm) of topsoil from a nearby flatwoods to overburden. The effort at this site has resulted in a successfully reclaimed mesic flatwoods as evidenced by a high cover and rich diversity of native flatwoods species, including *Schizachyrium stoloniferum, Paspalum setaceum, Sorghastrum secundum, Solidago stricta, Scleria ciliata, Aristida beyrichiana,* and *Andropogon glomeratus* var. *glaucopsis*. In many areas, *Schizachyrium stoloniferum* forms a dense mat and out-competes most other species.

Soil profiles revealed a very distinct topsoil layer ranging from 10 to 25 cm thick. Qualitatively, we noticed that the darker color topsoil with apparent higher organic matter tended to favor high cover of desirable species. The three high weedy quadrats contained light color topsoil (HL-2 and HL-8) or a very thin surface layer of topsoil (HL-1) (Appendix E). In contrast, the six quadrats with high cover of desirable species contained a darker, thicker surface horizon of topsoil. This site demonstrates the success associated in reclaiming a mesic flatwoods, by removing topsoil from a somewhat poorly drained to poorly drained flatwoods community and applying it to a reclaimed site with a similar moisture regime, and thus successfully transferring and establishing a diversity of flatwoods species that are adapted to a similar moisture regime. Robert Van Olinda (personal communication) said that after the site was topsoiled, it rained very heavily. These rains would have presumably contributed to the success of this site.

Only two differences were detected between HW quadrats and the other less weedy quadrats at Hardee Lakes. The HW plots contained a significantly higher pH and significantly lower total C in the surface layer as compared to all other plots (Table 16). The low total C in the HW plots is presumably reflective of the lower visual organic matter content in the surface soils at the HW plots.

Margaret Gilbert Site. Portions of this site were reclaimed to a scrub community by seeding or planting scrub species onto sand tailings soils. A scrub island was left unmined to facilitate seed transfer from the island to the reclaimed areas. Other portions of the site contained overburden material and were planted in 1985 with a mixture of annual and perennial (bahiagrass) grasses, sand pines (*Pinus clausa*), and mixed hardwood trees. Twelve years later we found a very thick layer of bahiagrass and a well-established stand of sand pine trees. The thick bahiagrass closely corresponded with the presence of overburden that was generally tan or light brown in color, with a sand or sandy loam texture. Soils in plots with less weedy species (high cover of desirable species or low cover of desirable species) are distinctly different from those in the HW plots in that they are all light-colored fine sands, and lack an overburden substrate. In fact, these soils so closely resemble native scrub soils in the unmined scrub island that we questioned whether these soils were indeed mined. Due to this uncertainty, we conducted more extensive physical and chemical comparisons between plots with high cover of desirable species and the unmined scrub island. Soil chemical differences in pH, Ca, Mg, Zn, Fe, Mn, Na, and Ca suggested that the highly desirable plots had indeed been mined and reclaimed. The planted and seeded scrub species appeared to successfully establish onto adjacent sand tailings, but were unsuccessful in establishing on adjacent overburden soils, which were marked with a thick mat of bahiagrass.

As expected, many soil differences were detected between HW plots and other less weedy plots. In fact, the Margaret Gilbert site exhibited the greatest number of soil differences, with a total of 9 soil differences in the surface layer and 13 differences in the subsurface layer. This result is not surprising since the weedy plots at Margaret Gilbert were on overburden while the desirable vegetation was found on sand tailings (see soil profiles in Appendix E).

Noralyn South. This 127-acre site was reclaimed in 1983, and represents one of the first attempted upland reclamation projects following phosphate mining in central Florida. Early results of this reclamation project are reported by King et al. (1992). This site originally served as a clay settling pond and was drained of surface water and then filled with sand tailings. The sand then had clay disked into its surface as a soil enhancement. In 1981 topsoil from a xeric habitat at west Noralyn was spread in test plots of approximately 0.25 acre in size. Because we were able to locate only a few of the topsoil pockets, we did not include topsoil areas in our study quadrats. The site was fertilized and planted with native trees and bahiagrass to create a grassy understory. Isolated patches of native species were observed during our 1997 field survey and included *Eragrostis spectabilis, Eragrostis elliottii, Garberia heterophylla, Bulbostylis ciliatifolia, Licania michauxii, Opuntia humifusa,* and *Polygonella polygama*. However, the majority of the understory is colonized by the aggressive grasses bahiagrass, cogongrass, and natalgrass.

Plots were established slightly differently at the Noralyn South site in terms of dominant weedy species. Three plots of HW/bahiagrass and three plots of HW/cogongrass were constructed to allow us to investigate whether soil parameters differed significantly in bahiagrass-dominated plots, cogongrass-dominated plots, or plots with high cover of desirable species. With regard to physical observations, we noted that cogongrass-dominated plots (NS-2, NS-6, and NS-9) appeared to contain a higher clay content than plots with high cover of desirable species as observed by many clay chunks or a thicker horizon of clayey overburden. The bahiagrass-dominated plots were also supported by soils with a relatively high clay content. Conversely, plots with high cover of desirable species were on sand tailings soils with little or no orange staining from either the clay slurry or clay from the original settling pond. Plots with low cover of weedy species visually were intermediate in clay content, and were primarily sand tailings that had been stained orange from the clay slurries, but lacked clay chunks.

Comparison of soil parameters between HW plots (bahiagrass and cogongrass plots combined) and the other less weedy plots revealed that the HW plots were more strongly associated with a higher Fe concentration, micronutrients, and moisture index in the surface layer and a higher P concentration in the subsurface layer (Table 16). When bahiagrass-dominated plots were separated from cogongrass-dominated plots, we found that bahiagrass soils exhibited a significantly higher Fe concentration (91.3 mg kg^{-1}), that cogongrass soils contained an intermediate concentration of Fe (83.2 mg kg^{-1}), and the other less weedy plots exhibited a significantly lower Fe concentration (37.06 mg kg^{-1}).

PCS Site. This site differs from the other nine study sites in that it is the only site located in north Florida (Figure 1). The PCS site was mined in the mid-1980s and reclaimed with an overburden matrix. A thin layer of topsoil was added in strips four to five years later. The site was then planted with bare root seedlings of pines and hardwoods at a density of 650 trees per acre. In 1997 the site was heavily vegetated, with percent cover of vegetation exceeding 100% in many areas. Common plants included *Andropogon glomeratus* var. *glomeratus, Gelsemium sempervirens, Agalinis purperea, Solidago fistulosa, Eupatorium capillifolium, Eupatorium compositifolium, Baccharis halimifolia, Kummerowia striata, Chenopodium ambrosioides, Indigofera hirsuta,* and *Rubus cuneifolius.* The aggressive grass bahiagrass was also present.

In many areas, soils at PCS contained a surface overburden with many hard concretions at the surface. The concretions were sandy clay or of a harder texture such as limerock, which made digging through the overburden quite difficult. Some areas had thick gray and/or gleyed clay at the surface with prominent orange oxidized mottles. Topsoil was apparent at several locations, however the topsoil differed from typical topsoil in that it contained more loam material. Possible explanations for a higher loam content are that the topsoil may have been mixed with overburden from the site, the topsoil may have come from a donor site with a higher surface loam content, or the topsoil could have come from deeper in the soil profile of the donor site where loam was higher than the surface horizon.

Qualitatively, soils that supported a suite of desirable species tended to be associated with a surface layer of overburden material, whereas the exotic aggressive species such as bahiagrass were associated more frequently with a surface layer of topsoil (Appendix E). All three plots with a high cover of desirable species (PC-6, PC-7, and PC-8) contained many hard concretions in the overburden. The desirable species, several which are listed above, are indicative of a mesic flatwoods assemblage. The topsoil plots, which contain topsoil over overburden, are more similar in soil drainage conditions to a natural flatwoods Spodosol, in that the Spodosols generally contain topsoil on top of a spodic hardpan horizon. It is interesting that the topsoil plots would favor bahiagrass, whereas the overburden surface soils with many hard concretions would favor desirable mesic flatwoods species. Perhaps the bahiagrass is more competitive in the slightly drier topsoil areas and is able to out-compete native species that would otherwise colonize the topsoil areas, or simply bahiagrass seeds were present in the donor topsoil and consequently established in the topsoil areas. Though not much topsoil was found on the site, either that factor or the proximity of other native vegetation may be credited with a fairly heavy cover of native herbaceous species that was introduced without heavy topsoiling, planting, or seeding. Also, the only major exotic aggressive competitor was bahiagrass.

Several differences in soil nutrient properties were detected between HW plots and all other plots at the PCS site. The HW plots contained a lower pH, lower concentration of micronutrients, and a higher total C in the surface layer. For subsurface soils at PCS, bulk density was significantly higher and phosphorus and micronutrients were significantly lower than the less weedy plots.

Sixteen-Acre Site. This site represents the first large-scale effort to direct seed wiregrass to a reclaimed phosphate mined site. A mulching experiment was conducted at the time of seeding to determine if mulch would increase germination of wiregrass and other desirable seeds by stabilizing the seeds and retaining moisture from rainfall. Half of the site was mulched with a bahiagrass mulch that was free of weeds and seeds. We decided to also test this mulching hypothesis by locating half of our study quadrats in mulched areas and half in unmulched areas.

Some differences in soil parameters were detected between mulched and unmulched quadrats (Table 17). Soil differences might have confounded the mulch effect. The surface soil of the LW mulched quadrats had significantly higher bulk density compared to the unmulched quadrats. Quadrats located in the LW and HW areas, had significantly higher pH in the subsurface soils of mulched areas, probably as a result of leaching of cations such as Ca (and Mg) from the surface soils. Subsurface soils of mulched areas of LW quadrats had significantly higher Mn and Zn concentrations. Significantly lower total N and total C were found in the subsurface soils of HW quadrats of mulched compared to unmulched areas. We speculate that nutrients increased in the surface soil as a result of mineralization of the mulch. Leaching has presumably occurred within the surface and subsurface soil layers, which would lead to higher soil nutrients in both the surface and subsurface layers of the mulched plots.

Table 17. Comparison of Soil Parameters Between Mulched and Unmulched Plots at the 16-Acre Site. Comparison Shown Are Only for Observations Which Are Statistically Different *($P < 0.05$)*.

Soil Parameter	Soil Layer	Vegetation Plot†	Mulched	Unmulched	Level of Significance‡
Bulk Density ($g\ cm^{-3}$)	Surface	LW	1.8	1.3	.**
pH	Subsurface	HW + LW	6.48	5.93	**
pH	Subsurface	LW	6.49	5.69	*
Total N (%)	Subsurface	HW	0.0033	0.012	**
Total C (%)	Subsurface	HW	0.23	0.47	**
Total C (%)	Subsurface	HW + LW	0.22	0.41	**
Ca ($mg\ kg^{-1}$)	Surface	LW	845.7	421.8	**
Ca ($mg\ kg^{-1}$)	Subsurface	LW	710.8	405.2	*
Mg ($mg\ kg^{-1}$)	Surface	LW	119.5	54.5	*
Mn ($mg\ kg^{-1}$)	Subsurface	LW	0.55	0.31	**
Zn ($mg\ kg^{-1}$)	Subsurface	LD	0.41	0.64	*
Zn ($mg\ kg^{-1}$)	Subsurface	LW	0.58	0.39	*

† HW = Plots with high cover of weedy species
LD = Plots with low cover of desirable species
LW = Plots with low cover of weedy species

‡ * p = *0.05 - 0.01*
** *p < 0.01*

A comparison of vegetative cover between mulched and unmulched plots was also conducted to determine if mulching affected vegetative cover of specific species or plant groups. In all but one case-mulched plots produced a higher average percent cover than unmulched plots (Table 18). Wiregrass grew at a higher percent cover in mulched plots than unmulched plots. Undesirable species such as weedy species, natalgrass, exotic species, and aggressive grasses also grew at a higher percent cover in the mulched plots than unmulched plots. These observations pertained primarily to plots with low cover of weedy species. Native species was the only plant group that occurred at a lower percent cover in mulched plots than in unmulched plots. These results follow closely to results reported by Bissett (1995b), where more wiregrass seedlings as well as more exotic and invasive seedlings were detected in the mulched plots just nine months after mulching. Desiccation is a problem in newly reclaimed areas which lack trees or leaf litter to shade young seedlings. It appears that mulching did help to retain moisture, which increased the overall germination and growth of both wiregrass and aggressive grasses.

Table 18. Comparison of Average Percent Cover of Vegetation Between Mulched and Unmulched Plots at the 16-acre Site. Comparison Shown Are Only for Observations Which Are Statistically Different *(P < 0.05)*.

Vegetation	Vegetation Plot†	Average Percent Cover		Level of Significance‡
		Mulched	Unmulched	
Native Species	HW	27.6	54.6	*
Wiregrass	LD	20.0	11.4	*
Wiregrass	LD + HD	23.0	10.9	**
Wiregrass	LW	10.4	4.6	**
Weedy Species	LW	22.1	10.5	*
Weedy Species	LW	40.4	13.9	*
Natalgrass	LW	13.3	4.0	**
Exotic Species	LW	45.2	18.2	*
Aggressive Grasses	LW	22.6	10.5	**

† HW = Plots with high cover of weedy species
LD = Plots with low cover of desirable species
LW = Plots with low cover of weedy species
‡ * p = *0.05 - 0.01*
** *p < 0.01*

When mulched and unmulched plots were combined, the Sixteen-Acre site exhibited a number of differences in soil parameters between HW plots and other less weedy plots, especially in the subsurface layer. In all cases, the HW plots were associated with higher concentrations of soil nutrients than the other less weedy plots (Table 16). Total C and total N were significantly higher in the surface layer of HW plots, while in the subsurface layer, Ca, K, P, Zn, Cu, Mn, and micronutrients were significantly higher in HW plots than all other plots.

Wildlife Corridor. This 58-acre site was reclaimed in 1986 through 1992 as a forested upland wildlife corridor by planting woody plant species that are considered beneficial to wildlife. Vegetation planted at this site included *Serenoa repens, Cratageus flava, Diospyros virginiana, Prunus geniculata, Morus rubra, Asimina obovata, Callicarpa americana, Ilex glabra, Viburnum obovatum,* and *Lonicera sempervirens.* There were no herbaceous groundcover species planted. Soils at the site generally consist of overburden on top of sand tailings; however, we found the reverse pattern at some plots. Aggressive grasses have become problematic at this site, especially cogongrass and natalgrass.

Plots at the Wildlife Corridor site were established similar to the Noralyn South site and different from the other eight sites by constructing cogongrass-dominated plots and natalgrass-dominated plots for both the HW vegetation category and the low weedy vegetation category. These plots allowed us to investigate whether soil parameters differed significantly among plots with high cover of cogongrass, low cover of cogongrass, high cover of natalgrass, low cover of natalgrass, and low cover of desirable species.

With regards to physical soil characteristics, we noted several patterns at the Wildlife Corridor site. The wettest plot (WC-5) contained the thickest layer of overburden soil and supported a high cover of cogongrass. Cogongrass-dominated plots were associated with a wide range of overburden thickness, ranging from 0 to >30 cm. In contrast, high cover of natalgrass was associated with a consistent thickness of 15 cm of overburden, while low cover of natalgrass was associated with a consistently thinner layer of overburden. Like cogongrass, soils in plots with a low cover of desirable species exhibited a wide range in thickness of overburden. Based on these physical observations it appears that cogongrass grows successfully at this site regardless of overburden thickness, a consistent thickness of 15 cm of overburden favored high cover of natalgrass, and a thinner overburden favored lower cover of natalgrass. Location of desirable species appeared unaffected by soil physical properties, but rather was dictated by the initial planting location of desirable species. From a cursory observation it appears that the desirable species that have survived and spread since the initial planting event favor or tolerate a high pH soil, such as *Myrcianthes fragans, Lonicera sempervirens, Passiflora incarnata, Erythrina herbacea, and Prunus angustifolia.*

Several comparisons were made to determine if there were differences in soil chemical parameters among different vegetation groups at the Wildlife Corridor site. We found no differences in any of the soil chemical parameters among high cover of cogongrass, low cover of cogongrass, and low cover of desirable species; high cover of natalgrass, low cover of natalgrass, and low cover of desirable species; or high and low cover of cogongrass, high and low cover of natalgrass, and low cover of desirable species.

FIELD EXPERIMENTS

TOPSOIL AUGMENTATION FIELD EXPERIMENT

Methodology

This field experiment was designed to field-test the efficacy of seed transfer and revegetation by means of topsoil augmentation. Topsoil was collected from a burned flatwoods and an unburned flatwoods and applied as a thick layer and thin layer to an overburden site and a sand tailings site. Approximately 5 acres of unmined flatwoods located at CF Industries in northwestern Hardee County were burned in early June 1996 (Figure 1). The prescribed burn occurred in the growing season to stimulate seed production of fire-dependent species such as wiregrass *(Aristida beyrichiana)*. The adjacent unmined flatwoods, approximately 10 acres in size, was not burned. The burned and unburned flatwoods served as topsoil donor sites for this project. The burned flatwoods was examined after the fire to qualitatively assess production of wiregrass seeds. Seeds were observed maturing in November 1996 and had fully dispersed by January 1997.

In mid-January 1997, when wiregrass seeds had dispersed, topsoil was removed from both burned and unburned donor topsoil sites and transferred to two nearby mined and reclaimed sites; an overburden site (Range 24E, Township 33S, Section 09) and a sand tailings site (Range 24E, Township 33S, Section 06). Topsoil was applied at two different thicknesses, a thick layer (approximately 16 cm) and thin layer (approximately 8 cm) to both the overburden and sand tailings sites. A control (no topsoil) and four treatments (burned, unburned, thin topsoil, thick topsoil) were replicated four times in 10 m x 10 m plots at both the overburden and sand tailings sites, for a total of 20 plots each at both sites (Figures 5 and 6). This field experiment was designed as a random split plot design to evaluate the transfer of flatwoods seeds and plant parts in topsoil from unmined pine flatwoods to a reclaimed overburden site and reclaimed sand tailings site. This study allowed us to evaluate vegetation characteristics in topsoil from burned and unburned sites, thick vs. thin layers of topsoil, and overburden vs. sand tailings. The effects of topsoil were also evaluated by comparing vegetation in topsoil plots to vegetation in control plots (no topsoil).

A plant inventory and estimated relative abundance of each species were obtained at both the burned and unburned flatwoods. Wiregrass seeds were collected from the burned flatwoods donor site on two occasions. In November 1996 seeds were collected when the seeds were still attached to the plants. For random samples, one spikelet was randomly taken from each culm, and for full samples, one spikelet was collected from each culm that had developed a full caryopsis. Wiregrass seeds were collected a second time in January 1997 just one week before the topsoil was transferred to the reclaimed sites, by collecting spikelets from the ground. Random and full selections were made, but after the random samples were taken we could only find 26 spikelets in our collection with full seeds were then sent to the U.S.D.A. Natural Resource Conservation Service (NRCS) Plant Materials Center for germination tests, which were conducted at 20° to 30° for 32 days, using potassium nitrate as wetting agent.

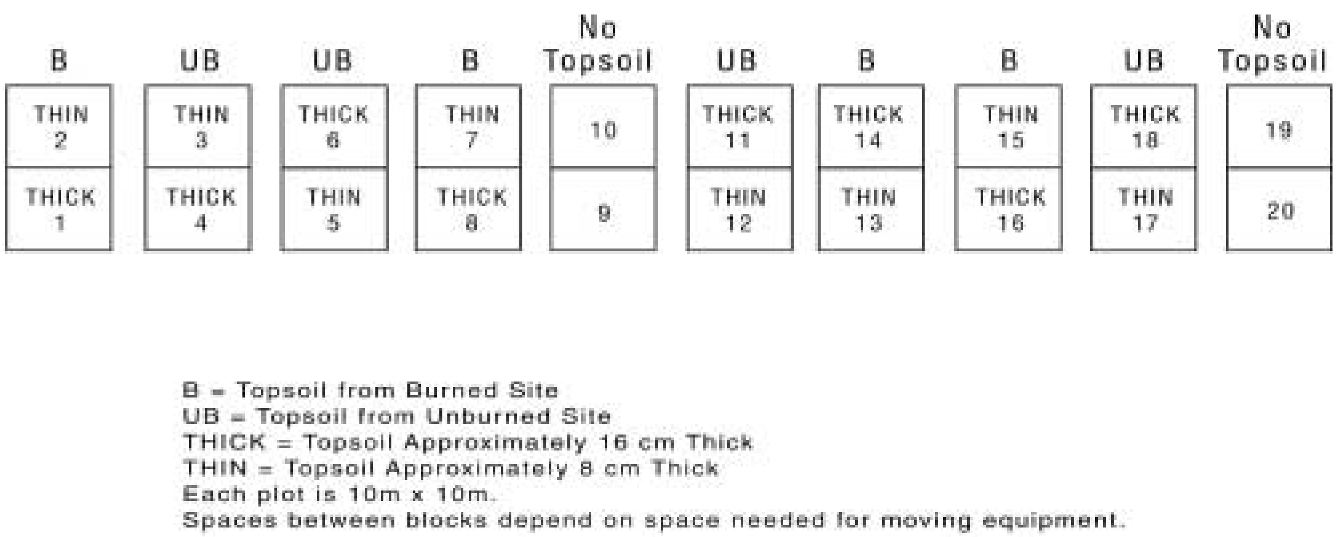

Figure 5. Topsoil Augmentation Plot Layout at Overburden Site.

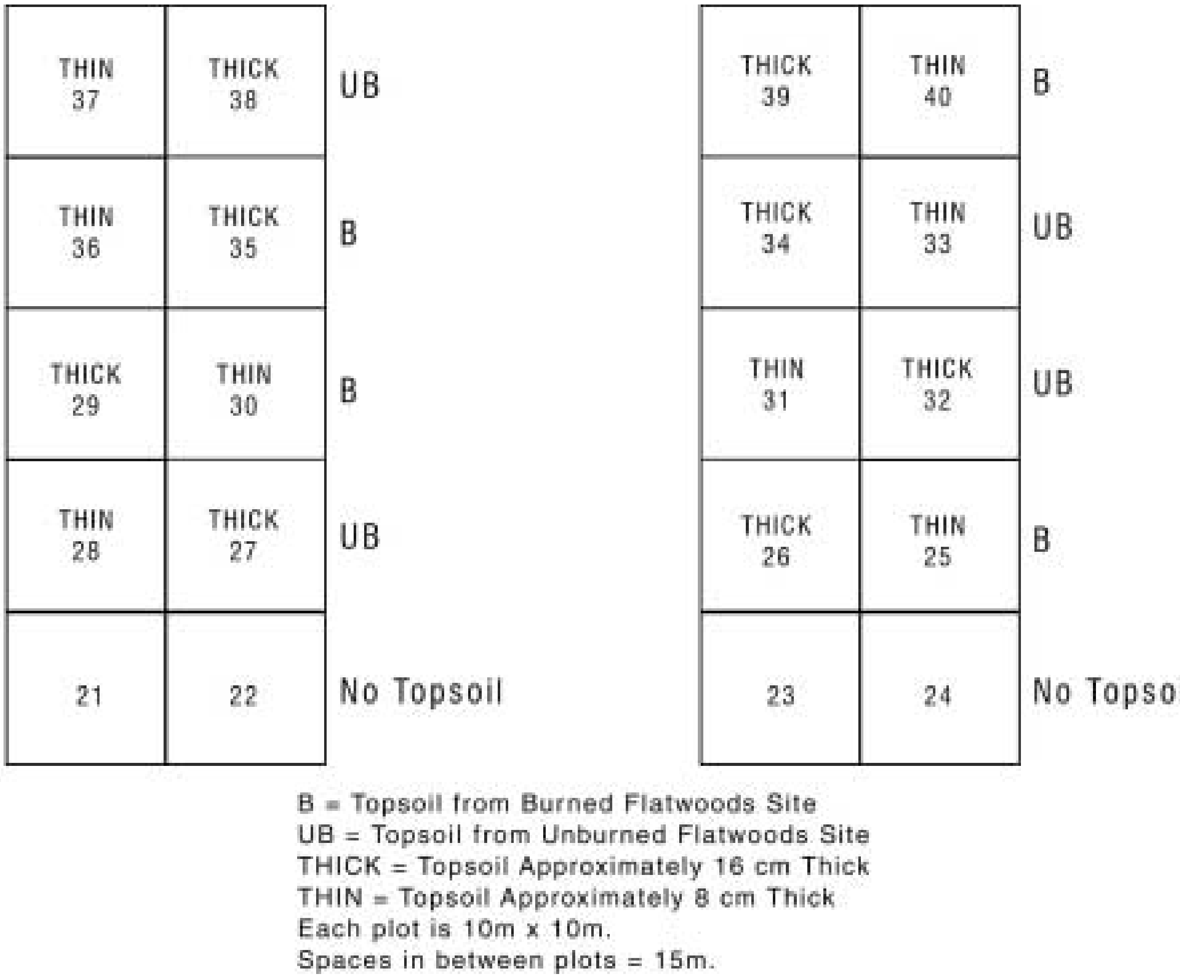

Figure 6. Topsoil Augmentation Plot Layout at Sand Tailings Site.

A plant inventory and estimated relative abundance of each species were obtained at both the burned and unburned flatwoods. Wiregrass seeds were collected from the burned flatwoods donor site on two occasions. In November 1996 seeds were collected when the seeds were still attached to the plants. For random samples, one spikelet was randomly taken from each culm, and for full samples, one spikelet was collected from each culm that had a developed a full caryopsis. Wiregrass seeds were collected a second time in January 1997 just one week before the topsoil was transferred to the reclaimed sites, by collecting spikelets from the ground. Random and full selections were made, but after the random samples were taken we could only find 26 spikelets in our collection with full seeds. The seeds were then sent to the U.S.D.A. Natural Resource Conservation Service (NRCS) Plant Materials Center for germination tests, which were conducted at 20° to 30° C for 32 days, using potassium nitrate as a wetting agent.

Topsoil was transferred from the donor burned site and donor unburned site by using a bulldozer to scrape up roughly one to two feet of soil and plant parts, and then loading the topsoil with a front-end loader onto dump trucks. The dump trucks then transferred the topsoil to the recipient overburden and sand trailing sites. Two dump-truck loads of topsoil were added to the plots labeled as "thick" topsoil, which when spread out equated to approximately 16 cm thick. One dump-truck load was added to the plots labeled as "thin" topsoil, which equated to approximately 8 cm when smoothed out. Four plots at each site received no topsoil, and were designated as controls. On the day of topsoil transfer, topsoil samples were collected from burned and unburned study plots at both the overburden and sand tailings sites. Topsoil samples were analyzed for pH, total C, total N, and available nutrients (P, K, Ca, Mg, Zn, Mn, Cu, Fe, and Na) using the methods described earlier in this report. Duplicate samples of overburden and sand tailings were taken from control plots (no topsoil) and also analyzed for the same soil parameters. The topsoil was allowed to "settle" for two months. Intact soil cores were then collected in triplicate from each plot, and separated into surface (topsoil) and subsurface (overburden or sand tailings) samples. For each plot three surface soil samples were composited as well as the three subsurface soil samples. A fourth intact soil core was collected at each plot and analyzed for bulk density measurements. The depth of surface and subsurface soils was noted. The central point around which the four cores were sampled was marked so future vegetation monitoring could coincide with the location of soil sampling.

Vegetation monitoring was conducted in October 1997 and September 1998 to document vegetation composition at the end of the first and second growing seasons, respectively, following topsoil augmentation. Vegetation characterization followed the methodology outlined in this report. Two-way classification linear models (Littell et al. 1991; Sokal and Rolhf 1969b) were used to analyze soil parameter differences. Initial analysis indicated very strong sand tailings versus overburden differences; hence these data were statistically analyzed separately. Since many analyses produced significant soil type by burn interactions, data were recoded to allow a one-way classification model to be used with subsequent use of the Waller-Duncan K-ratio t-test to separate out interaction means.

Results and Discussion

Vegetation. Topsoil transfer from a mesic pine flatwoods resulted in a rich assortment of desirable native pioneer and native characteristic species at both the overburden and sand tailings recipient sites (Figure 7). Species richness at the topsoil recipient sites reflected the high species richness at the donor mesic flatwoods site (Table 19). In general, species richness was highest at the topsoil from burned sites, intermediate on topsoil from unburned sites, and lowest at the control plots where no topsoil was added (Figure 7). Total number of desirable plant species increased from 1997 to 1998 for all treatments (burned and unburned; thin topsoil and thick topsoil; overburden and sand tailings), except for the thin and thick layer of topsoil from the burned donor site at the sand tailings plots, where a decline was noted. A list of vegetation from each treatment during the 1997 and 1998 monitoring events are provided in Appendix K and L, respectively. The species are listed in descending percent cover.

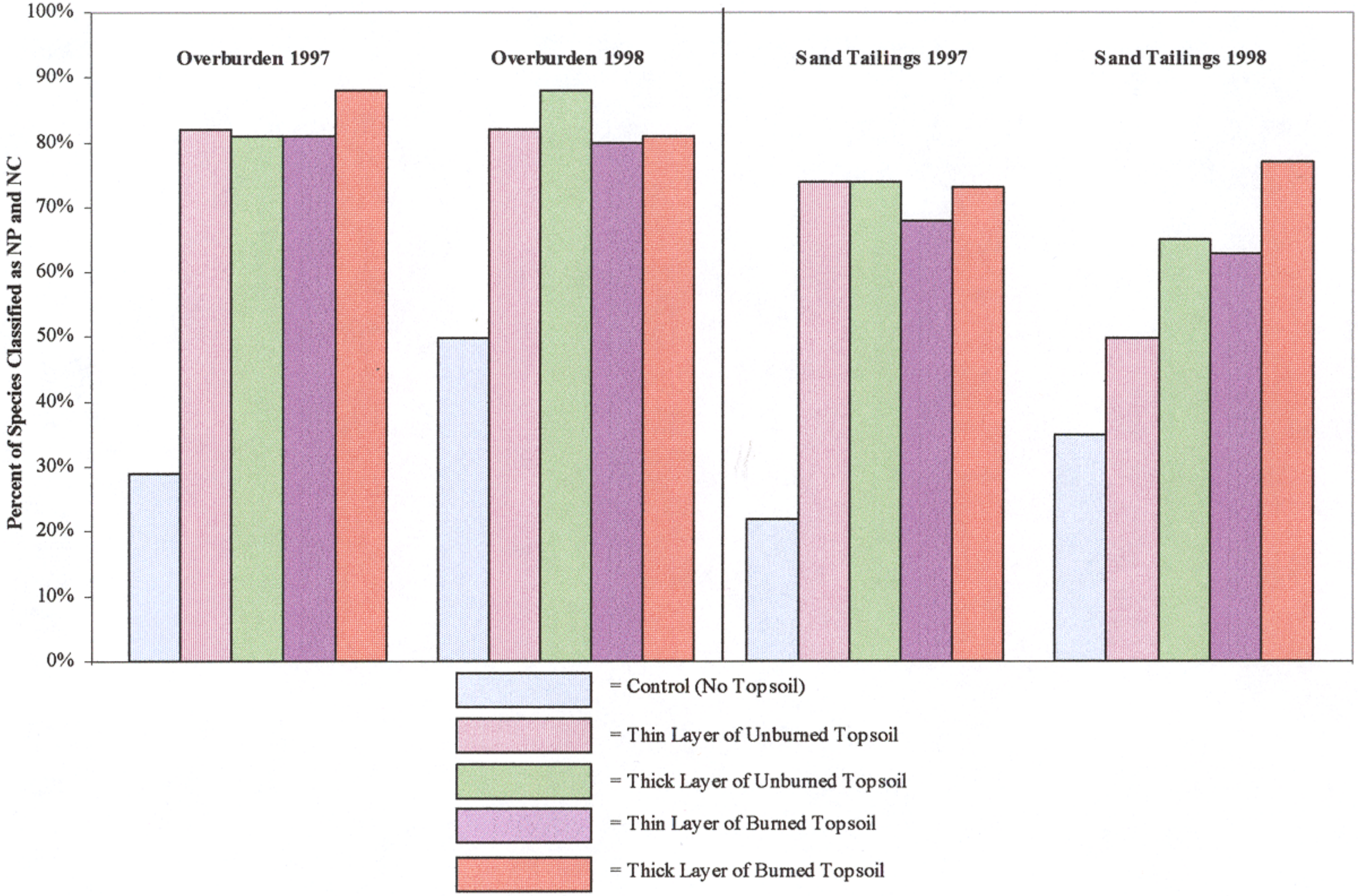

Figure 7. Percent of Desirable Species Classified as Native Pioneer (NP) and Native Characteristic at the Topsoil Augmentation Plots.

Table 19. Plant Species and Estimated Abundance at the Burned and Unburned Topsoil Donor Sites Prior to Topsoil Transfer. Page 1 of 2.

Botanical Name	Common Name	Estimated Abundance in Burned Flatwoods†	Estimated Abundance in Unburned Flatwoods†
Andropogon brachystachyus	Shortspike Bluestem	O	F
Andropogon glomeratus	Bluestem	O	O
Andropogon gyrans var. gyrans, common variant	Elliott's Bluestem	R	O
Andropogon ternarius	Splitbeard Bluestem	O	O
Angdropogon virginicus	Broomsedge	O	O
Andropogon virginicus var. glaucus	Broomsedge	O	F
Aristida beyrichiana	Wiregrass	A	A
Aristida purpurascens	Arrowfeather	R	O
Aristida spiciformis	Bottlebrush Threeawn	-	O
Asimina reticulata	Flatwoods Pawpaw	O	O
Bulbostylis stenophylla	Sandyfield Hairsedge	F	-
Callicarpa americana	Beautyberry	-	R
Carphephorus corymbosus	Large-Headed Carphephorus	O	O
Chamaecrista fasciculata	Partridge-Pea	R	-
Cladina subtenuis	Reindeer Lichen	-	O
Cladonia leporina	Cup Lichen	-	O
Cyperus retrorsus	Pinebarren Flatsedge	F	F
Dichanthelium aciculare	Needle-leaf Witchgrass	F	F
Eleocharis sp. (Small fine viviparous)	Spikerush	-	O
Elephantopus elatus	Florida Elephant's Foot	R	-
Eragrostis refracta	Coastal Lovegrass	-	R
Eupatorium capillifolium	Dogfennel	-	O
Euthamia minor	Flat-top Goldenrod	O	F
Gaylussacia dumosa	Dwarf Huckleberry	F	F
Gratiola hispida	Scrub Hedge-Hyssop	O	F
Hypericum tetrapetalum	Heart-Leaved St. Peter's-Wort	-	O
Helianthemum corymbosum	Clustered Rock-Rose	F	O

Table 19. Plant Species and Estimated Abundance at the Burned and Unburned Topsoil Donor Sites Prior to Topsoil Transfer. Page 2 of 2.

Juncus scirpoides	Needle-Pod Rush	-	R
Lachnocaulon beyrichianum	Little Bog-Button	F	A
Lechea torreyi	Piedmont Pinweed	O	O
Licania michauxii	Gopher Apple	F	O
Lyonia fruticosa	Staggerbush	A	F
Momordica balsamina	Southern Balsampear	O	-
Myrica cerifera	Wax Myrtle	R	-
Myrica pusilla	Dwarf Wax Myrtle	O	O
Paspalum setaceum	Thin Paspalum	R	R
Phytolacca americana	Pokeweed	O	-
Piloblephis rigida	Pennyroyal	-	O
Pinus palustris	Longleaf Pine	O	-
Pityopsis tracyi	Silk-Grass	O	-
Polygala grandiflora	Large-Flowered Polygala	R	-
Pterocaulon pycnostachyum	Black Root	O	R
Quercus minima	Dwarf Live Oak	F	O
Quercus virginiana	Live Oak	-	O
Rhus copallina	Winged Sumac	O	O
Rhynchelytrum repens	Natalgrass	R	-
Rhynchospora breviseta	Shortbristle Beaksedge	O	F
Rhynchospora fernaldii	Fernald's Beaksedge	-	O
Schizachyrium scoparium	Creeping Bluestem	O	O
Serenoa repens	Saw Palmetto	A	A
Solidago fistulosa	Pinebarren Goldenrod	-	O
Sorghastrum secundum	Lopsided Indiangrass	R	O
Stipulicida setacea	Wire Weed	O	-
Syngonanthus flavidulus	Shoe Buttons	-	O
Vaccinium myrsinites	Shiny Blueberry	F	F
Vitis rotundifolia	Muscadine	O	-
Xyris difformis	Pink-Leafed Yellow-Eyed-Grass	-	R
Yucca filamentosa	Adam's Needle	R	-

† A= Abundant
F = Frequent
O = Occasional
R = Rare

The transfer of topsoil not only produced a high number of species but also a high percent of desirable species. Over 80% of the species documented at the overburden site that received topsoil were desirable native pioneer or native characteristic species (Figure 8). These results were irrespective of thickness of topsoil (thick or thin), burn treatment (burned or unburned), and monitoring year (1997 or 1998). In contrast only 28% of the plant species in 1997, and 50% in 1998, at the control plots (no topsoil added) were considered desirable species.

A similar pattern in desirable species was also documented at the sand tailings site. All treatments of topsoil at the sand tailings site contained over 63% desirable species, except for the treatment of thin layer of topsoil from the unburned site (Figure 8). In contrast, control plots at the sand tailings sites (no topsoil added) produced only 22% desirable species in 1997 and 35% in 1998. Overall, the sand tailings site produced an almost equivalent number of species as the overburden site, but a lower percentage of desirable species.

Average percent cover was compared by site and year for each treatment for selected plant species or plant groups (Table 20). Statistical comparison of average percent cover among treatments was calculated for desirable species or plant groups such as pioneer and characteristic species, wiregrass, saw palmetto, *Dichanthelium aciculare*, and *Dichanthelium portoricense*. Average percent cover was also calculated for undesirable species or plant groups such as exotic aggressive and weedy species, natalgrass, and torpedograss. Lowest percent cover of pioneer and characteristic species was consistently documented at the control plots for both study years (1997 and 1998) and both the overburden and sand tailings sites (Table 20). Pioneer and characteristics species exhibited an increase in cover from 1997 to 1998 at the overburden site and a decrease in cover from 1997 to 1998 at the sand tailings site. Highest percent cover of this desirable plant group was documented in 1998 at the overburden site. Burning, soil type, year/soil type interaction, and burning/soil type interaction were all highly significant factors affecting percent cover of this desirable plant group.

Wiregrass transferred in with the topsoil from the burned site was documented at a low average percent cover at both the overburden and sand tailings sites in 1997 (Table 20). Wiregrass persisted, albeit at low percent cover, in the topsoil plots from the burned site in 1997 and 1998 at both sites. Wiregrass was also recorded in some of the unburned topsoil plots. Thick topsoil tended to produce slightly higher coverage of wiregrass than thin topsoil in 1997 at both the overburden and sand tailings sites (Table 20). Wiregrass plant parts, and seeds were transferred in the topsoil from the burned sites, whereas only plant parts were transferred in the topsoil from the unburned site. One important goal of this field experiment was to compare establishment of wiregrass with two different burn treatments, two different topsoil thicknesses, and two different soil types. These percent cover data may underestimate the future wiregrass populations in the study plots as wiregrass seedlings are very small and slow growing, so that even a high density of wiregrass seedlings would also tend to produce a low percent cover. These data are inconclusive in determining the effects of various topsoil treatments on the establishment of wiregrass. Note the frequency of wiregrass in topsoil from burned and unburned donor sites in Appendix J. This data gives a better indication of seedling frequencies. Additional long-term quantitative vegetation monitoring at these two sites is needed to assess the effects of burning, topsoil thickness, and soil type on the establishment of wiregrass.

Saw palmetto (*Serenoa repens*) was recorded in the overburden plots with topsoil from the unburned site in 1997, and at both the overburden and sand tailings plots with topsoil from the unburned sites in 1998 (Table 20). Although the 1997 data from the sand tailings' plots were too small to compare, saw palmetto was present in the unburned sand tailings plots in 1997. Saw palmetto was also recorded in the burned thick topsoil plots at the overburden site in 1997 but not in 1998. In contrast to wiregrass, this species was more common at the unburned plots than the burned plots. This is because a very heavy crop of palmetto seeds were produced in the unburned flatwoods during the summer of 1996, and consequently, palmettos were transferred in unburned topsoil in the form of seeds and plant parts to the recipient sites. Saw palmetto seeds were not produced after the summer burn in the burned flatwoods areas, so palmettos were transferred in the topsoil from the burned sites only via plant parts. Saw palmetto will typically begin producing seeds about two years after a burn, so naturally the burned plots would not have contained saw palmetto seeds. Saw palmetto successfully transferred in the topsoil from the unburned plots as evidenced by a high density of saw palmetto seedlings. Again, note the frequency of saw palmetto in Appendices I and J. The percent cover of palmetto was low in the plots because it takes several years before even a palm-shaped frond is produced. Like wiregrass, long-term quantitative vegetation monitoring is needed to assess the effects of burning, topsoil thickness, and soil type on the establishment of saw palmetto at these two study sites.

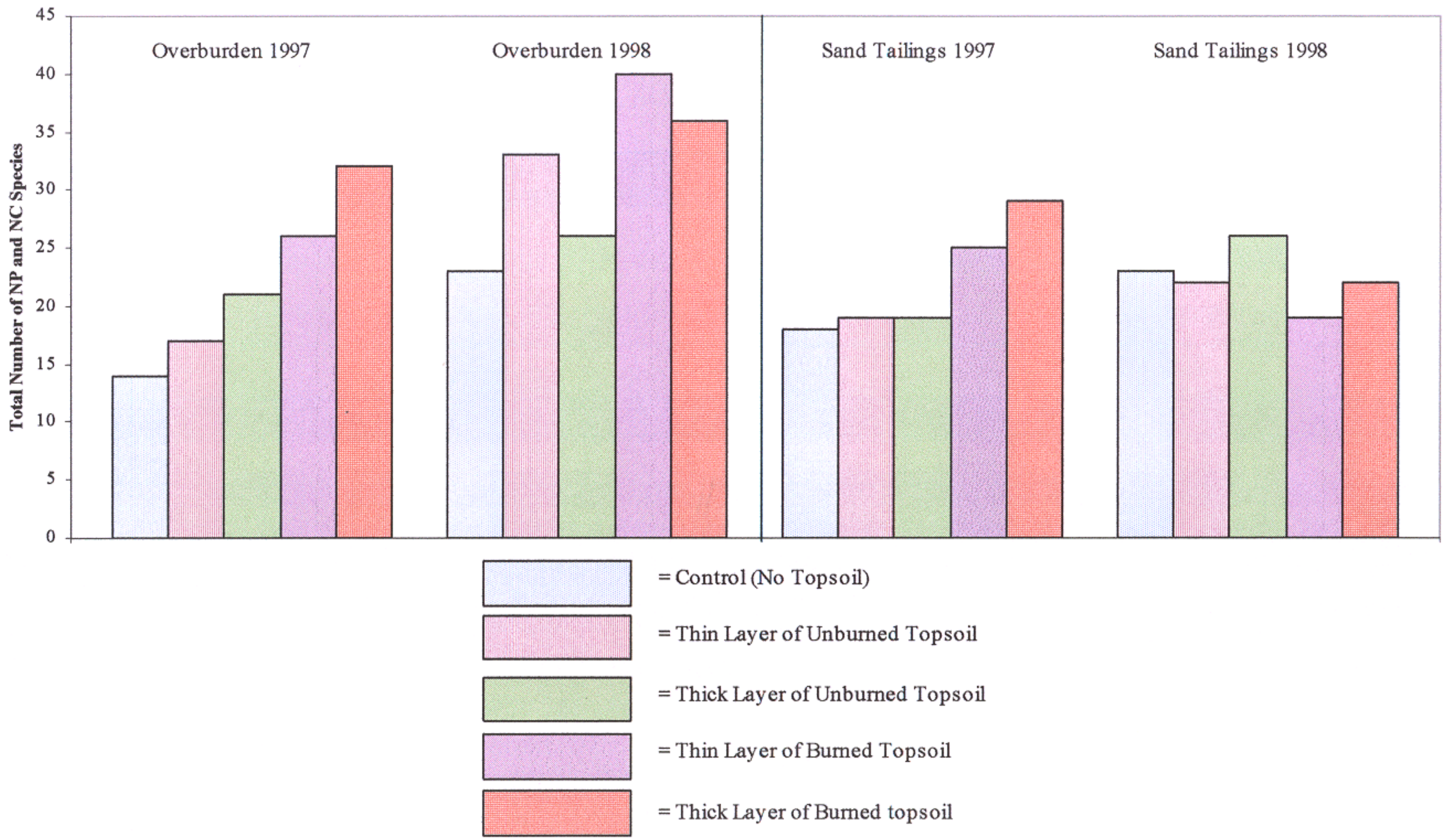

Figure 8. Total Number of Species Classified as Native Pioneer (NP) and Native Characteristic (NC) at the Topsoil Augmentation Plots.

Table 20. Average Percent Cover of Select Plant and Plant Groups for Each Treatment at the Topsoil Augmentation Study. Treatments Include Topsoil from Burned and Unburned Sites, Thin and Thick Topsoil, and Overburden and Sand Tailings Soils.

Year	Soil	Treatment	Pioneer & Characteristic Species	*Aristida beyrichiana* (Wiregrass)	*Serenoa repens* (Saw Palmetto)	*Dichanthelium aciculare*	*Dichanthelium portoricense*	Exotic, Aggressive, & Weedy Species	*Rhynchelythrum repens* (Natalgrass)	*Panicum repens* (Torpedo grass)
1997	Overburden	Unburned/Thin	67.81^{A}	0^{C}	3.81^{A}	4.38^{B}	32.50^{A}	36.94^{AB}	1.94^{B}	0
		Unburned/Thick	90.31^{A}	0^{C}	3.75^{A}	3.13^{B}	42.50^{A}	32.06^{AB}	2.56^{B}	0
		Control	2.75^{B}	0^{C}	0.00^{B}	0.00^{C}	0.00^{C}	18.13^{B}	5.00^{B}	0
		Burned/Thin	62.06^{A}	0.69^{B}	0.00^{B}	6.88^{AB}	3.25^{BC}	36.56^{AB}	2.56^{B}	0
		Burned/Thick	62.88^{A}	3.19^{A}	0.63^{B}	12.5^{A}	6.25^{B}	59.00^{A}	17.50^{A}	0
1997	Sand Tailings	Unburned/Thin	57.31^{AB}	0^{A}	1.56^{A}	3.75^{C}	4.44^{B}	30.75^{AB}	1.88^{A}	13.13^{A}
		Unburned/Thick	71.63^{A}	0^{A}	2.62^{A}	5.00^{BC}	16.88^{A}	8.19^{B}	0^{A}	2.5^{A}
		Control	3.81^{C}	0^{A}	0^{A}	0.00^{D}	0.00^{C}	66.06^{A}	3.85^{A}	32.5^{A}
		Burned/Thin	48.81^{B}	0.75^{A}	0.69^{A}	8.75^{AB}	2.00^{B}	16.13^{B}	5.63^{A}	1.88^{A}
		Burned/Thick	55.63^{B}	1.31^{A}	0.75^{A}	16.25^{A}	2.63^{B}	27.88^{AB}	1.94^{A}	10.0^{A}
1998	Overburden	Unburned/Thin	91.20^{B}	0.63^{AB}	5.20^{A}	1.40^{BC}	35.00^{B}	1.55^{B}	1.33^{C}	0
		Unburned/Thick	139.30^{A}	0^{B}	0.90^{B}	3.13^{B}	55.00^{A}	3.20^{B}	1.95^{BC}	0
		Control	7.45^{C}	0^{B}	0.00^{B}	0.00^{C}	0.00^{D}	44.65^{A}	16.25^{A}	0
		Burned/Thin	103.40^{B}	3.13^{A}	0.00^{B}	16.88^{A}	4.38^{C}	39.03^{A}	6.88^{ABC}	0
		Burned/Thick	105.05^{B}	3.13^{A}	0.00^{B}	18.75^{A}	4.45^{C}	13.50^{B}	10.63^{AB}	0
1998	Sand Tailings	Unburned/Thin	14.68^{B}	0^{A}	1.40^{A}	0^{A}	0^{A}	57.25^{A}	9.38^{A}	16.88^{A}
		Unburned/Thick	38.45^{AB}	1.25^{A}	0.75^{AB}	0.63^{A}	0.63^{A}	77.18^{A}	5.0^{A}	15.00^{A}
		Control	16.15^{B}	0^{A}	0.00^{B}	0^{A}	0^{A}	66.38^{A}	8.83^{A}	25.00^{A}
		Burned/Thin	38.90^{AB}	1.25^{A}	0.00^{B}	0.63^{A}	0^{A}	40.85^{A}	21.25^{A}	1.25^{A}
		Burned/Thick	59.60^{A}	1.25^{A}	0.00^{B}	1.25^{A}	0.63^{A}	46.95^{A}	27.5^{A}	12.50^{A}
Significant Effects			Burn** Soil** Year/Soil** Burn/Soil**	Burn**	Year * Burn **	Year** Burn** Soil** Year/Soil** Burn/Soil*	Year** Burn** Soil** Year/Soil** Burn/Soil**	Soil** Year/Soil** Burn/Soil*	Year ** Burn ** Year/Soil *	Soil**

* p = *0.05 - 0.01*
**p<*0.01*

We noticed during vegetation monitoring that *Dichanthelium aciculare* was noticeably more common in the topsoil from the burned site while *D. portoricense* was more common in the topsoil from the unburned site. Therefore, we decided to explore these two desirable witchgrass species in greater detail. *Dichanthelium aciculare* was recorded in both the burned and unburned plots at both sites in 1997, however at a higher percent cover in the plots with topsoil from the burned site than in the plots with topsoil from the unburned site (Table 20). This species increased in percent cover from 1997 to 1998 in the overburden plots with topsoil from the burned sites, but decreased in percent cover from 1997 to 1998 in the overburden plots with topsoil from the unburned sites. The reverse pattern was documented for *D. portoricense* at both the overburden and sand tailings sites, where higher cover was documented in the plots with topsoil from the unburned sites compared to the plots with topsoil from the burned site (Table 20). This species maintained similar cover values from 1997 to 1998 at the overburden site. Both species decreased in cover at the sand tailings site.

Exotic, aggressive, and weedy species were problematic at both the overburden and sand tailings sites in 1997 (Table 20). This undesirable plant group was most problematic in control plots (that received no topsoil) at the sand tailings site in 1997, with an average percent cover of 66.06%. These species declined in most of the treatment plots at the overburden site between 1997 and 1998, and increased substantially from 18% to 45% in control plots over the same period of time. These species increased at all of the treatment plots at the sand tailings site. It is interesting to note that where pioneer and characteristic species were heavy and increasing, the aggressive and weedy species were diminishing. Conversely, where the space was not occupied successfully by characteristic species, the aggressive species had increased. In future monitoring, it would be interesting to separate the weedy from the aggressive species in the analyses.

Natalgrass and torpedograss were two aggressive grasses that were observed at the sand tailings topsoil augmentation plots. We analyzed percent cover of the two species for each of the treatments, however, the mean separation of the data was not statistically significant for either 1997 or 1998.

Perhaps the most obvious qualitative difference observed between soil types was the persistence and dominance of undesirable species at the sand tailings site compared to the overburden site (Tables 21 and 22). Regardless of whether or not topsoil was from a burned or unburned site, thick, or even applied, the sand tailings site was dominated by weedy and/or exotic taxa including torpedograss, natalgrass, and southern crabgrass (*Digitaria ciliaris*). While some desirable native species were recorded in moderate percent coverages on the sand tailings site in 1997, by 1998 they were markedly reduced in nearly all plots regardless of treatment. The initial weed cover around the sand tailings site was quite high and presumably contributed to the heavy cover of natalgrass and torpedograss. The extended drought of 1998 was an extreme and highly unusual weather event. In a normal spring drought, the *Dichantheliums* and other native species that were lost on the sand tailings site would probably have survived, as many of these species do occur on fairly dry sites.

Although native species were recorded at low coverage, it is important to note that cover in more xeric systems is usually less dense than in moist communities, and a higher percent cover does not necessarily indicate greater success. Data from this limited data set suggest that while the seed source for desirable species was present at the sand tailings site (at least in the topsoil plots), unfavorable conditions such as a lack of sufficient water during the extended drought, and a large seed source for aggressive grasses in adjacent areas, contributed to the failure of desirable taxa to persist, and instead favored some of the aggressive grasses noted above.

Results from the overburden site indicated a much higher percent cover of desirable species. Though some of the more dominant species are definitely pioneer species such as *Dichanthelium spp.* (Tables 23 and 24), the whole cover consists of a good mix of a large number of flatwood species. See Appendices J and K for a more accurate picture. It will be interesting to see whether monitoring in future years will show a shift toward increased cover by characteristic species and at what rate this change occurs. Several of the species actually attained dominance in some of the treatment plots (Tables 23 and 24). The ability of overburden soil to retain moisture longer than sand tailings probably played an important role in providing favorable conditions for emerging donor seedlings, particularly where topsoil was applied. Additionally, the moisture conditions provided by the overburden probably more closely matched the moisture conditions at the donor mesic flatwoods site as compared to the moisture conditions at the sand tailings site. Thus, the more favorable moisture conditions at the overburden site probably contributed not only to more successful germination, but to more successful establishment of mesic flatwoods species. Additionally, the overburden site lacked the high initial weed cover of adjacent areas as was the case at the sand tailings site, so presumably less weed seed was introduced to the overburden site.

Results of seed germination tests from samples analyzed at the NRCS Plant Materials Center showed a wide range in wiregrass seed germination (Table 25). The highest germination of wiregrass occurred from full spikelets collected from the plants (70%), while a low germination rate of 4% was measured from random samples collected from the ground. these laboratory-generated germination rates represent potential seed germination under ideal conditions, and can overestimate true germination in field conditions. Most wiregrass germination tests are performed on spikelets, whether or not they contain a developed caryopsis. These tests indicate that if there are developed seeds then the germination rate may be fairly high. Though the developed seeds are difficult to see in the field, we can easily field test a potential wiregrass harvest by bending spikelets. A developed seed will break or snap, and an empty spikelet will just fold over. We do not fully understand what happens to wiregrass seeds after they have fallen from the culms and are exposed to heat and moisture over time. The small sample of full seed collected from the ground in mid-January one week before topsoiling tested at 23%, while random seed tested at only 4% (Table 25).

Soils. Soils were characterized to determine differences in soil properties among topsoil from a burned flatwood, topsoil from an unburned flatwoods, and plots with no topsoil. Soil comparisons were also made between plots that received a thick layer of topsoil

(2 truck loads) and plots that received a thin layer of topsoil (1 truck load). These comparisons were made for both surface and subsurface soils, and at both the overburden and sand tailings site. Control plots received no topsoil and consisted of either overburden (at the overburden site) or sand tailings (at the sand tailings site).

The addition of topsoil improved soil properties in the surface layer at the overburden site by decreasing bulk density and C:N ratio, and increasing total C, total N, Ca, Mg, K, Zn, Mn, and Na (Table 26). There were no changes in Fe concentrations or CEC values between the topsoil and the control plots. Improvements to soil properties were generally irrespective of whether topsoil originated from a burned or unburned flatwoods, or if topsoil was applied as a thick layer or thin layer. Only one difference was detected in soil properties between thick and thin topsoil in the surface soil layer at the overburden site; Ca concentrations in the surface were higher in the thin topsoil plots. Topsoil from the unburned flatwoods exhibited a higher total N content than topsoil from burned flatwoods (Table 26) likely as a result of N volatilization during the burning process. The C:N ratio in the surface layer was decreased by addition of topsoil, going from over 50 in the control sites to between 24 and 32 in the amended sites. Mineralization and immobilization processes are balanced at a C:N ratio of 23. However, any differences noted for N concentrations and C:N ratios must be interpreted with caution since low N values encountered in most of these soils would result in significant error in the calculation of C:N ratios.

Table 21. Average Percent Cover of the Most Abundant Vegetation in Topsoil from Burned Sites on Sand Tailings.

Scientific Name	Average Percent Cover						Vegetation Category			
	No Topsoil		Thin Topsoil		Thick Topsoil					
	1997	1998	1997	1998	1997	1998	Desirable or Weedy	Origin and Type		Ecosystem Category
Bare Ground	40.0	35.6	40.0	35.0	17.6	19.4	—	—		—
Ambrosia artemisiifolia		11.3		10.0			W	Native	Weedy	—
Bulbostylis stenophylla				3.8		5.1	D	Native	Characteristic	—
Conyza canadensis	5.0	3.4		7.5			W	Native	Weedy	—
Cyperus retrorsus	2.5	2.6	8.8	3.8	5.0	6.9	D	Native	Pioneer	—
Cynodon dactylon	5.0	15.0					W	Exotic	Aggressive	Aggressive Grass
Dactyloctenium aegyptium	5.0				2.5		D	Native	Pioneer	---
Dichanthelium aciculare			8.8	2.5	16.3	5.0	D	Native	Pioneer	—
Digitaria ciliaris	3.8	3.8	5.9	3.3	26.3	3.8	W	Exotic	Weedy	—
Diodia teres	2.5	2.5	16.9	18.1	18.8	40.8	W	Native	Weedy	—
Eragrostis refracta			5.0	11.3	2.7	9.2	W	Native	Pioneer	Lovegrass
Heterotheca subaxillaris	10.6	2.6		5.7	0.3	5.1	W	Native	Weedy	—
Indigofera hirsuta	9.5	8.2	3.9	5.7		5.0	W	Exotic	Weedy	Legume
Panicum repens	65.0	50.0	3.8	2.5	40.0	50.0	W	Exotic	Aggressive	Aggressive Grass/ Wetland Sp.
Paspalum setaceum			3.1	12.5	2.6	3.3	D	Native	Pioneer	—
Rhynchelytrum repens	7.5	11.8	7.5	21.3	3.9	55.0	W	Exotic	Aggressive	Aggressive Grass

Table 22. Average Percent Cover of the Most Abundant Vegetation in Topsoil from Unburned Sites on Sand Tailings.

Scientific Name	Average Percent Cover						Vegetation Category			
	No Topsoil		Thin Topsoil		Thick Topsoil					
	1997	1998	1997	1998	1997	1998	Desirable or Weedy	Origin and Type		Ecosystem Category
Bare Ground	40.0	35.6	23.1	35.0	20.0	17.5	—	—		—
Ambrosia artemisiifolia		11.3		2.5			W	Native	Weedy	—
Aristida purpurescens			11.3	2.5	10.6	6.3	D	Native	Characteristic	—
Axonopus affinis			2.5		8.8	12.5	D	Native	Pioneer	—
Conyza canadensis	5.0	3.4		1.0		2.5	W	Native	Weedy	—
Crotalaria pallida				10.0			W	Exotic	Weedy	Legume
Cynodon dactylon	5.0	15.0					W	Exotic	Aggressive	Aggressive Grass
Cyperus retrorsus	2.5	2.6	21.3	3.4	16.3	6.9	D	Native	Pioneer	—
Dactyloctenium aegyptium	5.0						D	Exotic	Weedy	—
Dichanthelium aciculare			5.0		5.0	2.5	D	Native	Pioneer	—
Dichanthelium portoricense			4.4		16.9	2.5	D	Native	Pioneer	—
Digitaria ciliaris	3.8	3.8	4.2	11.7	5.0	28.2	W	Exotic	Weedy	—
Diodia teres	2.5	2.5	6.3	6.4	5.0	5.0	W	Native	Weedy	—
Eragrostis sp.				10.0		2.5	—	—		Lovegrass
Eupatorium capillifolium	0.3	0.3			2.5	6.4	W	Native	Weedy	—
Euthamia tenuifolia			4.3	3.8	7.6	7.5	D	Native	Pioneer	—
Heterotheca subaxillaris	10.6	2.6	1.8	15.6	2.5	9.4	W	Native	Weedy	—
Indigofera hirsuta	9.5	8.2	15.0	3.4	3.9	20.8	W	Exotic	Weedy	Legume
Panicum repens	65.0	50.0	17.5	16.9	10.0	30.0	W	Exotic	Aggressive	Aggressive Grass/ Wetland Sp.
Paspalum setaceum			4.4	5.0	4.4	7.5	D	Native	Pioneer	—
Rhynchelytrum repens	7.5	11.8	2.5	12.5		6.7	W	Exotic	Aggressive	Aggressive Grass
Vitis rotundifolia			5.0				D	Native	Pioneer	—

Table 23. Average Percent Cover of the Most Abundant Vegetation in Topsoil from Burned Sites on Overburden.

Scientific Name	Average Percent Cover						Vegetation Category			
	No Topsoil		Thin Topsoil		Thick Topsoil					
	1997	1998	1997	1998	1997	1998	Desirable or Weedy	Origin and Type		Ecosystem Category
Bare Ground	83.8	50.0	30.6	21.9	16.3	30.1	—	—		—
Chamaecrista nictitans			10.1	14.3	2.5		D	Native	Pioneer	Legume
Cyperus globulosus	0.3		12.5		12.5		D	Native	Pioneer	—
Cyperus retrorsus	3.4	2.2	15.0	8.8	8.1	12.5	D	Native	Pioneer	—
Dichanthelium aciculare			6.9	16.9	12.5	18.8	D	Native	Pioneer	—
Dichanthelium portoricense			3.3	4.4	6.3	4.4	D	Native	Pioneer	—
Digitaria ciliaris	5.0		33.1	1.4	40.0		W	Exotic	Weedy	—
Diodia teres		0.3	15.0	12.5	5.0	2.8	W	Native	Weedy	—
Elephantopus elatus			1.4	2.6	2.5	5.1	D	Native	Characteristic	—
Euthamia tenuifolia			20.0	15.2	6.7	23.8	D	Native	Pioneer	—
Indigofera hirsuta	1.8	20.6	0.9	26.9	1.1	0.3	W	Exotic	Weedy	Legume
Panicum anceps					5.0	10.3	D	Native	Characteristic	—
Paspalum setaceum			3.8	12.5	4.4	20.1	D	Native	Pioneer	—
Pityopsis graminifolia			2.5	0.3	5.0	5.0	D	Native	Characteristic	—
Pterocaulon pycnostachyum				5.0	0.3	2.5	D	Native	Pioneer	—
Rhynchelytrum repens	5.0	16.3	3.4	6.9	17.5	10.6	W	Exotic	Aggressive	Aggressive Grass
Sabatia brevifolia				5.0			D	Native	Characteristic	—
Hedyotis corymbosa	5.0						W	Exotic	Weedy	—

Table 24. Average Percent Cover of the Most Abundant Vegetation in Topsoil from Unburned Site on Overburden.

Scientific Name	Average Percent Cover						Vegetation Category			
	No Topsoil		Thin Topsoil		Thick Topsoil		Desirable or Weedy	Origin and Type		Ecosystem Category
	1997	1998	1997	1998	1997	1998				
Bare Ground	83.8	50.0	15.0	28.8	10.1	9.6	—	—		—
Cyperus globulosus	0.3		0.3	0.3	5.0		D	Native	Pioneer	—
Cyperus retrorsus	3.4	2.2	8.8	6.9	15.6	4.4	D	Native	Pioneer	—
Dichanthelium portoricense			32.5	35.0	42.5	55.0	D	Native	Pioneer	—
Digitaria ciliaris	5.0		35.0		28.8	2.5	W	Exotic	Weedy	—
Euthamia tenuifolia			5.8	12.5	4.2	37.6	D	Native	Pioneer	—
Hedyotis corymbosa	5.0						W	Exotic	Weedy	—
Hedyotis sp.		0.3		5.0			—	—		—
Indigofera hirsuta	1.8	20.6		0.3			W	Exotic	Weedy	Legume
Myrica cerifera						10.0	D	Native	Pioneer	—
Paspalum setaceum			5.0	8.8	5.0	6.3	D	Native	Pioneer	—
Rhus copallina			5.0	3.8	3.8	4.5	D	Native	Characteristic	—
Rhynchelytrum repens	5.0	16.3	1.9	1.8	3.4	2.6	W	Exotic	Aggressive	Aggressive Grass
Scleria ciliata				1.1		5.0	D	Native	Characteristic	—
Serenoa repens			3.8	5.2	5.0	1.2	D	Native	Characteristic	—
Solidago fistulosa		0.3	2.8	3.9	9.2	12.5	D	Native	Pioneer	—

Table 25. Germination of Wiregrass Seed from Three Studies: the Topsoil Augmentation Study, Site Preparation Study, and an Unrelated CFI Upland Reclamation Study.

Field Experiment	Date Seed Collected	Seed Source	Full or Random Spikelets	Number of Spikelets Tested	% Germination
FIPR Topsoil Augmentation	11/20/96	Hardee County	Random	400	30
FIPR Topsoil Augmentation	11/20/96	Hardee County	Full	300	70
FIPR Topsoil Augmentation	1/14/97 (1 week before topsoiling)	Hardee County	Random from ground	400	4
FIPR Topsoil Augmentation	1/14/97 (1 week before topsoiling)	Hardee County	Full from ground	26	23
FIPR Site Preparation	11/25/96	Okeechobee County	Random	400	42
FIPR Site Preparation	11/25/96	Okeechobee County	Full	400	77
CFI Upland Reclamation	11/20/96	Hillsborough County	Full	400	81
CFI Upland Reclamation	11/20/96	Hillsborough County	Random from middle of stem	400	53

Table 26. Comparison of Soil Properties† at the Overburden Site.

Soil Properties	Soil Layer	Control (No Topsoil)	Topsoil from Burned Flatwoods		Topsoil from Unburned Flatwoods	
			Thin	Thick	Thin	Thick
BD, g cm^{-3}	Surface‡	1.53^{A†}	1.26^{B}	1.32^{B}	1.30^{B}	1.30^{B}
pH		4.82^{AB}	5.03^{A}	4.99^{AB}	4.84^{AB}	4.69^{AB}
C, %		0.83^{B}	2.28^{A}	1.97^{AB}	2.23^{A}	2.61^{A}
N, %		0.017^{C}	0.067^{B}	0.077^{B}	0.087^{AB}	0.108^{A}
C:N		51.4^{A}	32.1^{B}	27.9^{B}	25.5^{B}	24.1^{B}
Ca, mg kg^{-1}		81.5^{C}	382^{A}	203^{BC}	246^{AB}	224^{BC}
Mg, mg kg^{-1}		13.3^{B}	69.5^{A}	39.8^{AB}	41.5^{AB}	37.5^{AB}
K, mg kg^{-1}		15.8^{B}	27.0^{AB}	34.5^{A}	34.3^{A}	37.0^{A}
P, mg kg^{-1}		155^{A}	77.5^{B}	39.3^{B}	87.3^{B}	48.3^{B}
Zn, mg kg^{-1}		0.38^{B}	0.77^{A}	0.87^{A}	0.87^{A}	0.97^{A}
Cu, mg kg^{-1}		0.20^{B}	0.28^{AB}	0.30^{AB}	0.26^{AB}	0.34^{A}
Mn, mg kg^{-1}		0.280^{B}	1.43^{A}	1.59^{A}	1.17^{A}	1.19^{A}
Fe, mg kg^{-1}		33.2^{A}	38.2^{A}	33.5^{A}	55.6^{A}	55.6^{A}
Na, mg kg^{-1}		24.4^{B}	36.3^{AB}	36.1^{AB}	46.4^{A}	50.2^{A}
CEC, cmol kg^{-1}		10.4^{A}	7.52^{A}	6.15^{A}	6.97^{A}	8.17^{A}
BD, g cm^{-3}	Sub-surface¶	1.53^{A}	1.47^{A}	1.40^{A}	1.49^{A}	1.31^{A}
pH		4.82^{B}	5.01^{AB}	4.99^{AB}	5.06^{A}	4.97^{AB}
C, %		0.83^{A}	0.98^{A}	1.06^{A}	0.93^{A}	0.97^{A}
N, %		0.017^{A}	0.031^{A}	0.030^{A}	0.029^{A}	0.036^{A}
C:N		51.4^{A}	34.4^{AB}	41.9^{AB}	34.4^{AB}	27.9^{B}
Ca, mg kg^{-1}		81.5^{A}	335^{A}	192^{A}	224^{A}	168^{A}
Mg, mg kg^{-1}		13.3^{A}	17.3^{A}	18.0^{A}	14.8^{A}	15.0^{A}
K, mg kg^{-1}		15.8^{A}	15.5^{A}	19.8^{A}	16.3^{A}	17.0^{A}
P, mg kg^{-1}		155^{A}	286^{A}	222^{A}	260^{A}	254^{A}
Zn, mg kg^{-1}		0.38^{A}	0.59^{A}	0.59^{A}	0.57^{A}	0.54^{A}
Cu, mg kg^{-1}		0.20^{A}	0.26^{A}	0.22^{A}	0.30^{A}	0.20^{A}
Mn, mg kg^{-1}		0.28^{A}	0.50^{A}	0.32^{A}	0.34^{A}	0.32^{A}
Fe, mg kg^{-1}		33.2^{A}	34.9^{A}	34.8^{A}	33.7^{A}	34.5^{A}
Na, mg kg^{-1}		24.4^{A}	28.2^{A}	30.8^{A}	29.2^{A}	30.8^{A}

† Mean values for a given soil property followed by the same letter are not different within a row of data according to a Waller-Duncan K-ratio t-test of means with K set to 100 (approximate 0.05 type I error rate).

‡ Surface depth varies with topsoil thickness. Thin layer of topsoil has a depth of approximately 8 cm and a thick layer of topsoil has a depth of approximately 16 cm.

¶ Subsurface is overburden material.

In the subsurface layer at the overburden site, there were also few significant differences among control plots, topsoil from the burned site, and topsoil from unburned site presumably because all samples were collected from the underlying overburden material (Table 26). All soils were collected two months after topsoil application, and differences in soil properties of the overburden material is not expected during this short period. The only differences were a lower pH at the control plot and a lower C:N ratio at thick unburned topsoil plots. A lower C:N ratio beneath a thick layer of topsoil suggests there is a possibility that the topsoil is enriching the overburden material from leaching of organics from the topsoil above.

Addition of topsoil at the sand tailings site changed soil properties in the surface layer by decreasing pH, C:N ratio, Ca, P, and Zn concentrations, and increasing total C and total N (Table 27). Nitrogen concentrations in topsoil from a burned flatwoods (thin application) was lower than from an unburned flatwoods at the sand tailings site, again due to the loss of N during burning. Few differences in soil properties were noted between thick topsoil and thin topsoil applications at the sand tailings site. The pH, Ca, and P concentrations were significantly higher in thick topsoil than thin topsoil from a burned flatwoods. Likewise, P concentration was higher at the thick topsoil plots from unburned flatwoods (Table 27).

In the subsurface layer at the sand tailings site, there were also few differences among control plots, topsoil from burned sites, and topsoil from unburned sites, and these differences were generally not significant (Table 27). One difference worth noting was a significantly lower pH in subsurface soils from control plots, which is opposite from surface soils in that the pH was significantly higher (Table 27). The above soil tests were performed by separating thick and thin topsoil from the burned site, from thick and thin topsoil from the unburned site for both the overburden and sand tailings sites. Differences in soil parameters were then reexamined by combining topsoil from the burned and unburned sites and testing for differences in topsoil thickness, and by combining thick and thin topsoil and testing for differences in top soil from burned vs. unburned sites (Table 28). These tests were performed for both overburden and sand tailings sites and for surface and subsurface soils.

Comparison of soil properties for surface soil at the overburden site indicated differences in pH, total N, Fe and Na between topsoil from burned and unburned flatwoods (Table 28). The topsoil from the burned site had higher pH (5.01 *vs.* 4.76), but lower Fe (35.8 *vs.* 55.6 mg kg^{-1}) and Na (36.2 *vs.* 48.3 mg kg^{-1}) concentrations. No differences in soil properties were noted for topsoil thickness on overburden material (Table 28). Differences were not expected since the thick topsoil came from the same donor site as the thin topsoil. Neither were there any interactions (IA) among topsoil from burned and unburned sites, and soil thicknesses.

Table 27. Comparison of Soil Properties† at the Sand Tailings Site.

Soil Properties	Soil Layer	Control (No Topsoil)	Topsoil from Burned Flatwood		Topsoil from Unburned Flatwoods	
			Thin	Thick	Thin	Thick
BD, g cm^{-3}	Surface ‡	1.57^{A}	1.51^{A}	1.49^{A}	1.53^{A}	1.41^{A}
pH		7.25^{A}	5.48^{B}	4.87^{D}	5.29^{BC}	5.19^{C}
C, %		0.28^{B}	1.37^{A}	1.51^{A}	1.56^{A}	2.25^{A}
N, %		0.007^{C}	0.047^{B}	0.054^{AB}	0.06^{AB}	0.075^{A}
C:N		45.8^{AB}	28.4^{B}	27.7^{B}	26.2^{B}	29.9^{B}
Ca, mg kg^{-1}		968^{A}	521^{B}	284^{D}	488^{BC}	336^{CD}
Mg, mg kg^{-1}		155^{B}	87.8^{AB}	43.0^{AB}	57.3^{AB}	38.8^{B}
K, mg kg^{-1}		16.3^{A}	36.8^{A}	29.5^{A}	27.5^{A}	26.5^{A}
P, mg kg^{-1}		294^{A}	115^{B}	58.3^{C}	126^{B}	72.5^{C}
Zn, mg kg^{-1}		1.65^{A}	0.91^{B}	0.73^{B}	0.81^{B}	0.69^{B}
Cu, mg kg^{-1}		0.44^{A}	0.32^{AB}	0.30^{AB}	0.24^{B}	0.18^{B}
Mn, mg kg^{-1}		1.55^{A}	1.47^{A}	1.13^{A}	1.07^{A}	0.99^{A}
Fe, mg kg^{-1}		69.8^{A}	46.7^{A}	38.8^{A}	46.2^{A}	46.4^{A}
Na, mg kg^{-1}		22.2^{A}	39.7^{A}	35.1^{A}	32.5^{A}	38.5^{A}
CEC, cmol kg^{1}		11.8^{A}	13.7^{A}	18.9^{A}	17.1^{A}	20.3^{A}
BD, g cm^{-3}	Sub-surface ¶	1.57^{A}	1.61^{A}	1.51^{A}	1.50^{A}	1.58^{A}
pH		7.25^{B}	7.52^{A}	7.59^{A}	7.49^{A}	7.44^{AB}
C, %		0.28^{A}	0.35^{A}	0.17^{A}	0.31^{A}	0.18^{A}
N, %		0.007^{A}	0.005^{A}	0.002^{A}	0.013^{A}	0.005^{A}
C:N		45.8^{C}	111^{A}	87.5^{AB}	35.0^{C}	52.0^{BC}
Ca, mg kg^{-1}		968^{A}	1078^{A}	828^{A}	887^{A}	868^{A}
Mg, mg kg^{-1}		155^{A}	259^{A}	97.3^{A}	145^{A}	109^{A}
K, mg kg^{-1}		16.3^{A}	21.0^{A}	10.0^{A}	18.0^{A}	12.5^{A}
P, mg kg^{-1}		294^{A}	267^{A}	274^{A}	268^{A}	286^{A}
Zn, mg kg^{-1}		1.65^{A}	1.05^{A}	0.87^{A}	1.15^{A}	1.15^{A}
Cu, mg kg^{-1}		0.44^{A}	0.32^{AB}	0.16^{B}	0.22^{B}	0.28^{AB}
Mn, mg kg^{-1}		1.55^{A}	2.40^{A}	1.13^{A}	1.53^{A}	1.21^{A}
Fe, mg kg^{-1}		69.8^{A}	51^{A}	27.6^{A}	42.3^{A}	45.7^{A}
Na, mg kg^{-1}		22.2^{B}	29.0^{A}	23.0^{B}	24.8^{AB}	25.6^{AB}

† Mean values for a given soil property followed by the same letter are not different according to a Waller-Duncan K-ratio t-test of means with K set to 100 (approximate 0.05 type I error rate).

‡ Surface depth varies with topsoil thickness. Thin layer of topsoil has a depth of approximately 8 cm and a thick layer of topsoil has a depth of approximately 16 cm.

¶ Subsurface is sand tailings.

Table 28. Comparison of Surface Soil Properties for Two Treatments; Topsoil from Burned vs. Topsoil from Unburned Flatwoods, and Thin Topsoil vs. Thick Topsoil. (Significant Differences Occurred When *P < 0.05*).

Subsurface soil = Overburden															
Effect	BD	pH	C	N	C:N	Ca	Mg	K	P	Zn	Cu	Mn	Fe	Na	CEC
	g cm^{-3}		%	%		mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	cmol kg^{-1}
Burn/Unb	NS	0.0128	NS	0.0068	NS	NS	NS	NS	NS	NS	NS	NS	0.0025	0.0487	NS
Thickness	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
IA	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Mean	1.29	4.89	2.27	0.0833	27.4	264	47.1	33.2	63.1	0.87	0.295	1.35	45.7	42.2	7.2
Burned		5.01											35.8	36.2	
Unburned		4.76											55.6	48.3	

Subsurface soil = Sand tailings															
Effect	BD	pH	C	N	C:N	Ca	Mg	K	P	Zn	Cu	Mn	Fe	Na	CEC
	g cm^{-3}		%	%		mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	mg kg^{-1}	cmol kg^{-1}
Burn/Unb	NS	0.015	NS	NS	NS	NS	NS	NS	NS	NS	0.0362	NS	NS	NS	NS
Thickness	NS	0.0025	NS	NS	NS	0.0037	NS	NS	0.0049	NS	NS	NS	NS	NS	NS
IA	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
Mean	1.483	5.21	1.675	0.059	28.0	407	56.7	30.1	92.9	0.78	0.26	1.14	44.5	36.4	17.5
Burned		5.34									0.31				
Unburned		5.08									0.21				
Thickness 1		5.38				504			120.5						
Thickness 2		5.04				310			65.4						

NS indicates not significant, value in table indicates significance probability value.
Means associated with significant model effect presented below table.
IA = Interactions among topsoil from burned and unburned flatwoods, and thickness of topsoil application.
BD=Bulk Density

Comparison of soil properties for surface soil on sand tailings showed differences in pH and Cu concentrations between topsoil from burned and unburned site treatments (Table 28). Topsoil from the burned site had a higher pH (5.33 *vs.* 5.08), and Cu concentration (0.31 mg kg^{-1} *vs.* 0.21 mg kg^{-1}) than the topsoil from the unburned site. Additionally, pH of the topsoil was greater (pH=5.38) for thin topsoil compared to thick topsoil (pH=5.04). Calcium and P concentrations were also higher in thin topsoil than thick topsoil (Table 28), probably due to contamination with sand tailings in the thin topsoil plots. Differences in soil properties between topsoil thicknesses were not expected, and any differences can probably be explained in terms of heterogeneity in soil properties at the donor site. There were no interactions among topsoil from burned and unburned sites and soil thicknesses.

The greatest number of differences in soil properties in the topsoil augmentation study were detected between overburden and sand tailings sites. Soil differences for BD, pH, C, N, C:N, Ca, Mg, Zn, Mn, and Na were highly significant (comparison of controls) between the overburden and sand tailings (Table 29). Potassium, P, Cu, Fe, and CEC were not significantly different between the two soils. The pH for sand tailings was much higher (pH=7.25) than overburden material (pH= 4.82), and these differences can be attributed to high Ca and Mg concentrations in the sand tailings (Ca = 968 mg kg^{-1}, Mg = 155 mg kg^{-1}) compared to that in the overburden (Ca = 82 mg kg^{-1}, Mg = 13 mg kg^{-1}). Zinc and Mn concentrations were also higher in sand tailings compared to overburden.

The addition of topsoil to overburden and to sand tailings changed the soil characteristics of the control soil. However, the basic characteristics of the control are altered in different ways, due to the great differences in soil characteristics between overburden and sand tailings (Table 28). The type of vegetation that would successfully grow in topsoil-amended plots will depend on soil conditions required for a given plant species, and will depend on the underlying soil material and the source of topsoil. Burning an area prior to removing topsoil could result in loss of N, and high N-requiring species may not grow well in low N soils. The impact of the thickness of topsoil application was not apparent at this stage of the study.

The data presented above were obtained from soil sampling two months after the addition of topsoil to the overburden and the sand tailings. Although some differences in subsurface soil characteristics were noted during this short period, it is probable that the soil properties will continue to change. The changes in soil characteristics will also be reflected in changes in the vegetation characteristics over a period of time. It will therefore be necessary to monitor both the soil and vegetation characteristics over an extended period of time.

Table 29. Differences in Soil Properties Between Control Plots at the Overburden Site and Control Plots at the Sand Tailings Site.

Soil Parameter	Overburden Control	Sand Tailings Control	Significant Difference†
Bulk Density (g cm^{-3})	1.53	1.57	*
pH	4.82	7.25	*
Total C (%)	0.832	0.284	*
Total N (%)	0.017	0.007	*
C:N	51.4	45.8	*
Ca (mg kg^{-1})	82	968	*
Mg (mg kg^{-1})	13	155	*
K (mg kg^{-1})	15.8	16.3	NS
P (mg kg^{-1})	155	294	NS
Zn (mg kg^{-1})	0.38	1.65	*
Cu (mg kg^{-1})	0.20	0.44	NS
Mn (mg kg^{-1})	0.280	1.553	*
Fe (mg kg^{-1})	33.2	69.8	NS
Na (mg kg^{-1})	24.4	22.2	*
CEC (cmol kg^{-1})	10.4	11.8	NS

† NS=No significant difference

SITE PREPARATION FIELD EXPERIMENT

Methodology

This field experiment was designed to study two site preparation methods, burning and disking, for removing weedy vegetation and preparing the location for direct seeding. A third method, herbiciding, was originally planned, however timing of the prescribed burn combined with dormant vegetation precluded us from applying herbicide. The project site is the Gopher Hills site that was also used in this upland reclamation study (Figure 1), which is described in greater detail earlier in this report. The substrate is primarily sand tailings on overburden material, with topsoil added to the surface. Much of the site was planted with shrubs and wiregrass *(Aristida beyrichiana)* in fall 1995; however, the intermediate elevations along both hills were not planted and contained many weedy species. Reclamation plans included direct seeding these intermediate elevations, but first the weedy vegetation had to be removed. Therefore, two site preparation techniques were implemented prior to direct seeding: (1) burn and disk four times; and (2) disk four times. This study investigated the efficacy of these two site preparation methods for removal of nuisance and exotic species.

Portions of the intermediate elevations were burned in October 1996 by lighting a back fire. The fire was inconsistent and sporadic due to variable wind conditions and high humidity. Quadrats, each 30-m long, were constructed through the most consistently and completely burned areas perpendicular to the slope of both hills. Quadrats were also constructed in adjacent unburned areas, which closely resembled the elevation, grade, and vegetation community of the burned quadrat areas. More land area was burned along the edge of the north hill than the south hill. Therefore, six burned and six unburned quadrats were constructed on the east side of the north hill, whereas four burned and four unburned quadrats were constructed on the east side of the south hill (Figure 9). The intermediate elevation areas, including all 20 quadrats, were then disked four times in October through December 1996.

A dry prairie in Okeechobee County was burned in June 1996 to stimulate seed production of fire dependent species such as wiregrass. Seed was harvested from this donor site in November and December 1996 and applied to both the burned/disked and unburned/disked areas in January 1997. At the time of seed harvesting, wiregrass seeds were collected from the dry prairie to test potential germination rates. Both random and full samples were collected from wiregrass plants. The seeds were sent to the NRCS Plant Materials Center for germination tests. Each quadrat was divided into three segments: 0-10 m; 11-20 m; and 21-30 m. Soil samples were collected from random soil blocks within each segment of the burned/disked and unburned/disked quadrats in May 1997, and analyzed for pH, total C, total N, and available nutrients (P, K, Ca, Mg, Zn, Mn, Cu, Fe, and Na) using the analytical methods outlined in this report. A total of 120 soil samples were analyzed.

Vegetation was characterized in October 1997 following the methodology described earlier in this report to document species composition after the first growing season following direct seeding. A second quantitative vegetation-monitoring event was scheduled in October 1998 after the second growing season, however, an extremely dry spring in 1997 and summer in 1998 apparently precluded growth of desirable species. Therefore, only a qualitative assessment of the site was conducted in October 1998.

Results and Discussion

Results in October 1997 after the first growing season showed that both the disked and burned/disked areas supported primarily weedy, exotic, and aggressive species such as natalgrass, hairy indigo (*Indigofera hirsuta*), bahiagrass, smutgrass (*Sporobolus indicus*), and camphorweed (*Heterotheca subaxillaris*) (Table 30). The only desirable species with an average percent cover greater than 4.0% in the treatment areas were common carpetgrass (*Axonopus affinis*) and partridge-pea (*Chamaecrista fasciculata*). Bare ground occupied a substantial portion of both the disked and burned/disked treatment areas. A list of plant species from each treatment during the 1997-monitoring event is provided in Appendix M. The species are listed in order of descending percent cover.

A total of 45 species were recorded in the burned/disked monitoring plots after the first growing season of direct seeding in 1997. Of these 45 species, 38 were sparsely documented, and had an average percent cover less than 5% (Appendix M). Almost half of the species recorded were either native pioneer (16 species) or native characteristic (4 species) (Figure 10). The disked-only treatment produced a lower species richness than the burned/disked treatment, with a total of 34 species recorded. Similar to the burned/disked plots, the majority of the species were sparsely represented with 29 of the 34 species exhibiting an average percent cover of less than 5%. Almost half of the species were native pioneer (13 species) or native characteristic (1). Only four of the species in the combined data sets are thought to have come from direct seeding.

A qualitative vegetation survey in October 1998 indicated that weedy, exotic, and aggressive species were still problematic after the second growing season. In the disked areas, hairy indigo, camphorweed, and thin paspalum (*Paspalum setaceum*) declined while bahiagrass, velvetleaf (*Abutilon theophrasti*), and India crabgrass (*Digitaria longiflora*) increased in percent cover. Similar results were observed in the burned/disked treatment areas. Smutgrass, bahiagrass, and velvetleaf increased in overall coverage while hairy indigo, natalgrass, camphorweed, and thin paspalum declined.

Although seeds of wiregrass and associated dry prairie species were direct seeded in January 1997, very few wiregrass seedlings were detected in the monitoring plots at the end of the first growing season. In 1997, the average percent cover of wiregrass was 1.1% in disked/burned quadrats, and not recorded in the disked only quadrats (Appendix M). Results from wiregrass germination tests (77% germination from full spikelet samples and 42% from random spikelet samples) suggest that the seeds collected from the dry prairie in Okeechobee County were viable and fertile (Table 25). However, these germination rates are indicative of ideal growing conditions rather than field conditions. Very few wiregrass seedlings were detected in 1998. The severe drought in spring 1997 prevented germination of most seeds and the severe drought in summer 1998 and competition from aggressive species could have caused additional mortality of desirable species. Additional monitoring of this site will be imperative to document longer-term success of both site preparation methods and direct seeding.

Several reasons could be attributed for the lack of clear results on this field experiment. The site had a heavy cover of weedy species, especially natalgrass, smutgrass, and hairy indigo, for several years prior to the beginning of the project. These species are capable of producing a large number of seed for the seed bank. Neither disking nor burning and disking were sufficient to reduce the weedy seeds in the seed bank. The harvester used to collect seed from the dry prairie could not sufficiently strip wiregrass seed, which has little bulk and so the density of wiregrass seeds actually distributed was very low. Very little rain fell in the months following seeding, which was sufficient for many weedy species that require only a single rain event, but not for many of the perennials which need two to six weeks of frequent soil moisture. Without the establishment and competition of these native perennials, the weedy species reestablished themselves and became dominant in the disked and disked/burned study plots.

Table 30. Percent Cover of Primary Plant Species at the Site Preparation Study Site in October 1997, at the End of the First Growing Season after Treatment. (Only Includes Plants with Percent Cover > 4.0).

Treatment	Species	Common Name	Average Percent Cover (%)	Desirable or Weedy	Origin and Type	Special Group
Disked	*Rhynchelytrum repens*	Natalgrass	58.2	Weedy	Exotic, Aggressive	Aggressive Grass
	---	Bare Ground	21.2	---	---	---
	Indigofera hirsuta	Hairy Indigofera	19.5	Weedy	Exotic, weedy	Legume
	Paspalum notatum	Bahiagrass	16.3	Weedy	Exotic, Aggressive	Aggressive Grass
	Heterotheca subaxillaris	Camphorweed	9.4	Weedy	Native, weedy	---
	Axonopus affinis	Common Carpetgrass	5.8	Desirable	Native, pioneer	—
Disked and Burned	---	Bare Ground	25.6	---	---	---
	Indigofera hirsuta	Hairy Indigo	21.5	Weedy	Exotic, weedy	Legume
	Sporobolus indicus	Smutgrass	18.2	Weedy	Exotic, weedy	---
	Rhynchelytrum repens	Natalgrass	16.6	Weedy	Exotic, aggressive	Aggressive Grass
	Heterotheca subaxillaris	Camphorweed	14.8	Weedy	Native, weedy	---
	Paspalum notatum	Bahiagrass	13.3	Weedy	Exotic, Aggressive	Aggressive Grass
	Axonopus affinis	Common Carpetgrass	9.3	Desirable	Native, pioneer	---
	Chamaecrista fasciculata	Partridge-Pea	5.1	Desirable	Native, pioneer	---
	Digitaria longiflora	India Crabgrass	4.6	Weedy	Exotic, weedy	---
	Richardia scabra	Florida Parsley	4.0	Weedy	Exotic, weedy	—

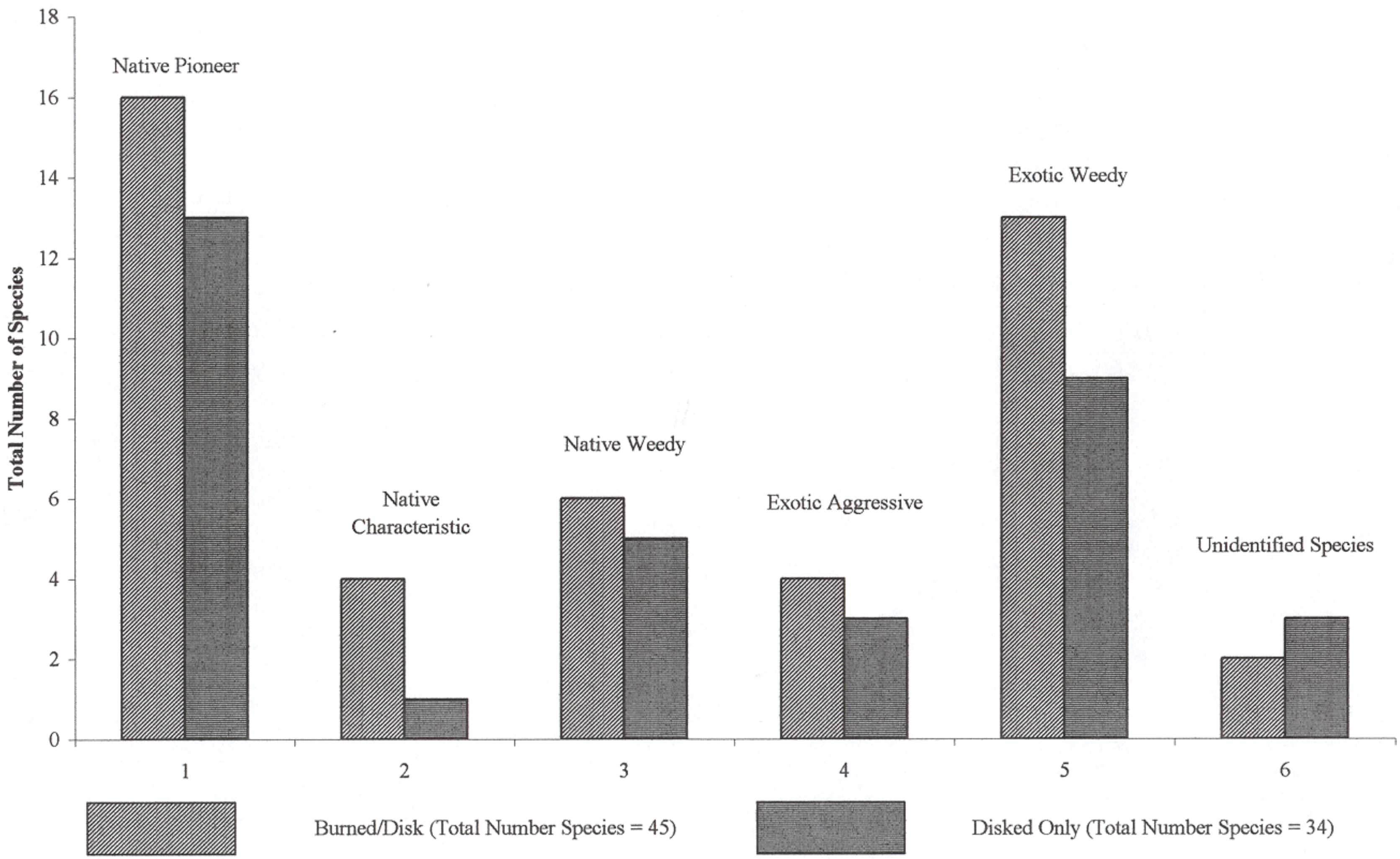

Figure 10. Comparison of Species Richness in 1997 Between Burned/Disked and Disked Only Treatments for the Site Preparation Study for Each Origin (Native, Exotic) and Typed (Pioneer, Characteristic, Weedy, Aggressive) Vegetation Category.

CONCLUSIONS AND RECOMMENDATIONS

There are numerous complicated and interwoven factors that result in a successful upland reclamation project. Similarly, there can be numerous factors that result in poor establishment of native taxa, and instead result in domination by undesirable aggressive grasses. In the Reclamation Site Study, seven soil types were analyzed including overburden, sand tailings, clays, topsoil, and combinations of these. Overburden exhibited a high degree of variability in chemical parameters, while sand tailings were characterized as nutrient poor and droughty. Therefore, depending on soil conditions and introduction of plant material, a large number of vegetation types were established in these reclaimed upland soils.

The site sampling protocols were chosen to produce a wide range of "typical" vegetation types in the hopes that this would also reflect a wide range of soil physical and chemical values. Strong correlations between soil parameters and vegetation cover would have been immediately identified in the resulting data. However, vegetation cover and composition were only moderately correlated with soil parameters suggesting that soil physical and chemical parameters are not the only critical factors for many of the vegetation types examined. After soil parameter effects were factored into the relationship, some of the residual variability could be explained by either soil type or site characteristics.

Matching moisture regimes between a reclaimed site and the targeted vegetative community moisture requirements was perhaps the factor we most frequently encountered while evaluating the success of a reclamation site with respect to native vegetation. In other words, if a xeric scrub or sandhill community is targeted to be reclaimed, then the soils should be droughty sand tailings with a low moisture holding capacity and low fertility. These recommendations also apply directly to topsoiling. Topsoiling has been demonstrated as a successful method for transferring a viable seed bank and plant parts (roots, rhizomes, and stems) to a reclaimed area if the donor site has a heavy native cover. However, recruitment appears to be more successful if the moisture regime at the reclaimed site closely matches the moisture regime from the donor site. In order to closely match moisture conditions, topsoil removed from a xeric scrub or sandhill donor site could be added to droughty sand tailings. Conversely, topsoil removed from a mesic flatwoods or hydric flatwoods could be added to a sandy or loamy overburden. Likewise, if the reclamation area consists of a mixture of sand tailings and overburden, the topsoil could come from a sandhill, scrubby flatwoods, or mesic flatwoods. These observations were exemplified at several of our study sites, namely Estech, Gopher Hills, Hardee Lakes, and the Topsoil Augmentation Study, where closely matching the moisture regime at the reclamation site with the moisture regime from the topsoil donor site produced a higher density and diversity of native species that were more successful at out-competing aggressive grasses.

A higher concentration of soil nutrients promoted higher coverage of weedy species, particularly aggressive grasses. Our data also showed that aggressive grasses tended to grow more successfully than desirable taxa at a higher pH. Of particular note is that natalgrass appeared to favor higher pH and P concentrations. More definitive research would be useful.

Native taxa, especially characteristic species, are adapted to 'stressful' soil conditions, and consequently grow slowly. In reclaimed communities, these slow-growing, native species can be easily out-competed in the initial stages by fast growing aggressive grasses, especially in conditions of high soil nutrients and high soil moisture. Therefore, soil amendments added to the soil to increase fertility may benefit undesirable aggressive grasses. Likewise, areas with increased moisture-holding capacity such as low-lying pockets, increased clay content, and overburden with high clay content near the surface may favor aggressive grasses in communities where xeric species are targeted. However, these same areas with higher moisture holding capacity can favor native taxa indicative of mesic flatwoods or hydric flatwoods.

Soil fertility and soil moisture are important factors in promoting aggressive grasses, however, our results suggest that there is roughly an equal chance that aggressive grasses will establish on a random basis irrespective of soil and site conditions. Therefore, it is important not to introduce weed species in the final soil layer, to control the surrounding weed population prior to planting, and to establish native groundcover vegetation as quickly as possible before a weed population becomes established.

Moisture conditions during the first growing season have a profound effect on the vegetative community that establishes, and in fact can select for certain species during the first growing season. The plants that establish early have an availability of nutrients, space, and moisture with which to spread. For this reason, it may be advantageous to irrigate during the first growing season after topsoiling or seeding, so that the slower growing characteristic native plants can germinate or resprout and compete successfully with weedy and aggressive species that may need only a single rain event to become established. Reclaiming an upland with overburden material over sand tailings will lower the moisture conditions of overburden material, and thus make the site more suitable for vegetation that require less moisture.

Some other possible factors and interactions causing variation in groundcover vegetation between and within sites are considered below. Introduction of native species and method of introduction were primary factors. Some sites had no native groundcover introduced during reclamation whereas others were seeded, topsoiled, or planted in densities ranging from sparse to heavy. The nearness of the restoration site to a similar native community would allow more incidental introduction of native species, but this is uncommon in large-scale mine restoration and usually only a few pioneer species contribute to the flora from adjacent donor sites. The presence and density of weedy and aggressive species at or near the site is especially important in influencing the vegetative cover. The time of year initial restoration occurs and weather conditions at the time of restoration can favor some species over others. The vegetation community in the first year or two after restoration is generally weedier. Then there is a jump to a more stable system, followed by succession to a more mature community when characteristic native species spread and reproduction slows. From a historical perspective, site age is also important because reclamation practices (goals and methods) have changed over the years. Also, on reclaimed land, soils show great variation even within small areas. One other caution is that the more xeric upland communities typically have a less dense groundcover, and so a lower percent cover between one area and another does not necessarily indicate less success.

Wiregrass is an example of an important cover grass in upland communities that serves the significant function of carrying fire which is essential in maintaining the community. Wiregrass showed tendencies to grow at lower soil pH, Ca, P, Na, and CEC and higher total C, total N, and K than aggressive grasses. However, we need to be especially cautious about interpreting these data since wiregrass cover depended highly on methods of introduction to the sites. Controlled research on soil parameters for wiregrass is needed.

The three lovegrasses, *Eragrostis elliottii*, *Eragrostis spectabilis*, and *Eragrosis refracta*, were compared to aggressive grasses because they have shown potential as pioneer species that reseed easily and may offer quick competition against the exotic aggressive grasses. Few significant differences in soil parameters between these two groups were shown which may indicate that these lovegrasses can accept many of the same soil conditions as the aggressive species. Controlled research to determine the soil parameters of this group may be especially useful if these species are developed as seed crops for restoration.

If these early-established plants are tolerant of a wide range of soil conditions, as is the case with aggressive species such as cogongrass or bahiagrass, then their spread can occur irrespective of soil conditions. Therefore targeting fast-growing, easy colonizing desirable species such as *Schizachyrium stoloniferum* or *Panicum anceps* can help to displace or discourage the encroachment of aggressive grasses. Even pioneer species such as the three *Eragrostis* spp., *Paspalum setaceum*, or *Dichanthelium portoricense* can be particularly useful in planning restoration since they can be more easily established and compete with the weedy or aggressive species.

Compaction was prevalent on many of the reclaimed soils and much of the soil compaction may be caused by the extensive travel of heavy equipment over the soil. One solution might be to incorporate a deep subsoiling operation at the end of the soil preparation process. A reclamation site with sand tailings, sand tailings over overburden, and topsoiled sites generally were less compacted than sites containing overburden only.

In the Reclamation Site Study, the physical location of the quadrats within each strata were not totally random, which led to the potential for bias in the collected data (vegetation cover indices). In all of the statistical analyses, in which site values were compared, there was the potential that comparison differences were greater than would be observed from data collected at random locations. However, while identifying the statistical limitations of the sampling design, it is important to recognize that the main objective of this study was the examination of the relationship of soil parameters with vegetation cover.

The results obtained from the Topsoil Augmentation Study at CF Industries and the Site Preparation Field Study at Gopher Hills were both more statistically definitive. Both of these experiments were manipulative in nature as compared to the Reclamation Site Study that was completely mensurative in nature. As a logical next step, the current study suggests that the effects of soil moisture and soil type on seed germination be examined under more controlled conditions. Determining the soil parameters best suited to native taxa under controlled experimentation is needed for advancing the base knowledge to improve upland site reclamation as a whole.

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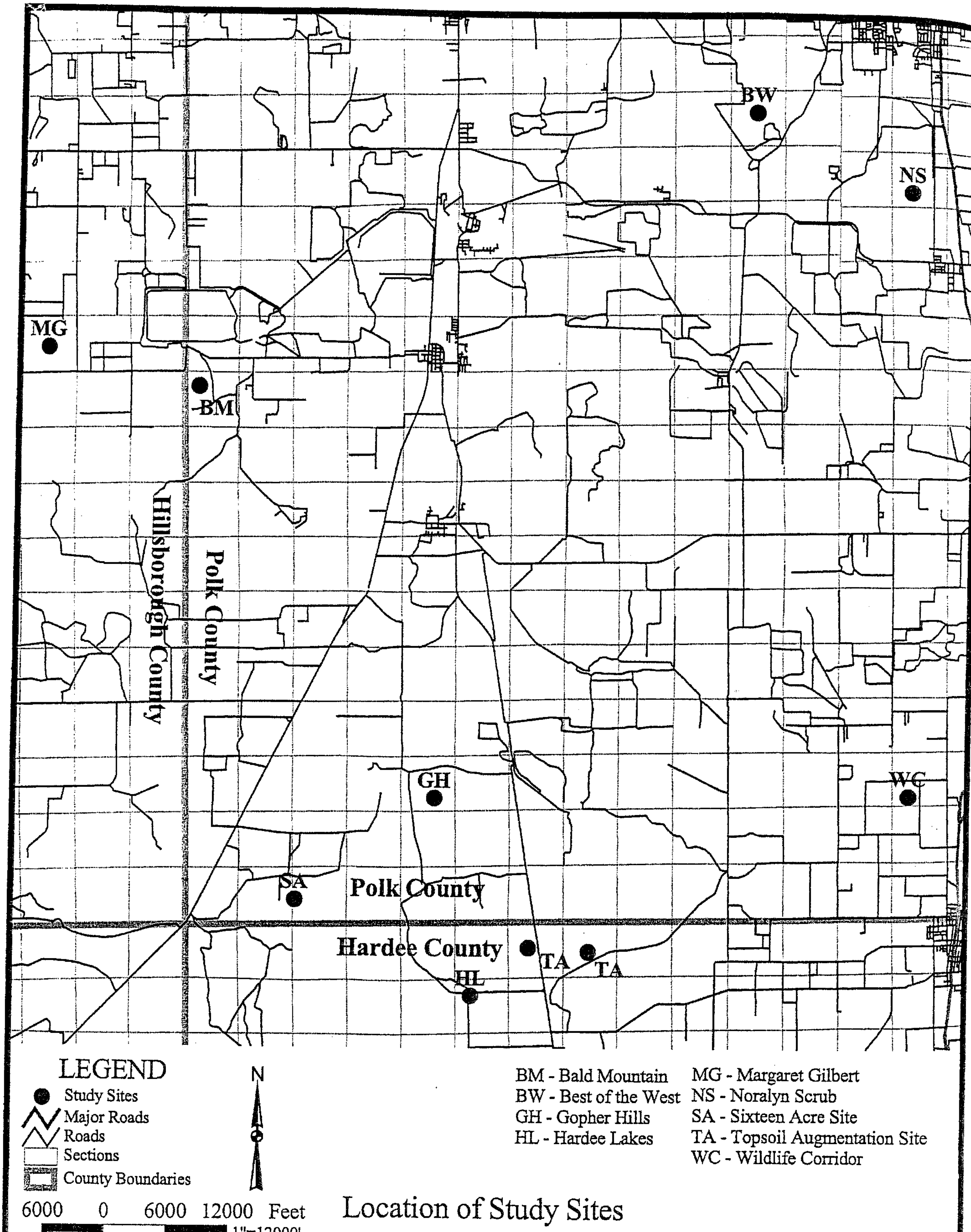
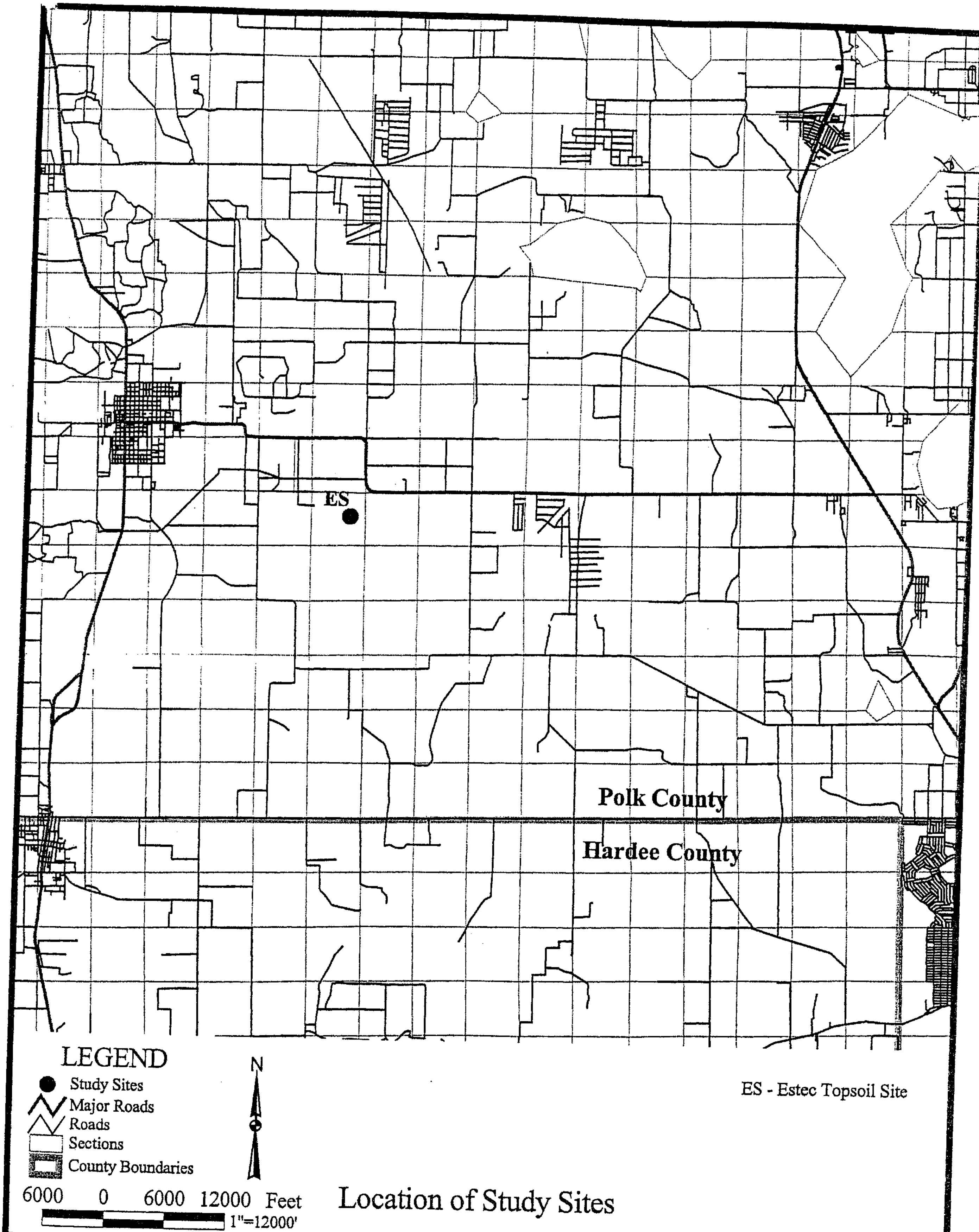
Appendix A

LOCATION OF UPLAND RECLAMATION STUDY SITES



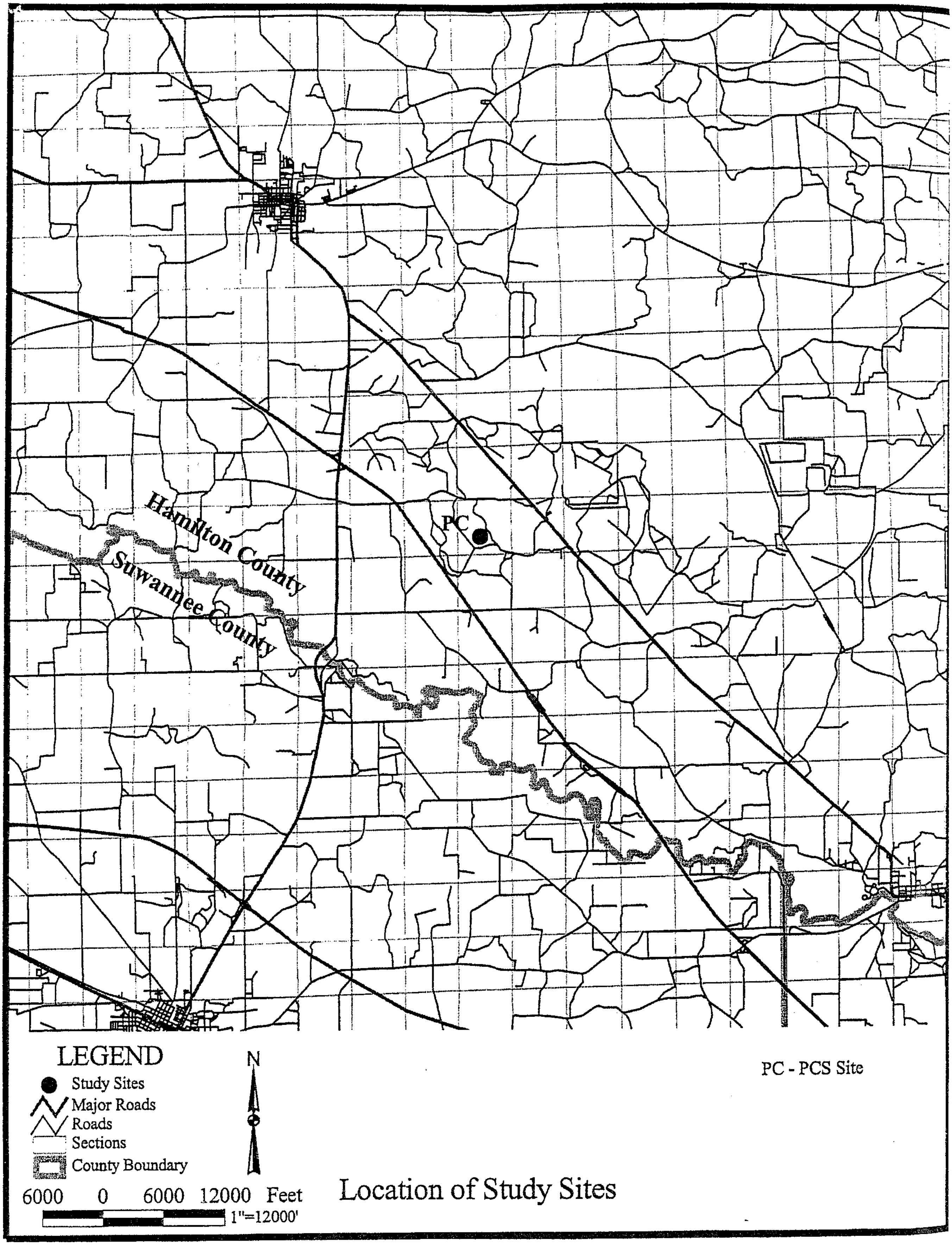
Location of Study Sites

For informational purposes only.



Location of Study Sites

For informational purposes only.



Location of Study Sites

For informational purposes only.

Appendix B

LIST OF ALL PLANT SPECIES RECORDED AT EACH STUDY SITE AND THEIR ASSOCIATED CLASSIFICATION

Species Code	Scientific Name with Authority	Common Name	Origin/Type Classification*	Ecosystem Category	Desirable/ Weedy†
ACA GRA	*Acalypha gracilens* A. Gray	Three-seeded mercury	NP	---	D
ACE RUB	*Acer rubrum* L.	Red maple	NC	---	D
AES AME	*Aeschynomene americana* L.	Shy-leaf	NW	Legume	W
AGA PUR	*Agalinis purpurea* (L.) Pennell	Gerardia	NC	Wetland Sp.	D
AGA SP.	*Agalinis* sp.	False foxglove	---	---	---
ALB JUL	*Albizia julibrissin* Durazz.	Mimosa	EW	---	W
ALY OVA	*Alysicarpus ovalifolius* (Schum. & Thonn.) J. Leonard	False moneywort	EW	---	W
AMB ART	*Ambrosia artemisiifolia* L.	Common ragweed	NP	---	W
AMP ARB	*Ampelopsis arborea* (L.) Koehne	Peppervine	NC	---	D
AMP MUH	Amphicarpum muhlenbergianum (Schult.) Hitchc.	Blue maidencane	NC	Wetland Sp.	D
AND BRA	Andropogon brachystachyus Chapm.	Shortspike bluestem	NC	---	D
AND cf. GLO	*Andropogon* cf. *glomeratus*	Bluestem	---	---	---
AND GCP	*Andropogon glomeratus* (Walt.) BSP var. glaucopsis (Ell.) Mohr	Bushy beardgrass	NP	Wetland Sp.	D
AND GLA	*Andropogon virginicus* L. var. *glaucus* Hackel	Chalky bluestem	NC	---	D
AND GLO	*Andropogon glomeratus* (Walt.) BSP var. *glomeratus*	Bushy bluestem	NP	Wetland Sp.	D
AND GYR	*Andropogon gyrans* Ashe var. gyrans	Elliott's bluestem	NC	---	D
AND HIR	*Andropogon glomeratus* (Walt.) BSP var. *hirsutior* (Hackel) Mohr	Bushy bluestem	NP	Wetland Sp.	D
AND SP.	*Andropogon* sp.	Bluestem	---	---	---
AND TER	*Andropogon ternarius* Michx.	Splitbeard bluestem	NC	---	D
AND VIR	*Andropogon virginicus* L. var. virginicus	Broomsedge	NP	---	D
ARI BEY	*Aristida beyrichiana* Trinius & Ruprecht	Wiregrass	NC	Wiregrass	D
ARI GYR	*Aristida gyrans* Chapm.	Corkscrew threeawn	NP	---	D
ARI PUR	*Aristida purpurescens* Poir.	Arrowfeather	NC	---	D
ARI SPI	*Aristida spiciformis* Ell.	Bottlebrush threeawn	NP	---	D
AST DUM	*Aster dumosus* L.	Bush aster	NC	---	D
AST TOR	*Aster tortifolius* Michx.	White-topped aster	NC	---	D
AXO AFF	*Axonopus affinis* Chase	Common carpetgrass	NP	---	D
AXO FUR	*Axonopus furcatus* (Fluegge) Hitchc.	Carpetgrass	NP	---	D
BAC HAL	*Baccharis halimifolia* L.	Sea myrtle	NP	---	D
BAL ANG	*Balduina angustifolia* (Pursh) Robins.	Yellow buttons	NP	Scrub Sp.	D
BAR GRO	Bare Ground	Bare ground	---	---	---
BEF RAC	*Befaria racemosa* Vent.	Tarflower	NC	---	D
BID ALB	*Bidens alba* (L.) DC.	Begger-ticks	NW	---	W
BLE SER	*Blechnum serrulatum* L. C. Rich.	Swamp fern	NC	Wetland Sp.	D
BUC AME	*Buchnera americana* L.	Blueheart	NC	---	D
BUL BAR	*Bulbostylis barbata* (Rottb.) C.B. Clarke	Watergrass	EW	---	W
BUL CIL	*Bulbostylis ciliatifolia* (Ell.) Fern.	Capillary hairsedge	NC	---	D
BUL STE	*Bulbostylis stenophylla* (Elliott) C.B. Clarke	Sandyfield hairsedge	NC	---	D
BUM TEN	*Bumelia tenax* (L.) Willd.	Tough bumelia	NC	---	D
CAL AME	*Callicarpa americana* L.	Beautybush	NC	---	D
CAR ALB	*Carex albolutescens* Schwein.	Greenish-white sedge	NP	---	D
CAR COR	*Carphephorus corymbosus* (Nutt.) Torr. & Gray	Large-headed carphephorus	NC	---	D
CAR FLO	*Carya floridana* Sarg.	Scrub hickory	NC	---	D

Species Code	Scientific Name with Authority	Common Name	Origin/Type Classification*	Ecosystem Category	Desirable/ Weedy†
CAR PAN	*Carphephorus paniculatus* (J. F. Gmel.) Herb.	Hairy trilisa	NC	---	D
CAR VER	*Carex verrucosa* Muhl.	Warty sedge	NC	Wetland Sp.	D
CEL LAE	*Celtis laevigata* Willd.	Hackberry	NC	Wetland Sp.	D
CEN ASI	*Centella asiatica* (L.) Urban	Coinwort	NP	Wetland Sp.	D
CEN ECH	*Cenchrus echinatus* L.	Southern sandspur	NW	---	W
cf. ARI PUR	cf. *Aristida purpurescens*		---	---	---
CHA FAS	*Chamaecrista fasciculata* (Michx.) Greene	Partridge-pea	NP	Legume	D
CHA FLO	*Chapmannia floridana* Torr. & Gray	Alicia	NC	---	D
CHA HYS	*Chamaesyce hyssopifolia* (L.) Small	Eyebane	NW	---	W
CHA NIC	*Chamaecrista nictitans* (L.) Moench	Wild sensitive plant	NP	Legume	D
CHA SP.	*Chamaecrista* sp.		---	---	---
CHA TOM	*Chaptalia tomentosa* Vent.	Pineland daisy	NC	Wetland Sp.	D
CHE AMB	*Chenopodium ambrosioides* L.	Mexican tea	EW	---	W
CHM SP.	*Chamaesyce* sp.	Sandmat	---	---	---
CHR FLO	*Chrysopsis floridana* Small	Florida goldenaster	NC	Scrub Sp.	D
CHR PAU	*Chrysopogon pauciflorus* (Chapm.) Benth. ex Vasey	Florida false beardgrass	NP	---	D
CIR SP.	*Cirsium* sp.	Thistle	---	---	---
CLA EVA	*Cladina evansii* (Abbayes) Hale & Culb.	Evans' reindeer lichen	NC	Scrub Sp.	D
CLA LEP	*Cladonia leporina* Fr.	Cup lichen	NC	Scrub Sp.	D
CLA SUB	*Cladina subtenuis* (Abbayes) Hale & Culb.	Reindeer lichen	NC	Scrub Sp.	D
COM ERE	*Commelina erecta*	Day-flower	NC	---	D
COM NIG	*Commelina nigritiana* Benth.	Gambian dayflower	EW	---	W
CON CAN	*Conyza canadensis* (L.) Cronq. var. pusilla (Nutt.) Cronq.	Dwarf horseweed	NW	---	W
COR FLO	*Coreopsis floridana* E. B. Smith	Florida tickseed	NC	Wetland Sp.	D
CRO LAN	*Crotalaria lanceolata* E. Mey.	Rattlebox	EW	Legume	W
CRO LIN	*Crotonopsis linearis* Michx.	Rushfoil	NP	---	D
CRO PAL	*Crotalaria pallida* Ait.	Rattlebox	EW	Legume	W
CRO ROT	*Crotalaria rotundifolia* (Walt.) Gmel.	Rabbit-bells	NC	Legume	D
CRO SPE	*Crotalaria spectabilis* Roth	Rattlebox	EW	Legume	W
CTE ARO	*Ctenium aromaticum* (Walt.) Wood	Toothachegrass	NC	Wetland Sp.	D
CYN DAC	*Cynodon dactylon* (L.) Pers.	Bermudagrass	EA	Agg. Grass	W
CYP BRE	*Cyperus brevifolius* (Rottb.) Hassk.	Shortleaf spikesedge	NC	Wetland Sp.	D
CYP GLO	*Cyperus globulosus* Aubl.	Baldwin's flatsedge	NP	---	D
CYP ODO	*Cyperus odoratus* L.	Rusty flatsedge	NC	Wetland Sp.	D
CYP POL	*Cyperus polystachyos* Rottb.	Manyspike flatsedge	NP	Wetland Sp.	D
CYP RET	*Cyperus retrorsus* Chapm.	Pinebarren flatsedge	NP	---	D
CYP SP.	*Cyperus* sp.	Flatsedge	---	---	---
CYP SUR	*Cyperus surinamensis* Rottb.	Tropical flatsedge	NP	Wetland Sp.	D
CYR ARI	*Cyrilla arida* Small	Scrub titi	NC	---	D
DAC AEG	*Dactyloctenium aegyptium* (L.) Beauv.	Crowfootgrass	EW	---	W
DAL SP.	*Dalea* sp.	Ticktrefoil	---	---	---
DES INC	*Desmodium incanum* DC.	Creeping beggarweed	NP	---	D

Species Code	Scientific Name with Authority	Common Name	Origin/Type Classification*	Ecosystem Category	Desirable/ Weedy†
DES TRI	*Desmodium triflorum* (L.) DC.	Sagotia beggarweed	EW	Legume	W
DIC ACI	*Dichanthelium aciculare* (Desvaux ex Poiret) Gould & Clark	Needle-leaf witchgrass	NP	---	D
DIC ACU	*Dichanthelium acuminatum* (Swartz) Gould & Clark	Tapered witchgrass	NC	---	D
DIC COM	*Dichanthelium commutatum* (Schultes) Gould	Variable witchgrass	NC	---	D
DIC ENS	*Dichanthelium ensifolium* (Baldwin ex Elliott) Gould var. ensifolium	Witchgrass	NC	---	D
DIC POR	*Dichanthelium portoricense* (Desvaux ex Hamilton) B. F. Hansen & Wunderlin	Hemlock witchgrass	NP	---	D
DIC SP.	*Dichanthelium* sp.	Witchgrass	---	---	---
DIG CIL	*Digitaria ciliaris* (Retz.) Koel	Southern crabgrass	EW	---	W
DIG LON	*Digitaria longiflora* (Retz.) Pers.	India crabgrass	EW	---	W
DIG SER	*Digitaria serotina* (Vasey) Fern.	Blanket crabgrass	NW	---	W
DIO TER	*Diodia teres* Walt.	Poor joe	NP	---	W
EARTH STAR	Earth star fungus	Earth star fungus	---	---	
ELE ELA	*Elephantopus elatus* Bertol.	Florida elephant's-foot	NC	---	D
ELE SP.	*Eleocharis* sp.	Spikerush	---	---	---
ELY TRI	*Elyonurus tripsacoides* Humb. & Bonpl. ex Willd.	Pan-american balsamscale	NC	Wetland Sp.	D
ERA EL RE	*Eragrostis elliottii* or *refracta* (sterile)	Lovegrass	NP	Lovegrass	D
ERA ELL	*Eragrostis elliottii* S. Wats.	Elliott lovegrass	NP	Lovegrass	D
ERA GAN	*Eragrostis gangetica* (Roxb.) Steud.	Slimflower lovegrass	EW	---	W
ERA REF	*Eragrostis refracta* (Muhl.) Scribn.	Coastal lovegrass	NP	Lovegrass	D
ERA SPE	*Eragrostis spectabilis* (Pursh) Steud.	Purple lovegrass	NP	Lovegrass	---
ERA SP.	*Eragrostis* sp. (sterile)	Lovegrass	---	Lovegrass	D
ERE HIE	*Erechtites hieracifolia* (L.) Raf.	Fireweed	NW	---	W
ERE OPH	*Eremochloa ophiuroides* (Munro) Hack.	Centipedegrass	EA	---	W
ERY YUC	*Eryngium yuccifolium* Michx.	Button snakeroot	NC	---	D
EUP CAP	*Eupatorium capillifolium* (Lam.) Small	Dog fennel	NW	---	W
EUP MOH	*Eupatorium mohrii* Greene	Mohr's eupatorium	NC	---	D
EUPHORB	*Euphorbiaceae*	Euphorb	---	---	D
EUP POL	*Euphorbia polyphylla* Engelm.	Spurge	NC	---	D
EUP ROT	*Eupatorium rotundifolium* L.	False hoarhound	NC	---	---
EUS PET	*Eustachys petraea* (Sw.) Desv.	Pinewoods fingergrass	NP	---	D
EUT TEN	*Euthamia tenuifolia* (Pursh) Greene	Slender fragrant-goldenrod	NP	---	D
FERN SP.	Fern (too small for confident identification)		---	---	---
FIM DIC	*Fimbristylis dichotoma* (L.) Vahl	Tall fimbry	EW	Wetland Sp.	W
FIM PUB	*Fimbristylis puberula* (Michx.) Vahl	Vahl's hairy fimbry	NC	Wetland Sp.	D
FIM SP.	*Fimbristylis* sp.	Fimbry	---	---	---
FONTINALIS	*Fontinalis* sp.	Fontinalis moss	NC	---	D
FRO FLO	*Froelichia floridana* (Nutt.) Moq.	Cottonweed	NP	---	D
GAL ELL	*Galactia elliottii* Nutt.	Elliott's milkpea	NP	Legume	D
GAL SP.	*Galium* sp.	Bedstraw	---	---	---
GAR HET	*Garberia heterophylla* (Bartr.) Merr. & Harp.	Garberia	NC	Scrub Sp.	D
GAY DUM	*Gaylussacia dumosa* (Andr.) Torr. & Gray	Dwarf huckleberry	NC	---	D

Species Code	Scientific Name with Authority	Common Name	Origin/Type Classification*	Ecosystem Category	Desirable/ Weedy†
GEL SEM	*Gelsemium sempervirens* (L.) J. St. Hil.	Yellow jessamine	NC	---	D
GNA OBT	*Gnaphalium obtusifolium* L.	Sweet everlasting	NP	---	D
GNA SP.	*Gnaphalium* sp.		---	---	---
GRA HIS	*Gratiola hispida* (Benth.) Pollard	Scrub hedge-hyssop	NC	---	D
HED COR	*Hedyotis corymbosa* (L.) Lam.	Old world diamond-flower	EW	---	W
HED SP.	*Hedyotis* sp.		---	---	---
HED UNI	*Hedyotis uniflora* (L.) Lam.	Clustered diamond-flower	NC	---	D
HEL ANG	*Helianthus angustifolius* L.	Swamp sunflower	NC	---	D
HEL COR	*Helianthemum corymbosum* Michx.	Clustered rock-rose	NC	---	D
HEL RAD	*Helianthus radula* (Pursh) Torr. & Gray	Rayless sunflower	NC	---	D
HET SUB	*Heterotheca subaxillaris* (Lam.) Britt. & Rusby	Camphorweed	NW	---	W
HYD UMB	*Hydrocotyle umbellata* L.	Marsh pennywort	NP	Wetland Sp.	D
HYP GEN	*Hypericum gentianoides* (L.) BSP.	Pineweeds	NC	---	D
HYP HYP	*Hypericum hypericoides* (L.) Crantz	St. Andrew's-cross	NC	---	D
HYP TET	*Hypericum tetrapetalum* Lam.	Heart-leaved St. Peter's-wort	NC	---	D
ILE GLA	*Ilex glabra* (L.) A. Gray	Gallberry	NC	---	D
IMP CYL	*Imperata cylindrica* (L.) Beauv.	Cogongrass	EA	Agg. Grass	W
IND HIR	*Indigofera hirsuta* Harv.	Hairy indigo	EW	Legume	W
IVA MIC	*Iva microcephala* Nutt.	Piedmont sumpweed	NP	Wetland Sp.	D
JUN DIC	*Juncus dichotomus* Ell.	Forked rush	NP	Wetland Sp.	D
JUN EFF	*Juncus effusus* L.	Soft rush	NP	Wetland Sp.	D
JUN SCI	*Juncus scirpoides* Lam.	Needle-pod rush	NP	Wetland Sp.	D
JUN SP.	*Juncus* sp.	Rush	---	---	---
KUM STR	*Kummerowia striata* (Thunb.) Schindler	Japanese clover	EW	Legume	W
LAC CAR	*Lachnanthes caroliniana* (Lam.) Dandy	Bloodroot	NP	---	D
LEC DIV	*Lechea divaricata* Shuttlew ex Britt.	Pinweed	NC	---	D
LEC SES	*Lechea sessiliflora* Raf.	Pineland pinweed	NC	---	D
LEC TOR	*Lechea torreyi* (Chapm.) Legg. ex Britton	Piedmont pinweed	NC	---	D
LEP VIR	*Lepidium virginicum* L.	Poorman's pepper	NW	---	W
LIA CHA	*Liatris chapmanii* Torr. & Gray	Slender-headed blazing-star	NC	Scrub Sp.	D
LIA LAE	*Liatris laevigata* Nutt.	Long-leaf blazing-star	NC	---	D
LIA OHL	*Liatris ohlingerae* (Blake) Robins.	Large-headed blazing-star	NC	Scrub Sp.	D
LIA SPI	*Liatris spicata* (L.) Willd.	Dense blazing-star	NC	---	D
LIA SP.	*Liatris* sp.	Blazing-star	NC	---	D
LIA TEN	*Liatris tenuifolia* Nutt.	Fine leaf blazing-star	NC	---	D
LIC MIC	*Licania michauxii* Prance	Gopher apple	NC	---	D
LIN GRA	*Lindernia grandiflora* Nutt.	Savannah false-pimpernel	NC	Wetland Sp.	D
LON SEM	*Lonicera sempervirens* L.	Coral honeysuckle	NC	---	D
LUD MAR	*Ludwigia maritima* Harper	Seaside seedbox	NP	Wetland Sp.	D
LUD PER	*Ludwigia peruviana* (L.) Hara	Primrose willow	NW	Wetland Sp.	W
LUD SP.	*Ludwigia* sp.		---	---	---
LYO FRU	*Lyonia fruticosa* (Michx.) Torr.	Staggerbush	NC	---	D

Species Code	Scientific Name with Authority	Common Name	Origin/Type Classification*	Ecosystem Category	Desirable/ Weedy†
MAC LAT	*Macroptilium lathyroides* (L.) Urban	Phasey bean	EW	Legume	W
MOM CHA	*Momordica charantia* L.	Balsampear	EW	---	W
MYR CER	*Myrica cerifera* L.	Wax myrtle	NP	---	D
MYR PUS	*Myrica pusilla* Raf.	Dwarf wax myrtle	NC	---	D
NEP SP.	*Nephrolepis* sp.	Boston fern	---	---	---
NOL BRI	*Nolina brittoniana* Nash	Beargrass	NC	Scrub Sp.	D
OEN LAC	*Oenothera laciniata* Hill	Cut-leaved evening primrose	NW	---	W
OPP HERB	Opposite herb		---	---	---
OPU HUM	*Opuntia humifusa* (Raf.) Raf.	Prickly-pear cactus	NC	---	D
PAL FEA	*Palafoxia feayi* A. Gray	Palafoxia	NC	---	D
PAN ANC	*Panicum anceps* Michx.	Beaked panicum	NC	---	D
PAN DIC	*Panicum dichotomiflorum* Michx.	Fall panicum	NP	---	D
PAN HEM	*Panicum hemitomon* Schult.	Maidencane	NC	Wetland Sp.	D
PAN REP	*Panicum repens* L.	Torpedograss	EA	Agg. Grass/ Wetland Sp.	W
PAN SP.	*Panicum* sp.		---	---	---
PAN TEN	*Panicum tenerum* Beyr.	Bluejoint panicum	NC	Wetland Sp.	D
PAR QUI	*Parthenocissus quinquefolia* (L.) Planch.	Virginia creeper	NC	---	D
PAS INC	*Passiflora incarnata* L.	Maypop	NC	---	D
PAS NOT	*Paspalum notatum* Fluegge	Bahiagrass	EA	Agg. Grass	W
PAS SET	*Paspalum setaceum* Michx.	Thin paspalum	NP	---	D
PAS URV	*Paspalum urvillei* Steud.	Vaseygrass	EW	---	W
PER HUM	*Persea humilis* Nash	Silkbay	NC	Scrub Sp.	D
PER PAL	*Persea palustris* (Raf.) Sarg.	Swampbay	NC	Wetland Sp.	D
PHO GRA	*Phoebanthus grandiflora* (Torr. & Gray) Blake	Phoebanthus	NC		D
PHY AME	*Phytolacca americana* L.	American pokeweed	NW	---	W
PHY ARE	*Physalis arenicola* Kearney	Pubescent ground cherry	NC	---	D
PHY NOD	*Phyla nodiflora* (L.) Greene	Turkey tangle fogfruit	NP	---	D
PIL RIG	*Piloblephis rigida* (Bartr. ex Benth.) Raf.	Pennyroyal	NC	---	D
PIN CLA	*Pinus clausa* (Chapm. ex Engelm.) Vasey ex Sarg.	Sand pine	NC	---	D
PIN ELL	*Pinus elliottii* Engelm.	Slash pine	NC	---	D
PIN PAL	*Pinus palustris* Mill.	Longleaf pine	NC	---	D
PIR CAR	*Piriqueta caroliniana* (Walt.) Urban	Piriqueta	NC	---	D
PIT GRA	*Pityopsis graminifolia* (Michx.) Nutt.	Grass-leaf golden aster	NC	---	D
PIT TRA	*Pityopsis graminifolia* var. *tracyi* (Small) Semple	Tracy's silkgrass	NC	---	D
PLU ROS	*Pluchea rosea* Godfrey	Godfrey's marsh fleabane	NC	Wetland Sp.	D
POACEAE	*Poaceae* (sterile grass)		---	---	---
POL GRA	*Polygala grandiflora* Walt.	Large-flowered polygala	NC	---	D
POL HYD	*Polygonum hydropiperoides* Michx.	Mild water-pepper	NP	Wetland Sp.	D
POL POLY	*Polygonella polygama* (Vent.) Engelm. & Gray	Jointweed	NC	Scrub Sp.	D
POL PRO	*Polypremum procumbens* L.	Rustweed	NP	---	D
POL ROB	*Polygonella robusta* (Small) Nesom & Bates	Sandhill wireweed	NC	---	D

Species Code	Scientific Name with Authority	Common Name	Origin/Type Classification*	Ecosystem Category	Desirable/ Weedy†
PTE PYC	*Pterocaulon pycnostachyum* (Michaux) Elliott	Blackroot	NP	---	D
QUE CHA	*Quercus chapmanii* Sarg.	Chapman's oak	NC	---	D
QUE GEM	*Quercus geminata* Small	Sand live oak	NC	---	D
QUE HEM	*Quercus hemisphaerica* Bartr.	Laurel oak	NC	---	D
QUE INC	*Quercus incana* Bartr.	Bluejack oak	NC	---	D
QUE INO	*Quercus inopina* Ashe	Scrub oak	NC	---	D
QUE MAR	*Quercus margaretta* Ashe	Sand-post oak	NC	---	D
QUE MIN	*Quercus minima* (Sarg.) Small	Dwarf live oak	NC	---	D
QUE VIR	*Quercus virginiana* Mill.	Virginia live oak	NC	---	D
RHU COP	*Rhus copallina* L.	Winged sumac	NC	---	D
RHY FAS	*Rhynchospora fascicularis* (Michx.) Vahl	Fasciculate beakrush	NP	Wetland Sp.	D
RHY PLU	*Rhynchospora plumosa* Ell.	Plumed beakrush	NC	Wetland Sp.	D
RHY REP	*Rhynchelytrum repens* (Willd.) C. E. Hubb.	Natalgrass	EA	Agg. Grass	W
RHYN DIF	*Rhynchosia difformis* (Ell.) DC.	Twining rhynchosia	NC	---	D
RHYN MIC	*Rhynchosia michauxii* Vail	One-leaf rhynchosia	NC	---	D
RIC BRA	*Richardia brasiliensis* (Moq.) Gomez	Brazil pusley	EW	---	W
RIC SCA	*Richardia scabra* L.	Florida pusley	EW	---	W
RUB BET	*Rubus betulifolius* Small	Blackberry	NP	---	D
RUB CUN	*Rubus cuneifolius* Pursh	Sand blackberry	NP	---	D
RUD HIR	*Rudbeckia hirta* L.	Blackeyed susan	NC	---	D
RUM HAS	*Rumex hastatulus* Baldw.	Hastate-leaved dock	NW	---	W
RUM SP.	*Rumex* sp.	Dock	---	---	---
SAB BRE	*Sabatia brevifolia* Raf.	Short-leaf rose-gentian	NC	---	D
SAB ETO	*Sabal etonia* Swingle ex Nash	Scrub palmetto	NC	---	D
SAC IND	*Sacciolepis indica* (L.) Chase	India cupscale	EW	---	W
SAL CAR	*Salix caroliniana* Michx.	Carolina willow	NP	Wetland Sp.	D
SCH STO	*Schizachyrium stoloniferum* Nash	Creeping bluestem	NC	---	D
SCL CIL	*Scleria ciliata* Michx.	Fringed nutrush	NC	---	D
SCO DUL	*Scoparia dulcis* L.	Sweet broom	NW	---	W
SER REP	*Serenoa repens* (Bartr.) Small	Saw palmetto	NC	---	D
SES SP.	*Sesbania* sp.	Sesban	---	---	---
SET GEN	*Setaria geniculata* (Lam.) Beauv.	Knotroot foxtail	NP	---	D
SMI BON	*Smilax bona-nox* L.	Greenbrier	NC	---	D
SMI GLA	*Smilax glauca* Walt.	Wild sarsaparilla	NC	---	D
SMI LAU	*Smilax laurifolia* L.	Catbrier	NC	---	D
SOL CHA	*Solidago odora Ait.* var. *chapmanii* (A. Gray) Cronq.	Goldenrod	NC	---	D
SOL ELL	*Solidago elliottii* Torr. & Gray	Goldenrod	NP	Wetland Sp.	D
SOL FIS	*Solidago fistulosa* Ait.	Pinebarren goldenrod	NP	---	D
SOL SCA	*Solidago canadensis* L. var. *scabra* T. & G.	Goldenrod	NP	---	D
SOL STR	*Solidago stricta* Ait.	Goldenrod	NC	Wetland Sp.	D
SOR SEC	*Sorghastrum secundum* (Ell.) Nash	Lopsided indiangrass	NC	---	D
SPO IND	*Sporobolus indicus* (L.) R. Br.	Smutgrass	EW	---	W

Species Code	Scientific Name with Authority	Common Name	Origin/Type Classification*	Ecosystem Category	Desirable/ Weedy†
SPO JUN	*Sporobolus junceus* (Michx.) Kunth	Pineywoods dropseed	NC	---	D
STI SET	*Stipulicida setacea* Michx.	Wire weed	NC	---	D
STI SYL	*Stillingia sylvatica* L.	Queen's delight	NC	---	D
STR GES†	*Striga gesnerioides* (Willd.) Vatke†	Cowpea witchweed†	EW	---	W
TEP CHR	*Tephrosia chrysophylla* Pursh	Golden hoary-pea	NC	Legume	D
TEP HIS	*Tephrosia hispidula* (Michx.) Pers.	Rusty hoary-pea	NC	Legume	D
TEP SP.	*Tephrosia* sp.	Hoarypea	---	---	---
THE DEN	*Thelypteris dentata* (Forsk.) E. St. John	Downy shield fern	NC	Wetland Sp.	D
THE HIS	*Thelypteris hispidula* (Dcne.) Reed	Shield fern	NC	---	D
TOX RAD	*Toxicodendron radicans* (L.) Kuntze	Poison ivy	NC	---	D
URE LOB	*Urena lobata* L.	Caesar-weed	EW	---	W
VAC MYR	*Vaccinium myrsinites* Lam.	Shiny blueberry	NC	---	D
VIT AES	*Vitis aestivalis* Michx.	Summer grape	NC	---	D
VIT ROT	*Vitis rotundifolia* Michx.	Muscadine	NP	---	D
WAL MAR	Wahlenbergia marginata (Thunb.) DC.	Asiatic bellflower	EW	---	W
XYR AMB	*Xyris ambigua* Beyr. ex Kunth	Coastalplain yelloweyed grass	NC	Wetland Sp.	D
XYR BRE	*Xyris brevifolia* Michx.	Shortleaf yelloweyed grass	NC	---	D
XYR CAR	*Xyris caroliniana* Walt.	Carolina yelloweyed grass	NC	Wetland Sp.	D
XYR ELL	*Xyris elliottii* Chapm.	Elliott's yelloweyed grass	NC	---	D
XYR SP.	*Xyris* sp.	Yelloweyed grass	---	---	---
YUC FIL	*Yucca filamentosa* L.	Adam's needle	NC	---	D

*Origin: N = Native
E = Exotic

†D = Desireable
W= Weedy

Type: C = Characteristic
P = Pioneer
A = Aggressive
W = Weedy

Appendix C

VEGETATION ZONE, LENGTH, COMPASS BEARING, AND ADDITIONAL INFORMATION FOR QUADRATS INSTALLED AT EACH UPLAND RECLAMATION STUDY SITE

BALD MOUNTAIN (BM) TRANSECT INFORMATION
FIPR UPLAND RECLAMATION STUDY

Transect #	Vegetation Zone[a]	Simplified Vegetation Zone	Transect Length (ft)	Location	Compass Bearing	Moisture Index
BM1	LD/LW	LD	80	North Slope	295	1
BM2	HW/LD	HW	10	North Slope	301	2.5
BM3	LD/LW	LD	40	North Slope	266	2
BM4	LW/LD	LW	30	North Slope	263	2
BM5	HD/LW	HD	50	North Slope	261	2
BM6	HW/LD	HW	30	North Slope	254	2
BM7	HD/LW	HD	10	North Slope	166	1
BM8	LD/LW	LD	20	South Slope	152	1.5
BM9	HW/LD	HW	30	South Slope	201	2
BM10	LW/LD	LW	30	South Slope	74	2
BM11	HD/LW	HD	20	South Slope	268	1
BM12	LW/LD	LW	30	South Slope	80	2

[a]Vegetation Zones: HW/LD = High Cover of weedy Species/Low Cover of Desirable Species
HD/LW = High Cover of Desirable Species/Low Cover of Weedy Species
LW/LD = Low Cover of Weedy Species/Low Cover of Desirable Species
LD/LW = Low Cover of Desirable Species/Low Cover of Weedy Species

BEST OF THE WEST SITE TRANSECT INFORMATION
FIPR UPLAND RECLAMATION STUDY

Transect #	Vegetation Zone[a]	Simplified Vegetation Zone	Species Present	Transect Length (ft)	Compass Bearing (°)	Moisture Index
BW-1	HW	HW	Cogon Grass	30	78	2
BW-2	LW/LD	LW	--	30	78	2
BW-3	HD	HD	Other Nonscrub Species	30	323	2
BW-4	HD	HD	Scrub Species	30	66	1
BW-5	HW	HW	Cogon Grass	30	278	3
BW-6	LW/LD	LW	--	30	225	3
BW-7	HD	HD	Other Nonscrub Species	30	52	1.5
BW-8	HW	HW	Cogon Grass	30	52	3
BW-9	LW/LD	LW	--	30	81	2
BW-10	HD	HD	Other Nonscrub Species	30	144	3
BW-11	HD	HD	Scrub Species	30	16	1
BW-12	HD	HD	Scrub Species	30	206	1

[a] Vegetation Zones: HW = High Cover of Weedy Species
LW/LD = Low Cover of Weedy Species/Low Cover of Desirable Species
HD = High Cover of Desirable Species

ESTECH TOPSOIL (ES) TRANSECT INFORMATION
FIPR UPLAND RECLAMATION STUDY

Transect #	Vegetation Zone[a]	Simplified Vegetation Zone	Transect Length (ft)	Compass Bearing	Moisture Index
ES1	HD	HD	20	37	3
ES2	HW	HW	30	298	3
ES3	HD	HD	20	343	3
ES4	LW/LD	LW	30	19	2.5
ES5	LW/LD	LW	20	60	3
ES6	LW/LD	LW	20	73	3
ES7	HD	HD	30	13	3
ES8	HW	HW	20	358	3
ES9	HW	HW	30	15	3

[a] Vegetation Zones: HD = High Cover of Desirable Species
HW = High Cover of Weedy Species
LW/LD = Low Cover of Weedy Species/Low Cover of Desirable Species

GOPHER HILLS (GH) TRANSECT INFORMATION
FIPR UPLAND RECLAMATION STUDY

Transect #	Vegetation Zone[a]	Simplified Vegetation Zone	Transect Length (ft)	Location	Compass Bearing	Location of Soil Sample	Moisture Index
GH1	HD	HD	50	North Peak	218	Right side of Transect	2.5
GH2	LW	LW	70	North Peak	176	" "	2
GH3	HW	HW	100	North Peak	194	" "	2.5
GH4	LD/LW	LD	50	North Peak	346	" "	2.5
GH5	LW	LW	70	North Peak	193	" "	2.5
GH6	HW	HW	70	North Peak	220	" "	3
GH7	LD/LW	LD	30	North Peak	29	" "	2
GH8	HD	HD	40	North Peak	40	" "	3
GH9	LD	LD	40	North Peak	12	" "	2.5
GH10	LD	LD	30	South Peak	237	" "	3
GH11	HW	HW	100	South Peak	182	4 -5 feet past centerline on left side of transect	3.5
GH12	HD	HD	30	South Peak	272	Right side of transect	3.5
GH13	LW	LW	20	South Peak	174	" "	2.5
GH14	LD/LW	LD	80	South Peak	267	" "	3.5
GH15	LD	LD	40	North Peak	348	" "	2.5

[a]Vegetation Zones:
HD = High Cover of Desirable Species
LD = Low Cover of Desirable Species
HW = High Cover of Weedy Species
LW = Low Cover of Weedy Species
LD/LW = Low Cover of Desirable and Weedy Species

HARDEE LAKES SITE TRANSECT INFORMATION
FIPR UPLAND RECLAMATION STUDY

Transect #	Vegetation Zone[a]	Simplified Vegetation Zone	Species Present	Transect Length (ft)	Compass Bearing (°)	Moisture Index
HL-1	HW	HW	--	30	77	4
HL-2	HW	HW	--	30	135	4
HL-3	HD	HD	Mixed Native Species	30	268	4
HL-4	HD	HD	Schizachyrium scoparium	30	254	4
HL-5	HD	HD	Mixed Native Species	20	263	4
HL-6	HD	HD	Mixed Native Species	20	156	4
HL-7	HD	HD	Schizachyrium scoparium	30	154	4
HL-8	HW	HW	--	20	106	3.5
HL-9	HD	HD	Schizachyrium scoparium	30	92	4

[a] Vegetation Zones: HD = High Cover of Desirable Species
HW = High Cover of Weedy Species

MARGARET GILBERT (MG) TRANSECT INFORMATION
FIPR UPLAND RECLAMATION STUDY

Transect #	Vegetation Zone[a]	Simplified Vegetation Zone	Treatment[b]	Transect Length (ft)	Compass Bearing (°)	Moisture Index
MG-1	HW	HW	Planted	40	278	2.5
MG-2	HD	HD	Planted	30	311	1
MG-3	LD/LW	LD	Planted	30	150	1
MG-4	HD	HD	Seeded	30	48	1
MG-5	HW	HW	Seeded	30	330	2
MG-6	LD/LW	LD	Seeded	30	350	1
MG-7	HW	HW	Planted	40	108	3
MG-8	LD/LW	LD	Planted	30	355	1
MG-9	HD	HD	Planted	20	295	1
MG-10	HD	HD	Seeded	30	327	1
MG-11	HW	HW	Seeded	20	180	2
MG-12	LD/LW	LD	Seeded	30	360	1

[a] Vegetation Zones: HW = High Cover of Weedy Species
HD = High Cover of Desirable Species
LW/LD = Low Cover of Weedy Species/Low Cover of Desirable Species

[b] Planted = Native Species Initially Planted
Seeded = Native Species Initially Seeded

NORALYN SCRUB (NS) TRANSECT INFORMATION
FIPR UPLAND RECLAMATION STUDY

Transect #	Vegetation Zone[a]	Simplified Vegetation Zone	Dominant Weedy Species	Transect Length (ft)	Transect Location	Compass Bearing (°)	Moisture Index
NS-1	HW	HW	Bahia Grass	30	South	120	3
NS-2	HW	HW	Cogon Grass	30	South	120	3
NS-3	HD	HD	---	40	South	230	1
NS-4	LW/LD	LW	---	30	South	114	2
NS-5	HD	HD	---	40	South	50	1
NS-6	HW	HW	Cogon Grass	30	Center	38	4
NS-7	LW/LD	LW	---	40	Center	215	2
NS-8	HW	HW	Bahia Grass	40	Center	193	3
NS-9	HW	HW	Cogon Grass	30	Center	206	2
NS-10	HW	HW	Bahia Grass	30	North	108	3
NS-11	HD	HD	---	30	North	60	2
NS-12	LW/LD	LW	---	30	North	290	2

[a] Vegetation Zones: HW = High Cover of Weedy Species
HD = High Cover of Desirable Species
LW/LD = Low Cover of Weedy Species/Low Cover of Desirable Species

PCS SITE (PC) TRANSECT INFORMATION
FIPR UPLAND RECLAMATION STUDY

Transect #	Vegetation Zone[a]	Simplified Vegetation Zone	Transect Length (ft)	Compass Bearing (°)	Moisture Index
PC-1	HW	HW	30	80	4
PC-2	HW	HW	30	84	4
PC-3	LW/LD	LW	30	152	4
PC-4	LW/LD	LW	30	80	4
PC-5	HW	HW	30	82	4
PC-6	HD	HD	30	100	4
PC-7	HD	HD	30	85	4
PC-8	HD	HD	20	82	4
PC-9	LW/LD	LW	30	110	4

[a] Vegetation Zones: HW = High Cover of Weedy Species
HD = High Cover of Desirable Species
LW/LD = Low Cover of Weedy Species/Low Cover of Desirable Species

SIXTEEN ACRE (SA) TRANSECT INFORMATION
FIPR UPLAND RECLAMATION STUDY

Transect #	Vegetation Type[a]	Simplified Vegetation Zone	Treatment	Quadrat Length (ft)	Compass Bearing	Moisture Index
SA1	HD	HD	Unmulched	40	2	2
SA2	LD	LD	Unmulched	40	10	2
SA3	HD	HD	Mulched	40	5	2.5
SA4	LD	LD	Mulched	40	358	2
SA5	HW	HW	Mulched	20	358	2
SA6	LW/LD	LW	Mulched	40	22	2.5
SA7	LD	LD	Unmulched	30	6	4
SA8	HD	HD	Mulched	50	8	3.5
SA9	HW	HW	Unmulched	40	354	4
SA10	HW	HW	Mulched	20	40	4.5
SA11	HW	HW	Mulched	30	3	4
SA12	LW/LD	LW	Mulched	40	18	3
SA13	LD	LD	Mulched	20	301	3.5
SA14	LW/LD	LW	Unmulched	60	359	2
SA15	LW/LD	LW	Mulched	30	28	3.5
SA16	LD	LD	Mulched	40	356	3
SA17	LW/LD	LW	Unmulched	40	8	3
SA18	HD	HD	Unmulched	20	6	3.5
SA19	HD	HD	Unmulched	20	11	4.5
SA20	LD	LD	Unmulched	70	270	3
SA21	HW	HW	Unmulched	30	231	3.5
SA22	LW/LD	LW	Unmulched	30	0	3.5
SA23	HW	HW	Unmulched	30	54	3.5
SA24	HD	HD	Mulched	50	0	4.5

[a]Vegetation Zones:
HD = High Cover of Desirable Species
HW = High Cover of Weedy Species
LW = Low Cover of Weedy Species
LW/LD = Low Cover of Weedy Species/Low Cover of Desirable Species

WILDLIFE CORRIDOR (WC) TRANSECT INFORMATION
FIPR UPLAND RECLAMATION STUDY

Transect #	Vegetation Zone[ab]	Dominant Nuisance Species	Transect Length (ft)	Location	Compass Bearing	Moisture Index
WC1	LW	Natal Grass	40	South	242	2.5
WC2	HW	Cogon Grass	70	Mid-South	35	3
WC3	LD	-----	30	Mid-South	323	3
WC4	LW	Cogon Grass	30	North	198	3
WC5	HW	Cogon Grass	40	North	201	4
WC6	HW	Natal Grass	50	Mid-North	171	2.5
WC7	LD	-----	20	Mid-North	144	2.5
WC8	LW	Cogon Grass	30	Mid	157	3
WC9	HW	Natal Grass	30	Mid	163	3
WC10	LW	Natal Grass	20	Mid	154	2.5
WC11	HW	Cogon Grass	30	South	41	3
WC12	LW	Natal Grass	50	South	234	2
WC13	LW	Cogon Grass	40	South	33	2.5
WC14	HW	Natal Grass	40	South	358	2.5
WC15	LD	-----	20	South	85	3

[a]Vegetation Zones: HW = High Cover of Weedy Species
LD = Low Cover of Desirable Species
LW = Low Cover of Weedy Species

[b]Vegetation Zone and Simplified Vegetation Zone are the same for this site.

Appendix D

POOLED ANALYSES OF VEGETATION DATA FOR EACH UPLAND RECLAMATION SUTDY SITE

BALD MOUNTAIN SITE

High Desirable / Low Weedy (HD/LW) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	80	100.0	---	57.3	---	3
Rhynchelytrum repens	59	73.8	1	9.7	1	3
Eragrostis elliottii	52	65.0	2	8.0	2	3
Aristida gyrans	48	60.0	3	7.0	3	3
Cyperus retrorsus	28	35.0	4	5.0	4	1
Dalea sp.	10	12.5	9	5.0	4	1
Imperata cylindrica	3	3.8	17	5.0	4	1
Aristida beyrichiana	6	7.5	14	4.2	7	1
Cyperus sp.	3	3.8	17	3.8	8	2
Eragrostis spectabilis	22	27.5	7	3.6	9	2
Heterotheca subaxillaris	28	35.0	4	3.5	10	3
Indigofera hirsuta	26	32.5	6	3.1	11	3
Andropogon virginicus var. virginicus	3	3.8	17	2.8	12	1
Diodia teres	10	12.5	9	2.6	13	2
Andropogon glomeratus var. glomeratus	5	6.3	15	2.5	14	1
Polygonella robusta	4	5.0	16	2.5	14	1
Chamaecrista fasciculata	7	8.8	12	2.2	16	1
Sporobolus junceus	9	11.3	11	2.1	17	1
Crotalaria rotundifolia	16	20.0	8	1.8	18	2
Elephantopus elatus	7	8.8	12	1.2	19	1
Bulbostylis ciliatifolia	1	1.3	22	1.0	20	1
Paspalum setaceum	2	2.5	20	1.0	20	1
Ambrosia artemisiifolia	1	1.3	22	0.3	22	1
Eupatorium capillifolium	1	1.3	22	0.1	23	1
Liatris chapmanii	1	1.3	22	0.1	23	1
Palafoxia feayi	1	1.3	22	0.1	23	1
Paspalum notatum	2	2.5	20	0.1	23	1
Rumex hastatulus	1	1.3	22	0.1	23	1

High Weedy / Low Desirable (HW/LD) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	70	100.0	---	15.0	---	3
Rhynchelytrum repens	64	91.4	1	24.4	1	3
Imperata cylindrica	36	51.4	3	20.8	2	2
Indigofera hirsuta	61	87.1	2	15.0	3	3
Sporobolus junceus	14	20.0	6	11.7	4	2
Heterotheca subaxillaris	34	48.6	4	9.5	5	3
Desmodium triflorum	6	8.6	10	6.7	6	1
Aristida gyrans	2	2.9	14	5.0	7	1
Paspalum notatum	3	4.3	13	5.0	7	1
Cyperus retrorsus	7	10.0	9	3.3	9	2
Euthamia tenuifolia	6	8.6	10	3.3	9	1
Chamaecrista fasciculata	5	7.1	12	2.6	11	2
Diodia teres	8	11.4	8	2.6	11	2
Wahlenbergia marginata	18	25.7	5	2.4	13	3
Conyza canadensis	10	14.3	7	1.8	14	2
Elephantopus elatus	1	1.4	15	0.5	15	1
Palafoxia feayi	1	1.4	15	0.5	15	1
Rumex hastatulus	1	1.4	15	0.5	15	1

Low Desirable / Low Weedy (LD/LW) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	140	100.0	---	80.0	---	3
Rhynchelytrum repens	97	69.3	1	6.9	1	3
Indigofera hirsuta	54	38.6	3	6.2	2	3
Polygonella robusta	16	11.4	7	5.0	3	1
Heterotheca subaxillaris	93	66.4	2	4.6	4	3
Eragrostis spectabilis	14	10.0	8	3.8	5	1
Sporobolus junceus	26	18.6	5	3.4	6	2
Eragrostis elliottii	28	20.0	4	2.9	7	2
Befaria racemosa	2	1.4	17	2.5	8	1
Cyperus retrorsus	2	1.4	17	2.5	8	1
Chamaecrista fasciculata	11	7.9	9	2.3	10	2
Polygala grandiflora	4	2.9	14	2.0	11	2
Crotalaria rotundifolia	21	15.0	6	2.0	11	3
Andropogon glomeratus var. glomeratus	8	5.7	11	1.9	13	2
Paspalum setaceum	3	2.1	16	1.6	14	2
Aristida gyrans	2	1.4	17	1.3	15	1
Eustachys petraea	2	1.4	17	1.3	15	1
Liatris tenuifolia	1	0.7	23	1.3	15	1
Palafoxia feayi	1	0.7	23	1.3	15	1
Sorghastrum secundum	2	1.4	17	1.3	15	1
Andropogon glomeratus var. glaucopsis	4	2.9	14	0.9	20	2
Rumex hastatulus	7	5.0	12	0.5	21	2
Bulbostylis ciliatifolia	5	3.6	13	0.3	22	2
Diodia teres	10	7.1	10	0.3	22	2
Serenoa repens	1	0.7	23	0.3	22	1
Conyza canadensis	2	1.4	17	0.1	25	1
Elephantopus elatus	1	0.7	23	0.1	25	1
Liatris sp.	1	0.7	23	0.1	25	1
Polypremum procumbens	1	0.7	23	0.1	25	1
Ambrosia artemisiifolia	1	0.7	23	0.1	25	1
Andropogon virginicus var. virginicus	1	0.7	23	0.1	25	1
Liatris chapmanii	1	0.7	23	0.1	25	1

Low Weedy / Low Desirable (LW/LD) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	90	100.0	---	53.9	---	3
Rhynchelytrum repens	74	82.2	1	35.0	1	3
Rhynchosia michauxii	22	24.4	3	10.0	2	1
Indigofera hirsuta	53	58.9	2	8.9	3	3
Heterotheca subaxillaris	16	17.8	7	4.3	4	2
Cyperus retrorsus	16	17.8	7	4.2	5	2
Diodia teres	17	18.9	6	3.4	6	2
Palafoxia feayi	3	3.3	12	3.3	7	1
Aristida gyrans	21	23.3	4	2.6	8	2
Bulbostylis ciliatifolia	20	22.2	5	2.6	8	2
Polygonella polygama	4	4.4	11	1.8	10	1
Crotalaria rotundifolia	10	11.1	9	1.8	10	3
Andropogon glomeratus var. glomeratus	2	2.2	15	1.7	12	1
Aristida beyrichiana	2	2.2	15	1.7	12	1
Chamaecrista fasciculata	2	2.2	15	1.7	12	1
Eragrostis elliottii	2	2.2	15	1.7	12	1
Sorghastrum secundum	3	3.3	12	1.7	12	1
Wahlenbergia marginata	2	2.2	15	0.9	17	2
Eragrostis spectabilis	5	5.6	10	0.3	18	1
Conyza canadensis	3	3.3	12	0.3	18	2
Ambrosia artemisiifolia	1	1.1	20	0.2	20	1
Liatris chapmanii	1	1.1	20	0.2	20	1

BEST OF THE WEST SITE

High Desirable "Scrub Species" (HDS) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	90	100.0	---	44.4	---	3
Helianthemum corymbosum	47	52.2	2	20.9	1	2
Panicum anceps	10	11.1	9	15.0	2	1
Polygonella polygama	55	61.1	1	13.3	3	3
Quercus minima	26	28.9	3	8.4	4	2
Opuntia humifusa	26	28.9	3	6.2	5	3
Chapmannia floridana	6	6.7	13	5.0	6	1
Quercus geminata	12	13.3	8	5.0	6	1
Serenoa repens	7	7.8	12	5.0	6	2
Commelina erecta	10	11.1	9	3.3	9	1
Smilax bona-nox	14	15.6	7	3.3	9	2
Cyperus retrorsus	22	24.4	5	2.9	11	3
Dichanthelium portoricense	18	20.0	6	2.6	12	2
Paspalum setaceum	8	8.9	11	1.8	13	1
Rhynchelytrum repens	4	4.4	14	1.8	13	2
Euthamia tenuifolia	1	1.1	18	1.7	15	1
Bulbostylis ciliatifolia	2	2.2	16	1.7	15	1
Palafoxia feayi	4	4.4	14	1.7	15	1
Richardia brasiliensis	2	2.2	16	1.7	15	1

High Desirable "Other Non-Scrub Species" (HDO) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	90	100.0	---	35.6	---	3
Schizachyrium stoloniferum	30	33.3	3	78.3	1	1
Serenoa repens	10	11.1	15	20.0	2	1
Quercus minima	19	21.1	8	10.0	3	1
Tephrosia chrysophylla	21	23.3	6	8.5	4	1
Andropogon glomeratus var. glomeratus	9	10.0	16	8.3	5	1
Eragrostis elliottii	16	17.8	10	8.3	5	1
Chamaecrista fasciculata	4	4.4	23	6.7	7	1
Euthamia tenuifolia	54	60.0	1	6.2	8	3
Polygonella polygama	36	40.0	2	5.9	9	2
Quercus geminata	13	14.4	12	5.8	10	2
Galactia elliottii	25	27.8	4	5.0	11	1
Helianthemum corymbosum	22	24.4	5	5.0	11	2
Cyperus retrorsus	21	23.3	6	4.2	13	2
Rhynchelytrum repens	5	5.6	19	3.5	14	1
Eupatorium capillifolium	5	5.6	19	3.3	15	1
Andropogon virginicus var. virginicus	11	12.2	14	2.6	16	2
Dichanthelium aciculare	12	13.3	13	2.6	16	2
Euphorbiaceae	7	7.8	17	1.8	18	1
Palafoxia feayi	5	5.6	19	1.8	18	1
Rhus copallina	5	5.6	19	1.8	18	1
Dichanthelium portoricense	18	20.0	9	1.8	18	3
Smilax bona-nox	15	16.7	11	1.8	18	3
Commelina erecta	3	3.3	24	1.7	23	1
Desmodium triflorum	2	2.2	29	1.7	23	1
Fimbristylis puberula	3	3.3	24	1.7	23	1
Opuntia humifusa	3	3.3	24	1.7	23	1
Paspalum setaceum	7	7.8	17	1.7	23	2
Rhynchosia difformis	1	1.1	33	1.7	23	1
Sporobolus indicus	3	3.3	24	1.7	23	2
Yucca filamentosa	2	2.2	29	1.7	23	1
Diodia teres	2	2.2	29	0.3	31	1
Earth Star	3	3.3	24	0.3	31	1
Vitis aestivalis	2	2.2	29	0.3	31	1
Ambrosia artemisiifolia	1	1.1	33	0.2	34	1
Bulbostylis ciliatifolia	1	1.1	33	0.2	34	1
Hedyotis corymbosa	1	1.1	33	0.2	34	1
Indigofera hirsuta	1	1.1	33	0.2	34	1
Physalis arenicola	1	1.1	33	0.2	34	1
Piriqueta caroliniana	1	1.1	33	0.2	34	1
Pityopsis graminifolia	1	1.1	33	0.2	34	1

Low Weedy / Low Desirable (LW/LD) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	90	100.0	---	28.9	---	3
Euthamia tenuifolia	68	75.6	1	15.1	1	3
Solidago fistulosa	28	31.1	8	15.0	2	1
Eupatorium capillifolium	41	45.6	3	14.2	3	2
Andropogon glomeratus var. glomeratus	47	52.2	2	9.4	4	3
Helianthemum corymbosum	33	36.7	7	9.2	5	2
Sporobolus indicus	18	20.0	10	7.5	6	2
Smilax bona-nox	36	40.0	6	6.2	7	3
Rhus copallina	11	12.2	12	5.8	8	2
Rhynchelytrum repens	41	45.6	3	5.6	9	3
Acalypha gracilens	10	11.1	13	5.0	10	1
Cyperus retrorsus	41	45.6	3	3.9	11	3
Physalis arenicola	5	5.6	17	3.5	12	1
Quercus geminata	12	13.3	11	3.4	13	2
Ambrosia artemisiifolia	22	24.4	9	3.3	14	2
Quercus minima	3	3.3	25	3.3	14	1
Andropogon virginicus var. virginicus	6	6.7	16	2.5	16	2
Opuntia humifusa	5	5.6	17	1.8	17	2
Chamaecrista fasciculata	4	4.4	21	1.7	18	1
Cyperus globulosus	3	3.3	25	1.7	18	1
Eragrostis sp. (sterile)	1	1.1	31	1.7	18	1
Heterotheca subaxillaris	5	5.6	17	1.7	18	1
Paspalum setaceum	3	3.3	25	1.7	18	1
Piriqueta caroliniana	8	8.9	14	1.7	18	1
Polygonella polygama	4	4.4	21	1.7	18	1
Richardia brasiliensis	2	2.2	30	1.7	18	1
Scoparia dulcis	3	3.3	25	1.7	18	1
Serenoa repens	4	4.4	21	1.7	18	1
Conyza canadensis	7	7.8	15	1.0	28	2
Dichanthelium portoricense	4	4.4	21	0.9	29	2
Galactia elliottii	2	2.2	29	0.9	29	2
Dichanthelium aciculare	5	5.6	17	0.5	31	1
Euphorbiaceae	1	1.1	31	0.2	32	1

Cogongrass (*Imperata cylindrica*) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	90	100.0	---	17.8	---	3
Imperata cylindrica	90	100.0	1	82.2	1	3
Quercus geminata	20	22.2	3	7.5	2	2
Baccharis halimifolia	7	7.8	6	4.2	3	2
Euthamia tenuifolia	25	27.8	2	3.9	4	3
Polygonella polygama	8	8.9	5	3.5	5	1
Opuntia humifusa	3	3.3	9	1.8	6	1
Smilax bona-nox	9	10.0	4	1.8	6	2
Eupatorium capillifolium	5	5.6	7	1.7	8	1
Parthenocissus quinquefolia	3	3.3	9	1.7	8	1
Salix caroliniana	2	2.2	11	1.7	8	1
Vitis rotundifolia	1	1.1	12	1.7	8	1
Rubus betulifolius	4	4.4	8	1.0	12	2
Callicarpa americana	1	1.1	12	0.2	13	1
Rhynchelytrum repens	1	1.1	12	0.2	13	1

ESTECH 2 ACRE SITE

High Desirable (HD) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	70	100.0	---	15.0	---	3
Schizachyrium stoloniferum	49	70.0	2	38.6	1	3
Galactia elliottii	45	64.3	3	25.0	2	2
Aristida beyrichiana	27	38.6	5	18.3	3	3
Pityopsis graminifolia var. tracyi	35	50.0	4	10.0	4	3
Euthamia tenuifolia	51	72.9	1	9.2	5	3
Elephantopus elatus	11	15.7	8	4.3	6	2
Opuntia humifusa	8	11.4	10	4.2	7	2
Rhynchelytrum repens	21	30.0	6	4.2	7	3
Paspalum setaceum	7	10.0	11	3.5	9	1
Bulbostylis ciliatifolia	4	5.7	14	3.3	10	1
Pterocaulon pycnostachyum	4	5.7	14	3.3	10	1
Paspalum notatum	12	17.1	7	2.9	12	2
Andropogon glomeratus var. glomeratus	3	4.3	17	2.5	13	1
Baccharis halimifolia	2	2.9	18	2.5	13	1
Chapmannia floridana	2	2.9	18	2.5	13	1
Digitaria longiflora	2	2.9	18	2.5	13	1
Rhus copallina	11	15.7	8	2.2	17	3
Sporobolus indicus	5	7.1	13	2.1	18	2
Cyperus retrorsus	6	8.6	12	1.9	19	2
Euphorbia polyphylla	2	2.9	18	1.7	20	1
Dichanthelium portoricense	4	5.7	14	0.4	21	2
Helianthemum corymbosum	2	2.9	18	0.3	22	1
Indigofera hirsuta	1	1.4	23	0.3	22	1
Diodia teres	1	1.4	23	0.2	24	1
Stipulicida setacea	1	1.4	23	0.2	24	1

Low Weedy / Low Desirable (LW/LD) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	70	100.0	---	19.2	---	3
Paspalum notatum	46	65.7	2	37.8	1	3
Galactia elliottii	70	100.0	1	26.7	2	3
Pityopsis graminifolia var. tracyi	34	48.6	4	13.0	3	2
Rhynchelytrum repens	43	61.4	3	10.0	4	3
Chamaecrista fasciculata	4	5.7	14	8.3	5	1
Schizachyrium stoloniferum	11	15.7	7	5.0	6	1
Euthamia tenuifolia	29	41.4	5	3.9	7	3
Balduina angustifolia	5	7.1	12	3.3	8	1
Bulbostylis ciliatifolia	8	11.4	8	3.3	8	1
Dichanthelium portoricense	3	4.3	16	2.5	10	1
Elephantopus elatus	2	2.9	18	2.5	10	1
Gelsemium sempervirens	4	5.7	14	2.5	10	1
Helianthemum corymbosum	5	7.1	12	2.5	10	1
Lyonia fruticosa	3	4.3	16	2.5	10	1
Vaccinium myrsinites	2	2.9	18	2.5	10	1
Vitis aestivalis	1	1.4	23	2.5	10	1
Opuntia humifusa	14	20.0	6	2.4	17	3
Paspalum setaceum	6	8.6	10	2.1	18	2
Cyperus retrorsus	8	11.4	8	1.9	19	3
Indigofera hirsuta	6	8.6	10	1.8	20	1
Pterocaulon pycnostachyum	2	2.9	18	1.7	21	1
Richardia brasiliensis	2	2.9	18	1.7	21	1
Euphorbia polyphylla	2	2.9	18	0.5	23	1

High Weedy (HW) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	80	100.0	---	3.5	---	3
Imperata cylindrica	60	75.0	1	95.0	1	2
Paspalum notatum	20	25.0	4	80.0	2	1
Galactia elliottii	30	37.5	2	20.0	3	1
Euthamia tenuifolia	22	27.5	3	10.8	4	2
Opuntia humifusa	7	8.8	6	5.0	5	1
Rhus copallina	11	13.8	5	4.2	6	2
Rhynchelytrum repens	4	5.0	7	2.5	7	1
Cyperus retrorsus	3	3.8	8	1.3	8	2
Sporobolus indicus	1	1.3	9	0.3	9	1
Callicarpa americana	1	1.3	9	0.2	10	1

GOPHER HILLS SITE

High Desirable (HD) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	120	100.0	---	33.4	---	3
Myrica pusilla	7	5.8	23	20.0	1	1
Schizachyrium stoloniferum	8	6.7	20	20.0	1	1
Paspalum setaceum	53	44.2	1	11.6	3	3
Panicum hemitomon	20	16.7	8	10.0	4	1
Sorghastrum secundum	17	14.2	9	9.5	5	2
Helianthemum corymbosum	44	36.7	2	9.1	6	3
Rhus copallina	6	5.0	25	8.3	7	1
Indigofera hirsuta	25	20.8	7	6.8	8	2
Euthamia tenuifolia	44	36.7	2	6.8	8	3
Dichanthelium portoricense	35	29.2	6	6.7	10	3
Galactia elliottii	42	35.0	4	6.5	11	2
Aristida beyrichiana	7	5.8	23	5.0	12	1
Rhynchelytrum repens	42	35.0	4	4.1	13	2
Pinus palustris	3	2.5	33	4.0	14	1
Quercus virginiana	3	2.5	33	4.0	14	1
Andropogon glomeratus var. glomeratus	12	10.0	16	3.6	16	2
Paspalum notatum	11	9.2	17	3.3	17	1
Pityopsis graminifolia var. tracyi	16	13.3	10	3.0	18	1
Cyperus retrorsus	16	13.3	10	3.0	18	3
Dichanthelium ensifolium var. ensifolium	10	8.3	19	2.9	20	2
Andropogon virginicus var. virginicus	13	10.8	15	2.8	21	2
Setaria geniculata	5	4.2	28	2.5	22	1
Smilax bona-nox	8	6.7	20	2.5	22	1
Lechea divaricata	6	5.0	25	2.4	24	2
Aristida gyrans	5	4.2	28	2.3	25	2
Polypremum procumbens	15	12.5	12	2.1	26	2
Chamaecrista fasciculata	14	11.7	14	2.1	26	3
Bulbostylis ciliatifolia	11	9.2	17	1.9	28	2
Juncus scirpoides	3	2.5	33	1.8	29	1
Pterocaulon pycnostachyum	5	4.2	28	1.7	30	2
Ambrosia artemisiifolia	1	0.8	45	1.7	30	1
Juncus dichotomus	2	1.7	37	1.7	30	1
Ludwigia sp.	2	1.7	37	1.7	30	1
Sporobolus indicus	4	3.3	31	1.5	34	2
Rumex hastatulus	6	5.0	25	1.4	35	1
Diodia teres	15	12.5	12	1.3	36	2
Baccharis halimifolia	2	1.7	37	1.3	36	1
Fimbristylis puberula	3	2.5	33	1.3	36	1
Lindernia grandiflora	1	0.8	45	1.3	36	1
Phoebanthus grandiflorus	1	0.8	45	1.3	36	1
Andropogon virginicus var. glaucus	1	0.8	45	1.0	41	1
Andropogon glomeratus var. hirsutior	2	1.7	37	1.0	41	1
Commelina erecta	2	1.7	37	1.0	41	1
Panicum anceps	1	0.8	45	1.0	41	1
Scleria ciliata	2	1.7	37	1.0	41	1

High Desirable (HD) Quadrats (Cont.)

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Serenoa repens	2	1.7	37	1.0	41	1
Conyza canadensis	4	3.3	31	0.4	47	1
Dichanthelium aciculare	8	6.7	20	0.3	48	2
Scoparia dulcis	1	0.8	45	0.2	49	1
Callicarpa americana	1	0.8	45	0.1	50	1
Crotalaria rotundifolia	2	1.7	37	0.1	50	1
Eupatorium rotundifolium	1	0.8	45	0.1	50	1
Froelichia floridana	1	0.8	45	0.1	50	1
Chapmannia floridana	1	0.8	45	0.1	50	1
Digitaria longiflora	1	0.8	45	0.1	50	1
Eragrostis sp. (sterile)	1	0.8	45	0.1	50	1

Low Desirable (LD) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	110	100.0	---	40.0	---	3
Galactia elliottii	58	52.7	1	13.8	1	2
Paspalum setaceum	58	52.7	1	12.1	2	3
Andropogon virginicus var. virginicus	49	44.5	3	11.3	3	3
Helianthemum corymbosum	30	27.3	6	8.4	4	2
Polypremum procumbens	43	39.1	5	8.0	5	3
Quercus minima	12	10.9	18	5.8	6	2
Chamaecrista fasciculata	12	10.9	18	5.0	7	1
Fimbristylis sp.	6	5.5	23	5.0	7	1
Froelichia floridana	16	14.5	10	5.0	7	1
Rhynchelytrum repens	45	40.9	4	4.3	10	3
Euthamia tenuifolia	16	14.5	10	3.8	11	3
Piloblephis rigida	3	2.7	33	3.3	12	1
Crotalaria rotundifolia	9	8.2	21	3.0	13	2
Andropogon glomeratus var. glomeratus	14	12.7	14	2.9	14	2
Dichanthelium portoricense	30	27.3	6	2.7	15	3
Dichanthelium aciculare	6	5.5	23	2.6	16	1
Aristida gyrans	23	20.9	8	2.6	16	2
Dichanthelium ensifolium var. ensifolium	13	11.8	17	2.5	18	2
Quercus virginiana	4	3.6	27	2.5	18	1
Bulbostylis ciliatifolia	15	13.6	13	2.3	20	3
Cyperus retrorsus	17	15.5	9	2.3	20	3
Conyza canadensis	14	12.7	14	2.1	22	2
Chapmannia floridana	8	7.3	22	2.0	23	2
Hypericum tetrapetalum	4	3.6	27	2.0	23	1
Imperata cylindrica	5	4.5	25	1.8	25	1
Indigofera hirsuta	16	14.5	10	1.7	26	2
Axonopus affinis	2	1.8	39	1.7	26	1
Eleocharis sp.	2	1.8	39	1.7	26	1
Eragrostis elliottii or refracta (sterile)	4	3.6	27	1.7	26	1
Lechea divaricata	2	1.8	39	1.7	26	1
Panicum repens	4	3.6	27	1.7	26	1
Pinus palustris	2	1.8	39	1.7	26	1
Pityopsis graminifolia var. tracyi	3	2.7	33	1.7	26	1
Vaccinium myrsinites	1	0.9	46	1.7	26	1
Rumex hastatulus	5	4.5	25	1.5	35	1
Pterocaulon pycnostachyum	4	3.6	27	1.5	35	2
Aristida beyrichiana	2	1.8	39	1.3	37	1
Chenopodium ambrosioides	3	2.7	33	1.3	37	1
Heterotheca subaxillaris	10	9.1	20	1.3	37	3
Lachnanthes caroliniana	2	1.8	39	1.3	37	1
Panicum anceps	3	2.7	33	1.3	37	1
Phoebanthus grandiflorus	4	3.6	27	1.3	37	1
Scleria ciliata	3	2.7	33	1.3	37	1
Yucca filamentosa	2	1.8	39	1.3	37	1
Diodia teres	14	12.7	14	0.6	45	3
Crotonopsis linearis	3	2.7	33	0.3	46	1
Eragrostis elliottii	1	0.9	46	0.2	47	1
Panicum hemitomon	1	0.9	46	0.2	47	1

Low Desirable (LD) Quadrats (Cont.)

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Scoparia dulcis	1	0.9	46	0.2	47	1
Solidago stricta	1	0.9	46	0.2	47	1
Baccharis halimifolia	1	0.9	46	0.1	51	1
Dichanthelium commutatum	1	0.9	46	0.1	51	1
Dichanthelium sp.	1	0.9	46	0.1	51	1
Panicum tenerum	1	0.9	46	0.1	51	1

Low Weedy / Low Desirable (LW/LD) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	160	100.0	---	32.3	---	3
Rhynchelytrum repens	99	61.9	1	19.7	1	3
Helianthemum corymbosum	93	58.1	2	15.7	2	3
Amphicarpum muhlenbergianum	19	11.9	10	10.0	3	1
Paspalum notatum	28	17.5	7	9.5	4	2
Yucca filamentosa	9	5.6	20	9.0	5	1
Galactia elliottii	38	23.8	4	8.3	6	2
Rhus copallina	2	1.3	40	6.7	7	1
Polypremum procumbens	74	46.3	3	6.3	8	3
Andropogon virginicus var. virginicus	18	11.3	12	5.1	9	1
Smilax laurifolia	6	3.8	29	5.0	10	1
Paspalum setaceum	30	18.8	6	4.6	11	2
Panicum anceps	12	7.5	15	4.3	12	2
Cyperus retrorsus	37	23.1	5	3.8	13	3
Axonopus affinis	11	6.9	18	3.8	13	1
Sporobolus indicus	19	11.9	10	3.2	15	1
Fimbristylis puberula	12	7.5	15	3.1	16	1
Froelichia floridana	7	4.4	24	3.0	17	1
Setaria geniculata	8	5.0	23	3.0	17	1
Euthamia tenuifolia	22	13.8	9	2.6	19	1
Rhynchospora plumosa	10	6.3	19	2.6	19	1
Panicum hemitomon	9	5.6	20	2.5	21	1
Eragrostis elliottii or refracta (sterile)	7	4.4	24	1.9	22	1
Panicum repens	9	5.6	20	1.9	22	1
Eragrostis elliottii	6	3.8	29	1.9	22	1
Indigofera hirsuta	24	15.0	8	1.7	25	2
Gaylussacia dumosa	3	1.9	37	1.7	25	1
Sorghastrum secundum	3	1.9	37	1.7	25	1
Andropogon glomeratus var. glomeratus	15	9.4	13	1.6	28	3
Lechea divaricata	7	4.4	24	1.4	29	2
Scleria ciliata	12	7.5	15	1.4	29	2
Bulbostylis ciliatifolia	7	4.4	24	1.4	29	2
Ludwigia maritima	5	3.1	31	1.3	32	1
Rumex hastatulus	13	8.1	14	1.1	33	2
Chamaecrista fasciculata	5	3.1	31	1.1	33	2
Conyza canadensis	4	2.5	33	1.1	33	1
Eragrostis sp. (sterile)	2	1.3	40	1.1	33	1
Cynodon dactylon	4	2.5	34	1.0	37	1
Richardia brasiliensis	1	0.6	44	1.0	37	1
Hypericum tetrapetalum	2	1.3	40	0.7	39	1
Imperata cylindrica	4	2.5	34	0.7	39	1
Pinus palustris	2	1.3	40	0.6	41	1
Pterocaulon pycnostachyum	1	0.6	44	0.6	41	1
Dichanthelium portoricense	7	4.4	24	0.6	41	2
Heterotheca subaxillaris	4	2.5	34	0.5	44	2
Scoparia dulcis	3	1.9	37	0.2	45	1
Digitaria ciliaris	1	0.6	44	0.1	46	1
Dichanthelium ensifolium var. ensifolium	1	0.6	44	0.1	46	1
Eleocharis sp.	1	0.6	44	0.1	46	1

Low Weedy / Low Desirable (LW/LD) Quadrats(Cont.)

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Eupatorium capillifolium	1	0.6	44	0.1	46	1
Gratiola hispida	1	0.6	44	0.1	46	1
Juncus dichotomus	1	0.6	44	0.1	46	1

High Weedy (HW) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	270	100.0	---	16.8	---	3
Rhynchelytrum repens	216	80.0	1	34.4	1	3
Imperata cylindrica	115	42.6	2	29.7	2	2
Indigofera hirsuta	78	28.9	4	14.0	3	2
Paspalum notatum	36	13.3	7	9.3	4	2
Cynodon dactylon	45	16.7	6	8.0	5	2
Digitaria longiflora	17	6.3	13	7.0	6	1
Paspalum setaceum	30	11.1	9	5.7	7	2
Panicum anceps	13	4.8	14	5.0	8	1
Conyza canadensis	94	34.8	3	4.7	9	3
Chenopodium ambrosioides	18	6.7	11	4.0	10	1
Cyperus retrorsus	58	21.5	5	3.9	11	3
Andropogon glomeratus var. glomeratus	18	6.7	11	3.3	12	2
Heterotheca subaxillaris	32	11.9	8	2.3	13	2
Dichanthelium portoricense	12	4.4	17	2.1	14	1
Digitaria ciliaris	13	4.8	14	1.8	15	2
Euthamia tenuifolia	24	8.9	10	1.8	15	2
Urena lobata	13	4.8	14	1.7	17	3
Chamaesyce hyssopifolia	5	1.9	22	1.4	18	1
Cyperus odoratus	8	3.0	19	1.4	18	1
Galactia elliottii	4	1.5	23	1.0	20	1
Helianthemum corymbosum	4	1.5	23	1.0	20	1
Scoparia dulcis	10	3.7	18	0.9	22	2
Bidens alba	3	1.1	28	0.8	23	1
Panicum repens	6	2.2	21	0.8	23	1
Setaria geniculata	4	1.5	23	0.8	23	1
Andropogon virginicus var. virginicus	2	0.7	29	0.5	26	1
Axonopus affinis	4	1.5	23	0.5	27	1
Baccharis halimifolia	2	0.7	29	0.5	27	1
Crotalaria pallida	2	0.7	29	0.5	27	1
Hypericum hypericoides	2	0.7	29	0.5	27	1
Polypremum procumbens	2	0.7	29	0.5	27	1
Scleria ciliata	2	0.7	29	0.5	27	1
Diodia teres	8	3.0	19	0.4	33	3
Fimbristylis puberula	2	0.7	29	0.3	34	2
Panicum hemitomon	4	1.5	23	0.3	34	2
Paspalum urvillei	2	0.7	29	0.1	36	1
Lepidium virginicum	1	0.4	37	0.1	36	1
Richardia brasiliensis	1	0.4	37	0.1	36	1
Rumex hastatulus	1	0.4	37	0.1	36	1
Solidago stricta	1	0.4	37	0.1	36	1

Low Weedy (LW) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	160	100.0	---	39.0	---	3
Rhynchelytrum repens	145	90.6	1	31.4	1	3
Polypremum procumbens	117	73.1	3	14.6	2	3
Indigofera hirsuta	120	75.0	2	11.4	3	2
Paspalum notatum	14	8.8	8	8.6	4	1
Diodia teres	66	41.3	4	5.7	5	2
Paspalum setaceum	42	26.3	5	3.0	6	3
Aristida gyrans	6	3.8	11	2.9	7	1
Cyperus retrorsus	17	10.6	6	2.6	8	3
Hedyotis corymbosa	1	0.6	25	2.5	9	1
Andropogon virginicus var. virginicus	16	10.0	7	2.2	10	2
Lechea divaricata	6	3.8	11	2.0	11	2
Scoparia dulcis	12	7.5	9	1.8	12	2
Froelichia floridana	9	5.6	10	1.1	13	2
Chamaecrista fasciculata	4	2.5	14	0.9	14	1
Helianthemum corymbosum	5	3.1	13	0.8	15	2
Andropogon glomeratus var. glomeratus	2	1.3	18	0.7	16	1
Eragrostis sp. (sterile)	3	1.9	16	0.7	16	2
Hypericum tetrapetalum	2	1.3	18	0.7	16	1
Imperata cylindrica	2	1.3	18	0.7	16	1
Setaria geniculata	2	1.3	18	0.7	16	1
Digitaria longiflora	4	2.5	14	0.4	21	2
Dichanthelium portoricense	1	0.6	25	0.3	22	1
Bulbostylis ciliatifolia	3	1.9	16	0.1	23	2
Carya floridana	1	0.6	25	0.1	23	1
Chapmannia floridana	1	0.6	25	0.1	23	1
Conyza canadensis	2	1.3	18	0.1	23	2
Heterotheca subaxillaris	1	0.6	25	0.1	23	1
Ludwigia maritima	1	0.6	25	0.1	23	1
Richardia brasiliensis	2	1.3	18	0.1	23	1
Rumex hastatulus	1	0.6	25	0.1	23	1
Scleria ciliata	2	1.3	18	0.1	23	1

HARDEE LAKES SITE

High Weedy (HW) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	80	100.0	---	23.3	---	3
Paspalum notatum	60	75.0	1	72.5	1	2
Urena lobata	21	26.3	4	30.1	2	2
Aeschynomene americana	21	26.3	4	15.0	3	1
Eupatorium capillifolium	6	7.5	18	12.5	4	1
Euthamia tenuifolia	35	43.8	2	11.7	5	2
Indigofera hirsuta	19	23.8	7	6.7	6	2
Andropogon glomeratus var. glomeratus	10	12.5	13	5.0	7	1
Galactia elliottii	15	18.8	10	5.0	7	1
Macroptilium lathyroides	17	21.3	9	5.0	7	1
Ludwigia sp.	6	7.5	18	3.5	10	1
Cyperus polystachyos	15	18.8	10	3.4	11	2
Sacciolepis indica	34	42.5	3	3.4	11	2
Andropogon virginicus var. virginicus	7	8.8	15	3.3	13	2
Cyperus surinamensis	18	22.5	8	3.3	13	2
Desmodium triflorum	4	5.0	23	3.3	13	1
Fimbristylis puberula	20	25.0	6	3.3	13	2
Cyperus retrorsus	10	12.5	13	2.6	17	2
Axonopus affinis	15	18.8	10	2.5	18	2
Panicum anceps	1	1.3	33	2.5	18	1
Cyperus globulosus	5	6.3	21	2.1	20	2
Andropogon glomeratus var. glaucopsis	1	1.3	33	1.7	21	1
Baccharis halimifolia	2	2.5	27	1.7	21	1
Crotalaria rotundifolia	2	2.5	27	1.7	21	1
Dichanthelium aciculare	1	1.3	33	1.7	21	1
Dichanthelium portoricense	3	3.8	24	1.7	21	1
Erechtites hieracifolia	2	2.5	27	1.7	21	1
Fimbristylis dichotoma	7	8.8	15	1.7	21	2
Gelsemium sempervirens	5	6.3	21	1.7	21	1
Juncus dichotomus	2	2.5	27	1.7	21	1
Juncus scirpoides	7	8.8	15	1.7	21	1
Panicum hemitomon	6	7.5	18	1.7	21	1
Paspalum setaceum	3	3.8	24	1.7	21	1
Rhynchospora plumosa	2	2.5	27	1.7	21	1
Serenoa repens	1	1.3	33	1.7	21	1
Vaccinium myrsinites	3	3.8	24	1.7	21	1
Panicum sp.	1	1.3	33	0.3	36	1
Cynodon dactylon	2	2.5	27	0.2	37	1

High Desirable – "*Schizachyrium* Dominated" (HDS) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	90	100.0	---	0.5	---	3
Schizachyrium stoloniferum	90	100.0	1	95.0	1	3
Aristida beyrichiana	17	18.9	4	6.7	2	2
Euthamia tenuifolia	44	48.9	2	6.3	3	3
Scleria ciliata	13	14.4	5	3.5	4	1
Andropogon glomeratus var. glaucopsis	2	2.2	8	1.7	5	1
Elephantopus elatus	1	1.1	12	1.7	5	1
Ilex glabra	3	3.3	7	1.7	5	1
Lyonia fruticosa	4	4.4	6	1.7	5	1
Phoebanthus grandiflorus	2	2.2	8	1.7	5	1
Panicum hemitomon	20	22.2	3	1.3	10	3
Solidago fistulosa	2	2.2	8	0.3	11	1
Dichanthelium aciculare	1	1.1	12	0.2	12	1
Dichanthelium ensifolium var. ensifolium	1	1.1	12	0.2	12	1
Hypericum tetrapetalum	1	1.1	12	0.2	12	1
Indigofera hirsuta	1	1.1	12	0.2	12	1
Persea palustris	1	1.1	12	0.2	12	1
Pityopsis graminifolia var. tracyi	1	1.1	12	0.2	12	1
Pterocaulon pycnostachyum	1	1.1	12	0.2	12	1
Stillingia sylvatica	2	2.2	8	0.2	12	1
Vaccinium myrsinites	1	1.1	12	0.2	12	1

High Desirable "Other Natives Dominated" (HDO) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	70	100.0	---	5.2	---	3
Schizachyrium stoloniferum	40	57.1	3	45.0	1	2
Aristida beyrichiana	33	47.1	5	19.4	2	3
Paspalum setaceum	43	61.4	2	17.2	3	3
Sorghastrum secundum	6	8.6	15	10.0	4	1
Euthamia tenuifolia	50	71.4	1	9.5	5	3
Andropogon glomeratus var. glaucopsis	37	52.9	4	9.2	6	3
Rhynchospora plumosa	23	32.9	6	7.6	7	2
Serenoa repens	9	12.9	10	5.4	8	2
Panicum hemitomon	23	32.9	6	3.9	9	2
Pityopsis graminifolia var. tracyi	6	8.6	15	2.8	10	1
Aristida purpurascens	5	7.1	18	2.5	11	1
Chapmannia floridana	2	2.9	23	2.5	11	1
Cyperus retrorsus	7	10.0	14	2.5	11	1
Elephantopus elatus	2	2.9	23	2.5	11	1
Eleocharis sp.	6	8.6	15	2.5	11	2
Tephrosia hispidula	1	1.4	33	2.5	11	1
Hypericum tetrapetalum	2	2.9	23	2.5	11	1
Setaria geniculata	2	2.9	23	2.5	11	1
Solidago odora var. chapmanii	5	7.1	18	2.5	11	1
Vaccinium myrsinites	8	11.4	11	2.1	20	3
Dichanthelium ensifolium var. ensifolium	13	18.6	8	2.0	21	3
Eupatorium mohrii	3	4.3	21	1.8	22	1
Xyris sp.	3	4.3	21	1.8	22	1
Juncus scirpoides	2	2.9	23	1.7	24	1
Panicum anceps	2	2.9	23	1.7	24	1
Tephrosia hispidula	2	2.9	23	1.7	24	1
Xyris caroliniana	2	2.9	23	1.7	24	1
Crotalaria rotundifolia	8	11.4	11	1.5	28	2
Dichanthelium aciculare	12	17.1	9	1.4	29	3
Pterocaulon pycnostachyum	4	5.7	20	1.4	29	2
Solidago fistulosa	8	11.4	11	0.9	31	3
Opposite herb	2	2.9	23	0.5	32	1
Andropogon virginicus var. virginicus	1	1.4	33	0.3	33	1
Chaptalia tomentosa	1	1.4	33	0.3	33	1
Commelina nigritiana	1	1.4	33	0.3	33	1
Hedyotis corymbosa	1	1.4	33	0.3	33	1
Indigofera hirsuta	2	2.9	23	0.3	33	1
Ludwigia sp.	1	1.4	33	0.3	33	1
Panicum sp.	1	1.4	33	0.3	33	1
Scleria ciliata	1	1.4	33	0.3	33	1
Hedyotis sp.	1	1.4	33	0.2	41	1
Piriqueta caroliniana	1	1.4	33	0.2	41	1

MARGARET GILBERT SITE

High Weedy (HW) Quadrats - Planted

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	80	100.0	---	5.0	--	2
Paspalum notatum	80	100.0	1	93.1	1	2
Indigofera hirsuta	23	28.8	2	7.6	2	2
Sabal etonia	4	5.0	4	5.0	3	1
Bumelia tenax	2	2.5	6	1.3	4	1
Galactia elliottii	1	1.3	13	1.3	4	1
Lyonia fruticosa	2	2.5	6	1.3	4	1
Nolina brittoniana	2	2.5	6	1.3	4	1
Palafoxia feayi	2	2.5	6	1.3	4	1
Pinus palustris	2	2.5	6	1.3	4	1
Quercus geminata	3	3.8	5	1.3	4	1
Rhus copallina	2	2.5	6	1.3	4	1
Yucca filamentosa	2	2.5	6	1.3	4	1
Richardia brasiliensis	13	16.3	3	1.1	13	2
Quercus virginiana	1	1.3	13	0.1	14	1

High Weedy (HW) Quadrats - Seeded

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	50	100.0	---	17.1	---	2
Paspalum notatum	50	100.0	1	80.4	1	2
Cyperus retrorsus	14	28.0	2	2.7	2	2
Polygonella polygama	8	16.0	3	5.0	3	1
Rhynchelytrum repens	6	12.0	4	8.3	4	1
Polypremum procumbens	3	6.0	5	2.5	5	1
Sabal etonia	3	6.0	5	1.7	6	1
Indigofera hirsuta	1	2.0	7	1.7	6	1

High Desirable (HD) Quadrats - Planted

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	50	100.0	---	66.7	---	2
Chrysopsis floridana	11	22.0	5	22.5	1	1
Polygonella polygama	37	74.0	1	16.3	2	2
Paspalum notatum	30	60.0	2	6.8	3	2
Liatris laevigata	10	20.0	7	5.0	4	1
Cyperus retrorsus	27	54.0	3	3.8	5	2
Balduina angustifolia	14	28.0	4	3.4	6	2
Rhynchelytrum repens	11	22.0	5	3.0	7	2
Cyrilla arida	1	2.0	10	2.5	8	1
Bulbostylis ciliatifolia	8	16.0	8	1.8	9	2
Befaria racemosa	3	6.0	9	1.7	10	1
Diodia teres	1	2.0	10	1.7	10	1
Quercus chapmanii	1	2.0	10	1.7	10	1
Andropogon virginicus var. virginicus	1	2.0	10	0.3	13	1
Liatris ohlingerae	1	2.0	10	0.3	13	1
Polygonella robusta	1	2.0	10	0.3	13	1
Sabal etonia	1	2.0	10	0.3	13	1
Earth Star	1	2.0	10	0.2	17	1
Opuntia humifusa	1	2.0	10	0.2	17	1

High Desirable (HD) Quadrats - Seeded

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	60	100.0	---	63.3	---	2
Polygonella polygama	53	88.3	1	25.0	1	2
Balduina angustifolia	10	16.7	7	5.0	2	1
Chrysopsis floridana	17	28.3	3	5.0	2	1
Paspalum setaceum	17	28.3	3	5.0	2	1
Cyperus retrorsus	33	55.0	2	4.3	5	2
Polygonella robusta	15	25.0	6	4.2	6	2
Aristida gyrans	5	8.3	8	3.3	7	1
Paspalum notatum	17	28.3	3	1.8	8	2
Galactia elliottii	1	1.7	11	1.7	9	1
Sorghastrum secundum	2	3.3	10	1.7	9	1
Bulbostylis ciliatifolia	3	5.0	9	0.3	11	2
Quercus geminata	1	1.7	11	0.2	12	1

Low Desirable / Low Weedy (LD/LW) Quadrats - Planted

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	60	100.0	---	53.3	---	2
Polygonella polygama	11	18.3	6	21.7	1	1
Cladonia leporina	25	41.7	3	20.2	2	1
Paspalum notatum	46	76.7	1	15.8	3	2
Polygonella robusta	20	33.3	4	9.2	4	2
Yucca filamentosa	3	5.0	13	6.7	5	1
Cyperus retrorsus	28	46.7	2	4.2	6	2
Cladina evansii	12	20.0	5	3.3	7	1
Liatris laevigata	7	11.7	7	3.3	7	1
Palafoxia feayi	5	8.3	9	3.3	7	1
Cladina subtenuis	6	10.0	8	1.8	10	1
Rhynchelytrum repens	5	8.3	9	1.8	10	2
Liatris ohlingerae	2	3.3	16	1.7	12	2
Persea humilis	3	5.0	13	1.7	12	1
Quercus incana	3	5.0	13	1.7	12	1
Sabal etonia	4	6.7	12	1.7	12	1
Bulbostylis ciliatifolia	5	8.3	9	0.9	16	2
Aristida gyrans	1	1.7	18	0.2	17	1
Pityopsis graminifolia var. tracyi	2	3.3	16	0.2	17	1

Low Desirable / Low Weedy (LD/LW) Quadrats - Seeded

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	60	100.0	---	50.0	---	2
Paspalum notatum	44	73.3	2	20.8	1	2
Polygonella polygama	52	86.7	1	15.0	2	2
Chrysopsis floridana	17	28.3	5	10.0	3	1
Cyperus retrorsus	35	58.3	3	4.3	4	2
Sorghastrum secundum	5	8.3	8	4.2	5	2
Paspalum setaceum	5	8.3	8	3.3	6	1
Balduina angustifolia	18	30.0	4	2.6	7	2
Cyperus globulosus	8	13.3	6	2.0	8	1
Aristida gyrans	2	3.3	12	1.7	9	1
Carphephorus corymbosus	2	3.3	12	1.7	9	1
Pinus clausa	2	3.3	12	1.7	9	1
Quercus incana	5	8.3	8	1.7	9	1
Andropogon virginicus var. virginicus	5	8.3	8	1.0	13	2
Polygonella robusta	7	11.7	7	1.0	13	2
Bulbostylis ciliatifolia	1	1.7	17	0.2	15	1
Liatris chapmanii	1	1.7	17	0.2	15	1
Nolina brittoniana	2	3.3	12	0.2	15	1
Palafoxia feayi	1	1.7	17	0.2	15	1
Pityopsis graminifolia	2	3.3	12	0.2	15	1
Rhynchelytrum repens	1	1.7	17	0.2	15	1

NORALYN SCRUB (N5) SITE

High Weedy – "Bahia Dominated" (HW-BAHIA) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	100	100.0	---	7.3	---	3
Paspalum notatum	100	100.0	1	91.7	1	3
Indigofera hirsuta	19	19.0	2	2.6	2	2
Conyza canadensis	3	3.0	3	1.3	3	1
Cyperus retrorsus	1	1.0	6	1.3	3	1
Rhynchelytrum repens	2	2.0	4	1.3	3	1
Opuntia humifusa	1	1.0	6	0.1	6	1
Paspalum urvillei	1	1.0	6	0.1	6	1
Striga sp.	2	2.0	4	0.1	6	1

High Weedy "Cogon Dominated" (HW-COGON) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	90	100.0	---	30.0	---	3
Imperata cylindrica	90	100.0	1	65.0	1	3
Passiflora incarnata	3	3.3	4	3.3	2	1
Vitis rotundifolia	20	22.2	2	3.3	2	1
Bulbostylis ciliatifolia	6	6.7	3	2.0	4	1
Conyza canadensis	2	2.2	5	1.7	5	1
Indigofera hirsuta	2	2.2	5	0.3	6	1

High Desirable (HD) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	110	100.0	---	56.1	---	3
Garberia heterophylla	14	12.7	4	20.0	1	1
Eragrostis spectabilis	72	65.5	1	19.9	2	3
Licania michauxii	14	12.7	4	15.0	3	1
Quercus inopina	4	3.6	10	5.0	4	1
Rhynchelytrum repens	56	50.9	2	4.4	5	2
Heterotheca subaxillaris	37	33.6	3	4.0	6	3
Diodia teres	8	7.3	8	3.5	7	1
Eustachys petraea	6	5.5	9	3.3	8	1
Serenoa repens	4	3.6	10	2.5	9	1
Opuntia humifusa	10	9.1	7	1.8	10	3
Conyza canadensis	4	3.6	10	1.7	11	1
Bulbostylis ciliatifolia	14	12.7	4	1.4	12	3
Cenchrus echinatus	2	1.8	14	1.3	13	1
Euthamia tenuifolia	4	3.6	10	0.7	14	2
Indigofera hirsuta	2	1.8	14	0.1	15	2
Cyperus retrorsus	2	1.8	14	0.1	15	1

Low Weedy / Low Desirable (LW/LD) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	100	100.0	---	43.9	---	3
Rhynchelytrum repens	100	100.0	1	37.8	1	3
Heterotheca subaxillaris	50	50.0	2	10.5	2	3
Opuntia humifusa	31	31.0	5	9.2	3	3
Conyza canadensis	42	42.0	3	9.0	4	2
Indigofera hirsuta	37	37.0	4	2.6	5	2
Diodia teres	3	3.0	8	1.8	6	1
Cynodon dactylon	3	3.0	8	1.7	7	1
Eragrostis elliottii	3	3.0	8	1.7	7	1
Eragrostis spectabilis	3	3.0	8	1.7	7	1
Passiflora incarnata	4	4.0	7	1.7	7	1
Eupatorium capillifolium	3	3.0	8	1.4	11	1
Paspalum notatum	6	6.0	6	0.8	12	2

PCS LANG LAKE SITE

High Weedy (HW) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	90	100.0	---	7.8	---	3
Paspalum notatum	90	100.0	1	87.2	1	3
Chamaecrista nictitans	37	41.1	2	4.4	2	3
Euthamia tenuifolia	26	28.9	4	3.9	3	3
Kummerowia striata	33	36.7	3	3.6	4	3
Dichanthelium sp.	8	8.9	10	3.3	5	1
Quercus hemisphaerica	2	2.2	18	3.3	5	1
Galactia elliottii	26	28.9	4	2.6	7	2
Andropogon virginicus var. glaucus	8	8.9	10	2.5	8	2
Andropogon virginicus var. virginicus	14	15.6	6	2.5	8	2
Axonopus affinis	12	13.3	8	2.5	8	2
Dichanthelium acuminatum	7	7.8	12	2.5	8	2
Rubus cuneifolius	9	10.0	9	1.9	12	2
Eupatorium mohrii	6	6.7	13	1.8	13	2
Solidago canadensis var. scabra	6	6.7	13	1.8	13	2
Andropogon cf. glomeratus	2	2.2	18	1.7	15	1
Eupatorium capillifolium	1	1.1	25	1.7	15	1
Gelsemium sempervirens	13	14.4	7	1.7	15	2
Iva microcephala	3	3.3	16	1.7	15	1
Paspalum urvillei	2	2.2	18	1.7	15	1
Quercus margaretta	2	2.2	18	1.7	15	1
Smilax glauca	1	1.1	25	1.7	15	1
Conyza canadensis	3	3.3	16	0.3	22	2
Acalypha gracilens	1	1.1	25	0.2	23	1
Agalinis purpurea	1	1.1	25	0.2	23	1
Amphicarpum muhlenbergianum	1	1.1	25	0.2	23	1
Diodia teres	1	1.1	25	0.2	23	1
Eragrostis refracta	2	2.2	18	0.2	23	1
Gnaphalium sp.	1	1.1	25	0.2	23	1
Hypericum gentianoides	4	4.4	15	0.2	23	2
Indigofera hirsuta	1	1.1	25	0.2	23	1
Pinus elliottii	2	2.2	18	0.2	23	2
Toxicodendron radicans	2	2.2	18	0.2	23	1

High Desirable (HD) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	80	100.0	---	29.4	---	3
Andropogon virginicus var. virginicus	70	87.5	1	41.9	1	3
Agalinis purpurea	49	61.3	3	25.0	2	2
Euthamia tenuifolia	57	71.3	2	13.3	3	3
Baccharis halimifolia	32	40.0	5	7.5	4	3
Solidago canadensis var. scabra	43	53.8	4	5.0	5	3
Indigofera hirsuta	28	35.0	6	4.5	6	3
Rubus cuneifolius	19	23.8	7	3.9	7	2
Rhus copallina	13	16.3	8	3.6	8	3
Heterotheca subaxillaris	3	3.8	14	3.3	9	1
Quercus hemisphaerica	10	12.5	9	2.9	10	2
Acalypha gracilens	5	6.3	11	2.8	11	1
Paspalum notatum	3	3.8	14	2.5	12	1
Hypericum gentianoides	4	5.0	13	1.9	13	3
Andropogon virginicus var. glaucus	3	3.8	14	1.8	14	1
Paspalum urvillei	7	8.8	10	1.8	14	3
Ambrosia artemisiifolia	1	1.3	17	1.7	16	1
Conyza canadensis	1	1.3	17	1.7	16	1
Gelsemium sempervirens	5	6.3	11	0.9	18	2
Quercus virginiana	1	1.3	17	0.3	19	1
Dichanthelium sp.	1	1.3	17	0.2	20	1
Gnaphalium obtusifolium	1	1.3	17	0.2	20	1
Toxicodendron radicans	1	1.3	17	0.2	20	1

Low Weedy / Low Desirable (LW/LD) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	90	100.0	---	21.7	---	3
Andropogon cf. glomeratus	30	33.3	5	60.0	1	1
Andropogon virginicus var. virginicus	60	66.7	1	50.0	2	2
Baccharis halimifolia	30	33.3	5	15.0	3	2
Carex verrucosa	12	13.3	10	10.0	4	1
Gelsemium sempervirens	21	23.3	7	10.0	4	1
Euthamia tenuifolia	40	44.4	2	5.0	6	3
Hypericum gentianoides	8	8.9	15	5.0	6	1
Kummerowia striata	6	6.7	18	5.0	6	1
Solidago canadensis var. scabra	38	42.2	3	5.0	6	3
Indigofera hirsuta	31	34.4	4	4.3	10	2
cf. Aristida purpurascens	10	11.1	12	3.5	11	1
Fontinalis sp.	7	7.8	16	3.5	11	1
Poaceae (sterile grass)	5	5.6	21	3.5	11	1
Acalypha gracilens	5	5.6	21	3.3	14	1
Rhus copallina	9	10.0	14	2.6	15	2
Toxicodendron radicans	11	12.2	11	2.6	15	2
Eragrostis elliottii	10	11.1	12	2.5	17	2
Paspalum urvillei	6	6.7	18	2.5	17	2
Rubus cuneifolius	14	15.6	9	2.3	19	3
Chamaecrista nictitans	3	3.3	25	1.8	20	1
Dichanthelium sp.	20	22.2	8	1.8	20	3
Agalinis purpurea	1	1.1	31	1.7	22	1
Albizia julibrissin	2	2.2	27	1.7	22	1
Eupatorium capillifolium	4	4.4	24	1.7	22	2
Juncus effusus	1	1.1	31	1.7	22	1
Quercus margaretta	2	2.2	27	1.7	22	1
Vitis rotundifolia	5	5.6	21	1.7	22	1
Conyza canadensis	7	7.8	16	1.2	28	3
Heterotheca subaxillaris	6	6.7	18	0.7	29	3
Gnaphalium obtusifolium	3	3.3	25	0.3	30	1
Acer rubrum	1	1.1	31	0.2	31	1
Andropogon virginicus var. glaucus	2	2.2	27	0.2	31	1
Dichanthelium acuminatum	2	2.2	27	0.2	31	1
Vaccinium myrsinites	1	1.1	31	0.2	31	1

IMC 16 ACRE SITE

High Desirable (HD) Quadrats – Mulched

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	140	100.0		33.0		3
Aristida beyrichiana	136	97.1	1	26.0	1	3
Andropogon brachystachyus	52	37.1	6	7.8	2	3
Andropogon glomeratus var. hirsutior	41	29.3	8	5.8	3	3
Pityopsis graminifolia var. tracyi	77	55.0	3	5.7	4	3
Cyperus polystachyos	41	29.3	9	5.0	5	1
Rhynchelytrum repens	76	54.3	4	4.9	6	3
Paspalum notatum	26	18.6	11	4.5	7	3
Euthamia tenuifolia	44	31.4	7	4.4	8	3
Desmodium triflorum	81	57.9	2	4.2	9	3
Cyperus surinamensis	9	6.4	26	4.0	10	1
Helianthus angustifolius	12	8.6	19	4.0	10	1
Heterotheca subaxillaris	62	44.3	5	3.7	12	3
Cyperus retrorsus	12	8.6	19	3.0	13	1
Conyza canadensis	15	10.7	16	2.6	14	1
Indigofera hirsuta	40	28.6	10	2.5	15	3
Solidago stricta	19	13.6	13	2.5	15	3
Andropogon virginicus var. virginicus	15	10.7	16	2.5	15	3
Fimbristylis dichotoma	25	17.9	12	2.2	18	3
Andropogon glomeratus var. glaucopsis	18	12.9	14	2.2	18	2
Cynodon dactylon	8	5.7	27	2.2	18	1
Solidago fistulosa	11	7.9	21	2.2	18	1
Eupatorium capillifolium	18	12.9	14	2.2	18	2
Elyonurus tripsacoides	11	7.9	21	2.1	23	2
Andropogon glomeratus var. glomeratus	11	7.9	21	2.1	23	2
Xyris ambigua	14	10.0	18	2.1	23	1
Eryngium yuccifolium	11	7.9	21	2.1	23	3
Andropogon ternarius	7	5.0	28	2.0	27	1
Eragrostis elliottii	5	3.6	32	2.0	27	1
Elephantopus elatus	7	5.0	28	1.6	29	3
Andropogon virginicus var. glaucus	6	4.3	30	1.6	29	2
Digitaria serotina	3	2.1	36	1.3	31	1
Polypremum procumbens	11	7.9	21	1.2	32	3
Scoparia dulcis	5	3.6	33	1.2	32	1
Axonopus affinis	4	2.9	34	1.1	34	2
Desmodium incanum	1	0.7	40	1.0	35	1
Eragrostis sp. (sterile)	2	1.4	39	1.0	35	1
Eustachys petraea	1	0.7	40	1.0	35	1
Schizachyrium stoloniferum	3	2.1	36	1.0	35	1
Ctenium aromaticum	3	2.1	36	0.6	39	2
Aster dumosus	6	4.3	30	0.6	39	2
Rudbeckia hirta	4	2.9	34	0.2	41	1
Acalypha gracilens	1	0.7	40	0.1	42	1
Carphephorus paniculatus	1	0.7	40	0.1	42	1
Fern (too small for confident identification)	1	0.7	40	0.1	42	1
Hedyotis uniflora	1	0.7	40	0.1	42	1
Juncus sp.	1	0.7	40	0.1	42	1

High Desirable (HD) Quadrats – Mulched (Cont.)

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Liatris laevigata	1	0.7	40	0.1	42	1
Macroptilium lathyroides	1	0.7	40	0.1	42	1
Pluchea rosea	1	0.7	40	0.1	42	1
Rhynchospora fascicularis	1	0.7	40	0.1	42	1

High Desirable (HD) Quadrats - Unmulched

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	80	100.0	---	32.5	---	3
Xyris ambigua	17	21.3	9	20.0	1	1
Aristida beyrichiana	55	68.8	1	18.1	2	2
Euthamia tenuifolia	19	23.8	7	12.5	3	1
Andropogon brachystachyus	20	25.0	6	11.3	4	3
Elyonurus tripsacoides	11	13.8	13	10.6	5	2
Andropogon glomeratus var. hirsutior	11	13.8	13	7.5	6	2
Cyperus polystachyos	33	41.3	3	6.3	7	3
Pityopsis graminifolia var. tracyi	44	55.0	2	5.4	8	3
Axonopus affinis	6	7.5	22	5.0	9	1
Heterotheca subaxillaris	26	32.5	5	5.0	9	1
Rhynchospora fascicularis	7	8.8	20	5.0	9	1
Solidago stricta	16	20.0	10	4.7	12	3
Eupatorium capillifolium	16	20.0	10	3.9	13	2
Andropogon virginicus var. virginicus	10	12.5	16	3.8	14	3
Polypremum procumbens	14	17.5	12	3.8	14	2
Cyperus retrorsus	10	12.5	16	3.3	16	3
Rhynchelytrum repens	29	36.3	4	3.3	16	2
Acalypha gracilens	4	5.0	29	2.8	18	1
Cyperus surinamensis	5	6.3	25	2.8	18	1
Eustachys petraea	5	6.3	25	2.8	18	1
Cynodon dactylon	6	7.5	22	2.6	21	2
Desmodium triflorum	11	13.8	13	2.6	21	2
Setaria geniculata	7	8.8	20	2.6	21	2
Solidago fistulosa	4	5.0	29	2.6	21	2
Cyperus sp.	10	12.5	16	2.6	21	2
Ambrosia artemisiifolia	2	2.5	40	2.5	26	1
Andropogon glomeratus var. glaucopsis	3	3.8	31	2.5	26	1
Andropogon glomeratus var. glomeratus	2	2.5	40	2.5	26	1
Buchnera americana	1	1.3	45	2.5	26	1
Eragrostis elliottii	2	2.5	40	2.5	26	1
Eragrostis sp. (sterile)	1	1.3	45	2.5	26	1
Fimbristylis dichotoma	6	7.5	22	2.5	26	1
Paspalum notatum	2	2.5	40	2.5	26	1
Paspalum urvillei	3	3.8	31	2.5	26	1
Schizachyrium stoloniferum	3	3.8	31	2.5	26	1
Helianthus angustifolius	5	6.3	25	2.1	36	3
Chamaecrista fasciculata	5	6.3	25	1.9	37	2
Aster dumosus	3	3.8	31	1.9	37	2
Kummerowia striata	19	23.8	7	1.8	39	3
Indigofera hirsuta	8	10.0	19	1.4	40	3
Crotalaria rotundifolia	3	3.8	31	1.4	40	1
Scoparia dulcis	3	3.8	31	1.4	40	2
Helianthus radula	1	1.3	45	1.3	43	1
Aeschynomene americana	3	3.8	31	0.5	44	1
Gnaphalium sp.	3	3.8	31	0.5	44	1
Baccharis halimifolia	1	1.3	45	0.3	46	1
Cyperus brevifolius	1	1.3	45	0.3	46	1
Lindernia grandiflora	1	1.3	45	0.3	46	1

High Desirable (HD) Quadrats – Unmulched (Cont.)

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Panicum hemitomon	1	1.3	45	0.3	46	1
Polygonum hydropiperoides	2	2.5	40	0.3	46	1
Conyza canadensis	3	3.8	31	0.2	51	2
Andropogon sp.	1	1.3	45	0.1	52	1
Ctenium aromaticum	1	1.3	45	0.1	52	1
Phoebanthus grandiflorus	1	1.3	45	0.1	52	1

Low Desirable (LD) Quadrats - Mulched

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	100	100.0	---	51.7	---	3
Aristida beyrichiana	100	100.0	1	20.0	1	3
Indigofera hirsuta	52	52.0	5	8.9	2	3
Pityopsis graminifolia var. tracyi	60	60.0	4	7.5	3	3
Rhynchelytrum repens	65	65.0	3	6.3	4	3
Andropogon glomeratus var. glaucopsis	7	7.0	15	5.0	5	1
Chamaecrista fasciculata	9	9.0	11	5.0	5	1
Cyperus sp.	5	5.0	19	5.0	5	1
Heterotheca subaxillaris	73	73.0	2	5.0	5	3
Eryngium yuccifolium	9	9.0	11	3.9	9	2
Andropogon brachystachyus	19	19.0	8	3.8	10	3
Elyonurus tripsacoides	20	20.0	7	3.8	10	2
Fimbristylis dichotoma	9	9.0	11	3.8	10	1
Desmodium triflorum	51	51.0	6	3.1	13	3
Paspalum notatum	4	4.0	21	2.8	14	1
Andropogon glomeratus var. glomeratus	6	6.0	16	2.6	15	2
Andropogon glomeratus var. hirsutior	8	8.0	14	2.5	16	1
Cynodon dactylon	4	4.0	21	2.5	16	1
Cyperus retrorsus	1	1.0	34	2.5	16	1
Euthamia tenuifolia	6	6.0	16	2.5	16	1
Sporobolus indicus	3	3.0	28	2.5	16	1
Solidago stricta	5	5.0	19	1.7	21	3
Conyza canadensis	10	10.0	9	1.4	22	2
Eustachys petraea	3	3.0	28	1.4	22	1
Solidago fistulosa	3	3.0	28	1.4	22	1
Aster dumosus	10	10.0	9	1.3	25	2
Kummerowia striata	3	3.0	28	1.3	25	2
Digitaria serotina	1	1.0	34	1.3	25	1
Helianthus angustifolius	4	4.0	21	1.3	25	1
Andropogon virginicus var. glaucus	4	4.0	21	1.0	29	3
Andropogon virginicus var. virginicus	6	6.0	16	0.8	30	2
Macroptilium lathyroides	4	4.0	21	0.8	30	2
Helianthus radula	3	3.0	28	0.7	32	2
Liatris laevigata	4	4.0	21	0.4	33	1
Baccharis halimifolia	2	2.0	33	0.3	34	1
Crotalaria rotundifolia	1	1.0	34	0.3	34	1
Cyperus polystachyos	4	4.0	21	0.3	34	1
Acalypha gracilens	1	1.0	34	0.1	37	1
Coreopsis floridana	1	1.0	34	0.1	37	1

Low Desirable (LD) Quadrats - Unmulched

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	140	100.0	---	73.1	---	3
Aristida beyrichiana	99	70.7	1	9.8	1	3
Pityopsis graminifolia var. tracyi	76	54.3	3	8.4	2	3
Heterotheca subaxillaris	95	67.9	2	6.8	3	3
Desmodium triflorum	16	11.4	6	6.4	4	1
Eustachys petraea	8	5.7	12	5.0	5	1
Rhynchelytrum repens	39	27.9	4	3.6	6	3
Aeschynomene americana	5	3.6	15	3.3	7	1
Andropogon virginicus var. virginicus	18	12.9	5	3.1	8	3
Cynodon dactylon	14	10.0	8	2.9	9	2
Kummerowia striata	4	2.9	18	2.6	10	1
Euthamia tenuifolia	9	6.4	11	2.5	11	2
Solidago stricta	10	7.1	10	2.2	12	2
Polypremum procumbens	4	2.9	18	2.1	13	1
Andropogon brachystachyus	16	11.4	6	2.1	13	3
Indigofera hirsuta	13	9.3	9	2.0	15	2
Macroptilium lathyroides	3	2.1	20	1.7	16	2
Andropogon virginicus var. glaucus	1	0.7	29	1.7	16	1
Andropogon glomeratus var. glomeratus	2	1.4	24	1.7	16	1
Elephantopus elatus	2	1.4	24	1.7	16	1
Elyonurus tripsacoides	3	2.1	20	1.7	16	1
Helianthus angustifolius	2	1.4	24	1.7	16	1
Setaria geniculata	1	0.7	29	1.7	16	1
Andropogon glomeratus var. glaucopsis	3	2.1	20	1.4	23	1
Eupatorium capillifolium	6	4.3	14	1.3	24	2
Liatris laevigata	1	0.7	29	1.3	24	1
Paspalum notatum	7	5.0	13	1.2	26	2
Sporobolus indicus	5	3.6	15	1.2	26	2
Chamaecrista fasciculata	3	2.1	20	0.9	28	2
Andropogon glomeratus var. hirsutior	1	0.7	29	0.7	29	1
Cyperus sp.	5	3.6	15	0.7	29	3
Phoebanthus grandiflorus	2	1.4	24	0.3	31	1
Chenopodium ambrosioides	1	0.7	29	0.2	32	1
Conyza canadensis	1	0.7	29	0.2	32	1
Cyperus retrorsus	1	0.7	29	0.2	32	1
Andropogon sp.	2	1.4	24	0.1	35	1
Solidago fistulosa	1	0.7	29	0.1	35	1

Low Weedy/Low Desirable (LW/LD) Quadrats - Mulched

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	110	100.0	---	42.8	---	3
Heterotheca subaxillaris	103	93.6	2	13.8	1	3
Rhynchelytrum repens	108	98.2	1	13.3	2	3
Aristida beyrichiana	71	64.5	3	10.4	3	3
Kummerowia striata	36	32.7	7	8.8	4	2
Indigofera hirsuta	60	54.5	4	7.9	5	3
Desmodium triflorum	40	36.4	5	6.3	6	3
Cynodon dactylon	38	34.5	6	5.5	7	3
Paspalum notatum	29	26.4	8	5.0	8	2
Solidago fistulosa	4	3.6	18	5.0	8	1
Cyperus retrorsus	10	9.1	13	3.5	10	2
Euthamia tenuifolia	5	4.5	17	3.3	11	1
Eupatorium capillifolium	9	8.2	14	2.9	12	2
Cyperus sp.	4	3.6	18	2.6	13	1
Setaria geniculata	17	15.5	10	2.6	13	2
Pityopsis graminifolia var. tracyi	26	23.6	9	2.5	15	3
Cyperus polystachyos	16	14.5	11	2.4	16	3
Aeschynomene americana	15	13.6	12	2.3	17	2
Andropogon brachystachyus	4	3.6	18	2.3	17	2
Crotalaria lanceolata	8	7.3	15	2.1	19	2
Solidago stricta	4	3.6	18	2.0	20	1
Conyza canadensis	6	5.5	16	1.7	21	1
Juncus dichotomus	2	1.8	27	1.7	21	1
Andropogon glomeratus var. hirsutior	3	2.7	23	1.5	23	2
Fimbristylis dichotoma	3	2.7	23	1.5	23	2
Andropogon ternarius	2	1.8	27	1.3	25	1
Andropogon virginicus var. virginicus	3	2.7	23	1.3	25	2
Elephantopus elatus	1	0.9	29	1.3	25	1
Elyonurus tripsacoides	1	0.9	29	1.3	25	1
Eremochloa ophiuroides	1	0.9	29	1.3	25	1
Cyperus surinamensis	3	2.7	23	0.9	30	2
Macroptilium lathyroides	4	3.6	18	0.5	31	1
Centella asiatica	1	0.9	29	0.2	32	1
Aster tortifolius	1	0.9	29	0.1	33	1
Crotalaria rotundifolia	1	0.9	29	0.1	33	1

Low Weedy/Low Desirable (LW/LD) Quadrats - Unmulched

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	130	100.0	---	85.0	---	3
Heterotheca subaxillaris	99	76.2	1	5.0	1	3
Indigofera hirsuta	26	20.0	5	4.8	2	2
Aristida beyrichiana	54	41.5	4	4.6	3	3
Cynodon dactylon	61	46.9	2	4.2	4	3
Rhynchelytrum repens	57	43.8	3	4.0	5	3
Andropogon brachystachyus	23	17.7	6	3.9	6	2
Andropogon virginicus var. virginicus	18	13.8	8	3.9	6	2
Desmodium triflorum	12	9.2	12	3.6	8	2
Panicum hemitomon	7	5.4	17	3.3	9	1
Andropogon glomeratus var. glaucopsis	12	9.2	12	3.0	10	2
Eustachys petraea	9	6.9	16	2.6	11	2
Paspalum notatum	21	16.2	7	2.4	12	3
Kummerowia striata	15	11.5	9	2.2	13	2
Pityopsis graminifolia var. tracyi	14	10.8	10	1.9	14	3
Andropogon virginicus var. glaucus	7	5.4	17	1.8	15	2
Cyperus surinamensis	3	2.3	20	1.7	16	1
Elyonurus tripsacoides	3	2.3	20	1.7	16	1
Eryngium yuccifolium	2	1.5	24	1.7	16	1
Liatris spicata	2	1.5	24	1.7	16	1
Macroptilium lathyroides	2	1.5	24	1.7	16	1
Solidago fistulosa	3	2.3	20	1.7	16	1
Conyza canadensis	10	7.7	14	1.5	22	2
Euthamia tenuifolia	14	10.8	10	1.4	23	3
Andropogon glomeratus var. hirsutior	1	0.8	30	1.3	24	1
Polypremum procumbens	10	7.7	14	0.9	25	2
Cyperus sp.	1	0.8	30	0.8	26	1
Sesbania sp.	1	0.8	30	0.8	26	1
Cyperus retrorsus	4	3.1	19	0.5	28	2
Aeschynomene americana	2	1.5	24	0.3	29	1
Solidago stricta	3	2.3	20	0.3	29	1
Acalypha gracilens	1	0.8	30	0.2	31	1
Ambrosia artemisiifolia	1	0.8	30	0.2	31	1
Carphephorus paniculatus	1	0.8	30	0.2	31	1
Coreopsis floridana	1	0.8	30	0.2	31	1
Axonopus affinis	2	1.5	24	0.1	35	1
Eupatorium capillifolium	2	1.5	24	0.1	35	2
Sporobolus indicus	1	0.8	30	0.1	35	1
Setaria geniculata	1	0.8	30	0.1	35	1

High Weedy (HW) Quadrats - Mulched

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	70	100.0	---	18.3	---	3
Paspalum notatum	58	82.9	1	31.7	1	3
Rhynchelytrum repens	33	47.1	3	22.5	2	2
Indigofera hirsuta	22	31.4	7	15.1	3	2
Cynodon dactylon	34	48.6	2	6.8	4	3
Heterotheca subaxillaris	12	17.1	10	6.4	5	2
Aristida beyrichiana	25	35.7	6	5.0	6	3
Conyza canadensis	13	18.6	9	5.0	6	1
Euthamia tenuifolia	11	15.7	11	5.0	6	1
Fimbristylis dichotoma	27	38.6	5	3.7	9	3
Cyperus polystachyos	15	21.4	8	3.4	10	2
Desmodium triflorum	29	41.4	4	3.2	11	3
Cyperus retrorsus	5	7.1	14	2.8	12	1
Cyperus surinamensis	4	5.7	17	2.8	12	1
Aster dumosus	6	8.6	12	2.6	14	2
Andropogon brachystachyus	2	2.9	22	2.5	15	1
Andropogon glomeratus var. hirsutior	1	1.4	27	2.5	15	1
Axonopus furcatus	2	2.9	22	2.5	15	1
Cyperus brevifolius	2	2.9	22	2.5	15	1
Solidago stricta	4	5.7	17	2.2	19	2
Acalypha gracilens	6	8.6	12	2.0	20	1
Andropogon ternarius	2	2.9	22	1.7	21	1
Baccharis halimifolia	2	2.9	22	1.7	21	1
Elyonurus tripsacoides	5	7.1	14	1.7	21	1
Pityopsis graminifolia var. tracyi	3	4.3	21	1.7	21	1
Setaria geniculata	5	7.1	14	1.5	25	2
Macroptilium lathyroides	4	5.7	17	1.1	26	2
Andropogon virginicus var. virginicus	1	1.4	27	0.3	27	1
Eupatorium capillifolium	1	1.4	27	0.3	27	1
Kummerowia striata	4	5.7	17	0.2	29	2
Aeschynomene americana	1	1.4	27	0.2	29	1
Scoparia dulcis	1	1.4	27	0.2	29	1

High Weedy (HW) Quadrats - Unmulched

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	100	100.0	---	7.8	---	3
Cynodon dactylon	71	71.0	1	26.9	1	3
Desmodium triflorum	61	61.0	2	17.3	2	3
Paspalum notatum	47	47.0	3	17.1	3	3
Aristida beyrichiana	27	27.0	8	9.4	4	2
Euthamia tenuifolia	38	38.0	6	9.0	5	3
Rhynchelytrum repens	40	40.0	5	8.3	6	3
Sporobolus indicus	12	12.0	15	6.3	7	1
Setaria geniculata	41	41.0	4	6.1	8	3
Heterotheca subaxillaris	19	19.0	12	5.6	9	2
Kummerowia striata	21	21.0	10	5.6	9	2
Acalypha gracilens	11	11.0	16	5.0	11	1
Andropogon brachystachyus	9	9.0	21	5.0	11	1
Eragrostis gangetica	11	11.0	16	5.0	11	1
Fimbristylis dichotoma	22	22.0	9	4.4	14	2
Aeschynomene americana	28	28.0	7	3.9	15	2
Cyperus sp.	7	7.0	25	3.9	15	1
Eustachys petraea	11	11.0	16	3.9	15	1
Indigofera hirsuta	4	4.0	28	3.5	18	1
Cyperus polystachyos	8	8.0	23	3.2	19	2
Solidago stricta	20	20.0	11	3.0	20	3
Pityopsis graminifolia var. tracyi	19	19.0	12	2.7	21	3
Cyperus retrorsus	10	10.0	20	2.7	21	3
Ambrosia artemisiifolia	6	6.0	26	2.6	23	1
Cyperus surinamensis	11	11.0	16	2.6	23	2
Helianthus angustifolius	3	3.0	31	2.5	25	1
Macroptilium lathyroides	8	8.0	23	2.3	26	2
Crotalaria lanceolata	2	2.0	37	1.8	27	1
Eupatorium capillifolium	13	13.0	14	1.8	27	3
Andropogon glomeratus var. hirsutior	2	2.0	37	1.7	29	1
Carex albolutescens	3	3.0	31	1.7	29	1
Elyonurus tripsacoides	3	3.0	31	1.7	29	1
Paspalum urvillei	3	3.0	31	1.7	29	1
Aster dumosus	9	9.0	21	1.6	33	2
Eryngium yuccifolium	4	4.0	28	1.5	34	3
Cyperus globulosus	5	5.0	27	1.5	34	1
Andropogon virginicus var. glaucus	1	1.0	42	1.3	36	1
Coreopsis floridana	3	3.0	31	1.3	36	1
Elephantopus elatus	2	2.0	37	1.3	36	1
Panicum repens	2	2.0	37	1.3	36	1
Conyza canadensis	4	4.0	28	0.3	40	1
Sesbania sp.	3	3.0	31	0.3	40	1
Chamaecrista fasciculata	1	1.0	42	0.2	42	1
Scoparia dulcis	2	2.0	37	0.1	43	2
Chamaecrista sp.	1	1.0	42	0.1	43	1

CARGILL WILDLIFE CORRIDOR SITE

High Weedy – "Cogon Dominated" (HW-COGON) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	140	100.0	---	10.5	---	3
Imperata cylindrica	140	100.0	1	86.8	1	3
Thelypteris hispidula	12	8.6	4	7.6	2	1
Indigofera hirsuta	52	37.1	2	5.8	3	2
Quercus virginiana	4	2.9	7	5.0	4	1
Crotalaria pallida	8	5.7	5	3.9	5	1
Eupatorium capillifolium	6	4.3	6	2.2	6	1
Aeschynomene americana	33	23.6	3	1.8	7	3
Paspalum notatum	2	1.4	12	1.7	8	1
Passiflora incarnata	4	2.9	7	1.5	9	2
Solidago elliottii	3	2.1	10	1.4	10	1
Andropogon virginicus var. virginicus	4	2.9	7	1.3	11	1
Ludwigia peruviana	2	1.4	12	1.3	11	1
Nephrolepis sp.	1	0.7	14	1.3	11	1
Thelypteris dentata	1	0.7	14	1.3	11	1
Urena lobata	3	2.1	10	0.2	15	2
Blechnum serrulatum	1	0.7	14	0.1	16	1
Hydrocotyle umbellata	1	0.7	14	0.1	16	1

High Weedy – "Natal Dominated" (HW-NATAL) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	120	100.0	---	10.5	---	3
Indigofera hirsuta	116	96.7	2	56.1	1	3
Rhynchelytrum repens	120	100.0	1	50.8	2	3
Aeschynomene americana	30	25.0	3	4.8	3	2
Cyperus sp.	9	7.5	4	4.0	4	1
Richardia scabra	9	7.5	4	2.3	5	2
Cynodon dactylon	2	1.7	8	1.7	6	1
Eupatorium capillifolium	3	2.5	6	1.7	6	1
Sporobolus indicus	2	1.7	8	1.4	8	1
Cyperus retrorsus	3	2.5	6	1.3	9	1
Gnaphalium obtusifolium	2	1.7	8	0.7	10	2
Desmodium triflorum	2	1.7	8	0.2	11	1

Low Desirable (LD) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	70	100.0	---	8.5	---	3
Indigofera hirsuta	70	100.0	1	57.8	1	3
Aeschynomene americana	40	57.1	4	32.5	2	2
Passiflora incarnata	51	72.9	3	19.4	3	3
Crotalaria spectabilis	5	7.1	8	12.5	4	1
Euthamia tenuifolia	6	8.6	7	10.0	5	1
Rhynchelytrum repens	53	75.7	2	9.2	6	3
Paspalum notatum	10	14.3	5	8.3	7	1
Gnaphalium obtusifolium	10	14.3	5	3.3	8	1
Andropogon virginicus var. virginicus	3	4.3	9	2.5	9	1
Callicarpa americana	3	4.3	9	2.5	9	1
Chenopodium ambrosioides	2	2.9	11	2.5	9	1
Eupatorium capillifolium	2	2.9	11	2.5	9	1
Wahlenbergia marginata	2	2.9	11	0.5	13	1
Striga gesnerioides	2	2.9	11	0.3	14	1

Low Weedy – "Cogon Dominated" (LW-COGON) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	100	100.0	---	46.7	---	3
Imperata cylindrica	98	98.0	1	29.4	1	3
Indigofera hirsuta	70	70.0	2	29.4	1	3
Andropogon glomeratus var. hirsutior	15	15.0	4	10.0	3	1
Rhynchelytrum repens	36	36.0	3	9.4	4	2
Crotalaria pallida	11	11.0	6	5.0	5	1
Hedyotis corymbosa	9	9.0	8	3.5	6	1
Andropogon virginicus var. virginicus	9	9.0	8	3.3	7	1
Cyperus retrorsus	4	4.0	16	3.3	7	1
Juncus dichotomus	7	7.0	11	3.3	7	1
Rubus betulifolius	4	4.0	16	3.3	7	1
Aeschynomene americana	14	14.0	5	2.3	11	2
Scoparia dulcis	7	7.0	11	2.0	12	1
Bulbostylis ciliatifolia	8	8.0	10	1.8	13	1
Cyperus sp.	5	5.0	14	1.8	13	1
Richardia scabra	11	11.0	6	1.8	13	2
Agalinis sp.	1	1.0	27	1.7	16	1
Baccharis halimifolia	2	2.0	20	1.7	16	1
Eupatorium capillifolium	2	2.0	20	1.7	16	1
Lonicera sempervirens	1	1.0	27	1.7	16	1
Ludwigia peruviana	2	2.0	20	1.7	16	1
Myrica cerifera	2	2.0	20	1.7	16	1
Solidago elliottii	2	2.0	20	1.7	16	1
Sporobolus indicus	2	2.0	20	1.7	16	1
Striga gesnerioides	4	4.0	16	1.5	24	1
Paspalum notatum	3	3.0	19	1.4	25	1
Cyperus globulosus	5	5.0	14	0.9	26	2
Paspalum setaceum	2	2.0	20	0.3	27	1
Gnaphalium obtusifolium	6	6.0	13	0.3	27	2
Chenopodium ambrosioides	1	1.0	27	0.2	29	1
Desmodium triflorum	1	1.0	27	0.2	29	1
Macroptilium lathyroides	1	1.0	27	0.1	31	1

Low Weedy – "Natal Dominated" (LW-NATAL) Quadrats

Species Are Arranged in Order of Decreasing Cover

Species	Total Frequency	Relative Frequency	Frequency Rank	Avg. % Cover	Cover Rank	No. Quads Occurred
Bare Ground	110	100.0	---	33.3	---	3
Indigofera hirsuta	109	99.1	2	44.9	1	3
Rhynchelytrum repens	110	100.0	1	34.0	2	3
Heterotheca subaxillaris	27	24.5	3	7.1	3	1
Celtis laevigata	2	1.8	8	2.5	4	1
Quercus virginiana	3	2.7	6	2.5	4	1
Serenoa repens	3	2.7	6	2.5	4	1
Richardia scabra	6	5.5	4	1.4	7	2
Alysicarpus ovalifolius	2	1.8	8	1.0	8	1
Gnaphalium obtusifolium	4	3.6	5	0.8	9	2
Cyperus sp.	1	0.9	10	0.3	10	1
Striga gesnerioides	1	0.9	10	0.3	10	1
Oenothera laciniata	1	0.9	10	0.1	12	1

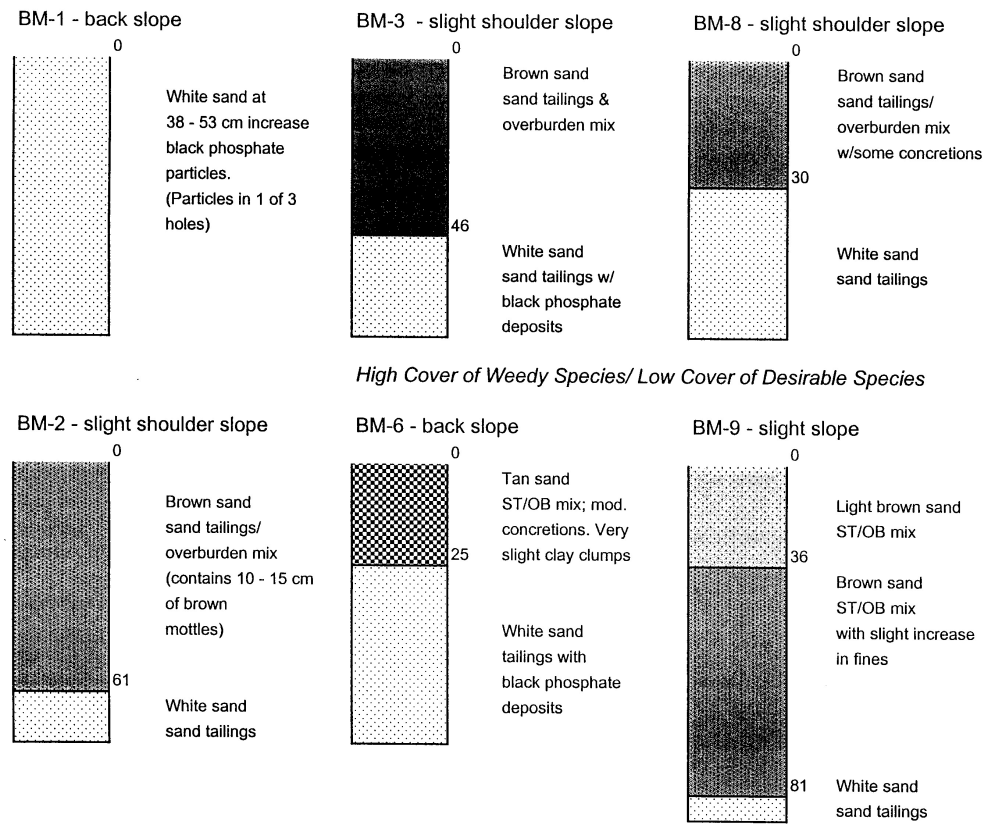
Appendix E

SOIL PROFILE DIAGRAMS FOR EACH UPLAND RECLAMATION SAMPLING SITE

SOIL PROFILE DIAGRAMS (CM)

BALD MOUNTAIN

Low Cover of Desirable Species/Low Cover of Weedy Species

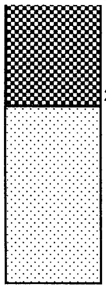


SOIL PROFILE DIAGRAMS (CM)

BALD MOUNTAIN

Low Cover of Weedy Species/Low Cover of Desirable Species

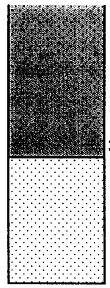
BM-4 - slight shoulder slope



0 — Brown sand or loamy sand ST/OB mix. Few to mod. concretions

25 — White fine sand sand tailings

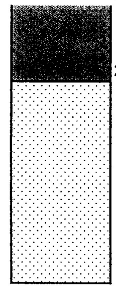
BM-10 - flat



0 — Light brown sand, mixture of overburden & sand tailing

38 — White sand sand tailings. (Profile in second hole began at 30 cm)

BM-12 - back slope

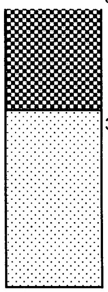


0 — Mixture of brown & white sand ST/OB mix. Few concretions (second hole had darker brown sand and profile extended down to 41cm.)

23 — White sand sand tailings

High Cover of Desirable Species/Low Cover of Weedy Species

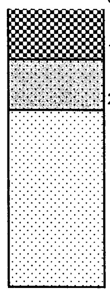
BM-5 - slight shoulder slope



0 — Brown loamy sand Mix of ST & OB. Few to no concretions

33 — White fine sand sand tailings (Profile began at 41 cm in second hole)

BM-7 - back slope

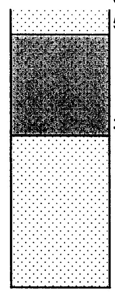


0 — Light tan ST

18 — Grayish white ST transition zone

23 — White fine sand sand tailings w/ phosphate specks

BM-11 - slight slope next to low basin



0 — White sand ST

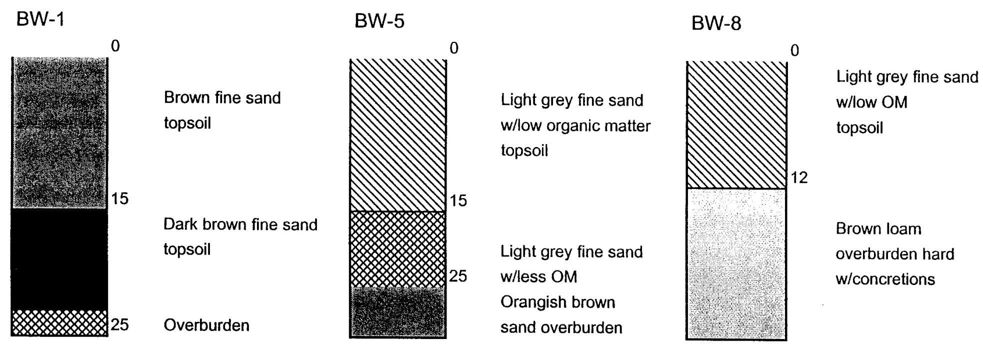
5 — Brown mix of ST/OB. Some concretions. Increase fines at 23 cm

30 — White sand sand tailings

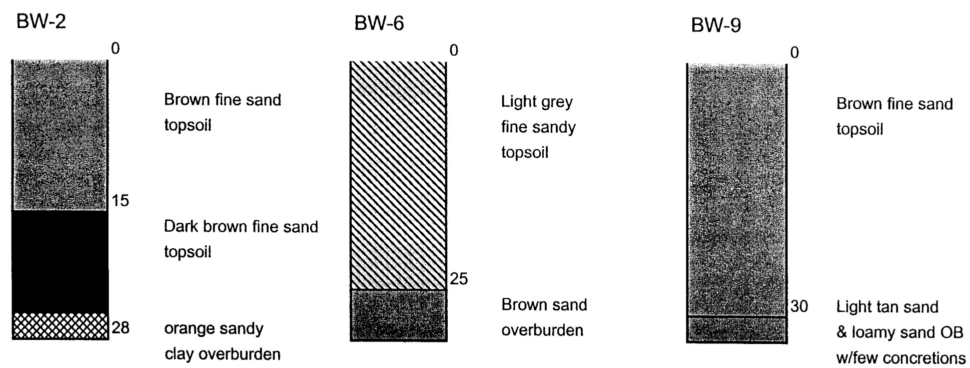
SOIL PROFILE DIAGRAMS (CM)

BEST OF THE WEST

High Cover Weedy Species - Cogan



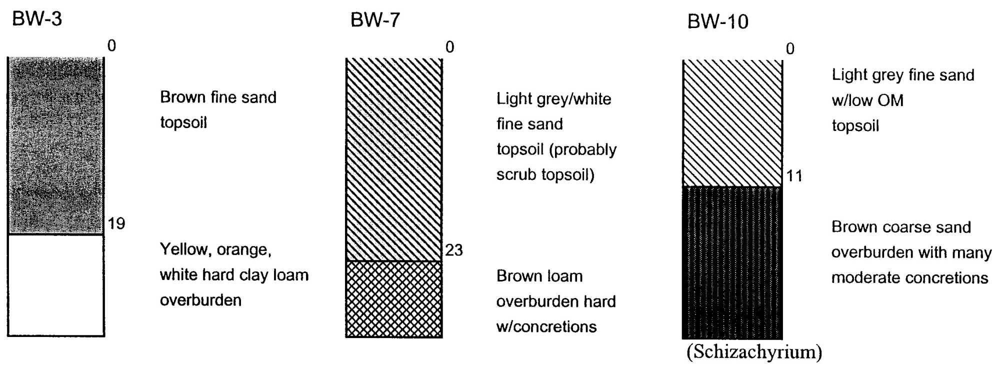
Low Cover of Weedy Species/Low Cover Desirable Species



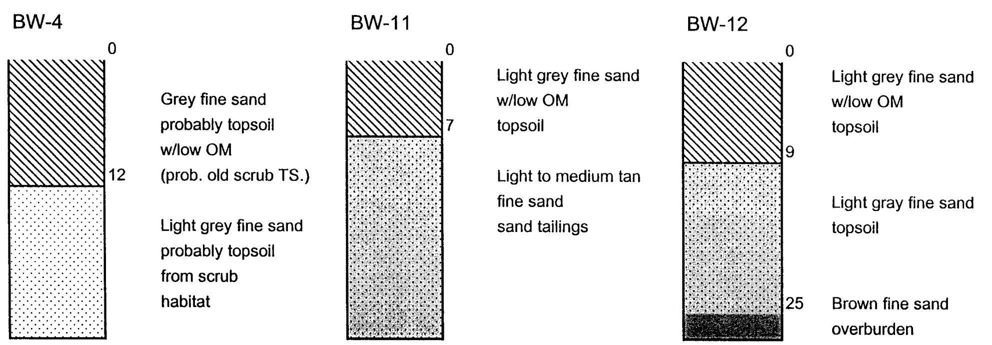
SOIL PROFILE DIAGRAMS (CM)

BEST OF THE WEST

High Cover of Desirable Non Scrub Species



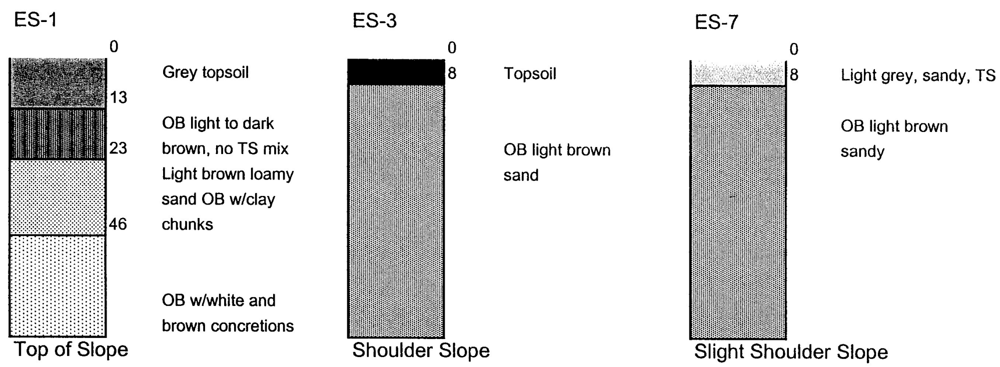
High Cover of Desirable Scrub Species



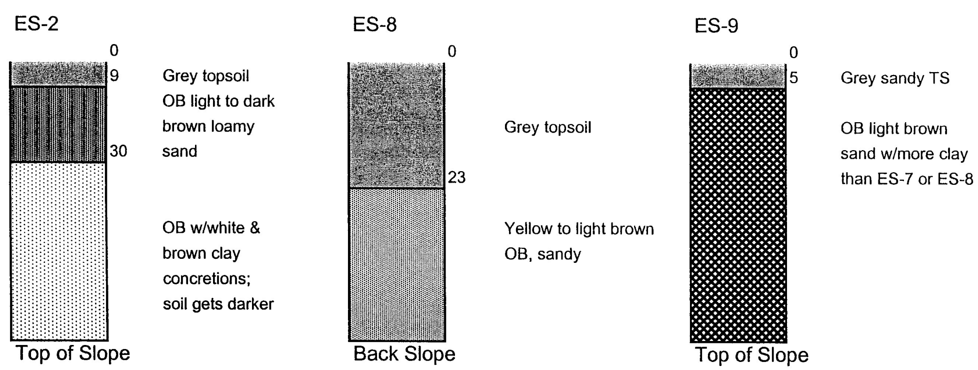
SOIL PROFILE DIAGRAMS (CM)

ESTEC

High Cover Desirable Species

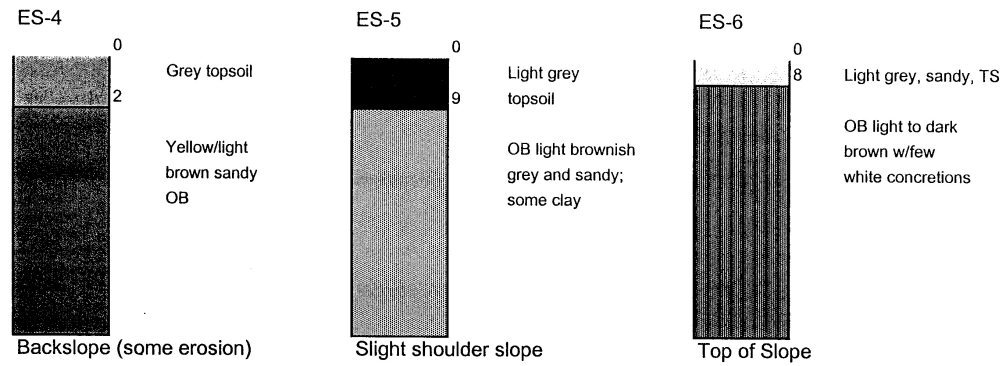


High Cover Weedy Species



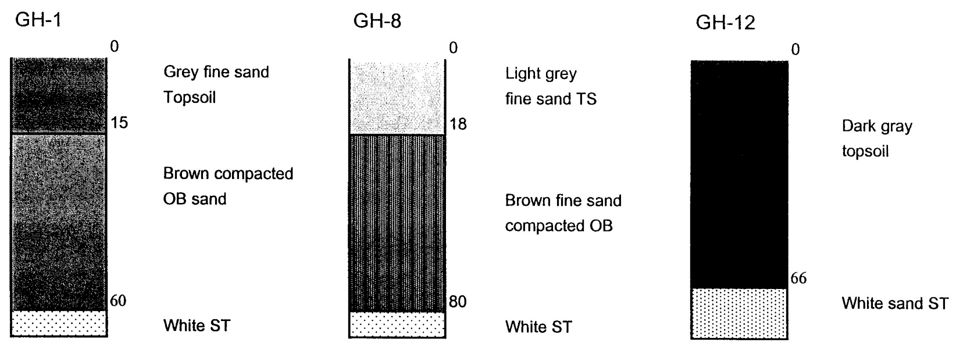
SOIL PROFILE DIAGRAMS (CM)

ESTEC
Low Cover Weedy Species/Low Cover Desirable Species

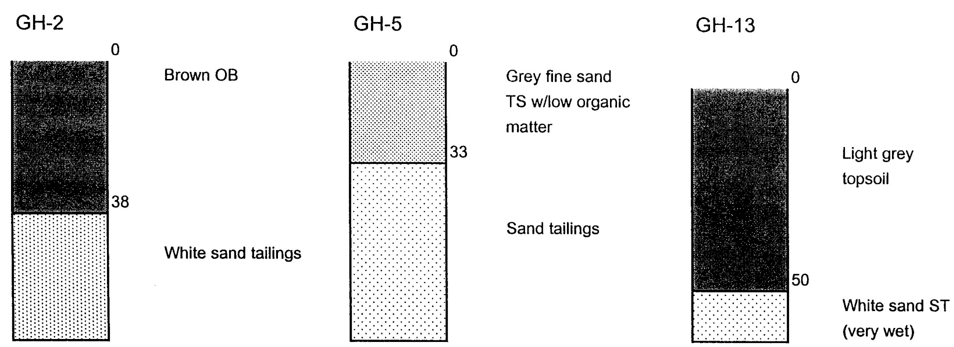


SOIL PROFILE DIAGRAMS (CM)

GOPHER HILLS
High Cover of Desirable Species

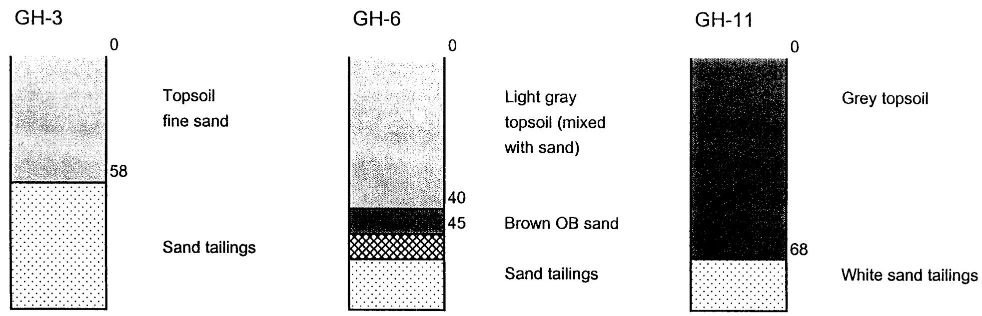


Low Cover Weedy Species



SOIL PROFILE DIAGRAMS (CM)

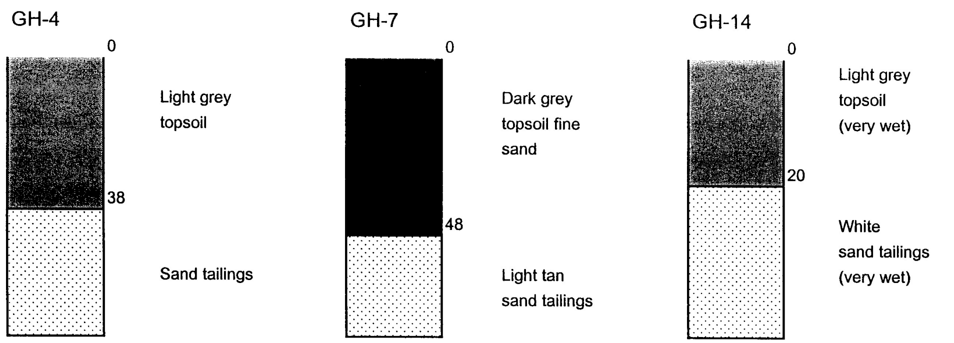
GOPHER HILLS
High Cover Weedy Species



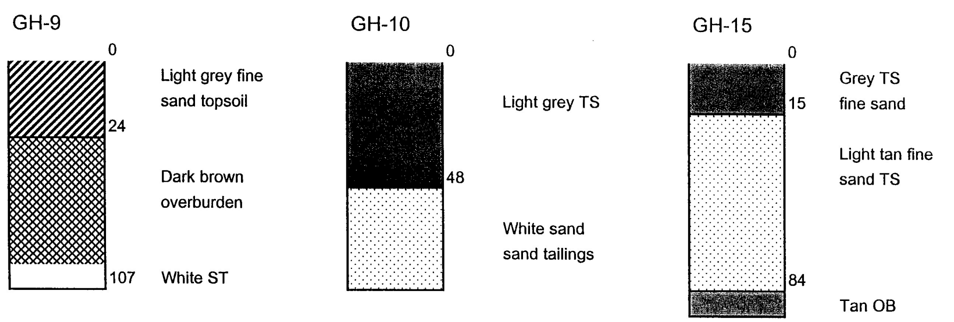
SOIL PROFILE DIAGRAMS (CM)

GOPHER HILLS

Low Cover Desirable Species/Low Cover Weedy Species



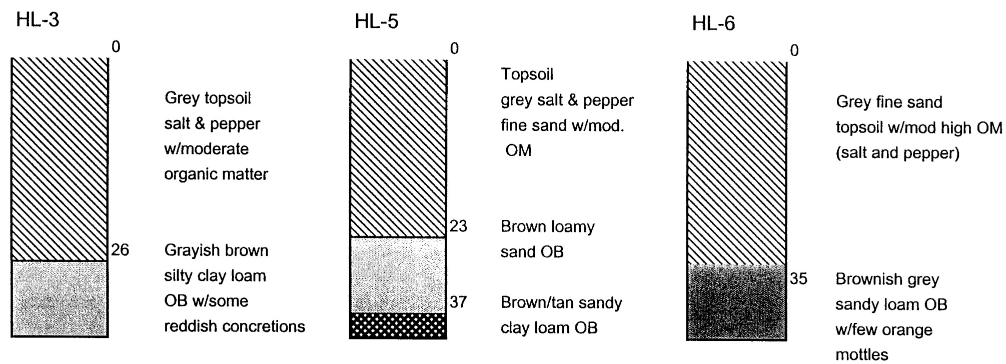
Low Cover Desirable Species



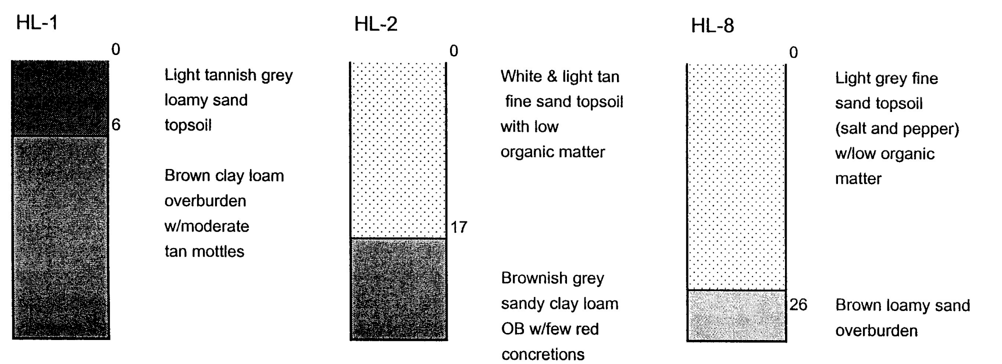
SOIL PROFILE DIAGRAMS (CM)

HARDEE LAKES

High Cover of Desirable Species Dominated by Other Mixed Natives



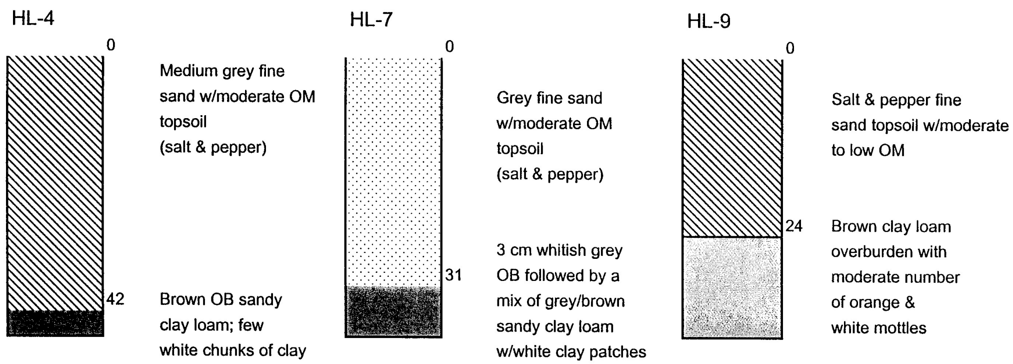
High Cover Weedy Species



SOIL PROFILE DIAGRAMS (CM)

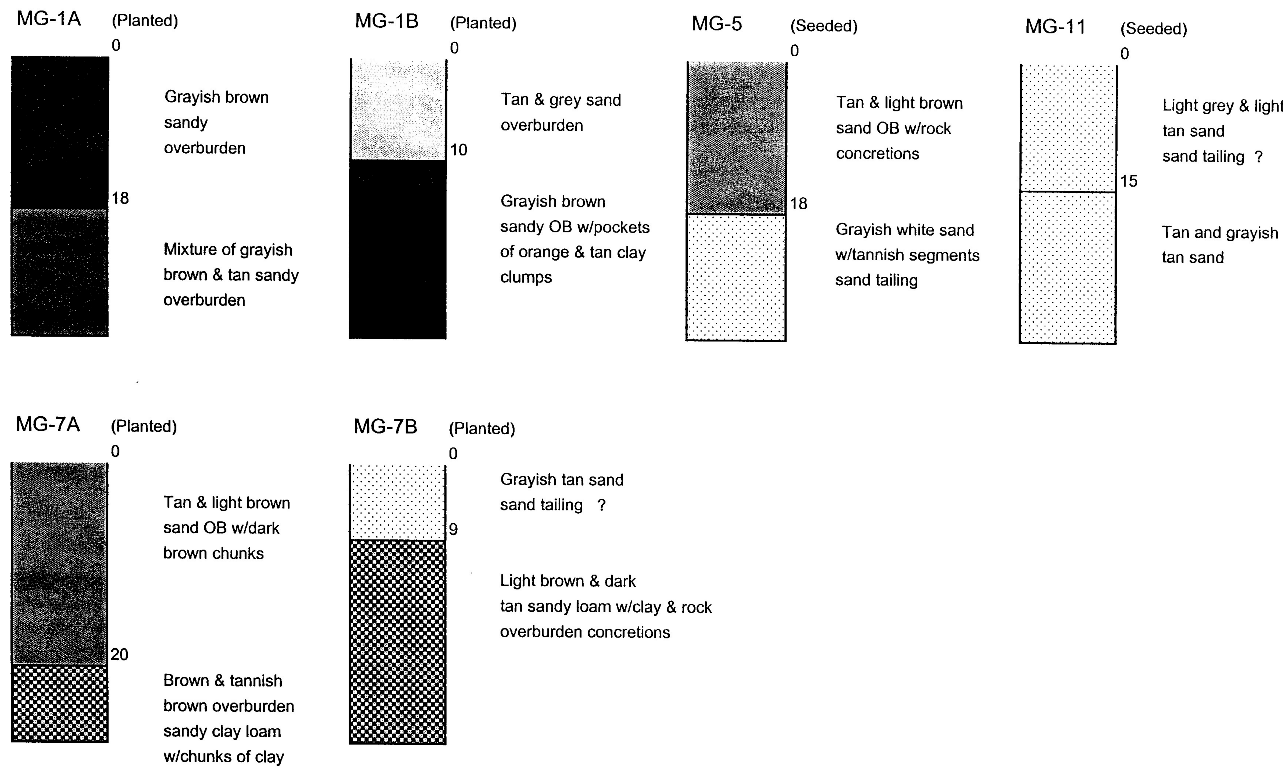
HARDEE LAKES

High Cover of Desirable Species Dominated by Schizachyrium scoparium



SOIL PROFILE DIAGRAMS (CM)

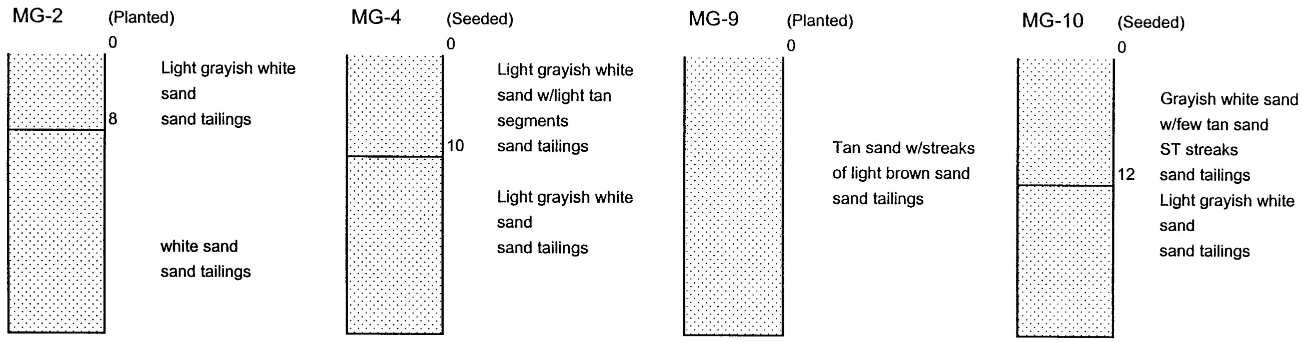
MARGARET GILBERT
High Cover of Weedy Species



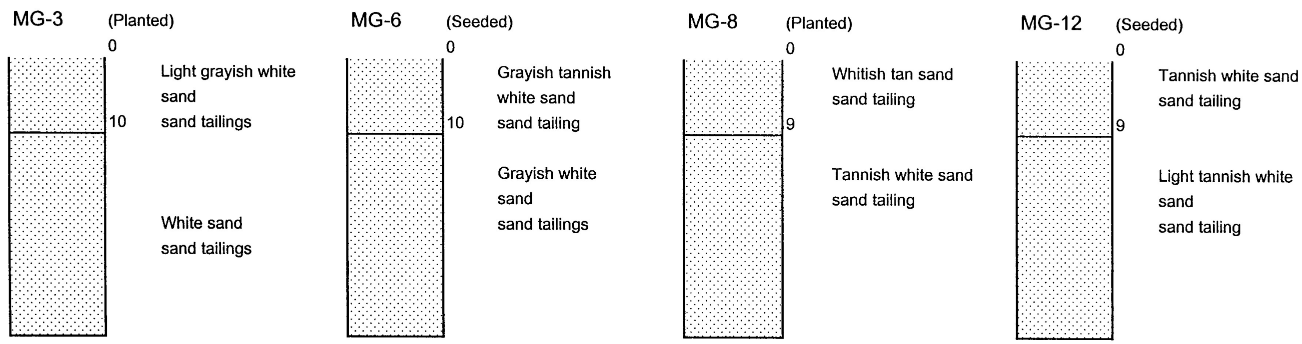
SOIL PROFILE DIAGRAMS (CM)

MARGARET GILBERT

High Cover of Desirable Species



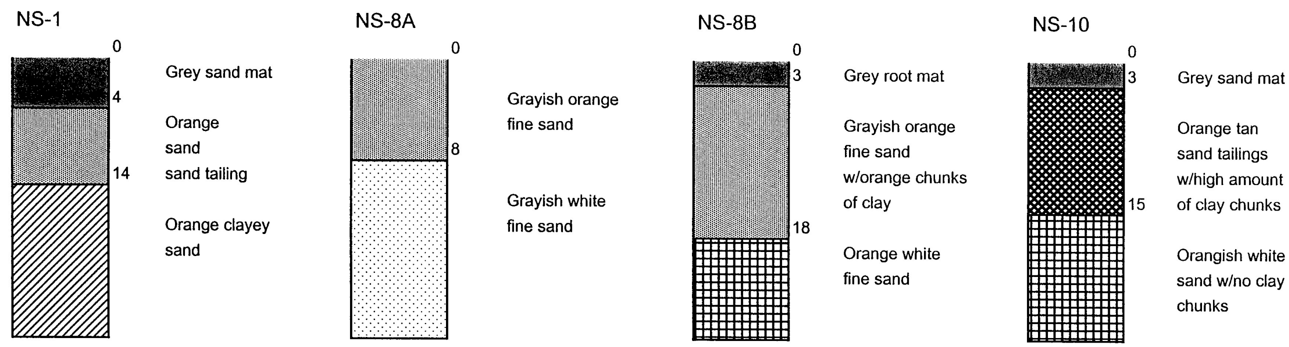
Low Cover of Desirable Species/Low Cover Weedy Species



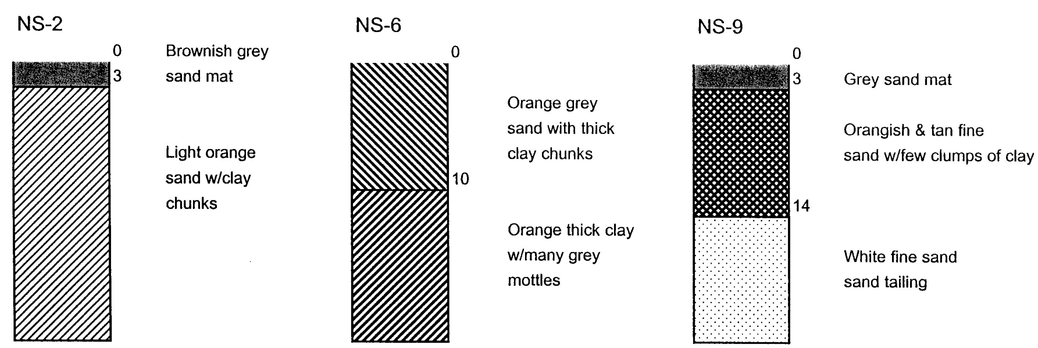
SOIL PROFILE DIAGRAMS (CM)

NORALYN SCRUB

High Cover of Weedy Species (Bahia Grass)

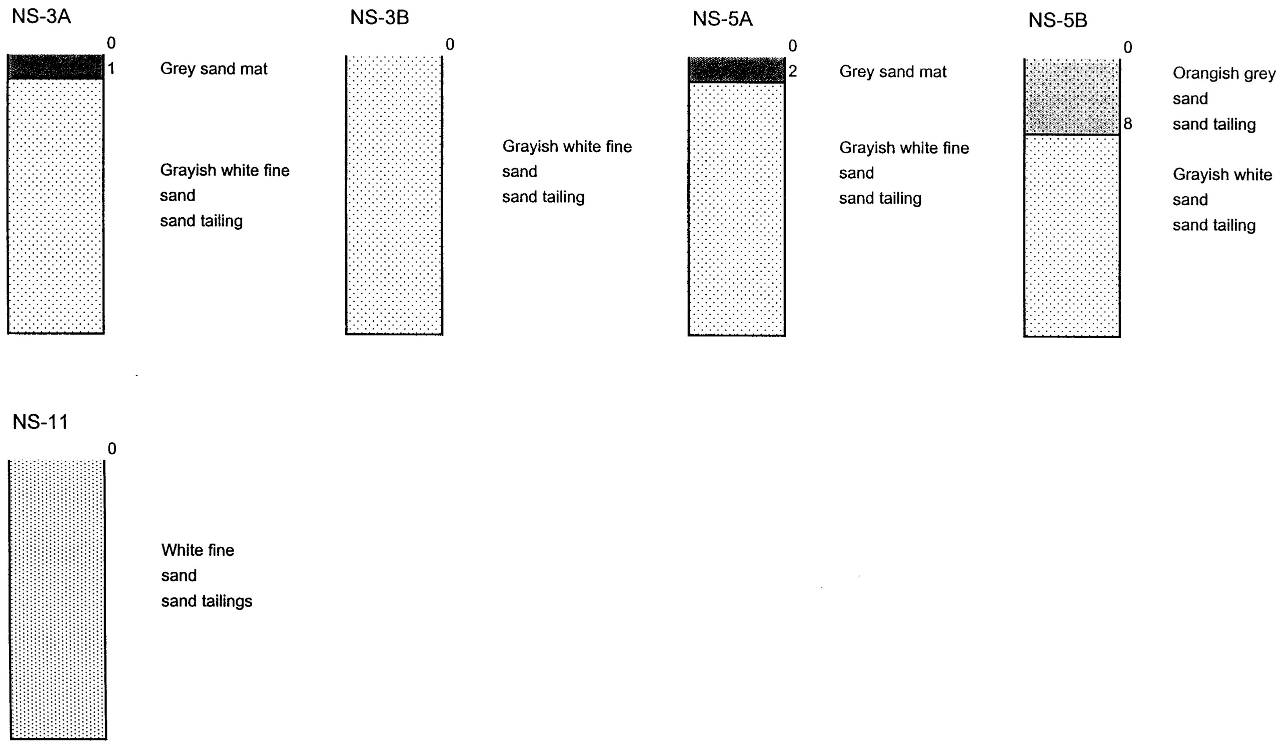


High Cover of Weedy Species (Cogan Grass)



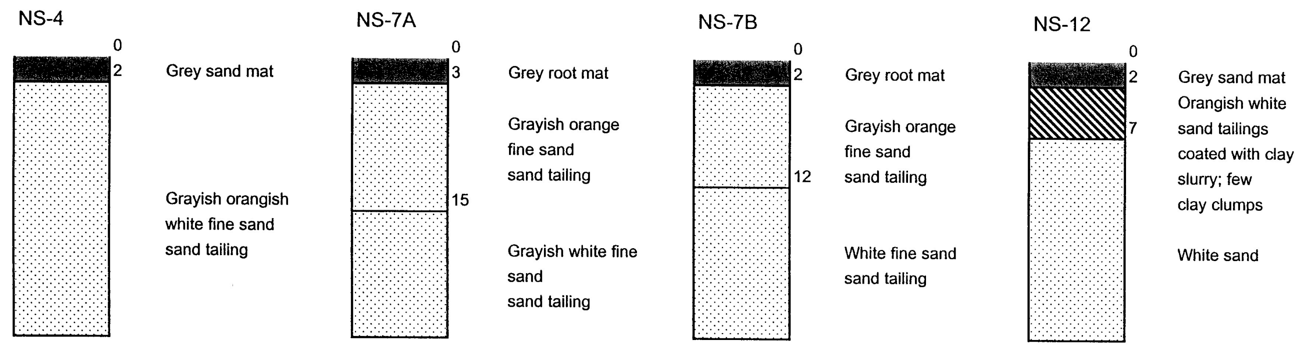
SOIL PROFILE DIAGRAMS (CM)

NORALYN SCRUB
High Cover of Desirable Species



SOIL PROFILE DIAGRAMS (CM)

NORALYN SCRUB
Low Cover of Weedy / Low Cover of Desirable Species



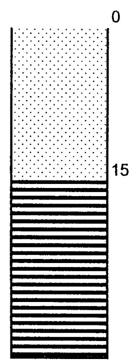
SOIL PROFILE DIAGRAMS (CM)

PCS SITE

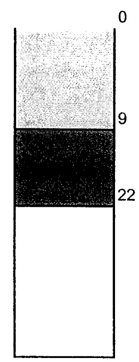
High Cover of Desirable Species

PC-6

PC-7

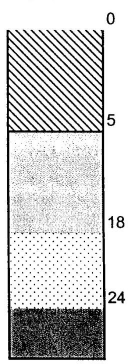


PC-8

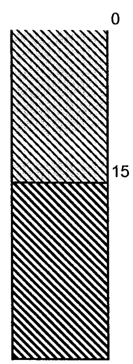


High Cover of Weedy Species

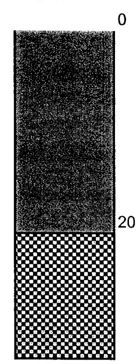
PC-1



PC-2



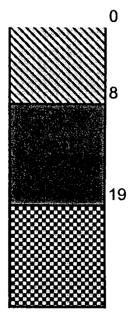
PC-5



SOIL PROFILE DIAGRAMS (CM)

PCS SITE
Low Cover of Weedy Species/Low Cover of Desirable Species

PC-3

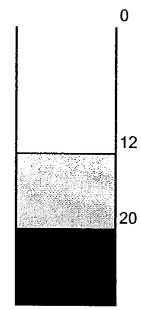


Grey topsoil Attached to roots; grey SL that has formed hard clumps w/tan sandy clay

Hard clay overburden w/matrix that is 1/2 orange oxidized and 1/2 grey reduced

Hard grey overburden clay w/few orange mottles

PC-4

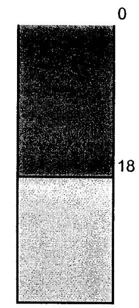


Grayish brown sandy cl. loam that formed hard concretions; overburden

Light tan loamy f. sand w/many large white concretions; OB

Light tan fine loamy sand w/few concretions; OB

PC-9



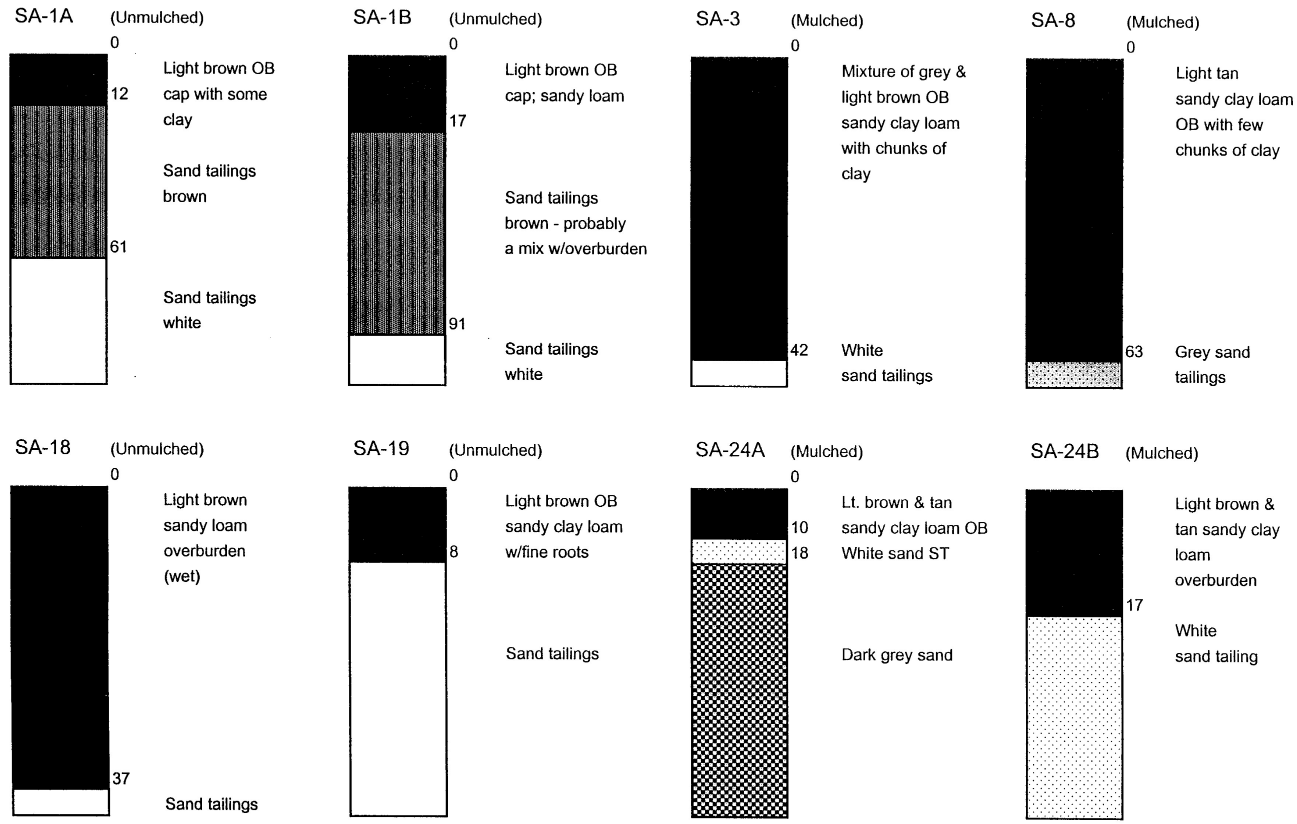
Brownish tan sandy loam overburden w/many med clay loam concretion

Sandy clay loam overburden tan w/many large grey gley clay concretions

SOIL PROFILE DIAGRAMS (CM)

SIXTEEN ACRE (SA)

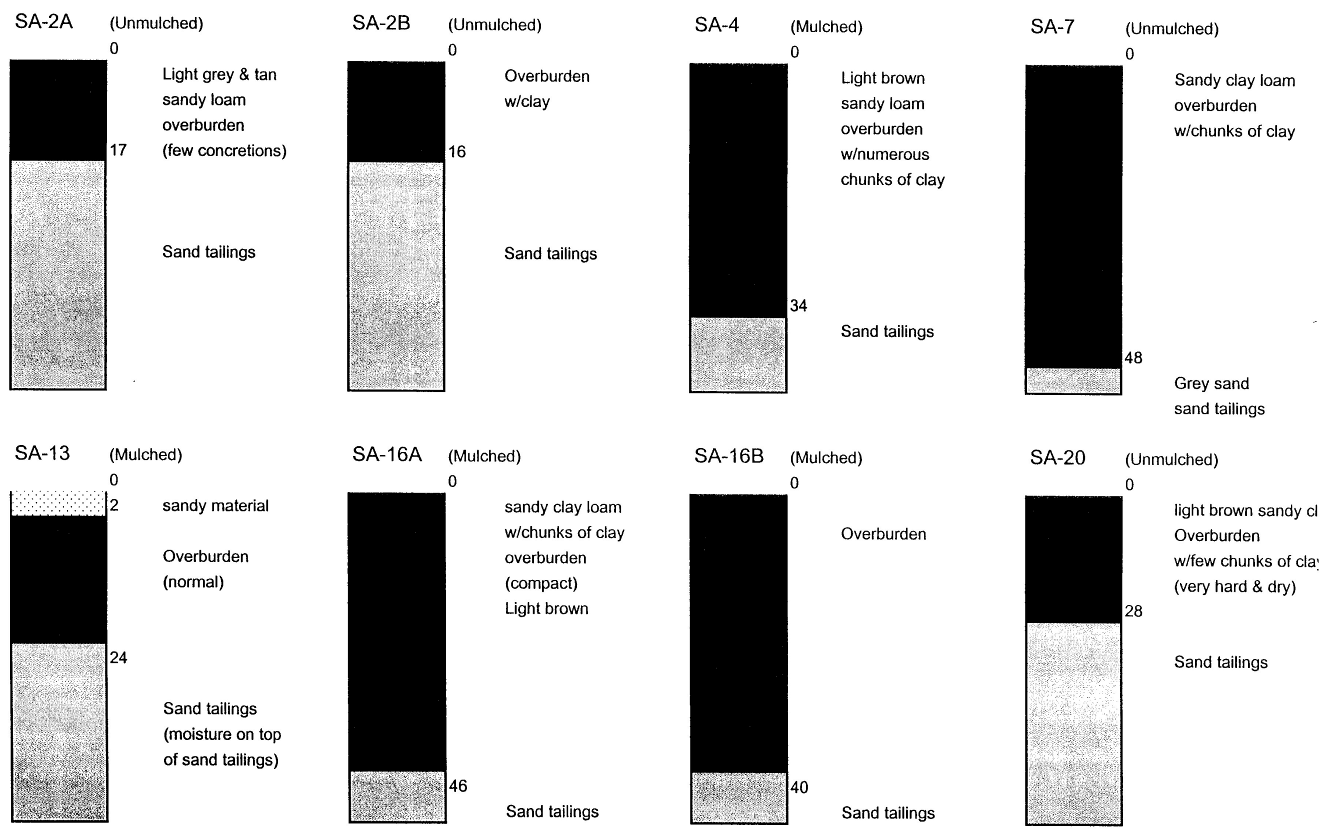
High Cover of Desirable Species



SOIL PROFILE DIAGRAMS (CM)

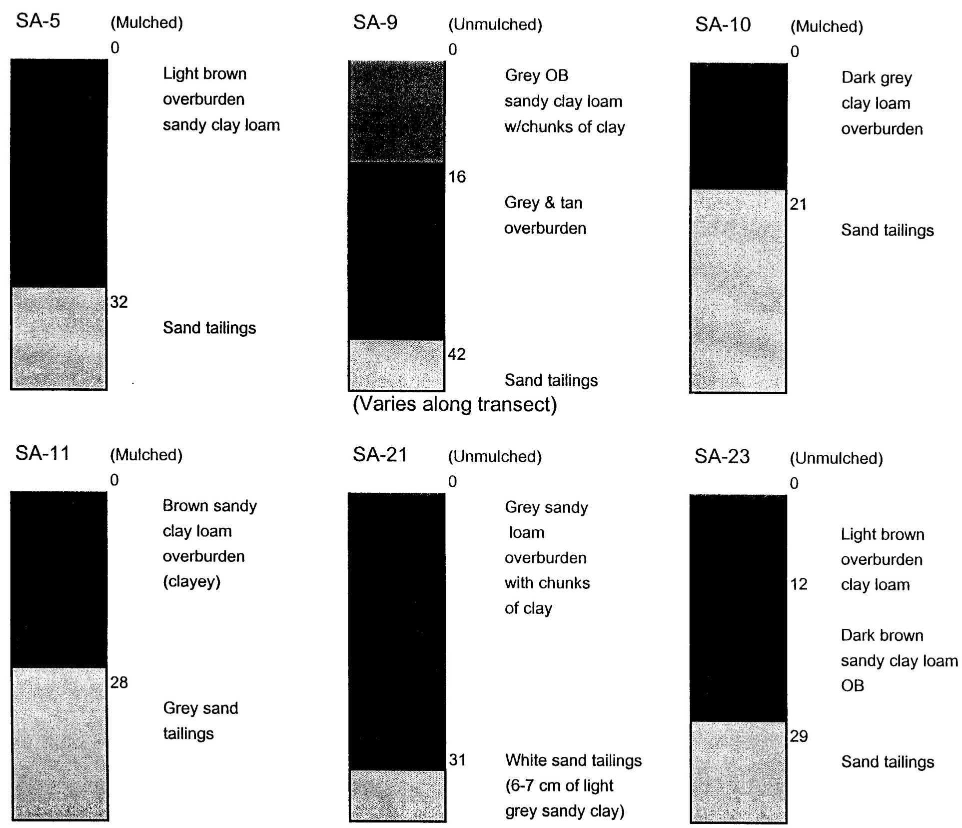
SIXTEEN ACRE (SA)

Low Cover of Desirable Species



SOIL PROFILE DIAGRAMS (CM)

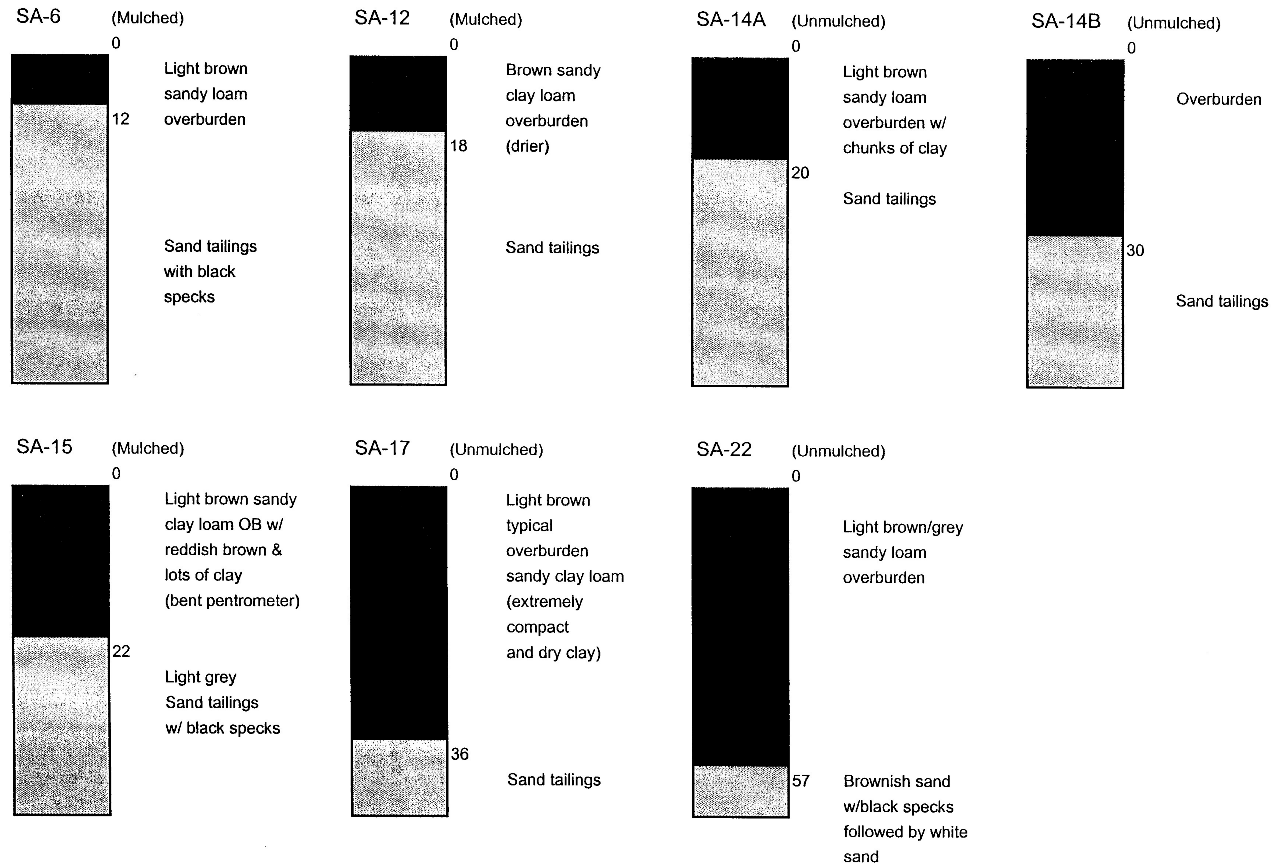
SIXTEEN ACRE (SA)
High Cover of Weedy Species



SOIL PROFILE DIAGRAMS (CM)

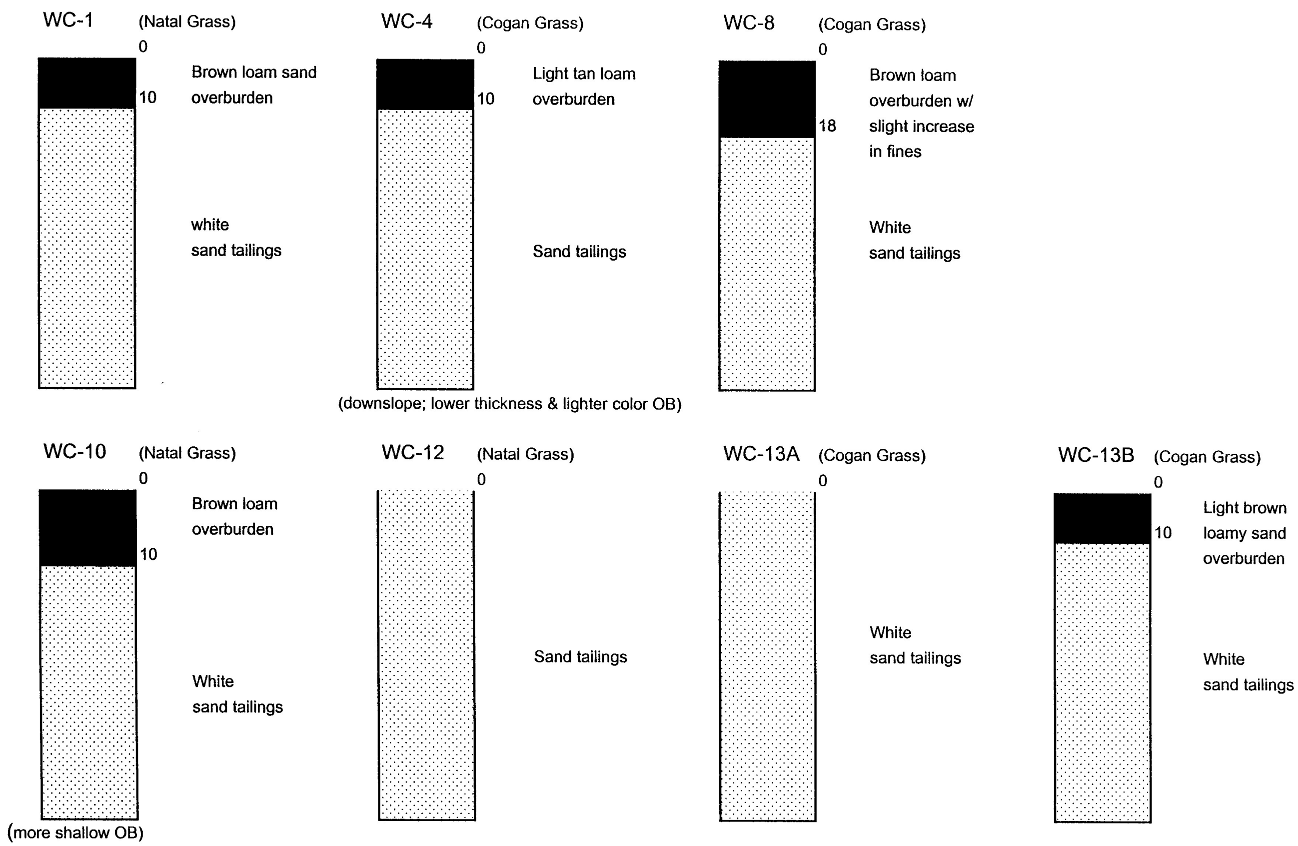
SIXTEEN ACRE (SA)

Low Cover of Weedy Species/Low Cover of Desirable Species



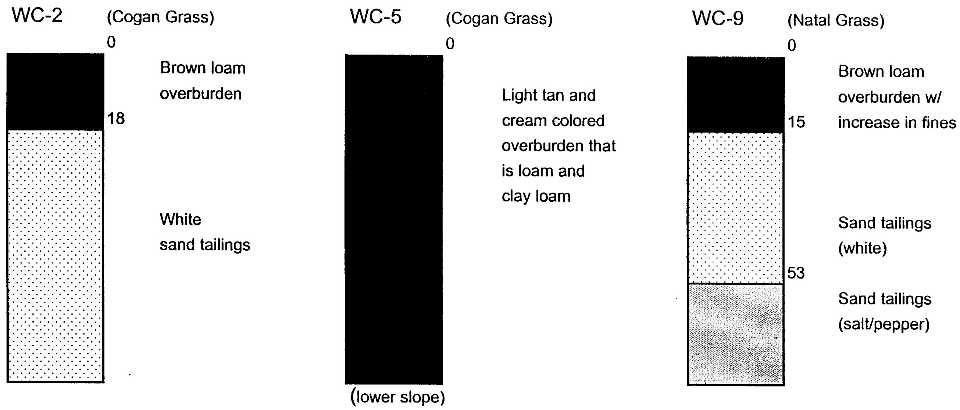
SOIL PROFILE DIAGRAMS (CM)

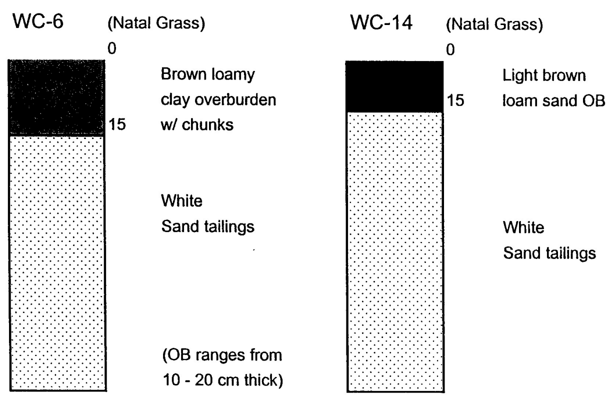
WILDLIFE CORRIDOR (WC)
Low Cover of Weedy Species



SOIL PROFILE DIAGRAMS (CM)

WILDLIFE CORRIDOR (WC)
High Cover of Weedy Species

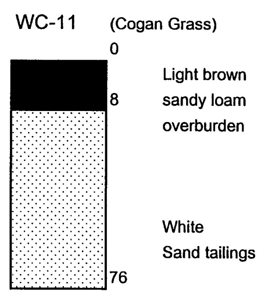




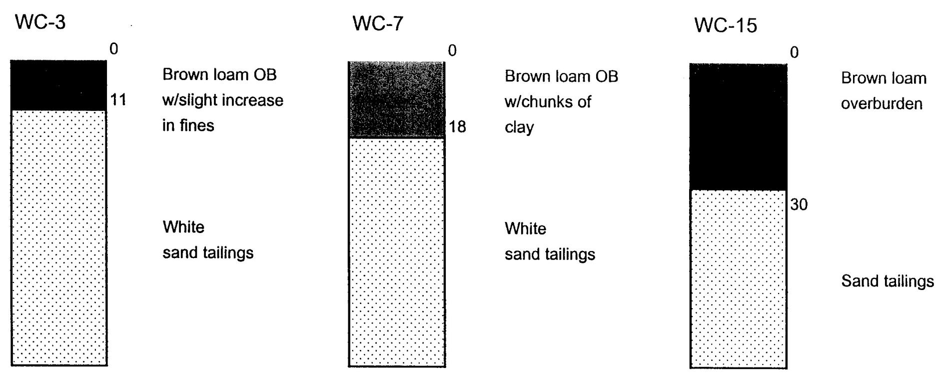
Soil Profiles from High Cover
of Weedy Species Continued
on Next Page

SOIL PROFILE DIAGRAMS (CM)

WILDLIFE CORRIDOR (WC)
High Cover of Weedy Species



Low Cover of Desirable Species



Appendix F

SOIL CHEMISTRY RAW DATA FOR EACH UPLAND RECLAMATION SAMPLING SITE

Lab #	Site	Soil type	HZ	Depth	Moist %	BD	pH	%C	%N	C/N	Ca	Mg	K	P	Zn	Cu	Mn	Fe	Na	CEC
				cm	dry wt	g/mL	---------------mg/kg---------------													cmol/kg
285	BM1	ST	1	15	0.00	1.90	6.40	0.238	0	NA	393	18	13.7	192	1.05	0.32	2.50	22.6	20.2	12.28
286	BM1	ST	2	15	3.09	1.68	6.85	0.178	0	NA	498	73	7.3	153	0.97	0.16	2.42	18.4	24.2	
287	BM1	ST	1	15	2.71	1.20	6.68	0.181	0	NA	447	48	9.7	153	0.97	0.32	1.94	17.7	21.0	
288	BM1	ST	2	15	3.29	1.26	6.88	0.146	0	NA	440	45	8.1	153	0.89	0.24	2.58	15.8	21.8	
289	BM1	ST	1	15	3.09	1.30	6.76	0.124	0	NA	467	54	5.6	163	0.89	0.24	1.94	18.6	20.2	
290	BM1	ST	2	15	3.55	1.31	6.77	0.159	0	NA	487	71	4.8	156	1.05	0.24	2.18	18.9	19.4	
291	BM2	ST/OB	1	15	5.05	1.38	6.20	0.583	0.03	19.4	231	23	13.7	205	0.48	0.16	0.56	13.8	21.8	16.74
292	BM2	ST	2	15	6.18	1.33	6.37	0.449	0.007	60	231	22	9.7	161	0.40	0.16	0.32	14	19.4	
293	BM3	ST/OB	1	15	6.56	1.37	6.46	0.401	0.007	59.8	182	14	7.3	174	0.40	0.16	0.32	13.7	19.4	
294	BM3	ST	2	15	9.57	1.33	6.50	0.472	0.006	73	233	26	7.3	177	0.48	0.16	0.48	15.2	22.6	
295	BM3	ST/OB	1	15	7.33	1.54	6.28	0.457	0.014	32	148	21	7.3	123	0.40	0.16	0.24	10.3	23.4	21.03
296	BM3	ST	2	15	9.26	1.14	6.09	0.543	0.007	81	118	19	8.1	131	0.40	0.16	0.24	9.9	23.4	
297	BM4	ST/OB	1	15	7.80	1.17	6.24	0.426	0.000	NA	147	10	6.5	141	0.40	0.16	0.24	8.1	19.4	
298	BM4	ST	2	15	8.49	1.28	6.24	0.518	0.006	87	150	13	4.8	125	0.32	0.16	0.16	7.3	16.9	
299	BM4	ST/OB	1	15	6.50	1.17	6.42	0.375	0.006	59.3	192	22	5.6	162	0.40	0.24	0.24	11.3	19.4	23.36
300	BM4	ST	2	15	8.28	1.27	6.48	0.434	0.004	97.4	181	27	4.8	171	0.32	0.16	0.40	12.9	17.7	
301	BM5	ST/OB	1	15	7.23	1.47	5.79	0.440	0.007	66.7	157	9	6.5	206	0.48	0.16	0.16	10.5	21.0	18.02
302	BM5	ST	2	15	7.71	1.26	5.98	0.469	0.008	58.5	154	9	4.8	189	0.40	0.16	0.16	10.1	18.5	
303	BM5	ST/OB	1	15	16.56	1.05	5.84	0.476	0.008	57.8	169	10	7.3	224	0.40	0.16	0.24	9.6	16.1	
304	BM5	ST	2	15	8.71	1.27	5.94	0.384	0.000	NA	136	9	29	204	0.40	0.16	0.16	9.9	18.5	
305	BM6	ST/OB	1	15	4.92	1.53	6.29	0.262	0.006	45.4	565	97	31.5	308	1.29	0.32	1.69	24.5	39.5	21.43
306	BM6	ST	2	15	8.29	1.07	7.05	0.234	0.000	NA	503	78	6.5	152	1.13	0.24	1.94	19.3	16.1	
307	BM6	ST/OB	1	15	7.54	1.14	6.26	0.425	0.013	33.9	382	64	13.7	227	0.56	0.16	0.40	22.9	21.0	
308	BM6	ST	2	15	7.20	1.19	6.19	0.225	0.000	NA	372	23	9.7	285	0.81	0.24	0.97	22.1	23.4	
309	BM7	ST	1	15	3.20	1.12	6.14	0.311	0.017	18.8	313	16	8.1	233	0.65	0.16	0.73	17.2	20.2	13.78
310	BM7	ST	2	15	4.74	1.33	6.13	0.199	0.000	NA	329	19	7.3	238	0.81	0.16	0.81	18.1	21.0	
311	BM8	ST/OB	1	15	4.32	1.69	6.36	0.286	0.007	38.9	385	10	6.5	288	0.89	0.16	1.05	15.5	19.4	12.66
312	BM8	ST	2	15	4.66	1.37	6.73	0.153	0.000	NA	409	21	5.6	284	1.13	0.16	0.89	12.1	21.0	
313	BM9	ST/OB	1	15	5.53	1.30	5.87	0.464	0.015	31.1	276	29	13.7	267	0.56	0.16	0.48	18.8	18.5	26.30
314	BM9	ST/OB	2	15	5.56	1.23	5.88	0.765	0.027	28.2	226	19	10.5	236	0.56	0.24	0.32	17.3	21.8	
315	BM9	ST/OB	1	15	7.40	1.29	6.02	0.514	0.017	30.7	266	23	14.5	275	0.48	0.16	0.48	17.7	18.5	
316	BM9	ST/OB	2	15	7.64	1.14	5.87	0.426	0.010	42.6	249	23	12.1	259	0.48	0.16	0.32	18.1	17.7	
317	BM10	ST/OB	1	15	4.84	1.43	6.10	0.569	0.009	62.2	308	17	12.1	210	0.56	0.16	0.56	17.1	18.5	26.37
318	BM10	ST	2	15	6.56	1.28	6.26	0.444	0.008	58.6	300	18	6.5	206	0.65	0.16	0.56	20.2	41.1	
319	BM10	ST/OB	1	15	2.80	1.69	6.23	0.358	0.008	44	361	23	12.1	222	0.97	0.16	0.89	19.4	19.4	
320	BM10	ST	2	15	6.38	1.32	6.27	0.386	0.007	59.4	363	17	4.8	270	0.65	0.16	0.65	21.9	16.1	
321	BM11	ST/OB	1	15	5.94	1.18	6.21	0.376	0.006	63	306	15	4.8	219	0.56	0.08	0.65	16.6	16.1	14.84
322	BM11	ST	2	15	13.83	1.29	5.85	0.603	0.009	65.1	276	31	6.5	154	0.32	0.16	0.32	18.5	16.1	
323	BM12	ST/OB	1	15	6.01	1.31	6.01	0.474	0.010	46	386	41	13.7	285	0.56	0.16	0.56	23.5	18.5	
324	BM12	ST	2	15	6.99	1.09	6.25	0.359	0.004	95.3	317	23	6.5	297	0.73	0.16	0.56	21	17.7	
325	BM12	ST/OB	1	15	5.65	1.22	5.85	0.420	0.009	46.7	223	23	11.3	274	0.48	0.16	0.32	19.8	22.6	18.29
326	BM12	ST	2	15	6.20	0.97	5.96	0.360	0.006	63.9	279	39	7.3	272	0.48	0.16	0.48	21.4	17.7	
327	ES1	TS	1	11	7.73	1.70	4.81	1.432	0.056	25.5	216	28	15.3	23	1.13	0.24	1.21	32.9	17.7	19.27
328	ES1	OB	2	14	6.12	1.06	6.68	0.955	0.019	51.6	806	108	8.1	474	5.16	1.85	4.52	103.2	16.9	
329	ES2	TS	1	10	6.66	0.79	5.88	2.525	0.112	22.5	580	98	25	72	2.74	0.4	3.63	65.1	15.3	17.48
330	ES2	OB	2	16	7.43	1.26	6.55	1.408	0.031	45.9	952	91	11.3	433	16.77	20.81	5.00	120.2	17.7	
331	ES3	TS	1	13	5.28	1.39	5.23	1.510	0.060	25.3	157	33	15.3	23	0.89	0.32	1.61	38	15.3	18.83
332	ES3	OB	2	10	4.52	1.60	5.43	0.614	0.010	63.9	81	10	8.9	272	0.32	0.24	4.44	109.7	16.1	
333	ES4	TS	1	5.5	3.22	1.74	5.57	0.852	0.032	26.6	150	11	13.7	265	0.81	0.24	3.23	98.4	14.5	14.93
334	ES4	OB	2	22.5	4.05	0.99	5.86	0.209	0.003	70.1	44	6	8.9	316	0.32	0.16	2.02	102.4	15.3	
335	ES5	TS	1	10	5.07	1.36	6.38	0.935	0.035	26.4	606	77	22.6	318	1.53	0.32	3.71	72.7	18.5	19.77
336	ES5	OB	2	10	6.48	1.49	6.57	0.734	0.014	52	665	55	11.3	435	0.81	0.24	3.23	85.5	19.4	

Lab #	Site	Soil type	HZ	Depth	Moist %	BD	pH	%C	%N	C/N	Ca	Mg	K	P	Zn	Cu	Mn	Fe	Na	CEC
				cm	dry wt	g/mL	------------------------mg/kg------------------------													cmol/kg
337	ES6	TS	1	9	5.47	1.10	5.16	2.100	0.082	25.7	248	52	17.7	110	0.97	0.24	2.02	54.7	16.9	16.54
338	ES6	OB	2	11	17.25	1.56	6.61	1.223	0.023	53.2	622	66	8.1	349	0.40	0.16	3.06	76	20.2	
339	ES7	TS	1	8.5	4.47	1.47	4.96	1.259	0.052	24.2	148	32	16.9	12	0.89	0.24	2.10	29.5	14.5	20.25
340	ES7	OB	2	13.5	5.24	1.55	6.27	0.884	0.016	56.1	185	52	7.3	210	0.32	0.16	4.52	103.2	16.1	
341	ES8	TS	1	21	5.95	1.42	4.53	1.389	0.065	21.2	256	20	9.7	10	0.81	0.24	0.97	35.6	15.3	17.93
342	ES8	OB	2	4	10.08	0.88	5.31	0.519	0.019	26.9	223	6	6.5	225	0.48	0.16	1.85	116.1	14.5	
343	ES9	TS	1	8	5.42	1.14	4.76	2.563	0.100	25.7	294	80	22.6	106	0.81	0.16	3.39	85.5	15.3	23.94
344	ES9	OB	2	16	6.47	1.70	5.52	0.782	0.015	52.3	185	60	10.5	335	0.32	0.08	4.68	140.3	19.4	
345	GH1	TS	1	6	10.63	1.22	5.12	1.918	0.064	29.9	244	19	19.4	54	0.81	0.24	0.81	27.9	21.0	57.59
346	GH1	OB/ST	2	9.5	10.25	1.88	5.07	1.091	0.024	46.1	84	6	8.9	328	0.40	0.16	0.24	22.7	12.9	
347	GH1	TS	1	13	9.41	1.63	4.92	0.783	0.019	41.7	121	16	9.7	13	0.48	0.08	0.24	20.2	8.1	
348	GH1	OB/ST	2	15.5	11.27	1.51	4.68	0.854	0.019	44.9	77	5	11.3	293	0.40	0.24	0.24	15.6	12.1	
349	GH2	TS	1	18	11.36	1.59	5.28	1.084	0.032	34.2	141	10	9.7	345	0.73	0.16	0.40	39.4	8.1	58.13
350	GH2	OB/ST	2	6.5	17.54	0.85	5.51	0.237	0.007	35.9	689	10	4.8	373	0.89	0.24	0.81	24.8	12.9	
351	GH2	TS	1	15	8.57	1.72	5.58	0.686	0.021	32.3	110	6	9.7	261	0.40	0.24	0.40	35.8	11.3	
352	GH2	OB/ST	2	13	4.23	1.58	6.34	0.171	0.000	NA	1008	10	4	382	0.73	0.16	0.97	20.6	16.1	
353	GH2	TS	1	12.5	8.61	1.42	5.44	0.761	0.023	33	133	10	9.7	250	0.65	0.16	0.73	23.1	7.3	
354	GH2	OB/ST	2	8.5	7.86	1.61	5.39	0.309	0.013	30	46	4	8.1	161	0.40	0.16	0.16	15.2	11.3	
355	GH2	OB/ST	3	12	4.54	1.45	6.09	0.194	0.007	26.6	903	10	3.2	348	0.89	0.16	0.89	23.2	14.5	
356	GH3	TS	1	12.5	13.59	1.41	4.67	0.593	0.009	63.2	450	40	11.3	36	0.81	0.16	0.81	38.5	7.3	80.82
357	GH3	ST	2	12	6.39	1.24	5.30	0.525	0.012	42.1	531	14	7.3	164	0.48	0.24	0.56	27.3	12.9	
358	GH3	TS	1	15	8.54	1.75	5.11	1.126	0.032	34.8	335	26	28.2	59	0.73	0.16	0.40	31.3	9.7	
359	GH3	ST	2	12.5	5.59	1.25	5.91	0.513	0.003	171.8	911	10	15.3	329	0.97	0.24	1.13	26.2	18.5	
360	GH3	TS	1	7.5	9.68	1.22	5.18	1.167	0.054	21.4	219	34	26.6	223	1.85	0.32	1.85	28.1	18.5	
361	GH3	TS	2	18.5	10.71	1.92	4.63	2.144	0.057	37.8	382	40	12.9	38	0.48	0.16	0.32	45.6	9.7	
362	GH3	ST	3	5	5.47	0.87	5.96	0.141	0.006	23.5	1048	20	4.8	375	0.89	0.24	1.29	24.8	16.1	
363	GH4	TS	1	15	8.03	1.67	5.59	0.243	0.010	24.9	109	6	8.1	31	0.48	0.08	0.24	14	9.7	43.21
364	GH4	ST	2	15	8.49	1.58	5.60	0.169	0.007	24.3	450	5	4	164	0.48	0.16	0.40	16	9.7	
365	GH4	TS	1	8	8.84	1.14	5.42	0.451	0.014	32.8	166	32	10.5	14	0.56	0.16	0.97	18.6	8.1	
366	GH4	ST	2	17	9.80	1.63	5.43	0.996	0.020	50.4	139	9	8.9	127	0.40	0.16	0.24	19.8	12.1	
367	GH5	TS	1	18	13.30	1.64	5.65	0.957	0.024	40.5	448	21	8.1	155	0.48	0.24	0.56	34.7	8.1	
368	GH5	ST	2	9.5	7.70	1.09	6.00	0.203	0.000	NA	1016	9	3.2	398	0.97	0.16	0.81	30.5	15.3	
369	GH5	TS	1	11.5	12.24	1.71	5.55	1.336	0.032	42	332	17	13.7	85	0.65	0.16	0.81	29.2	14.5	50.11
370	GH5	ST	2	12.5	9.36	1.53	6.05	0.318	0.000	NA	968	8	4	373	1.29	0.24	0.97	36.3	15.3	
371	GH5	TS	1	16.5	12.65	1.59	5.70	0.587	0.020	28.8	465	17	8.9	211	0.48	0.16	0.40	33	10.5	
372	GH5	ST	2	15	11.43	1.57	5.93	0.123	0.000	NA	831	6	5.6	325	0.81	0.16	0.81	21.5	19.4	
373	GH6	TS	1	20	24.52	1.37	6.14	1.124	0.059	19.2	729	111	19.4	239	1.13	0.32	1.37	76.9	14.5	
374	GH6	ST	2	13.5	11.84	1.40	6.19	0.211	0.007	29.2	1048	23	3.2	399	1.37	0.16	0.81	36.7	15.3	
375	GH6	TS	1	12	8.57	1.42	6.05	0.571	0.032	17.9	405	53	18.5	55	1.29	0.16	1.77	15.1	13.7	38.95
376	GH6	TS	2	12	11.75	1.67	5.51	0.602	0.029	20.7	286	35	8.1	190	0.40	0.16	0.32	55.5	7.3	
377	GH6	ST	3	4	7.52	1.22	6.01	0.215	0.010	21	1048	24	9.7	390	1.05	0.24	1.13	32	17.7	
378	GH6	TS	1	6	10.04	1.68	6.29	0.720	0.034	20.9	504	46	16.9	132	0.89	0.16	1.29	30.8	16.1	
379	GH6	TS	2	8.5	9.95	1.83	5.67	0.758	0.032	23.4	597	42	8.9	272	0.48	0.16	0.48	78.5	9.7	
380	GH6	ST	3	13.5	9.23	1.22	6.02	0.337	0.013	25.8	778	10	4	295	0.48	0.16	0.73	25.4	13.7	
381	GH7	TS	1	17.5	9.35	1.59	5.03	1.302	0.038	34.6	311	37	12.9	65	0.65	0.16	1.13	33	12.9	53.72
382	GH7	ST	2	8.5	7.76	1.32	4.84	0.717	0.020	35.3	466	9	6.5	178	0.56	0.08	0.32	25.4	12.1	
383	GH8	TS	1	7	11.70	1.39	5.02	0.415	0.012	34.5	131	10	12.9	37	0.73	0.24	0.48	17.7	8.9	
384	GH8	OB/ST	2	14	13.37	1.93	5.07	0.737	0.025	29.7	138	10	8.1	541	0.65	0.73	0.24	28.6	10.5	
385	GH8	TS	1	7	14.88	1.74	4.86	1.333	0.026	52.1	486	55	17.7	60	0.32	0.16	0.16	47.4	11.3	73.17
386	GH8	OB/ST	2	18	11.10	1.49	5.30	0.755	0.023	33.3	216	21	6.5	352	0.56	0.97	1.21	43.2	9.7	
387	GH9	TS	1	9.5	12.35	1.64	4.89	0.328	0.008	39.9	110	16	6.5	9	0.40	0.16	0.32	15.4	7.3	
388	GH9	OB	2	13	10.79	1.62	4.89	0.447	0.014	31.3	70	5	6.5	538	0.56	0.65	0.24	36.9	12.9	

Lab #	Site	Soil type	HZ	Depth	Moist %	BD	pH	%C	%N	C/N	Ca	Mg	K	P	Zn	Cu	Mn	Fe	Na	CEC
				cm	dry wt	g/mL	----------mg/kg----------													cmol/kg
389	GH9	TS	1	13	10.94	1.62	4.88	0.524	0.014	38.2	82	7	5.6	11	0.40	0.16	0.16	18.6	8.1	36.76
390	GH9	OB	2	8	10.63	1.63	5.03	0.659	0.019	34.1	124	7	4	516	0.73	0.4	0.32	31.5	8.1	
391	GH10	TS	1	9.5	19.59	1.61	5.67	0.931	0.033	28.4	600	27	16.1	131	0.56	0.16	0.89	53.1	14.5	48.17
392	GH10	ST	2	6	19.27	2.14	6.11	0.179	0.000	NA	911	14	12.1	336	0.97	0.16	1.29	57.7	17.7	
393	GH11	TS	1	17	18.29	1.73	5.10	1.305	0.037	35	173	28	19.4	14	0.81	0.08	0.81	20.6	7.3	
394	GH11	ST	2	10	18.93	1.42	5.74	0.208	0.004	53	944	39	5.6	352	0.81	0.24	1.13	46	25.8	
395	GH11	TS	1	15	19.64	1.76	5.66	1.605	0.062	25.9	519	75	22.6	57	0.81	0.4	1.05	118.5	13.7	44.63
396	GH11	ST	2	10	20.98	1.47	6.22	0.131	0.000	NA	944	18	6.5	363	0.81	0.16	0.89	22.8	17.7	
397	GH11	TS	1	11	16.60	1.40	5.68	0.820	0.026	31.9	287	53	12.9	30	0.81	0.16	0.81	79.4	7.3	
398	GH11	TS	2	7	21.21	1.68	6.38	3.810	0.126	30.2	1242	224	19.4	67	0.48	0.24	1.61	285.5	12.9	
399	GH11	ST	3	10	16.79	1.52	6.22	0.117	0.000	NA	887	20	8.1	329	0.73	0.16	1.05	28.3	20.2	
400	GH12	TS	1	21	20.49	1.66	4.64	1.398	0.039	35.3	295	13	11.3	18	0.73	0.16	0.73	54.8	10.5	48.26
401	GH12	ST	2	1	21.16	3.78	5.30	0.131	0.000	NA	927	20	6.5	356	0.73	0.24	1.13	30.6	22.6	
402	GH13	TS	1	20	19.55	1.23	5.18	1.429	0.045	32.1	604	44	7.3	123	0.40	0.16	0.40	80.2	10.5	29.92
403	GH13	ST	2	15	18.15	1.25	5.95	0.114	0.001	87.5	919	15	15.3	355	0.65	0.24	1.05	39.4	16.9	
404	GH14	TS	1	11	27.46	1.44	5.26	1.611	0.048	33.4	504	27	12.9	227	0.89	0.24	0.81	48.5	16.9	44.58
405	GH14	ST	2	14	16.45	1.70	6.46	0.160	0.003	49.5	1073	43	4.8	381	0.65	0.16	1.05	94.4	16.1	
406	GH14	TS	1	8	18.38	1.79	5.76	0.883	0.026	34.4	574	16	12.1	214	0.65	0.24	0.97	59.5	15.3	
407	GH14	ST	2	12	16.17	1.43	6.12	0.163	0.001	112.4	911	11	4.8	340	0.65	0.24	0.73	37.6	16.9	
408	GH15	TS	1	9	5.30	1.22	5.02	0.622	0.021	29	232	21	14.5	45	1.53	0.16	2.26	21.6	9.7	
409	GH15	TS	2	16	12.85	1.03	4.57	0.000	0.160	NA	368	73	16.9	25	0.65	0.16	0.56	38.7	17.7	
410	GH15	TS	1	12	10.14	1.53	4.75	0.980	0.023	43.4	218	25	14.5	26	0.48	0.16	0.73	25.6	9.7	23.75
411	GH15	TS	2	20	20.90	1.30	4.88	0.390	0.010	40.3	60	6	6.5	164	0.32	0.08	0.24	26.3	12.1	
412	WC1	OB	1	11	2.12	1.31	6.47	0.876	0.040	22	795	106	14.5	237	1.37	0.32	1.05	36.8	16.9	23.29
413	WC1	ST	2	13	1.01	1.68	6.28	0.298	0.011	27.3	552	52	4.8	183	1.05	0.16	0.81	23.1	13.7	
414	WC1	OB	1	9	13.61	1.04	6.48	1.337	0.060	22.5	831	141	14.5	215	1.45	0.24	1.61	33.7	16.1	
415	WC1	ST	2	9	0.54	1.32	6.42	0.092	0.000	NA	511	21	0	205	0.89	0.08	0.81	18.4	16.9	
416	WC2	OB	1	18	4.47	1.14	5.92	0.062	0.031	20.2	1153	167	16.1	324	1.69	0.65	0.97	81.5	19.4	28.00
417	WC2	ST	2	9	1.42	1.11	6.35	0.107	0.000	NA	619	27	1.6	261	0.97	0.24	1.13	31.9	15.3	
418	WC2	OB	1	18	3.95	1.38	6.33	0.533	0.000	NA	771	116	7.3	290	0.89	0.32	1.05	31.5	18.5	
419	WC2	ST	2	19	2.32	1.27	6.47	0.082	0.000	NA	606	15	0	225	0.73	0.16	1.21	15.7	16.1	
420	WC2	OB	1	23	4.82	1.02	6.31	0.795	0.019	40.8	757	186	4	362	0.81	0.24	1.21	24.6	13.7	
421	WC2	ST	2	28	3.21	1.03	6.49	0.079	0.000	NA	606	19	0	238	0.81	0.08	1.29	17.6	17.7	
422	WC3	OB	1	11	3.70	1.16	6.17	3.429	0.137	25.1	755	116	20.2	319	1.53	0.32	1.29	36	24.2	26.96
423	WC3	ST	2	8	19.69	1.98	6.10	0.161	0.020	7.8	480	15	0.8	202	0.97	0.16	1.53	18.5	15.3	
424	WC4	OB	1	20	11.10	1.33	5.68	0.518	0.025	20.4	361	37	12.9	346	0.65	0.24	0.48	17.3	29.0	23.41
425	WC4	ST	2	20	18.19	1.22	5.31	0.046	0.000	NA	40	5	0	294	0.32	0.16	0.16	9.8	12.1	
426	WC5	OB	1	20	36.88	1.08	5.82	0.632	0.021	30	397	81	13.7	303	0.56	0.16	0.73	54.7	28.2	30.39
427	WC5	OB	2	11	16.12	1.01	5.10	0.442	0.000	NA	148	35	11.3	313	0.40	0.16	0.48	22.6	20.2	
428	WC5	OB	1	12	23.79	1.16	6.77	0.736	0.040	18.4	528	96	4	240	0.48	0.16	0.97	34.5	14.5	
429	WC5	ST	2	12	17.29	1.39	6.49	0.074	0.000	NA	229	65	4.8	252	0.40	0.16	0.16	20.2	14.5	
430	WC6	OB	1	13	83.41	0.24	5.80	0.830	0.026	32.3	616	77	6.5	296	0.56	0.16	0.48	28.1	15.3	30.16
431	WC6	ST	2	12	1.28	1.41	6.27	0.248	0.000	NA	596	43	0	203	0.81	0.16	0.81	26.2	16.9	
432	WC6	OB	1	5	24.69	0.50	5.89	7.100	0.493	14.4	1250	189	56.5	279	2.18	0.32	2.66	29.7	14.5	
433	WC6	OB	2	5	5.09	1.98	5.65	0.499	0.182	2.7	567	69	6.5	285	0.48	0.16	0.48	32.3	13.7	
434	WC6	ST	3	10	4.80	0.75	5.39	0.173	0.000	NA	471	42	0	219	0.65	0.08	0.89	17.3	16.9	
435	WC7	OB	1	13	5.64	1.18	5.67	0.797	0.033	24.4	1218	317	41.9	214	0.97	0.32	0.65	43.7	21.8	31.59
436	WC7	ST	2	15	1.76	1.26	6.19	0.008	0.000	NA	423	35	1.6	204	0.48	0.16	0.65	23.5	18.5	
437	WC8	OB	1	18	6.83	1.19	5.56	0.434	0.000	NA	227	20	1.6	239	0.32	0.16	0.24	25.6	14.5	23.35
438	WC8	ST	2	16.5	2.90	0.86	6.52	0.069	0.000	NA	644	13	0	268	0.81	0.16	1.13	20.9	18.5	
439	WC9	OB	1	15	3.22	1.30	5.64	0.556	0.021	26	466	54	8.1	250	0.81	0.24	0.89	23.1	12.9	20.03
440	WC9	ST	2	13	1.63	1.67	6.41	0.153	0.000	NA	727	27	0	254	1.21	0.16	0.97	24	18.5	

Lab #	Site	Soil type	HZ	Depth	Moist %	BD	pH	%C	%N	C/N	Ca	Mg	K	P	Zn	Cu	Mn	Fe	Na	CEC
				cm	dry wt	g/mL	------------------------mg/kg------------------------													cmol/kg
441	WC10	OB	1	17	3.36	0.99	5.93	0.529	0.023	23.4	392	28	0	252	0.56	0.16	0.56	26.7	11.3	20.67
442	WC10	ST	2	14.5	2.77	1.54	6.32	0.098	0.000	NA	694	12	0	252	0.97	0.16	1.29	21.1	16.1	
443	WC11	OB	1	16	16.77	1.22	6.43	0.837	0.035	23.9	759	215	3.2	260	0.65	0.16	0.81	37.6	12.9	23.84
444	WC11	ST	2	12	3.59	0.50	6.49	0.246	0.000	NA	676	119	0	306	0.89	0.16	1.13	86.3	15.3	
445	WC12	ST	1	15	2.04	1.36	6.42	0.094	0.000	NA	504	15	0	192	0.97	0.16	1.29	16.8	16.9	12.73
446	WC12	ST	2	15	1.97	1.23	6.41	0.046	0.000	NA	527	9	0	207	1.13	0.08	1.29	16.3	15.3	
447	WC12	ST	1	15	0.64	1.39	6.40	0.080	0.000	NA	435	11	0	178	1.05	0.16	1.05	16.5	14.5	
448	WC12	ST	2	15	0.91	1.22	6.38	0.047	0.000	NA	494	8	0	190	0.89	0.08	1.37	15.6	13.7	
449	WC13	ST	1	15	1.57	1.59	6.34	0.130	0.000	NA	465	10	0	177	0.73	0.08	0.81	14.6	16.1	15.20
450	WC13	ST	2	14	2.94	1.00	6.40	0.053	0.000	NA	494	10	0	181	0.65	0.08	0.89	13.2	14.5	
451	WC13	OB	1	13	2.87	1.67	5.78	0.886	0.023	38.1	692	101	4.8	306	0.81	0.24	0.65	37.7	14.5	
452	WC13	ST	2	6	15.77	2.39	6.26	0.050	0.000	NA	516	16	19.4	190	0.97	0.16	1.29	17.7	24.2	
453	WC14	OB	1	12	2.01	1.15	6.51	0.402	0.016	24.6	815	156	6.5	230	0.73	0.16	0.89	38.1	17.7	17.19
454	WC14	ST	2	9	0.91	1.20	6.28	0.082	0.000	NA	470	26	3.2	171	0.73	0.08	0.65	18.5	18.5	
455	WC14	OB	1	15	3.37	1.43	6.37	0.455	0.013	34.9	784	125	1.6	302	0.97	0.24	0.81	36.9	14.5	
456	WC14	ST	2	12	1.17	0.78	6.30	0.317	0.000	NA	535	42	30.6	217	0.89	0.08	0.81	23.4	18.5	
457	WC15	OB	1	10	4.17	1.18	5.81	0.912	0.043	21	585	102	8.1	335	0.48	0.16	0.73	31.2	13.7	24.33
458	WC15	OB	2	15.5	5.82	0.86	6.32	0.902	0.028	32.3	708	134	4	352	0.56	0.16	0.48	32.9	16.9	
459	SA1	OB	1	12	8.26	1.61	6.30	0.300	0.000	NA	701	50	5.6	511	0.48	0.16	0.56	55.4	9.7	19.71
460	SA1	ST	2	13	7.48	1.25	6.39	0.054	0.000	NA	545	12	3.2	223	0.73	0.08	0.73	19.7	11.3	
461	SA1	OB	1	17	8.15	1.94	6.78	0.370	0.006	65	750	62	6.5	492	0.48	0.16	0.48	61.8	10.5	
462	SA1	ST	2	7	6.81	1.06	6.52	0.247	0.000	NA	735	16	4	294	0.81	0.16	0.81	22.4	15.3	
463	SA2	OB	1	16	5.31	1.37	6.26	0.238	0.004	61	616	60	7.3	449	0.40	0.16	0.32	59.1	11.3	18.78
464	SA2	ST	2	7.5	6.39	1.35	6.08	0.429	0.006	73	555	37	3.2	352	0.32	0.08	0.40	46.5	8.1	
465	SA2	OB	1	15	6.84	1.49	6.85	0.223	0.000	NA	793	106	7.3	519	0.48	0.16	0.48	72.2	11.3	
466	SA2	ST	2	10	3.97	1.19	6.55	0.114	0.000	NA	723	16	7.3	300	0.81	0.24	0.81	24.8	18.5	
467	SA3	OB	1	16.5	3.04	1.30	5.94	0.375	0.000	NA	490	57	13.7	516	0.48	0.16	0.24	44.8	19.4	27.71
468	SA3	OB	2	16.5	4.53	0.96	5.47	0.307	0.004	78.5	301	44	9.7	245	0.40	0.16	0.16	74.1	17.7	
469	SA4	OB	1	17.5	3.78	1.27	6.33	0.245	0.000	NA	713	70	5.6	508	0.40	0.08	0.40	87.1	12.9	25.76
470	SA4	OB	2	12.5	7.93	0.81	5.45	0.169	0.000	NA	742	65	3.2	347	0.40	0.08	0.56	83.1	12.9	
471	SA4	OB	1	16.5	3.52	1.33	6.20	0.280	0.006	46.3	747	84	8.9	528	0.40	0.16	0.24	78.7	12.1	
472	SA4	OB	2	16.5	4.19	1.18	6.55	0.312	0.005	66.5	739	83	7.3	569	0.40	0.08	0.40	64.5	13.7	
473	SA5	OB	1	14	2.90	1.21	6.23	0.387	0.011	34.9	707	81	9.7	542	0.40	0.16	0.56	76.2	9.7	24.16
474	SA5	OB	2	7.5	3.39	2.16	6.22	0.236	0.005	45	748	69	5.6	565	0.40	0.24	0.48	69.2	12.1	
475	SA6	OB	1	10	10.71	1.88	6.65	0.555	0.018	30.5	740	86	10.5	392	0.56	0.16	0.73	58.2	11.3	22.84
476	SA6	ST	2	20	16.13	1.38	6.36	0.218	0.000	NA	652	12	3.2	267	0.65	0.08	0.56	21.4	11.3	
477	SA6	OB	1	12	11.09	1.81	6.70	0.418	0.000	NA	976	149	12.1	337	0.56	0.24	1.05	81.5	9.7	
478	SA6	ST	2	15	10.84	1.34	6.35	0.183	0.000	NA	739	15	4.8	292	0.65	0.08	0.65	22.7	16.1	
479	SA7	OB	1	18	6.50	1.72	6.58	0.348	0.011	30.9	863	123	7.3	372	0.48	0.16	0.65	91.1	15.3	27.68
480	SA7	OB	2	12	6.93	1.45	6.47	0.280	0.007	39.5	952	153	8.9	355	0.48	0.24	0.97	91.1	21.0	
481	SA8	OB	1	16.5	3.53	1.29	5.83	0.352	0.006	58.9	499	98	5.6	437	0.65	0.08	0.24	57.5	21.0	20.12
482	SA8	OB	2	7.5	5.74	1.55	6.49	0.241	0.003	93.8	639	132	4	546	0.89	0.08	0.48	58.5	18.5	
483	SA8	OB	1	16	5.53	1.74	6.04	0.306	0.005	64.5	633	72	5.6	500	0.40	0.16	0.40	64.5	19.4	
484	SA8	OB	2	8.5	6.80	2.07	6.54	0.321	0.009	35.9	503	106	8.1	430	0.65	0.08	0.48	50.2	24.2	
485	SA9	OB	1	19	5.87	1.65	6.35	0.337	0.011	29.5	895	157	8.9	318	0.48	0.16	0.65	127.4	14.5	21.29
486	SA9	OB	2	6.5	5.99	2.34	6.43	0.449	0.010	46.1	887	146	9.7	306	0.40	0.24	0.97	115.3	16.1	
487	SA9	OB	1	14	5.54	1.30	6.30	0.425	0.023	18.2	879	129	10.5	304	0.48	0.24	0.48	118.5	16.1	
488	SA9	OB	2	14	8.72	1.39	5.93	0.346	0.012	29.2	815	148	8.9	276	0.40	0.24	0.40	128.2	19.4	
489	SA10	OB	1	14	12.37	1.43	6.23	0.786	0.019	42.2	823	102	10.5	353	0.65	0.24	0.48	140.3	22.6	24.40
490	SA10	ST	2	13	15.12	1.24	6.45	0.201	0.000	NA	644	25	7.3	275	0.81	0.16	0.65	43.6	15.3	
491	SA11	OB	1	15	6.92	1.75	6.21	0.410	0.013	32.2	531	56	4.8	560	0.32	0.08	0.24	57.8	12.1	18.00
492	SA11	OB	2	13	12.13	1.68	6.71	0.259	0.005	47.3	1331	230	12.9	587	0.48	0.4	1.21	86.3	23.4	

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				cm	dry wt	g/mL							mg/kg							cmol/kg
493	SA12	OB	1	12	11.47	2.12	6.62	0.281	0.010	29.4	855	131	8.1	273	0.40	0.16	0.65	122.6	12.1	22.39
494	SA12	ST	2	15	17.67	1.52	6.32	0.095	0.000	NA	508	10	2.4	200	0.56	0.08	0.48	24	11.3	
495	SA12	OB	1	18	5.77	1.52	5.74	0.450	0.016	28.5	729	105	6.5	335	0.56	0.16	0.40	98.4	12.1	
496	SA12	ST	2	14	12.50	1.26	6.65	0.130	0.000	NA	672	68	5.6	257	0.48	0.16	0.65	60.3	14.5	
497	SA13	OB	1	16	8.35	1.30	6.19	0.410	0.009	45.6	506	97	15.3	212	0.48	0.32	0.48	59.6	15.3	17.96
498	SA13	OB	2	15	13.03	1.31	6.04	0.353	0.007	50.2	226	65	4	153	0.40	0.16	0.32	46.1	9.7	
499	SA14	OB	1	17	6.48	1.63	5.50	0.458	0.010	45.9	231	40	4.8	111	0.40	0.16	0.32	25.2	8.1	20.14
500	SA14	OB	2	13	8.22	1.46	5.70	0.417	0.006	70	300	39	6.5	179	0.48	0.16	0.24	30.3	13.7	
501	SA14	OB	1	16	4.71	1.10	5.75	0.421	0.008	53.7	506	48	3.2	252	0.40	0.32	0.32	36.6	15.3	
502	SA14	OB	2	12	6.76	1.03	5.73	0.319	0.007	47.5	507	56	4	237	0.40	0.08	0.48	39.2	13.7	
503	SA15	OB	1	16	5.71	1.75	6.09	0.357	0.006	63.7	887	123	7.3	545	0.65	0.16	0.40	225	21.8	19.20
504	SA15	OB	2	9	10.16	1.57	6.63	0.310	0.025	12.5	847	141	6.5	518	0.56	0.24	0.48	254.8	18.5	
505	SA15	ST	3	7	14.58	1.00	5.97	0.207	0.000	NA	785	18	4	331	0.73	0.16	0.81	26.6	14.5	
506	SA16	OB	1	13	4.62	1.18	5.70	0.258	0.015	17.8	871	75	5.6	540	0.48	0.16	0.32	75.8	15.3	44.23
507	SA16	OB	2	9	5.54	1.20	5.66	0.271	0.000	NA	455	52	4	519	0.40	0.16	0.32	51.4	12.9	
508	SA16	OB	1	12	4.37	1.28	5.86	0.378	0.017	21.6	560	95	7.3	455	0.48	0.08	0.24	66.5	16.1	
509	SA16	OB	2	9	5.16	0.96	6.63	0.399	0.020	19.6	545	104	5.6	419	0.48	0.24	0.56	58.5	15.3	
510	SA17	OB	1	16.5	15.26	1.20	5.32	0.388	0.012	31.3	401	36	3.2	306	0.48	0.16	0.16	39.5	15.3	37.21
511	SA17	OB	2	16.5	17.60	1.19	5.27	0.384	0.000	NA	380	35	3.2	279	0.40	0.16	0.24	42.7	11.3	
512	SA17	OB	1	18	8.37	1.33	5.32	0.364	0.000	NA	265	35	4	240	0.48	0.16	0.24	29.1	29.8	
513	SA17	OB	2	12	10.65	2.51	5.34	0.335	0.000	NA	282	37	5.6	231	0.40	0.16	0.40	38.6	21.8	
514	SA18	OB	1	20	9.07	1.62	6.09	0.404	0.000	NA	423	44	4.8	328	0.40	0.16	0.24	50.8	12.1	39.22
515	SA18	OB	2	10	8.46	1.40	5.74	0.392	0.016	24.3	356	45	4.8	277	0.40	0.16	0.40	41.4	11.3	
516	SA19	OB	1	9	26.09	1.39	5.81	0.325	0.015	21.2	479	29	6.5	303	0.40	0.16	0.32	52.7	13.7	31.74
517	SA19	ST	2	17	25.90	1.23	6.11	0.145	0.000	NA	594	7	2.4	247	0.56	0.08	0.65	46.5	14.5	
518	SA20	OB	1	11	4.67	1.08	5.25	0.254	0.000	NA	129	28	6.5	158	0.32	0.08	0.24	39.4	34.7	31.67
519	SA20	OB	2	14	6.04	1.80	5.04	0.207	0.000	NA	101	21	3.2	186	1.45	0.08	0.24	45.1	22.6	
520	SA20	OB	1	12	4.46	1.45	5.15	0.378	0.012	31.8	102	19	5.6	160	0.32	0.08	0.16	33.9	16.1	
521	SA20	OB	2	12	6.51	1.25	5.14	0.228	0.000	NA	105	21	4	160	0.40	0.08	0.24	38.5	13.7	
522	SA20	OB	1	12	14.42	1.31	5.17	0.266	0.010	26	119	19	3.2	182	0.32	0.16	0.16	34.4	11.3	
523	SA20	OB	2	11	7.01	1.21	5.05	0.186	0.000	NA	94	20	4.8	346	0.40	0	0.24	49.9	14.5	
524	SA21	OB	1	13	3.86	1.02	5.79	0.648	0.018	35.1	585	73	16.1	378	0.89	0.24	0.56	63.7	12.1	47.80
525	SA21	OB	2	10	16.14	0.91	6.05	0.550	0.012	44.4	1008	64	8.1	547	1.53	0.65	0.81	89.5	16.1	
526	SA22	OB	1	19	5.75	1.19	6.19	0.336	0.018	18.7	564	84	9.7	484	0.32	0.16	0.32	70.4	22.6	45.79
527	SA22	OB	2	11	10.10	1.26	6.06	0.303	0.013	23.1	481	69	4	498	0.32	0.08	0.24	87.9	16.1	
528	SA23	OB	1	15	8.02	1.67	6.17	0.344	0.014	23.9	698	56	5.6	392	0.65	0.16	0.40	96.8	13.7	34.49
529	SA23	OB	2	8	11.34	1.35	6.26	0.480	0.013	36.5	823	58	4	435	1.21	0.32	0.48	89.5	19.4	
530	SA24	OB	1	10	13.09	2.46	5.48	0.350	0.012	30.4	288	28	4.8	187	0.32	0.08	0.24	59.3	9.7	31.23
531	SA24	ST	2	16	15.19	1.25	6.29	0.135	0.000	NA	683	10	1.6	285	0.65	0	0.73	34.4	13.7	
532	SA24	OB	1	19	15.47	1.65	5.74	0.356	0.011	32.5	401	31	6.5	239	0.32	0.08	0.24	58.4	16.1	
533	SA24	ST	2	10	15.74	1.32	6.33	0.087	0.000	NA	606	10	2.4	251	0.48	0.08	0.65	25.7	12.9	
534	NS1	STMAT	0	4	NA	NA	6.20	3.235	0.206	15.7	1460	268	72.6	98	5.73	0.4	12.02	57.3	29.0	39.21
535	NS1	ST/CS	1	10	1.19	1.46	6.64	0.377	0.030	12.6	728	45	3.2	262	1.05	0.16	1.61	50.8	21.8	
536	NS1	C	2	16	4.87	0.70	6.44	0.982	0.094	10.4	1129	154	16.9	369	2.02	0.4	3.87	137.9	29.8	
537	NS2	STMAT	0	3	NA	NA	6.75	1.740	0.122	14.2	1702	174	56.5	114	5.48	0.48	6.45	76.5	18.5	28.85
538	NS2	ST/CS	1	17	2.26	1.61	6.89	0.296	0.019	15.5	794	51	0.8	277	0.97	0.16	2.10	63.2	16.9	
539	NS3	STMAT	0	1	NA	NA	6.09	0.522	0.038	13.7	484	10	10.5	177	1.37	0.24	1.37	19.5	13.7	
540	NS3	ST	1	14	0.27	1.34	6.74	0.193	0.005	35.3	531	7	0	203	0.65	0.08	1.69	13.4	18.5	
541	NS3	ST	2	15	2.21	0.87	6.84	0.115	0.000	NA	537	6	0	208	0.65	0.08	1.53	13.2	16.1	
542	NS3	ST	1	15	1.01	1.58	6.49	0.220	0.007	30.3	521	8	0	194	0.48	0.08	1.94	12.2	14.5	12.79
543	NS3	ST	2	15	1.94	1.12	6.90	0.168	0.000	NA	575	14	4	215	0.65	0.16	1.94	12.7	18.5	
544	NS4	STMAT	0	2	NA	NA	5.99	0.446	0.028	16.1	676	23	21.8	214	2.34	0.32	3.23	31.3	23.4	26.12

Lab #	Site	Soil type	HZ	Depth	Moist %	BD	pH	%C	%N	C/N	Ca	Mg	K	P	Zn	Cu	Mn	Fe	Na	CEC
				cm	dry wt	g/mL	------------------------------mg/kg------------------------------cmol/kg													
545	NS4	ST	1	28	2.84	0.71	6.81	0.378	0.018	20.6	764	26	11.3	265	0.73	0.08	1.94	44.8	16.9	
546	NS5	STMAT	0	2	NA	NA	6.26	0.766	0.034	22.8	785	56	15.3	227	1.77	0.16	6.53	66.7	17.7	
547	NS5	ST	1	28	0.52	0.93	6.75	0.154	0.003	56.6	559	10	5.6	202	0.56	0.08	1.29	15.9	16.1	
548	NS5	ST	1	8	0.56	1.35	6.73	0.401	0.014	28.9	752	35	9.7	249	0.97	0.16	2.66	54.8	17.7	25.92
549	NS5	ST	2	22	1.17	1.09	6.80	0.166	0.000	NA	715	21	5.6	255	0.65	0.16	1.94	19.9	21.0	
550	NS6	ST/CS	1	10	3.84	1.77	7.59	0.691	0.022	31.4	1677	434	46	401	5.32	0.65	6.94	128.2	13.7	22.93
551	NS6	C	2	20	82.70	0.13	7.95	0.795	0.023	34.9	4081	1984	89.5	395	5.16	1.45	8.55	145.2	66.9	
552	NS7	STMAT	0	3	NA	NA	6.00	1.754	0.115	15.2	1500	267	42.7	198	5.16	0.48	5.89	76.8	16.1	34.13
553	NS7	ST/CL	1	12	0.72	1.82	6.70	0.488	0.015	32.9	792	69	8.1	259	1.37	0.16	2.74	48.2	16.9	
554	NS7	ST/CL	2	15	0.91	0.53	6.71	0.417	0.010	43.8	769	38	9.7	274	0.97	0.16	2.34	32.7	20.2	
555	NS7	STMAT	0	2	NA	NA	5.52	2.432	0.148	16.4	1274	140	41.1	150	7.90	0.4	5.65	73.9	19.4	
556	NS7	ST/CL	1	10	11.73	0.50	6.68	0.424	0.018	23.9	1137	158	15.3	339	1.69	0.48	4.27	95.2	23.4	
557	NS7	ST/CL	2	18	1.37	0.67	6.90	0.179	0.003	55.1	685	22	4.8	256	0.97	0.16	1.61	25.2	19.4	
558	NS8	ST/CL	1	8	12.71	0.62	7.81	0.513	0.027	18.7	1323	268	20.2	280	2.02	0.48	5.16	89.5	25.0	32.70
559	NS8	ST/CL	2	22	2.30	0.35	6.94	0.371	0.018	20.9	823	87	9.7	260	1.77	0.32	4.35	65.2	20.2	
560	NS8	STMAT	0	3	NA	NA	5.81	5.051	0.337	15	1589	246	59.7	88	9.84	0.56	10.73	54.4	23.4	
561	NS8	ST/CL	1	15	2.57	1.07	6.64	0.459	0.022	20.7	1137	114	19.4	298	1.69	0.32	3.55	116.1	18.5	
562	NS8	ST/CL	2	12	2.48	0.72	6.86	0.337	0.016	21.2	823	29	8.9	310	1.69	0.16	4.35	51.1	20.2	
563	NS9	STMAT	0	3	NA	NA	6.26	7.741	0.513	15.1	2548	303	46	77	9.11	0.56	12.74	35.6	19.4	88.20
564	NS9	ST/CL	1	11	1.64	2.07	6.75	0.208	0.014	14.5	785	48	11.3	260	1.37	0.16	2.42	58.3	19.4	
565	NS9	ST	2	16	1.91	0.95	6.78	0.131	0.005	27.7	674	15	3.2	256	1.13	0.16	1.85	24	20.2	
566	NS10	STMAT	0	3	NA	NA	6.59	8.255	0.574	14.4	3823	944	101.6	95	16.05	0.73	22.66	55.4	20.2	67.47
567	NS10	ST/CL	1	12	4.58	2.06	6.90	0.484	0.029	16.7	1298	290	19.4	359	1.61	0.48	4.35	120.2	19.4	
568	NS10	C	2	15	3.19	0.84	7.29	0.305	0.019	16.4	831	73	6.5	300	0.97	0.24	3.47	44	20.2	
569	NS11	ST	1	15	0.89	1.51	7.10	0.313	0.042	7.5	716	13	3.2	267	0.48	0.08	1.61	19.4	21.8	14.01
570	NS11	ST	2	15	0.55	1.07	6.85	0.176	0.005	37.1	707	9	1.6	266	0.48	0.08	1.77	18.1	21.8	
571	NS12	STMAT	0	2	NA	NA	5.77	1.145	0.066	17.4	693	43	30.6	179	3.23	0.32	3.95	34.4	21.8	21.79
572	NS12	ST/CL	1	5	0.52	3.77	6.70	0.376	0.017	22.5	701	31	8.1	240	0.56	0.16	1.85	38.3	19.4	
573	NS12	ST/CL	2	23	1.02	1.06	6.85	0.317	0.009	35.1	703	11	4	252	0.48	0.08	2.34	14.1	23.4	
574	MG1	OB	1	18	3.27	0.77	5.13	0.395	0.041	9.7	216	27	16.1	197	0.65	0.32	0.73	27.2	12.9	14.06
575	MG1	OB	2	12	3.97	0.95	5.33	0.267	0.032	8.4	235	17	12.1	245	0.48	0.32	0.32	30	11.3	
576	MG1	OB	1	10	2.12	1.28	5.16	0.799	0.055	14.6	286	26	18.5	182	1.21	0.32	2.90	30	14.5	
577	MG1	OB	2	20	3.95	1.18	5.25	0.290	0.027	10.6	391	18	10.5	276	0.56	0.4	0.32	33.9	13.7	
578	MG2	ST	1	8	1.37	1.32	5.32	0.260	0.030	8.7	64	4	8.9	36	1.13	0.32	0.73	22.3	14.5	9.67
579	MG2	ST	2	22	1.19	1.36	5.25	0.133	0.022	5.9	15	2	4.8	3	0.48	0.16	0.16	7.3	13.7	
580	MG3	ST	1	10	1.79	1.65	4.80	0.392	0.023	17.3	52	3	6.5	58	0.56	0.24	0.32	13.6	12.9	12.66
581	MG3	ST	2	20	2.89	0.85	5.53	0.102	0.006	16.8	29	2	3.2	25	0.48	0.16	0.16	10.2	12.9	
582	MG4	ST	1	10	0.46	1.50	5.17	0.373	0.022	17.1	41	3	9.7	31	0.48	0.24	0.24	15.6	16.1	9.54
583	MG4	ST	2	20	0.92	0.84	5.07	0.144	0.016	9.2	12	2	4.8	8	0.32	0.16	0.08	7	12.9	
584	MG5	OB	1	18	1.53	1.41	5.02	0.408	0.023	17.6	285	10	14.5	200	0.73	0.32	2.82	29.3	11.3	14.82
585	MG5	ST	2	12	1.37	1.42	5.57	0.311	0.014	21.6	205	5	4	79	0.40	0.16	1.37	23.4	8.1	
586	MG6	ST	1	10	0.91	2.15	5.03	0.246	0.014	17.9	76	5	9.7	75	0.65	0.24	1.85	27.1	12.9	10.11
587	MG6	ST	2	30	1.28	0.64	5.30	0.120	0.004	29.3	28	3	4.8	41	0.40	0.32	0.16	15.7	10.5	
588	MG7	OB	1	20	5.14	0.76	5.37	0.291	0.012	23.4	319	40	25.8	273	0.40	0.73	0.24	49.8	15.3	18.38
589	MG7	OB	2	10	11.23	2.35	5.03	0.398	0.018	22.2	99	19	21	102	1.13	0.4	0.89	23.4	12.9	
590	MG7	ST	1	9	1.72	1.11	5.23	0.820	0.036	22.5	353	45	22.6	99	2.98	0.32	6.21	27.6	14.5	
591	MG7	ST	2	21	7.01	1.17	5.04	0.351	0.015	24	359	51	19.4	304	0.40	1.13	0.24	57.7	17.7	
592	MG8	ST	1	9	1.10	1.59	4.95	0.142	0.005	30.1	24	3	4.8	32	0.65	0.24	0.24	13.4	12.9	9.36
593	MG8	ST	2	21	1.84	1.29	5.44	0.172	0.004	39.1	12	2	2.4	5	0.40	0.16	0.16	10.2	8.1	
594	MG9	ST	1	15	1.20	1.20	5.08	0.256	0.015	17.6	97	5	10.5	130	0.73	0.32	0.40	15.8	10.5	10.45
595	MG9	ST	2	15	1.37	1.01	5.06	0.129	0.002	51.7	153	5	7.3	179	0.40	0.32	0.24	17.3	11.3	
596	MG10	ST	1	12	1.27	1.39	5.10	0.495	0.022	22.6	180	11	11.3	60	2.10	0.4	6.13	31.4	8.1	10.56

Lab #	Site	Soil type	HZ	Depth	Moist %	BD	pH	%C	%N	C/N	Ca	Mg	K	P	Zn	Cu	Mn	Fe	Na	CEC
				cm	dry wt	g/mL	--mg/kg--cmol/kg													
597	MG10	ST	2	18	0.54	1.16	5.39	0.161	0.003	58.3	35	2	2.4	10	0.40	0.16	0.40	9.7	7.3	
598	MG11	OB	1	15	1.17	0.78	5.22	0.339	0.016	20.6	165	7	9.7	119	0.73	0.16	1.53	21.8	12.9	10.02
599	MG11	ST	2	15	1.09	1.15	5.49	0.161	0.001	151.6	163	3	7.3	152	0.40	0.16	0.16	24.8	24.2	
600	MG12	ST	1	9	1.19	1.71	5.10	0.324	0.006	58.2	69	10	19.4	58	0.65	0.16	0.81	19.3	17.7	11.24
601	MG12	ST	2	21	0.73	1.08	4.81	0.068	NA	NA	14	2	3.2	18	0.32	0.08	0.08	8.1	9.7	
602	PC1	TS	1	8	3.31	1.09	4.72	1.550	0.041	37.5	286	35	23.4	170	0.65	0.24	0.89	70.8	16.9	26.93
603	PC1	OB	2	14	3.17	1.53	4.26	1.110	0.028	39.5	106	5	13.7	101	0.48	0.16	0.24	143.5	14.5	
604	PC1	OB	3	8	4.92	0.47	4.56	0.801	0.023	34.9	67	5	13.7	169	0.48	0.24	0.48	317.7	15.3	
605	PC2	TS	1	15	3.99	1.03	4.99	1.765	0.052	34.2	602	54	25	125	0.73	0.24	2.58	69.8	13.7	33.28
606	PC2	OB	2	15	1.94	1.12	5.05	0.830	0.022	37	191	15	8.9	111	0.48	0.32	1.05	49.1	9.7	
607	PC3	TS	1	8	5.65	0.99	5.28	0.720	0.019	37.8	1613	314	64.5	183	0.56	0.32	3.79	111.3	16.9	38.81
608	PC3	OB	2	11	14.39	0.98	5.39	0.323	0.006	52.4	1806	366	60.5	173	0.32	0.56	1.05	130.6	21.0	
609	PC3	OB	3	11	14.24	1.66	5.54	0.510	0.002	236.1	1798	385	62.1	145	0.32	0.56	0.89	124.2	25.0	
610	PC4	OB	1	12	4.27	0.92	5.53	0.703	0.027	25.8	1339	170	51.6	217	0.40	0.32	0.81	122.6	18.5	27.41
611	PC4	OB	2	8	3.30	1.23	5.65	0.299	0.015	19.9	1113	106	34.7	323	0.48	0.65	0.40	98.4	21.0	
612	PC4	OB	3	10	2.91	1.00	5.61	0.163	0.011	15.2	871	71	22.6	262	0.48	0.32	0.48	80.2	17.7	
613	PC5	OB	1	20	5.31	1.03	5.08	2.110	0.079	26.8	1024	245	41.1	110	0.65	0.32	4.11	159.7	29.0	31.24
614	PC5	OB	2	10	10.25	1.42	5.26	0.375	0.012	30.8	1065	306	26.6	18	0.56	0.4	1.21	173.4	27.4	
615	PC6	OB	1	8	4.80	1.25	5.54	1.241	0.069	17.9	1065	133	54.8	169	0.73	0.24	3.47	133.9	24.2	27.35
616	PC6	OB	2	14	12.13	0.89	5.68	0.705	0.021	34.3	1500	253	55.6	243	0.40	0.32	0.48	171.8	21.0	
617	PC6	OB	3	8	4.64	1.21	5.95	0.225	0.003	77.8	1258	152	33.1	364	0.40	0.4	0.56	111.3	17.7	
618	PC7	OB	1	15	14.55	0.69	5.25	0.405	0.014	29.3	2000	369	142.7	227	0.56	2.34	0.40	60.2	35.5	28.71
619	PC7	OB	2	15	10.66	0.80	5.24	0.160	0.003	52.5	2185	390	148.4	285	0.65	2.02	0.81	69.9	38.7	
620	PC8	OB	1	9	5.42	1.71	5.43	0.778	0.038	20.4	911	109	64.5	261	0.56	0.65	1.05	126.6	16.1	27.30
621	PC8	OB	2	13	6.02	1.14	5.09	0.663	0.021	31.4	568	53	41.9	219	0.56	0.56	0.73	173.4	22.6	
622	PC8	OB	3	8	4.21	1.27	5.34	0.427	0.014	30.3	513	43	32.3	220	0.56	0.48	0.56	133.9	18.5	
623	PC9	OB	1	18	6.53	0.78	5.08	0.348	0.014	24.9	556	115	72.6	141	0.48	0.4	1.13	58.4	20.2	25.72
624	PC9	OB	2	12	11.81	0.95	4.61	0.279	0.006	43.4	573	122	70.2	126	0.48	0.89	0.65	52	24.2	
625	BW1	TS/OB	1	15	2.53	1.32	4.92	0.614	0.024	26.1	103	14	16.9	94	1.21	0.24	4.03	130.6	16.1	22.23
626	BW1	TS/OB	2	15	2.62	1.27	4.96	0.376	0.014	27.6	44	6	8.9	122	0.48	0.16	1.21	213.7	13.7	
627	BW2	TS/OB	1	15	2.24	1.28	5.13	0.776	0.037	21.1	256	26	13.7	133	2.02	0.24	6.77	129.8	16.1	29.63
628	BW2	TS/OB	2	15	3.89	1.26	5.22	0.509	0.027	18.9	155	21	10.5	116	0.48	0.24	1.53	250	19.4	
629	BW3	TS/OB	1	19	2.33	1.27	5.20	0.540	0.026	21	108	14	11.3	106	0.56	0.16	1.53	96.8	13.7	27.48
630	BW3	TS/OB	2	11	10.25	1.59	4.76	0.189	NA	NA	123	39	10.5	102	0.40	0.16	0.56	49.3	16.9	
631	BW4	TS	1	12	1.76	1.44	4.36	1.465	0.055	26.4	225	14	9.7	5	2.42	0.24	3.23	29.6	10.5	39.49
632	BW4	TS	2	18	2.23	1.31	4.28	0.680	0.020	33.7	48	3	4.8	2	0.48	0.24	0.16	27.2	12.9	
633	BW5	TS/OB	1	15	2.52	1.32	4.65	1.394	0.054	25.8	288	21	16.9	9	1.69	0.24	2.98	25.5	11.3	34.91
634	BW5	TS/OB	2	10	1.20	1.78	5.24	0.447	0.007	67.2	199	15	4.8	26	0.24	0.08	0.32	19.9	0.0	
635	BW5	TS/OB	3	5	6.53	0.63	6.40	0.823	0.022	37.8	1218	293	28.2	436	1.85	0.81	1.69	85.5	13.7	
636	BW6	TS/OB	1	25	2.81	1.34	4.98	0.489	0.023	21.3	80	13	2.4	8	0.40	0.08	0.24	14.3	0.8	10.33
637	BW6	TS/OB	2	5	7.84	1.61	5.02	0.518	0.007	74	165	20	5.6	213	0.24	0.32	0.16	41.2	2.4	
638	BW7	TS/OB	1	23	1.38	1.13	4.94	0.662	0.023	28.2	73	8	11.3	19	0.65	0.16	0.48	10.1	19.4	9.11
639	BW7	TS/OB	2	7	10.81	1.61	5.50	0.866	0.015	57.3	353	18	14.5	230	0.32	0.32	0.32	22.9	20.2	
640	BW8	TS/OB	1	12	3.39	1.36	5.02	0.831	0.026	31.7	144	12	18.5	40	1.05	0.24	0.97	23.9	14.5	11.13
641	BW8	TS/OB	2	18	12.94	1.36	5.75	0.241	NA	NA	498	41	17.7	340	0.40	0.4	0.48	34.8	20.2	
642	BW9	TS/OB	1	15	1.11	1.17	5.37	0.756	0.031	24.1	182	14	9.7	110	1.21	0.24	3.15	86.3	16.1	11.85
643	BW9	TS/OB	2	15	1.38	1.34	5.47	0.301	0.006	48.6	76	10	4.8	92	0.32	0.16	0.56	89.5	12.1	
644	BW10	TS/OB	1	11	4.47	1.50	4.47	3.018	0.109	27.6	423	18	15.3	17	1.21	0.16	0.56	43.8	8.1	17.91
645	BW10	TS/OB	2	19	4.17	1.10	5.07	0.541	0.013	41.5	355	6	4	277	0.32	0.32	0.48	38.1	1.6	
646	BW11	TS	1	7	1.85	1.69	4.57	0.858	0.028	30.2	67	4	4	18	0.81	0.08	0.56	21.7	0.0	12.67
647	BW11	ST	2	23	1.10	1.33	5.00	0.215	0.002	95.2	273	2	2.4	113	0.32	0.08	0.24	31.5	0.0	
648	BW12	TS/OB	1	9	1.67	1.15	5.26	3.089	0.122	25.4	530	44	19.4	36	4.11	0.32	7.42	22.7	0.0	13.29

Lab #	Site	Soil type	HZ	Depth	Moist %	BD	pH	%C	%N	C/N	Ca	Mg	K	P	Zn	Cu	Mn	Fe	Na	CEC
				cm	dry wt	g/mL	--------------------------mg/kg--------------------------													cmol/kg
649	BW12	TS/OB	2	21	1.10	1.35	5.34	0.351	0.002	177.1	187	4	3.2	92	0.32	0.08	0.32	27.3	0.0	
650	HL1	OB	1	10	7.76	1.38	5.91	1.062	0.046	22.9	523	56	30.6	350	0.73	0.24	1.13	80.6	9.7	24.62
651	HL1	OB	2	20	7.72	1.61	6.42	0.571	0.018	31.6	552	66	9.7	379	0.48	0.24	0.40	100	10.5	
652	HL2	TS	1	12	8.17	1.60	5.39	0.282	0.006	50.3	53	8	10.5	13	0.48	0.08	0.32	10.1	2.4	12.62
653	HL2	TS	2	5	11.73	1.48	5.75	1.442	0.027	53.3	431	42	6.5	47	0.48	0.16	0.24	45	8.1	
654	HL2	OB	3	13	10.58	1.11	6.26	0.294	0.006	53.3	752	130	8.1	444	0.48	0.4	0.40	156.5	21.8	
655	HL3	TS	1	5	13.75	1.89	4.77	2.853	0.092	31.1	145	31	25.8	16	0.65	0.24	0.48	29.7	10.5	22.00
656	HL3	TS	2	18	9.37	0.94	5.39	0.317	0.007	43.9	65	13	5.6	15	0.24	0.08	0.16	11.2	1.6	
657	HL3	OB	3	7	12.44	1.68	6.66	0.671	0.011	62.5	581	157	11.3	373	0.32	0.32	0.73	86.3	13.7	
658	HL4	TS	1	10	12.22	1.36	3.94	1.552	0.037	41.4	180	60	31.5	18	0.65	0.16	0.65	36.6	11.3	26.11
659	HL4	TS	2	20	17.08	1.14	4.16	2.443	0.053	46.3	266	72	6.5	6	0.32	0.16	0.16	46.5	5.6	
660	HL5	TS	1	20	7.53	1.49	4.74	1.108	0.022	49.7	144	32	9.7	16	0.40	0.16	0.32	23.5	1.6	16.81
661	HL5	OB	2	10	9.67	1.63	6.74	0.419	0.009	44.6	671	216	6.5	371	0.65	0.24	0.73	83.9	10.5	
662	HL6	TS	1	20	11.00	1.30	4.76	1.791	0.046	38.7	210	54	13.7	15	0.56	0.16	0.48	39.4	3.2	23.32
663	HL6	OB	2	10	12.26	0.88	5.41	0.793	0.020	40.3	346	50	2.4	372	0.32	0.08	0.32	135.5	4.8	
664	HL7	TS	1	23	12.98	1.29	4.71	1.455	0.042	34.4	152	25	17.7	19	0.65	0.16	0.48	28.2	14.5	19.21
665	HL7	OB	2	7	11.35	0.97	5.61	1.198	0.026	46.4	519	63	8.1	376	0.48	0.16	0.40	73.1	16.9	
666	HL8	TS	1	16	3.20	1.54	5.31	0.518	0.019	27.3	207	38	34.7	11	1.29	0.24	2.26	18.9	12.9	17.98
667	HL8	TS	2	16	4.47	0.74	4.97	0.730	0.017	41.9	173	22	12.1	52	0.40	0.16	0.16	25.5	14.5	
668	HL8	OB	3	4	5.66	0.91	5.31	0.596	0.013	46.3	633	80	16.9	470	0.40	0.24	0.56	59.3	19.4	
669	HL9	TS	1	18	10.14	1.14	4.62	1.367	0.040	33.9	186	29	18.5	24	0.89	0.16	0.73	24.4	9.7	25.33
670	HL9	OB	2	12	8.58	1.94	6.02	0.432	0.016	27.8	575	120	15.3	340	0.32	0.48	0.56	80.6	18.5	
671	MG-A		1	NA	NA	NA	4.50	0.186	0.000	NA	60	5	4	31	0.32	0.08	0.16	6.9	9.7	3.34
672	MG-B		1	NA	NA	NA	4.36	0.470	0.000	NA	23	5	8.9	5	0.56	0.08	0.16	2.9	11.3	2.93
673	MG-C		1	NA	NA	NA	4.56	0.096	0.000	NA	23	3	5.6	7	0.40	0.08	0.24	4.3	11.3	2.54

Appendix G

PENETROMETER READINGS FOR EACH UPLAND RECLAMATION SAMPLING SITE

Site	Surface Soil	Penetrometer Readings (Pressure kg/cm2)										Duplicate Penetrometer Readings (Pressure kg/cm2)								
		2 cm	5 cm	10 cm	15 cm	20 cm	30 cm	40 cm	50 cm	60 cm		2 cm	5 cm	10 cm	15 cm	20 cm	30 cm	40 cm	50 cm	60 cm
BM1	ST	4	5	9	13	17	28	28	28	28		3	4	7	10	16	28	28	28	28
BM2	ST/OB	1	2	2	2	2	1	1	28	28		6	7	11	15	19	28	28	28	28
BM3	ST/OB	3	6	22	28	28	28	28	28	28		14	23	28	28	28	28	28	28	28
BM4	ST/OB	12	21	28	28	28	28	28	28	28		20	28	28	28	28	28	28	28	28
BM5	ST/OB	19	28	28	28	28	28	28	28	28		16	21	28	28	28	28	28	28	28
BM6	ST/OB	14	23	28	28	28	28	28	28	28		9	10	9	12	9	22	28	28	28
BM7	ST	8	12	18	21	28	28	28	28	28		2	4	18	20	28	28	28	28	28
BM8	ST/OB	8	16	22	28	28	28	28	28	28		7	14	21	24	28	28	28	28	28
BM9	ST/OB	4	9	22	28	28	28	28	28	28		14	23	28	28	28	28	28	28	28
BM10	ST/OB	8	9	14	22	28	28	28	28	28		5	7	20	17	3	5	3	10	28
BM11	ST/OB	12	21	28	28	28	28	28	28	28		7	10	11	11	15	22	28	28	28
BM12	ST/OB	10	14	18	17	16	11	14	28	28		14	22	28	28	28	28	28	28	28
ES1	TS	2	6	14	16	22	28	28	28	28		5	14	22	28	28	28	28	28	28
ES2	TS	4	12	22	28	28	28	28	28	28		3	8	21	28	28	28	28	28	28
ES3	TS	5	6	9	24	28	28	28	28	28		4	6	6	9	14	24	28	28	28
ES4	TS	24	28	28	28	28	28	28	28	28		6	12	25	28	28	28	28	28	28
ES5	TS	6	11	24	28	28	28	28	28	28		3	6	26	28	28	28	28	28	28
ES6	TS	7	10	24	28	28	28	28	28	28		10	13	24	28	28	28	28	28	28
ES7	TS	6	8	24	28	28	28	28	28	28		6	10	23	28	28	28	28	28	28
ES8	TS	7	14	17	22	24	28	28	28	28		3	7	15	18	19	24	28	28	28
ES9	TS	16	23	28	28	28	28	28	28	28		4	23	28	28	28	28	28	28	28
GH1	TS	6	19	28	28	28	28	28	28	28		10	21	28	28	28	28	28	28	28
GH2	TS	14	20	28	28	28	28	28	28	28		6	18	28	28	28	28	28	28	28
GH3	TS	14	23	28	28	28	28	28	28	28		8	23	28	28	28	28	28	28	28
GH4	TS	7	12	23	28	28	28	28	28	28		8	14	20	23	28	28	28	28	28
GH5	TS	8	16	20	22	26	28	28	28	28		4	6	12	14	16	17	21	28	28
GH6	TS	10	16	15	15	20	28	28	28	28		8	14	20	28	28	28	28	28	28
GH7	TS	4	21	28	28	28	28	28	28	28		4	10	13	16	20	28	28	28	28
GH9	TS	7	18	23	28	28	28	28	28	28		4	14	22	28	28	28	28	28	28
GH10	TS	16	23	28	28	28	28	28	28	28		8	10	19	22	28	28	28	28	28
GH11	TS	22	26	28	28	28	28	28	28	28		4	9	15	22	23	28	28	28	28
GH12	TS	8	22	28	28	28	28	28	28	28		4	10	20	23	28	28	28	28	28
GH13	TS	18	22	28	28	28	28	28	28	28		12	22	28	28	28	28	28	28	28
GH14	TS	8	12	21	28	28	28	28	28	28		6	14	22	28	28	28	28	28	28
GH15	TS	6	12	22	28	28	28	28	28	28		3	12	17	24	28	28	28	28	28
WC1	OB	1	3	6	9	12	16	17	28	28		3	5	7	10	12	19	28	28	28
WC2	OB	6	14	21	13	12	14	28	28	28		4	8	18	20	21	28	28	28	28
WC3	OB	3	7	12	18	20	20	28	28	28		4	7	9	12	15	23	28	28	28
WC4	OB	3	6	10	18	14	14	12	10	10		7	9	6	6	8	14	12	7	7
WC5	OB	4	8	24	28	28	28	28	28	28		4	7	10	12	10	6	4	4	28
WC6	OB	1	2	4	4	4	6	12	18	28		2	2	2	6	8	12	21	28	28
WC7	OB	9	14	6	7	6	4	8	28	28		2	6	14	8	10	9	8	5	4
WC8	OB	1	2	6	11	14	13	11	9	28		2	4	8	11	14	20	28	28	28
WC9	OB	2	6	14	15	21	22	28	28	28		1	2	6	8	9	7	5	2	3
WC10	OB	1	2	3	3	4	4	2	8	28		1	2	6	11	15	22	28	28	28

Site	Surface Soil	Penetrometer Readings (Pressure kg/cm2)										Duplicate Penetrometer Readings (Pressure kg/cm2)								
		2 cm	5 cm	10 cm	15 cm	20 cm	30 cm	40 cm	50 cm	60 cm		2 cm	5 cm	10 cm	15 cm	20 cm	30 cm	40 cm	50 cm	60 cm
WC11	OB	4	6	11	23	28	28	28	28	28		2	6	8	11	14	23	28	28	28
WC11	OB	4	6	11	23	28	28	28	28	28		2	6	8	11	14	23	28	28	28
WC12	ST	1	1	2	4	10	20	28	28	28		3	6	11	17	21	28	28	28	28
WC13	ST	4	6	11	12	13	11	9	8	28		2	4	12	10	12	20	28	28	28
WC14	OB	2	4	9	9	15	22	28	28	28		2	3	6	8	10	11	10	18	28
WC15	OB	1	1	4	12	24	28	28	28	28		2	4	5	10	20	28	28	28	28
SA1	OB	1	12	19	13	16	26	28	28	28		1	6	13	21	18	27	28	28	28
SA2	OB	1.5	5	13.5	12.2	14	23	27	28	28		2	9.5	12	18	18	22	26	28	28
SA3	OB	27	28	28	28	28	28	28	28	28		27	28	28	28	28	28	28	28	28
SA4	OB	27	28	28	28	28	28	28	28	28		27	28	28	28	28	28	28	28	28
SA5	OB	1	23	28	28	28	28	28	28	28		4	24	28	28	28	28	28	28	28
SA6	OB	1.5	2	5	7	8.5	17	28	26	28		2.5	3.5	4	5	6	16	26	27	27
SA7	OB	2	12	13	14	17.5	27	27	28	28		4	23	19	16	18	25	20	27	28
SA8	OB	14	28	28	28	28	28	28	28	28		12	27	28	28	28	28	28	28	28
SA9	OB	4	5	7	9	14	26	26	26	28		6	12	14	25	27	26	26	26	28
SA10	OB	1	4	5	6	10	20	28	28	28		2	6	11	12	13	19	27	28	28
SA11	OB	1	6	11	12	13	19	27	28	28		2	5.5	9.5	13	14	18	27	28	28
SA12	OB	1	5	7	8	7	25	28	28	28		2	4	7	8	7	22	28	28	28
SA13	OB	4	10	12	19	9	12	22	27	28		2	7	18	17	15	21	28	28	28
SA14	OB	4	9	22	26.5	26.5	28	28	28	28		6	10	18	25	28	28	28	28	28
SA15	OB	1	3	6.5	7	8.5	21	28	28	28		0	0	1	28	28	28	28	28	28
SA16	OB	22	28	28	28	28	28	28	28	28		26	28	28	28	28	28	28	28	28
SA17	OB	28	28	28	28	28	28	28	28	28		28	28	28	28	28	28	28	28	28
SA19	OB	0	1	5.5	10	14	23	27	28	28		1	2	7	10	14	22	27	28	28
SA20	OB	6	10	22	28	28	28	28	28	28		26	26	28	28	28	28	28	28	28
SA21	OB	8	12	14	16	18	22	26	28	28		28	28	28	28	28	28	28	28	28
SA22	OB	6	16	14	13.5	13	8.5	13	25	28		2	8	11	10	8	17	23	28	28
SA23	OB	2	6	5	5	6	16	15	26	28		4	6	10	11	11.5	19	27	27	28
SA18	OB	3	7	13	16	26.5	28	28	28	28		1	6	14	2	28	28	28	28	28
SA24	OB	3	6	8	8.5	14	24	27	28	28		2	3	5	11	18	27	28	28	28
NS1	STMAT	4	10	18	28	28	28	28	28	28		4	10	19	28	28	28	28	28	28
NS2	STMAT	11	18	23	28	28	28	28	28	28		10	23	28	28	28	28	28	28	28
NS3	ST	2	7	15	19	24	28	28	28	28		2	4	13	19	22	24	28	28	28
NS4	STMAT	4	10	14	17	25	28	28	28	28		6	11	20	28	28	28	28	28	28
NS5	ST	2	4	7	14	21	28	28	28	28		5	19	28	28	28	28	28	28	28
NS6	ST/CS	1	2	5	4	1	11	28	28	28		1	2	8	7	8	2	4	4	28
NS7	STMAT	16	18	22	28	28	28	28	28	28		6	18	24	28	28	28	28	28	28
NS8	ST/CL	4	12	22	24	28	28	28	28	28		10	24	28	28	28	28	28	28	28
NS9	STMAT	8	11	23	28	28	28	28	28	28		3	8	16	22	28	28	28	28	28
NS10	STMAT	13	20	28	28	28	28	28	28	28		4	14	17	28	28	28	28	28	28
NS11	ST	5	9	17	18	28	28	28	28	28		5	11	18	28	28	28	28	28	28
NS12	STMAT	6	10	14	14	18	28	28	28	28		4	8	8	9	15	20	28	28	28
MG1	OB	7	10	22	28	28	28	28	28	28		6	14	24	28	28	28	28	28	28
MG2	ST	4	5	6	9	15	22	28	28	28		6	9	16	21	28	28	28	28	28
MG3	ST	2	6	18	16	22	28	28	28	28		6	9	10	15	22	28	28	28	28
MG4	ST	9	12	14	20	28	28	28	28	28		4	8	12	22	23	28	28	28	28

Site	Surface Soil	Penetrometer Readings (Pressure kg/cm2)										Duplicate Penetrometer Readings (Pressure kg/cm2)								
		2 cm	5 cm	10 cm	15 cm	20 cm	30 cm	40 cm	50 cm	60 cm		2 cm	5 cm	10 cm	15 cm	20 cm	30 cm	40 cm	50 cm	60 cm
MG5	OB	4	5	8	12	20	28	28	28	28		2	8	20	22	28	28	28	28	28
MG6	ST	6	12	15	19	20	22	28	28	28		6	8	11	16	22	28	28	28	28
MG7	OB	6	9	12	16	24	28	28	28	28		8	11	22	28	28	28	28	28	28
MG8	ST	2	4	8	12	18	28	28	28	28		4	6	9	14	22	28	28	28	28
MG9	ST	3	4	3	6	20	28	28	28	28		4	14	22	28	28	28	28	28	28
MG10	ST	2	6	10	15	18	28	28	28	28		4	7	8	11	16	28	28	28	28
MG11	OB	8	10	12	13	20	28	28	28	28		4	9	11	11	11	18	28	28	28
MG12	ST	7	8	9	18	23	28	28	28	28		6	8	9	12	24	28	28	28	28
PC1	TS	10	22	3	5	11	18	27	28	28		3	8	14	4	28	28	28	28	28
PC2	TS	2	16	28	28	28	28	28	28	28		2	21	28	28	28	28	28	28	28
PC3	TS	8	6	15	5	8	20	28	28	28		0	8	24	28	28	28	28	28	28
PC4	OB	22	28	28	28	28	28	28	28	28		6	21	28	28	28	28	28	28	28
PC5	OB	10	10	21	28	28	28	28	28	28		24	28	28	28	28	28	28	28	28
PC6	OB	26	28	28	28	28	28	28	28	28		6	14	6	28	28	28	28	28	28
PC7	OB	10	20	20	28	28	28	28	28	28		18	20	21	28	28	28	28	28	28
PC8	OB	24	28	28	28	28	28	28	28	28		0	2	6	24	28	28	28	28	28
PC9	OB	24	28	28	28	28	28	28	28	28		24	28	28	28	28	28	28	28	28
BW1	TS/OB	3	7	16	24	28	28	28	28	28		4	7	10	18	24	28	28	28	28
BW2	TS/OB	1	9	18	28	28	28	28	28	28		3	6	10	20	23	28	28	28	28
BW3	TS/OB	3	4	8	22	24	28	28	28	28		6	14	23	28	28	28	28	28	28
BW4	TS	4	5	7	7	9	14	28	28	28		3	5	9	14	16	28	28	28	28
BW5	TS/OB	5	5	6	10	18	28	28	28	28		4	9	16	28	28	28	28	28	28
BW6	TS/OB	3	5	8	10	17	28	28	28	28		7	8	12	28	28	28	28	28	28
BW7	TS/OB	1	3	4	5	21	28	28	28	28		4	6	8	18	28	28	28	28	28
BW8	TS/OB	3	6	12	16	28	28	28	28	28		8	12	18	28	28	28	28	28	28
BW9	TS/OB	8	13	16	16	21	28	28	28	28		4	8	16	18	21	28	28	28	28
BW10	TS/OB	4	12	18	28	28	28	28	28	28		1	4	7	10	14	19	28	28	28
BW11	TS	1	2	3	4	14	13	28	28	28		4	4	3	3	7	14	28	28	28
BW12	TS/OB	4	7	12	15	28	28	28	28	28		1	3	6	19	28	28	28	28	28
HL1	OB	10	24	28	28	28	28	28	28	28		5	9	20	28	28	28	28	28	28
HL2	TS	8	10	16	24	28	28	28	28	28		6	8	8	14	34	28	28	28	28
HL3	TS	4	6	12	18	22	28	28	28	28		5	6	10	10.5	18	28	28	28	28
HL4	TS	0	4	8	12	18	28	28	28	28		4	5.5	6	9	14	24	28	28	28
HL5	TS	6	6	8	10	16	28	28	28	28		4	5	8	12	17	28	28	28	28
HL6	TS	6	6	8	10	12	28	28	28	28		8	10	12	14	20	28	28	28	28
HL7	TS	5	8	11	11	18	28	28	28	28		4	8	9	9	12	28	28	28	28
HL8	TS	4	5	6	7	8	23	28	28	28		2	4	6	8	10	21	28	28	28
HL9	TS	8	10	11	10	22	28	28	28	28		2	4	4	6.5	10	28	28	28	28

Appendix H

TEXTURE ANALYSES CONDUCTED ON SELECTED SOIL SAMPLES

Texture Analyses Conducted on Selected Soil Samples

Transect	Soil*	%Sand	%Silt	%Clay	Texture**
BM1	ST	99.1	0.8	0.1	S
BM3	ST	94.6	5.3	0.1	S
BM4	ST/OB	94.7	5.2	0.1	S
BM5	ST/OB	94.2	5.7	0.1	S
BM6	ST/OB	97.3	2.6	0.1	S
BM9	ST/OB	93.4	5.5	1.1	S
BM11	ST/OB	95.3	3.5	1.1	S
BM12	ST/OB	93.4	4.9	1.7	S
BW1	TS/OB	96.6	1.8	1.6	S
BW2	TS/OB	95.6	3	1.4	S
BW3	TS/OB	95.4	2.8	1.8	S
BW4	TS	97	2.9	0.1	S
BW5	TS/OB	97.4	1.8	0.8	S
BW5	TS/OB	88.3	4.3	7.4	S
BW10	TS/OB	94.9	5	0.1	S
ES2	TS	93.6	5.6	0.8	S
ES4	OB	97.1	2.7	0.2	S
ES-6	TS	81.8	17	1.2	LS
ES-6	OB	92.4	5.4	2.2	S
ES9	OB	93.6	5.6	0.3	S
GH1	TS	95	4.9	0.2	S
GH1	OB/ST	94	5.2	0.8	S
GH2	OB/ST	98.5	1.1	0.4	S
GH2	TS	92.9	6.1	1	S
GH4	TS	96.6	3.2	0.2	S
GH5	TS	96.2	3.7	0.1	S
GH6	TS	96.6	3.3	0.1	S
GH8	OB/ST	94.2	5.7	0.1	S
GH11	TS	95	4.6	0.4	S
GH14	TS	92.8	5.9	1.3	S
HL1	OB	90.9	4.7	4.4	S
HL2	TS	97.6	2.3	0.1	S
HL3	TS	96.5	3.4	0.1	S
HL4	TS	93.5	4.2	2.3	S
HL5	OB	87.6	6.9	5.5	LS
HL6	TS	96.4	3.5	0.1	S

Transect	Soil*	%Sand	%Silt	%Clay	Texture**
MG1	OB	94.9	2.3	2.7	S
MG4	ST	99.3	0.4	0.2	S
MG7	OB	89.5	4	6.5	S
MG8	ST	98.7	1	0.3	S
MG10	ST	98	1.9	0.1	S
MG12	ST	98.3	1.6	0.1	S
NS3	ST	99.8	0.1	0.1	S
NS7	ST/CL	91.2	2.3	6.6	S
NS9	STMAT	91.5	6.9	1.6	S
NS11	ST	99.2	0.1	0.7	S
NS12	ST/CL	97.9	0.3	1.8	S
PC1	TS	85.6	9.1	5.3	LS
PC2	TS	88	9.1	2.9	LS
PC4	OB	80	5.5	14.5	SL
PC5	OB	73.1	12.7	14.2	SL
PC7	OB	67.1	6.1	26.8	SCL
PC8	OB	83.1	6.3	10.6	LS
PC9	OB	76.8	7.1	16.1	SL
SA2	OB	90.4	4.5	5.1	S
SA3	OB	88.7	11.2	0.1	S
SA4	OB	89	10.9	0.1	S
SA5	OB	90.4	3.7	5.8	S
SA10	OB	87	3.8	9.2	LS
SA14	OB	89.5	10.4	0.1	S
SA15	OB	98.8	0.2	1	S
SA16	OB	89.7	5.7	4.6	S
SA17	OB	88.3	5.3	6.3	LS
SA19	OB	90.3	2.7	7	S
SA23	OB	87	4	9	LS
WC-!	OB	93.6	3.3	3	S
WC-4	OB	89.2	3.7	7	S
WC-5	OB	88.1	7.1	4.8	S
WC--5	OB	81.3	4.9	13.8	SL
WC-7	OB	89.1	10.8	0.1	S
WC-9	OB	88.2	6	5.8	LS
WC-10	OB	93.4	6.5	0.1	S
WC-12	ST	99.6	0.1	0.3	S
WC-14	ST	90.3	9.6	0.1	S
WC-15	OB	87.1	5.3	7.6	LS

* ST = Sand tailings, OB = Overburden, TS = Topsoil
ST/OB = Sand tailings/Overburden mixture, ST/CL = Sand tailings/Clay
TS/OB = Topsoil/Overburden mixture, STMAT = Sand Tailings mat
**S = Sand, LS = Loamy Sand, SL = Sandy Loam, SCL = Sandy Clay Loam

Appendix I

MEAN SOIL PARAMETERS FOR EACH AGGRESSIVE GRASS PRESENTED BY SITE

Mean Soil Parameters for Each Aggressive Grass Presented by Site

Surface pH

SITE	BAHIA	TORPEDO	NATAL	BERMUDA	COGON	MEAN
BM	6.01	.	6.2	.	6.12	6.2
BW	.	.	5.06	.	4.86	5.01
ES	5.31	.	5.23	.	5.32	5.25
GH	5.41	5.78	5.31	5.55	5.69	5.26
HL	5.65	.	.	5.91	.	5.65
MG	5.1	.	5.03	.	.	5.1
NS	6.83	.	6.8	6.7	7.08	6.87
PC	5.06	.	.	.	.	5.06
SA	6.03	6.33	6.07	6.05	.	6.06
WC	6.22	.	6	5.64	6.04	6.04
MEAN	5.7	5.92	5.78	5.99	5.89	5.75

Surface C, %

SITE	BAHIA	TORPEDO	NATAL	BERMUDA	COGON	MEAN
BM	0.52	.	0.4	.	0.38	0.4
BW	.	.	1.02	.	0.95	1.04
ES	1.34	.	1.35	.	2.54	1.62
GH	1.16	0.99	0.97	0.7	1.04	0.99
HL	0.67	.	.	1.06	.	0.67
MG	0.37	.	0.28	.	.	0.37
NS	0.44	.	0.36	0.38	0.4	0.39
PC	1.55	.	.	.	.	1.55
SA	0.42	0.38	0.37	0.4	.	0.39
WC	1.59	.	1.16	0.56	0.57	1.02
MEAN	0.73	0.84	0.7	0.47	0.86	0.75

Surface N, %

SITE	BAHIA	TORPEDO	NATAL	BERMUDA	COGON	MEAN
BM	0.02	.	0.01	.	0.01	0.01
BW	.	.	0.04	.	0.03	0.04
ES	0.05	.	0.05	.	0.11	0.07
GH	0.04	0.04	0.03	0.03	0.04	0.03
HL	0.03	.	.	0.05	.	0.03
MG	0.02	.	0.02	.	.	0.02
NS	0.02	.	0.02	0.02	0.02	0.02
PC	0.05	.	.	.	.	0.05
SA	0.01	0.02	0.01	0.01	.	0.01
WC	0.06	.	0.05	0.02	0.02	0.05
MEAN	0.03	0.03	0.03	0.02	0.03	0.03

Surface Ca, mg/kg

SITE	BAHIA	TORPEDO	NATAL	BERMUDA	COGON	MEAN
BM	197	.	295.97	.	352.5	295.97
BW	.	.	189.43	.	178.33	195.33
ES	260.83	.	254.43	.	437	295
GH	405.39	561.67	339.54	339.39	485.27	336.57
HL	288	.	.	523	.	288
MG	136.67	.	99.67	.	.	136.67
NS	984.3	.	806.83	701	1085.33	920.27
PC	705.75	.	.	.	.	705.75
SA	580.87	887	608.87	622.84	.	612.38
WC	697.5	.	657.86	466	546.94	647.51
MEAN	463.79	643	440.97	579.97	519.57	465.35

Surface Mg, mg/kg

SITE	BAHIA	TORPEDO	NATAL	BERMUDA	COGON	MEAN
BM	16.25	.	25.46	.	40.83	25.46
BW	.	.	18.43	.	15.67	18
ES	37.5	.	36.14	.	89	47.89
GH	35.31	39.5	29.67	40.78	37.77	28.56
HL	32	.	.	56	.	32
MG	10.83	.	5	.	.	10.83
NS	134.1	.	65.25	31	177.67	114.5
PC	110.75	.	.	.	.	110.75
SA	75.97	143	76.8	78.5	.	75.85
WC	128.83	.	100.23	54	95.39	106.62
MEAN	60.88	65.38	50.78	69.85	74.62	58.79

Surface K, mg/kg

SITE	BAHIA	TORPEDO	NATAL	BERMUDA	COGON	MEAN
BM	10.3	.	10.36	.	14.93	10.36
BW	.	.	11.06	.	17.43	12.53
ES	15.98	.	15.89	.	23.8	17.64
GH	13.92	15.62	13.36	16.53	15.08	13.22
HL	20.55	.	.	30.6	.	20.55
MG	12.21	.	9.15	.	.	12.21
NS	12.44	.	9.76	8.1	19.37	12.66
PC	38.5	.	.	.	.	38.5
SA	8.32	9.7	7.89	7.56	.	7.94
WC	8.6	.	12.03	8.1	6.35	11.1
MEAN	13.44	14.14	10.82	9.69	14.38	12.67

Surface P, mg/kg

SITE	BAHIA	TORPEDO	NATAL	BERMUDA	COGON	MEAN
BM	210	.	221.94	.	257.17	221.94
BW	.	.	72.14	.	47.67	61.56
ES	123	.	108.71	.	89	104.33
GH	104.92	164.5	100.49	90.17	135.5	94.99
HL	181.5	.	.	350	.	181.5
MG	97.88	.	88.5	.	.	97.88
NS	289.8	.	252.83	240	312.67	279.64
PC	166.5	.	.	.	.	166.5
SA	356.62	311	391.46	380.23	.	386.17
WC	273.5	.	255.91	250	280.56	267.86
MEAN	218.61	201.13	221.31	331.44	199.61	213.69

Surface Zn, mg/kg

SITE	BAHIA	TORPEDO	NATAL	BERMUDA	COGON	MEAN
BM	0.46	.	0.63	.	0.7	0.63
BW	.	.	1.47	.	1.32	1.45
ES	0.98	.	1	.	1.78	1.18
GH	0.77	0.81	0.69	0.92	0.76	0.69
HL	0.61	.	.	0.73	.	0.61
MG	0.92	.	0.74	.	.	0.92
NS	1.32	.	1	0.56	2.55	1.48
PC	0.65	.	.	.	.	0.65
SA	0.48	0.48	0.47	0.49	.	0.48
WC	0.98	.	0.92	0.81	0.67	0.87
MEAN	0.77	0.73	0.77	0.57	1.14	0.86

Surface Cu, mg/kg

SITE	BAHIA	TORPEDO	NATAL	BERMUDA	COGON	MEAN
BM	0.16	.	0.17	.	0.19	0.17
BW	.	.	0.19	.	0.24	0.2
ES	0.27	.	0.26	.	0.28	0.27
GH	0.2	0.2	0.18	0.18	0.2	0.18
HL	0.16	.	.	0.24	.	0.16
MG	0.29	.	0.28	.	.	0.29
NS	0.3	.	0.19	0.16	0.32	0.25
PC	0.36	.	.	.	.	0.36
SA	0.17	0.2	0.16	0.17	.	0.17
WC	0.21	.	0.22	0.24	0.21	0.22
MEAN	0.23	0.2	0.2	0.17	0.23	0.22

Surface Mn, mg/kg

SITE	BAHIA	TORPEDO	NATAL	BERMUDA	COGON	MEAN
BM	0.38	.	0.71	.	0.75	0.71
BW	.	.	3.39	.	2.66	3.07
ES	2.27	.	2.12	.	3.51	2.43
GH	0.95	1.09	0.78	1.03	0.95	0.78
HL	0.73	.	.	1.13	.	0.73
MG	1.68	.	1.06	.	.	1.68
NS	3.13	.	2.57	1.85	3.82	2.99
PC	2.16	.	.	.	.	2.16
SA	0.41	0.57	0.4	0.42	.	0.4
WC	0.94	.	0.91	0.89	0.7	0.88
MEAN	1.31	0.96	1.16	0.6	1.71	1.38

Surface Fe, mg/kg

SITE	BAHIA	TORPEDO	NATAL	BERMUDA	COGON	MEAN
BM	11.93	.	16.36	.	19.72	16.36
BW	.	.	71.74	.	60	61.29
ES	54.82	.	51.69	.	75.3	56.93
GH	47.98	49.34	38.95	29.96	50.63	40
HL	45.35	.	.	80.6	.	45.35
MG	23.08	.	20.25	.	.	23.08
NS	76.76	.	50.96	38.3	83.23	66.04
PC	106.73	.	.	.	.	106.73
SA	70.87	122.95	74.49	81.84	.	76.32
WC	33.25	.	30.07	23.1	32.85	31.74
MEAN	55.08	67.75	47.09	71.04	49.53	50.35

Surface Na, mg/kg

SITE	BAHIA	TORPEDO	NATAL	BERMUDA	COGON	MEAN
BM	20.18	.	20.46	.	22.98	20.46
BW	.	.	8.97	.	13.97	9.84
ES	15.83	.	16.1	.	15.3	15.92
GH	12.46	15.12	11.49	11.83	13.17	11.43
HL	6.05	.	.	9.7	.	6.05
MG	13.2	.	12.5	.	.	13.2
NS	20.5	.	18.6	19.4	16.67	18.44
PC	18.92	.	.	.	.	18.92
SA	15.6	15.3	14.98	15.63	.	15.25
WC	17.47	.	16.08	12.9	18.38	17.16
MEAN	15.38	15.17	15	14.95	16.71	15.23

Surface CEC, cmol /kg

SITE	BAHIA	TORPEDO	NATAL	BERMUDA	COGON	MEAN
BM	17.38	.	18.76	.	20.5	18.76
BW	.	.	18.21	.	22.76	19.28
ES	18.04	.	18.22	.	20.71	18.77
GH	46.71	43.9	48.82	54.33	45.29	48.78
HL	18.62	.	.	24.62	.	18.62
MG	12.25	.	11.18	.	.	12.25
NS	39.06	.	25.58	21.79	46.66	36.37
PC	29.69	.	.	.	.	29.69
SA	28.56	21.29	28.06	28.55	.	28.06
WC	20.3	.	21.73	20.03	22.77	22.9
MEAN	25.49	38.25	26.3	30.97	30.3	26.56

Surface Moisture Index

SITE	BAHIA	TORPEDO	NATAL	BERMUDA	COGON	MEAN
BM	2.25	.	1.75	.	1.67	1.75
BW	.	.	1.86	.	2.67	2.11
ES	2.92	.	2.93	.	3	2.94
GH	2.89	2.94	2.6	2.44	2.97	2.66
HL	4	.	.	4	.	4
MG	1.58	.	1.17	.	.	1.58
NS	2.6	.	1.83	2	3	2.36
PC	4	.	.	.	.	4
SA	3.31	4	3.09	3.33	.	3.21
WC	2.75	.	2.63	3	3	2.78
MEAN	2.79	3.21	2.42	3.18	2.78	2.59

Subsurface pH

SITE	BAHIA	TORPEDO	NATAL	BERMUDA	COGON	MEAN
BM	6.17	.	6.28	.	6.21	6.28
BW	.	.	5.11	.	5.32	5.2
ES	6.01	.	6.1	.	6.04	6.09
GH	5.72	6.06	5.53	5.53	6.06	5.51
HL	6.09	.	.	6.42	.	6.09
MG	5.25	.	5.36	.	.	5.25
NS	6.86	.	6.85	6.85	7.37	6.97
PC	4.91	.	.	.	.	4.91
SA	6.08	6.18	6.11	6.13	.	6.13
WC	6.31	.	6.29	6.41	6.1	6.19
MEAN	5.85	6.09	5.97	6.11	6.11	5.92

Subsurface C, %

SITE	BAHIA	TORPEDO	NATAL	BERMUDA	COGON	MEAN
BM	0.44	.	0.38	.	0.34	0.38
BW	.	.	0.35	.	0.35	0.35
ES	0.7	.	0.73	.	1.1	0.81
GH	0.52	0.29	0.55	0.72	0.49	0.52
HL	1.01	.	.	0.57	.	1.01
MG	0.19	.	0.16	.	.	0.19
NS	0.45	.	0.26	0.32	0.46	0.39
PC	0.74	.	.	.	.	0.74
SA	0.3	0.4	0.3	0.3	.	0.29
WC	0.15	.	0.21	0.15	0.15	0.2
MEAN	0.4	0.32	0.37	0.36	0.39	0.39

Subsurface N, %

SITE	BAHIA	TORPEDO	NATAL	BERMUDA	COGON	MEAN
BM	0.01	.	0.01	.	0.01	0.01
BW	.	.	0.01	.	0.01	0.01
ES	0.01	.	0.01	.	0.02	0.02
GH	0.01	0.01	0.02	0.02	0.01	0.02
HL	0.02	.	.	0.02	.	0.02
MG	0.01	.	0.01	.	.	0.01
NS	0.03	.	0.01	0.01	0.01	0.02
PC	0.02	.	.	.	.	0.02
SA	0.01	0.01	0.01	0.01	.	0.01
WC	0.01	.	0.01	0	0	0.01
MEAN	0.01	0.01	0.01	0.01	0.01	0.01

Subsurface Ca, mg/kg

SITE	BAHIA	TORPEDO	NATAL	BERMUDA	COGON	MEAN
BM	188	.	292.54	.	334.67	292.54
BW	.	.	146.14	.	247	191.11
ES	303.33	.	375.14	.	568.5	418.11
GH	835.06	848.89	568.95	515.39	905.67	592.82
HL	491.5	.	.	552	.	491.5
MG	110.54	.	73.67	.	.	110.54
NS	842.6	.	704.8	703	2377.5	1137.67
PC	482.5	.	.	.	.	482.5
SA	614.25	851	626.32	670.36	.	625.71
WC	553.67	.	573.36	727	407.48	500.65
MEAN	482.83	849.42	466.39	649.78	682.62	491.17

Subsurface Mg, mg/kg

SITE	BAHIA	TORPEDO	NATAL	BERMUDA	COGON	MEAN
BM	15.5	.	27.29	.	30.17	27.29
BW	.	.	14.57	.	20.67	17.56
ES	32.5	.	43.29	.	75.5	50.44
GH	31.78	24.78	21.61	20.56	35.13	21.5
HL	54	.	.	66	.	54
MG	8.88	.	3.17	.	.	8.88
NS	65.2	.	26	11	999.5	261.78
PC	94.75	.	.	.	.	94.75
SA	69.7	147	71.05	75.43	.	66.47
WC	49	.	34.91	27	38.62	39.27
MEAN	46.56	55.33	37.28	63.47	124.93	57.03

Subsurface K, mg/kg

SITE	BAHIA	TORPEDO	NATAL	BERMUDA	COGON	MEAN
BM	13.3	.	8.1	.	8.9	8.1
BW	.	.	6.56	.	10.47	7.6
ES	8.5	.	8.44	.	10.9	8.99
GH	6.55	7.88	8.46	8.34	7.68	8.33
HL	8.1	.	.	9.7	.	8.1
MG	7.38	.	4.42	.	.	7.38
NS	8.79	.	5.63	4	46.35	16.03
PC	22.78	.	.	.	.	22.78
SA	6.02	9.3	5.75	5.93	.	5.67
WC	3.5	.	3.51	0	3.76	3.46
MEAN	8.18	8.23	6.43	6.06	10.79	8.06

Subsurface P, mg/kg

SITE	BAHIA	TORPEDO	NATAL	BERMUDA	COGON	MEAN
BM	178.75	.	206.5	.	234.67	206.5
BW	.	.	121.43	.	162.67	135.11
ES	301.17	.	325.86	.	384	338.78
GH	301.25	327.83	296.35	203.17	321.9	300.32
HL	213	.	.	379	.	213
MG	91.27	.	55.33	.	.	91.27
NS	294.2	.	253.7	252	325.5	287.61
PC	112.25	.	.	.	.	112.25
SA	343.65	291	360.92	374.59	.	352.59
WC	231.17	.	231.64	254	265.69	247.15
MEAN	243.79	318.63	260.08	343.22	276.38	250.57

Subsurface Zn, mg/kg

SITE	BAHIA	TORPEDO	NATAL	BERMUDA	COGON	MEAN
BM	0.4	.	0.63	.	0.77	0.63
BW	.	.	0.37	.	0.37	0.36
ES	0.44	.	1.12	.	8.55	2.77
GH	0.74	0.79	0.66	0.61	0.82	0.66
HL	0.48	.	.	0.48	.	0.48
MG	0.47	.	0.43	.	.	0.47
NS	1.23	.	0.9	0.48	3.15	1.53
PC	0.52	.	.	.	.	0.52
SA	0.61	0.4	0.58	0.62	.	0.59
WC	0.89	.	0.84	1.21	0.64	0.76
MEAN	0.62	0.69	0.67	0.63	1.61	0.84

Subsurface Cu, mg/kg

SITE	BAHIA	TORPEDO	NATAL	BERMUDA	COGON	MEAN
BM	0.16	.	0.17	.	0.2	0.17
BW	.	.	0.17	.	0.21	0.19
ES	0.19	.	0.42	.	10.45	2.65
GH	0.18	0.17	0.25	0.18	0.18	0.25
HL	0.2	.	.	0.24	.	0.2
MG	0.29	.	0.21	.	.	0.29
NS	0.22	.	0.15	0.08	0.81	0.33
PC	0.36	.	.	.	.	0.36
SA	0.19	0.24	0.19	0.19	.	0.18
WC	0.15	.	0.14	0.16	0.15	0.15
MEAN	0.22	0.19	0.21	0.19	1.17	0.41

Subsurface Mn, mg/kg

SITE	BAHIA	TORPEDO	NATAL	BERMUDA	COGON	MEAN
BM	0.24	.	0.7	.	0.86	0.7
BW	.	.	0.65	.	0.67	0.6
ES	3.19	.	3.38	.	4.84	3.7
GH	0.83	0.91	0.67	0.51	0.96	0.7
HL	0.32	.	.	0.4	.	0.32
MG	0.34	.	0.38	.	.	0.34
NS	3.2	.	2.47	2.34	5.2	3.34
PC	0.81	.	.	.	.	0.81
SA	0.54	0.69	0.54	0.56	.	0.55
WC	1.25	.	0.97	0.97	0.77	0.86
MEAN	1.06	0.85	0.99	0.64	1.58	1.09

Subsurface Fe, mg/kg

SITE	BAHIA	TORPEDO	NATAL	BERMUDA	COGON	MEAN
BM	12	.	16.14	.	18.83	16.14
BW	.	.	100.36	.	89.47	84.13
ES	98.82	.	99.44	.	130.25	106.29
GH	54.41	60.2	41.84	35.94	65.63	41.09
HL	72.5	.	.	100	.	72.5
MG	18.98	.	14.02	.	.	18.98
NS	56.62	.	26.81	14.1	84.6	53.91
PC	134.85	.	.	.	.	134.85
SA	61.61	121.75	68.44	74.1	.	66.49
WC	40.08	.	22.11	24	28.14	25.24
MEAN	57.4	75.59	49.35	65.82	58.17	52.56

Subsurface Na, mg/kg

SITE	BAHIA	TORPEDO	NATAL	BERMUDA	COGON	MEAN
BM	18.95	.	20.33	.	20.17	20.33
BW	.	.	9.21	.	11.3	9.41
ES	16.93	.	16.93	.	18.55	17.29
GH	16.24	14.99	13.96	11.79	16.09	14.54
HL	9.3	.	.	10.5	.	9.3
MG	12.45	.	10.77	.	.	12.45
NS	22.68	.	20.34	23.4	43.55	26.53
PC	18.55	.	.	.	.	18.55
SA	16.02	17.75	15.7	16.33	.	15.64
WC	16.65	.	16.98	18.5	16.62	16.58
MEAN	15.99	15.68	15.72	15.9	18.88	16.25

Appendix J

MEAN SOIL PARAMETERS FOR NATIVE PLANT GROUPINGS PRESENTED BY SITE

Surface pH

SITE	WEEDY	WIREGRASS	LOVEGRASS	SCRUB	LEGUMES	WETLAND	MEAN
BM	6.20	5.99	6.23	6.13	6.20	6.49	6.20
BW	5.01	.	5.16	4.86	5.02	4.75	4.91
ES	5.25	5.00	.	5.57	5.27	.	5.25
GH	5.26	4.95	5.46	.	5.27	5.31	5.26
HL	5.65	4.57	.	.	4.92	4.86	4.86
MG	5.10	.	.	5.09	5.14	.	5.10
NS	6.87	.	6.82	6.74	6.89	.	6.89
PC	5.06	.	5.12	.	5.21	5.19	5.21
SA	6.06	6.07	5.84	.	6.06	6.08	6.06
WC	6.04	.	.	.	6.04	5.97	6.04
MEAN	5.75	5.68	5.87	5.29	5.74	5.61	5.67

Surface C, %

SITE	WEEDY	WIREGRASS	LOVEGRASS	SCRUB	LEGUMES	WETLAND	MEAN
BM	0.40	0.46	0.37	0.39	0.40	0.31	0.40
BW	1.04	.	0.71	1.53	1.15	1.92	1.21
ES	1.62	1.40	.	0.85	1.52	.	1.62
GH	0.99	1.08	0.95	.	0.96	0.99	0.99
HL	0.67	1.73	.	.	1.44	1.43	1.43
MG	0.37	.	.	0.35	0.51	.	0.37
NS	0.39	.	0.29	0.28	0.37	.	0.38
PC	1.55	.	0.94	.	1.07	1.02	1.07
SA	0.39	0.39	0.36	.	0.39	0.39	0.39
WC	1.02	.	.	.	1.02	0.58	1.02
MEAN	0.75	0.72	0.59	0.73	0.80	0.79	0.81

Surface N, %

SITE	WEEDY	WIREGRASS	LOVEGRASS	SCRUB	LEGUMES	WETLAND	MEAN
BM	0.01	0.01	0.01	0.01	0.01	0.01	0.01
BW	0.04	.	0.03	0.06	0.05	0.07	0.05
ES	0.07	0.06	.	0.03	0.06	.	0.07
GH	0.03	0.03	0.03	.	0.03	0.03	0.03
HL	0.03	0.05	.	.	0.04	0.04	0.04
MG	0.02	.	.	0.02	0.03	.	0.02
NS	0.02	.	0.02	0.01	0.02	.	0.02
PC	0.05	.	0.03	.	0.04	0.04	0.04
SA	0.01	0.01	0.01	.	0.01	0.01	0.01
WC	0.05	.	.	.	0.05	0.03	0.05
MEAN	0.03	0.02	0.02	0.03	0.03	0.02	0.03

Surface Ca, mg/kg

SITE	WEEDY	WIREGRASS	LOVEGRASS	SCRUB	LEGUMES	WETLAND	MEAN
BM	295.97	248.75	269.52	309.42	295.97	300.33	295.97
BW	195.33	.	127.50	234.86	208.40	283.50	206.58
ES	295.00	173.67	.	150.00	259.86	.	295.00
GH	336.57	203.75	333.67	.	317.46	355.41	336.57
HL	288.00	173.00	.	.	209.17	199.13	199.13
MG	136.67	.	.	122.40	263.00	.	136.67
NS	920.27	.	665.38	655.50	916.14	.	903.25
PC	705.75	.	923.67	.	1044.00	1117.67	1044.00
SA	612.38	614.55	415.50	.	612.38	622.99	612.38
WC	647.51	.	.	.	647.51	405.17	647.51
MEAN	465.35	465.03	432.91	213.53	518.28	525.82	481.34

Surface Mg, mg/kg

SITE	WEEDY	WIREGRASS	LOVEGRASS	SCRUB	LEGUMES	WETLAND	MEAN
BM	25.46	14.75	19.14	25.38	25.46	28.75	25.46
BW	18.00	.	11.00	16.29	16.00	15.00	16.83
ES	47.89	31.00	.	11.00	44.71	.	47.89
GH	28.56	20.25	18.67	.	27.45	29.74	28.56
HL	32.00	41.20	.	.	40.17	36.88	36.88
MG	10.83	.	.	9.65	22.50	.	10.83
NS	114.50	.	17.25	22.50	100.57	.	106.04
PC	110.75	.	161.00	.	171.56	201.00	171.56
SA	75.85	78.89	34.17	.	75.85	77.24	75.85
WC	106.62	.	.	.	106.62	51.17	106.62
MEAN	58.79	61.90	36.90	15.02	68.75	69.92	62.72

Surface K, mg/kg

SITE	WEEDY	WIREGRASS	LOVEGRASS	SCRUB	LEGUMES	WETLAND	MEAN
BM	10.36	9.50	7.85	10.29	10.36	8.48	10.36
BW	12.53	.	10.50	12.56	12.26	16.90	12.43
ES	17.64	15.83	.	13.70	17.73	.	17.64
GH	13.22	14.53	12.06	.	13.65	14.76	13.22
HL	20.55	19.84	.	.	20.30	19.75	19.75
MG	12.21	.	.	11.95	16.83	.	12.21
NS	12.66	.	5.54	7.65	12.05	.	11.87
PC	38.50	.	54.03	.	60.02	68.40	60.02
SA	7.94	8.11	5.65	.	7.94	8.11	7.94
WC	11.10	.	.	.	11.10	7.25	11.10
MEAN	12.67	10.98	13.98	11.74	16.23	18.00	15.43

Surface P, mg/kg

SITE	WEEDY	WIREGRASS	LOVEGRASS	SCRUB	LEGUMES	WETLAND	MEAN
BM	221.94	215.50	193.19	219.96	221.94	158.92	221.94
BW	61.56	.	64.50	35.00	77.00	28.50	49.58
ES	104.33	19.33	.	265.00	122.43	.	104.33
GH	94.99	34.50	140.53	.	92.99	85.59	94.99
HL	181.50	17.80	.	.	71.33	58.88	58.88
MG	97.88	.	.	86.60	158.88	.	97.88
NS	279.64	.	239.00	225.50	280.64	.	278.58
PC	166.50	.	149.67	.	178.11	174.50	178.11
SA	386.17	389.69	281.33	.	386.17	395.07	386.17
WC	267.86	.	.	.	267.86	289.83	267.86
MEAN	213.69	271.18	182.94	107.88	224.51	232.55	199.22

Surface Zn, mg/kg

SITE	WEEDY	WIREGRASS	LOVEGRASS	SCRUB	LEGUMES	WETLAND	MEAN
BM	0.63	0.60	0.60	0.67	0.63	0.69	0.63
BW	1.45	.	0.93	1.64	1.13	1.13	1.45
ES	1.18	0.97	.	0.81	1.00	.	1.18
GH	0.69	0.83	0.60	.	0.71	0.76	0.69
HL	0.61	0.63	.	.	0.58	0.63	0.63
MG	0.92	.	.	0.94	1.36	.	0.92
NS	1.48	.	0.64	0.77	1.19	.	1.40
PC	0.65	.	0.59	.	0.59	0.59	0.59
SA	0.48	0.47	0.37	.	0.48	0.48	0.48
WC	0.87	.	.	.	0.87	0.58	0.87
MEAN	0.86	0.57	0.60	1.09	0.75	0.61	0.85

Surface Cu, mg/kg

SITE	WEEDY	WIREGRASS	LOVEGRASS	SCRUB	LEGUMES	WETLAND	MEAN
BM	0.17	0.16	0.17	0.19	0.17	0.23	0.17
BW	0.20	.	0.20	0.21	0.19	0.20	0.20
ES	0.27	0.27	.	0.24	0.25	.	0.27
GH	0.18	0.16	0.18	.	0.18	0.18	0.18
HL	0.16	0.18	.	.	0.17	0.17	0.17
MG	0.29	.	.	0.30	0.39	.	0.29
NS	0.25	.	0.09	0.12	0.23	.	0.24
PC	0.36	.	0.32	.	0.56	0.71	0.56
SA	0.17	0.17	0.13	.	0.17	0.16	0.17
WC	0.22	.	.	.	0.22	0.19	0.22
MEAN	0.22	0.18	0.18	0.24	0.23	0.23	0.23

Surface Mn, mg/kg

SITE	WEEDY	WIREGRASS	LOVEGRASS	SCRUB	LEGUMES	WETLAND	MEAN
BM	0.71	0.46	0.71	0.87	0.71	1.20	0.71
BW	3.07	.	1.82	2.34	2.50	0.77	2.66
ES	2.43	1.64	.	3.23	2.47	.	2.43
GH	0.78	1.01	0.67	.	0.81	0.86	0.78
HL	0.73	0.53	.	.	0.56	0.57	0.57
MG	1.68	.	.	1.68	3.50	.	1.68
NS	2.99	.	1.84	1.98	2.88	.	2.87
PC	2.16	.	2.50	.	2.03	2.18	2.03
SA	0.40	0.41	0.27	.	0.40	0.41	0.40
WC	0.88	.	.	.	0.88	0.63	0.88
MEAN	1.38	0.57	1.13	1.82	1.25	0.77	1.36

Surface Fe, mg/kg

SITE	WEEDY	WIREGRASS	LOVEGRASS	SCRUB	LEGUMES	WETLAND	MEAN
BM	16.36	14.15	14.78	17.40	16.36	15.82	16.36
BW	61.29	.	48.20	34.01	73.36	33.85	52.93
ES	56.93	33.47	.	98.40	58.81	.	56.93
GH	40.00	23.83	35.42	.	37.13	39.74	40.00
HL	45.35	30.72	.	.	36.65	34.06	34.06
MG	23.08	.	.	22.65	32.00	.	23.08
NS	66.04	.	28.09	35.35	64.65	.	62.15
PC	106.73	.	79.83	.	101.48	97.67	101.48
SA	76.32	76.47	54.12	.	76.32	78.30	76.32
WC	31.74	.	.	.	31.74	29.53	31.74
MEAN	50.35	59.18	37.06	29.04	53.56	59.72	50.47

Surface Na, mg/kg

SITE	WEEDY	WIREGRASS	LOVEGRASS	SCRUB	LEGUMES	WETLAND	MEAN
BM	20.46	18.75	19.30	19.63	20.46	20.93	20.46
BW	9.84	.	17.75	9.80	14.68	11.30	10.55
ES	15.92	15.83	.	14.50	16.10	.	15.92
GH	11.43	12.13	12.33	.	11.49	11.95	11.43
HL	6.05	7.26	.	.	6.45	7.86	7.86
MG	13.20	.	.	13.18	12.00	.	13.20
NS	18.44	.	18.03	16.90	19.47	.	18.72
PC	18.92	.	16.93	.	21.22	21.90	21.22
SA	15.25	15.39	12.90	.	15.25	15.40	15.25
WC	17.16	.	.	.	17.16	20.55	17.16
MEAN	15.23	14.24	16.25	13.49	15.82	14.66	15.21

Surface CEC, cmol/kg

SITE	WEEDY	WIREGRASS	LOVEGRASS	SCRUB	LEGUMES	WETLAND	MEAN
BM	18.76	22.20	18.53	18.74	18.76	16.66	18.76
BW	19.28	.	10.48	16.49	19.20	14.52	20.00
ES	18.77	19.45	.	14.93	19.08	.	18.77
GH	48.78	40.67	50.30	.	50.13	50.29	48.78
HL	18.62	22.71	.	.	20.91	21.25	21.25
MG	12.25	.	.	12.29	15.24	.	12.25
NS	36.37	.	19.71	25.92	41.22	.	34.51
PC	29.69	.	32.60	.	29.64	30.84	29.64
SA	28.06	27.60	34.06	.	28.06	28.41	28.06
WC	22.90	.	.	.	22.90	24.82	22.90
MEAN	26.56	26.62	29.25	15.27	28.13	30.88	26.28

Surface Moisture Index

SITE	WEEDY	WIREGRASS	LOVEGRASS	SCRUB	LEGUMES	WETLAND	MEAN
BM	1.75	2.00	1.57	1.75	1.75	1.50	1.75
BW	2.11	.	1.75	1.79	2.10	3.00	2.04
ES	2.94	3.00	.	2.50	2.93	.	2.94
GH	2.66	2.50	2.67	.	2.67	2.80	2.66
HL	4.00	4.00	.	.	4.00	4.00	4.00
MG	1.58	.	.	1.45	2.30	.	1.58
NS	2.36	.	1.50	1.00	2.14	.	2.33
PC	4.00	.	4.00	.	4.00	4.00	4.00
SA	3.21	3.14	4.17	.	3.21	3.26	3.21
WC	2.78	.	.	.	2.78	3.17	2.78
MEAN	2.59	3.15	2.44	1.63	2.83	3.28	2.69

Subsurface pH

SITE	WEEDY	WIREGRASS	LOVEGRASS	SCRUB	LEGUMES	WETLAND	MEAN
BM	6.28	6.11	6.24	6.29	6.28	6.56	6.28
BW	5.20	.	5.49	5.20	5.20	5.41	5.13
ES	6.09	6.13	.	5.86	6.13	.	6.09
GH	5.51	4.80	5.76	.	5.48	5.56	5.51
HL	6.09	5.54	.	.	5.65	5.69	5.69
MG	5.25	.	.	5.23	5.26	.	5.25
NS	6.97	.	6.84	6.80	6.90	.	6.95
PC	4.91	.	5.02	.	5.14	5.11	5.14
SA	6.13	6.12	6.05	.	6.13	6.15	6.13
WC	6.19	.	.	.	6.19	5.81	6.19
MEAN	5.92	5.96	5.96	5.49	5.91	5.82	5.86

Subsurface C, %

SITE	WEEDY	WIREGRASS	LOVEGRASS	SCRUB	LEGUMES	WETLAND	MEAN
BM	0.38	0.42	0.40	0.34	0.38	0.33	0.38
BW	0.35	.	0.58	0.46	0.48	0.39	0.44
ES	0.81	0.82	.	0.21	0.77	.	0.81
GH	0.52	0.58	0.39	.	0.55	0.56	0.52
HL	1.01	0.88	.	.	1.00	0.95	0.95
MG	0.19	.	.	0.19	0.30	.	0.19
NS	0.39	.	0.16	0.17	0.24	.	0.37
PC	0.74	.	0.48	.	0.53	0.44	0.53
SA	0.29	0.28	0.22	.	0.29	0.28	0.29
WC	0.20	.	.	.	0.20	0.17	0.20
MEAN	0.39	0.44	0.37	0.29	0.42	0.45	0.42

Subsurface N, %

SITE	WEEDY	WIREGRASS	LOVEGRASS	SCRUB	LEGUMES	WETLAND	MEAN
BM	0.01	0.01	0.00	0.00	0.01	0.00	0.01
BW	0.01	.	0.01	0.01	0.02	0.01	0.01
ES	0.02	0.02	.	0.00	0.01	.	0.02
GH	0.02	0.05	0.01	.	0.02	0.02	0.02
HL	0.02	0.02	.	.	0.02	0.02	0.02
MG	0.01	.	.	0.01	0.02	.	0.01
NS	0.02	.	0.00	0.00	0.01	.	0.02
PC	0.02	.	0.01	.	0.01	0.01	0.01
SA	0.01	0.01	0.01	.	0.01	0.01	0.01
WC	0.01	.	.	.	0.01	0.00	0.01
MEAN	0.01	0.01	0.01	0.01	0.01	0.01	0.01

Subsurface Ca, mg/kg

SITE	WEEDY	WIREGRASS	LOVEGRASS	SCRUB	LEGUMES	WETLAND	MEAN
BM	292.54	238.25	271.07	312.38	292.54	325.25	292.54
BW	191.11	.	214.50	255.71	212.40	426.50	206.33
ES	418.11	357.33	.	44.00	369.71	.	418.11
GH	592.82	147.25	632.89	.	569.52	620.85	592.82
HL	491.50	384.60	.	.	388.50	428.13	428.13
MG	110.54	.	.	87.36	202.20	.	110.54
NS	1137.67	.	659.33	715.00	746.17	.	1094.60
PC	482.50	.	856.67	.	1011.89	1064.67	1011.89
SA	625.71	618.18	531.50	.	625.71	635.37	625.71
WC	500.65	.	.	.	500.65	277.75	500.65
MEAN	491.17	510.76	511.10	198.31	529.68	604.83	520.19

Subsurface Mg, mg/kg

SITE	WEEDY	WIREGRASS	LOVEGRASS	SCRUB	LEGUMES	WETLAND	MEAN
BM	27.29	13.25	26.00	30.13	27.29	42.75	27.29
BW	17.56	.	14.00	12.00	18.80	23.50	15.42
ES	50.44	56.67	.	6.00	51.00	.	50.44
GH	21.50	22.50	11.53	.	21.96	25.86	21.50
HL	54.00	94.20	.	.	76.50	80.25	80.25
MG	8.88	.	.	8.64	18.90	.	8.88
NS	261.78	.	13.33	21.00	34.33	.	236.50
PC	94.75	.	167.67	.	179.56	208.67	179.56
SA	66.47	69.55	20.67	.	66.47	67.29	66.47
WC	39.27	.	.	.	39.27	29.25	39.27
MEAN	57.03	65.96	36.84	13.60	54.66	70.99	64.46

Subsurface K, mg/kg

SITE	WEEDY	WIREGRASS	LOVEGRASS	SCRUB	LEGUMES	WETLAND	MEAN
BM	8.10	11.28	7.94	9.05	8.10	7.22	8.10
BW	7.60	.	9.65	7.34	8.86	10.85	7.64
ES	8.99	8.10	.	8.90	9.01	.	8.99
GH	8.33	10.90	7.23	.	7.83	8.39	8.33
HL	8.10	7.26	.	.	6.20	7.58	7.58
MG	7.38	.	.	7.03	11.62	.	7.38
NS	16.03	.	3.07	5.60	5.58	.	14.59
PC	22.78	.	46.53	.	51.17	59.42	51.17
SA	5.67	5.90	3.07	.	5.67	5.69	5.67
WC	3.46	.	.	.	3.46	4.03	3.46
MEAN	8.06	6.90	11.51	7.47	10.53	12.37	10.54

Subsurface P, mg/kg

SITE	WEEDY	WIREGRASS	LOVEGRASS	SCRUB	LEGUMES	WETLAND	MEAN
BM	206.50	217.25	183.21	218.25	206.50	154.00	206.50
BW	135.11	.	161.00	163.71	163.40	308.50	143.75
ES	338.78	318.67	.	316.00	341.57	.	338.78
GH	300.32	202.50	303.86	.	296.42	285.41	300.32
HL	213.00	220.80	.	.	198.33	238.25	238.25
MG	91.27	.	.	70.36	151.10	.	91.27
NS	287.61	.	244.17	255.00	271.17	.	285.45
PC	112.25	.	136.67	.	177.67	155.33	177.67
SA	352.59	353.64	264.00	.	352.59	358.88	352.59
WC	247.15	.	.	.	247.15	277.75	247.15
MEAN	250.57	314.11	223.42	140.17	263.69	290.49	247.81

Subsurface Zn, mg/kg

SITE	WEEDY	WIREGRASS	LOVEGRASS	SCRUB	LEGUMES	WETLAND	MEAN
BM	0.63	0.53	0.56	0.66	0.63	0.71	0.63
BW	0.36	.	0.32	0.35	0.37	0.36	0.36
ES	2.77	1.93	.	0.32	1.09	.	2.77
GH	0.66	0.44	0.69	.	0.66	0.67	0.66
HL	0.48	0.37	.	.	0.42	0.41	0.41
MG	0.47	.	.	0.47	0.57	.	0.47
NS	1.53	.	0.59	0.65	0.99	.	1.42
PC	0.52	.	0.43	.	0.49	0.51	0.49
SA	0.59	0.57	0.51	.	0.59	0.60	0.59
WC	0.76	.	.	.	0.76	0.52	0.76
MEAN	0.84	0.65	0.55	0.47	0.66	0.57	0.79

Subsurface Cu, mg/kg

SITE	WEEDY	WIREGRASS	LOVEGRASS	SCRUB	LEGUMES	WETLAND	MEAN
BM	0.17	0.16	0.17	0.17	0.17	0.19	0.17
BW	0.19	.	0.24	0.23	0.24	0.36	0.21
ES	2.65	0.75	.	0.16	0.41	.	2.65
GH	0.25	0.16	0.18	.	0.25	0.25	0.25
HL	0.20	0.21	.	.	0.16	0.20	0.20
MG	0.29	.	.	0.29	0.44	.	0.29
NS	0.33	.	0.12	0.16	0.17	.	0.31
PC	0.36	.	0.59	.	0.65	0.79	0.65
SA	0.18	0.18	0.09	.	0.18	0.18	0.18
WC	0.15	.	.	.	0.15	0.16	0.15
MEAN	0.41	0.23	0.21	0.24	0.25	0.27	0.42

Subsurface Mn, mg/kg

SITE	WEEDY	WIREGRASS	LOVEGRASS	SCRUB	LEGUMES	WETLAND	MEAN
BM	0.70	0.38	0.70	0.92	0.70	1.38	0.70
BW	0.60	.	0.44	0.37	0.69	0.48	0.53
ES	3.70	4.49	.	2.02	3.78	.	3.70
GH	0.70	0.32	0.71	.	0.68	0.75	0.70
HL	0.32	0.39	.	.	0.34	0.37	0.37
MG	0.34	.	.	0.36	0.64	.	0.34
NS	3.34	.	1.82	1.94	2.56	.	3.19
PC	0.81	.	0.92	.	0.74	0.92	0.74
SA	0.55	0.54	0.58	.	0.55	0.55	0.55
WC	0.86	.	.	.	0.86	0.52	0.86
MEAN	1.09	0.85	0.83	0.59	0.98	0.63	1.03

Subsurface Fe, mg/kg

SITE	WEEDY	WIREGRASS	LOVEGRASS	SCRUB	LEGUMES	WETLAND	MEAN
BM	16.14	15.53	15.43	17.49	16.14	15.13	16.14
BW	84.13	.	56.20	38.76	89.96	36.45	70.45
ES	106.29	105.37	.	102.40	102.90	.	106.29
GH	41.09	25.83	35.06	.	41.22	45.20	41.09
HL	72.50	71.54	.	.	70.35	71.98	71.98
MG	18.98	.	.	17.27	29.23	.	18.98
NS	53.91	.	16.98	19.90	32.18	.	50.33
PC	134.85	.	77.23	.	118.01	108.07	118.01
SA	66.49	66.35	39.32	.	66.49	67.87	66.49
WC	25.24	.	.	.	25.24	18.42	25.24
MEAN	52.56	65.18	34.64	27.23	55.42	61.77	54.68

Subsurface Na, mg/kg

SITE	WEEDY	WIREGRASS	LOVEGRASS	SCRUB	LEGUMES	WETLAND	MEAN
BM	20.33	23.55	20.90	21.65	20.33	22.40	20.33
BW	9.41	.	16.15	9.57	14.04	10.90	9.95
ES	17.29	16.37	.	15.30	17.63	.	17.29
GH	14.54	13.70	14.62	.	14.37	15.01	14.54
HL	9.30	8.20	.	.	6.85	9.56	9.56
MG	12.45	.	.	11.37	11.70	.	12.45
NS	26.53	.	20.03	21.00	20.53	.	26.06
PC	18.55	.	18.30	.	22.23	23.93	22.23
SA	15.64	15.52	13.03	.	15.64	15.72	15.64
WC	16.58	.	.	.	16.58	15.73	16.58
MEAN	16.25	14.88	17.52	13.13	16.37	15.65	16.22

Appendix K

POOLED VEGETATION DATA FROM THE 1997 TOPSOIL AUGMENTATION STUDY SITE AT CF INDUSTRIES

Topsoil Augmentation Study
October 1997

OVERBURDEN SOIL TYPE ONLY

Burned Treatment on Thin Topsoil

Species*	Tot. Freq.	Rel. Freq.	Freq.** Rank	Avg. Cover	Cover ** Rank	No. Quads Occur.
BAR GRO	80	100.0	---	30.6	---	4
DIG CIL	80	100.0	1	33.1	1	4
EUT TEN	10	12.5	10	20.0	2	1
CYP RET	59	73.8	2	15.0	3	3
DIO TER	48	60.0	3	15.0	3	3
CYP GLO	20	25.0	7	12.5	5	1
CHA NIC	9	11.3	11	10.1	6	2
DIC ACI	48	60.0	3	6.9	7	4
PAS SET	31	38.8	5	3.8	8	4
CRO ROT	5	6.3	16	3.8	9	2
VAC MYR	6	7.5	15	3.8	9	2
ARI PUR	14	17.5	9	3.4	11	3
RHY REP	24	30.0	6	3.4	11	3
DIC POR	18	22.5	8	3.3	13	4
HEL COR	8	10.0	13	2.6	14	2
AND GLA	1	1.3	21	2.5	15	1
PIT GRA	1	1.3	21	2.5	15	1
RHU COP	2	2.5	19	2.5	15	1
GAY DUM	7	8.8	14	1.8	18	3
ARI BEY	3	3.8	17	1.4	19	2
ELE ELA	2	2.5	19	1.4	19	2
IND HIR	9	11.3	11	0.9	21	4
LUD SP.	3	3.8	17	0.5	22	1
AND GYR	1	1.3	21	0.3	23	1
GAL SP.	1	1.3	21	0.3	23	1
QUE MIN	1	1.3	21	0.3	23	1
YUC FIL	1	1.3	21	0.3	23	1

Topsoil Augmentation Study

OVERBURDEN SOIL TYPE ONLY

Burned Treatment on Thick Topsoil

Species	Tot. Freq.	Rel. Freq.	Freq.** Rank	Avg. Cover	Cover ** Rank	No. Quads Occur.
BAR GRO	80	100.0	---	16.3	---	4
DIG CIL	80	100.0	1	40.0	1	4
RHY REP	59	73.8	4	17.5	2	4
CYP GLO	12	15.0	10	12.5	3	1
DIC ACI	61	76.3	3	12.5	3	4
CYP RET	65	81.3	2	8.1	5	4
EUT TEN	19	23.8	7	6.7	6	3
DIC POR	38	47.5	6	6.3	7	4
DIO TER	17	21.3	8	5.0	8	1
PAN ANC	4	5.0	21	5.0	8	1
PIT GRA	4	5.0	21	5.0	8	1
PAS SET	42	52.5	5	4.4	11	4
AND VIR	8	10.0	13	3.9	12	2
ARI BEY	15	18.8	9	3.2	13	4
HEL COR	12	15.0	10	2.6	14	4
RHU COP	10	12.5	12	2.6	15	3
ARI PUR	5	6.3	18	2.5	16	2
CHA NIC	5	6.3	18	2.5	16	2
CHR PAU	5	6.3	18	2.5	16	1
ELE ELA	6	7.5	15	2.5	16	2
ELY TRI	6	7.5	15	2.5	16	1
ERA ELL	2	2.5	27	2.5	16	1
ERA REF	4	5.0	21	2.5	16	1
SER REP	3	3.8	25	2.5	16	1
SET GEN	3	3.8	25	2.5	16	1
GAY DUM	8	10.0	13	2.1	25	4
PHY AME	2	2.5	27	1.4	26	2
IND HIR	6	7.5	15	1.1	27	3
QUE MIN	4	5.0	21	0.5	28	2
CHA FLO	1	1.3	30	0.3	29	1
LUD MAR	2	2.5	27	0.3	29	1
PTE PYC	1	1.3	30	0.3	29	1
QUE VIR	1	1.3	30	0.3	29	1

Topsoil Augmentation Study

OVERBURDEN SOIL TYPE ONLY

Unburned Treatment on Thin Topsoil

Species	Tot. Freq.	Rel. Freq.	Freq.** Rank	Avg. Cover	Cover ** Rank	No. Quads Occur.
BAR GRO	80	100.0	---	15.0	---	4
DIG CIL	80	100.0	1	35.0	1	4
DIC POR	79	98.8	2	32.5	2	4
CYP RET	75	93.8	3	8.8	3	4
EUT TEN	11	13.8	9	5.8	4	3
PAS SET	47	58.8	4	5.0	5	4
RHU COP	6	7.5	11	5.0	5	1
DIC ACI	32	40.0	6	4.4	7	4
SER REP	40	50.0	5	3.8	8	4
ARI PUR	17	21.3	7	3.1	9	4
SOL FIS	8	10.0	10	2.8	10	2
AND BRA	2	2.5	13	2.5	11	1
AND VIR	1	1.3	16	2.5	11	1
CIR SP.	2	2.5	13	2.5	11	1
PTE PYC	2	2.5	13	2.5	11	1
RHY REP	13	16.3	8	1.9	15	4
VAC MYR	5	6.3	12	1.8	16	3
CYP GLO	1	1.3	16	0.3	17	1

Topsoil Augmentation Study

OVERBURDEN SOIL TYPE ONLY

Unburned Treatment on Thick Topsoil

Species	Tot. Freq.	Rel. Freq.	Freq.** Rank	Avg. Cover	Cover ** Rank	No. Quads Occur.
BAR GRO	80	100.0	---	10.1	---	4
DIC POR	80	100.0	1	42.5	1	4
DIG CIL	71	88.8	2	28.8	2	4
CYP RET	70	87.5	3	15.6	3	4
SOL FIS	20	25.0	6	9.2	4	3
CYP GLO	11	13.8	11	5.0	5	1
PAS SET	41	51.3	4	5.0	5	4
SER REP	36	45.0	5	5.0	5	3
DIC ACI	14	17.5	10	4.2	8	3
EUT TEN	16	20.0	9	4.2	8	3
ARI PUR	19	23.8	7	3.8	10	4
RHU COP	8	10.0	12	3.8	11	2
RHY REP	19	23.8	7	3.4	12	3
CHA NIC	4	5.0	13	2.5	13	1
JUN SCI	2	2.5	18	2.5	13	1
MYR PUS	3	3.8	14	2.5	13	1
PTE PYC	3	3.8	14	2.5	13	1
EUP CAP	3	3.8	14	1.4	17	2
VAC MYR	3	3.8	14	1.4	17	2
DIO TER	2	2.5	18	0.5	19	1
ARI SPI	1	1.3	20	0.3	20	1
SAC IND	1	1.3	20	0.3	20	1

Topsoil Augmentation Study

OVERBURDEN SOIL TYPE ONLY

Control Plots with No Topsoil Applied

Species	Tot. Freq.	Rel. Freq.	Freq.** Rank	Avg. Cover	Cover ** Rank	No. Quads Occur.
BAR GRO	80	100.0	---	83.8	---	4
DIG CIL	48	60.0	2	5.0	1	3
HED COR	12	15.0	5	5.0	1	1
RHY REP	79	98.8	1	5.0	1	4
CYP RET	12	15.0	5	3.4	4	3
EUP CAP	20	25.0	4	3.4	4	3
CON CAN	30	37.5	3	3.3	6	4
AES AME	4	5.0	8	2.5	7	1
IND HIR	6	7.5	7	1.8	8	3
RIC SCA	2	2.5	10	0.5	9	1
BUL BAR	3	3.8	9	0.3	10	2
CYP GLO	1	1.3	11	0.3	10	1
GNA OBT	1	1.3	11	0.3	10	1
PHY NOD	1	1.3	11	0.3	10	1
SCO DUL	1	1.3	11	0.3	10	1

Topsoil Augmentation Study

SAND TAILINGS SOIL TYPE ONLY

Burned Treatment on Thin Topsoil

Species	Tot. Freq.	Rel. Freq.	Freq.** Rank	Avg. Cover	Cover ** Rank	No. Quads Occur.
BAR GRO	80	100.0	---	40.0	---	4
DIO TER	72	90.0	1	16.9	1	4
CYP RET	69	86.3	2	8.8	2	4
DIC ACI	59	73.8	3	8.8	2	4
RHY REP	26	32.5	4	7.5	4	3
DIG CIL	23	28.8	5	5.9	5	3
ERA REF	11	13.8	9	5.0	6	1
IND HIR	18	22.5	6	3.9	7	4
PAN REP	8	10.0	10	3.8	8	2
ARI PUR	14	17.5	8	3.3	9	4
PAS SET	17	21.3	7	3.1	10	4
AND VIR	7	8.8	12	2.5	11	2
ARI SPI	2	2.5	16	2.5	11	1
EUT TEN	2	2.5	16	2.5	11	1
PIT TRA	1	1.3	19	2.5	11	1
POACEAE	2	2.5	16	2.5	11	1
DIC POR	8	10.0	10	2.0	16	4
SER REP	3	3.8	14	1.4	17	2
ARI BEY	5	6.3	13	1.0	18	3
EUP CAP	3	3.8	14	0.4	19	2
AES AME	1	1.3	19	0.3	20	1
AND GCP	1	1.3	19	0.3	20	1
AND GLO	1	1.3	19	0.3	20	1
CYP GLO	1	1.3	19	0.3	20	1
MOM CHA	1	1.3	19	0.3	20	1
POL PRO	1	1.3	19	0.3	20	1

Topsoil Augmentation Study

SAND TAILINGS SOIL TYPE ONLY

Burned Treatment on Thick Topsoil

Species	Tot. Freq.	Rel. Freq.	Freq.** Rank	Avg. Cover	Cover ** Rank	No. Quads Occur.
BAR GRO	80	100.0	---	17.6	---	4
PAN REP	18	22.5	6	40.0	1	1
DIG CIL	25	31.3	4	26.3	2	2
DIO TER	73	91.3	2	18.8	3	4
DIC ACI	75	93.8	1	16.3	4	4
CYP RET	40	50.0	3	5.0	5	2
ARI PUR	18	22.5	6	4.3	6	3
RHY REP	15	18.8	8	3.9	7	2
ERA REF	12	15.0	10	2.7	8	3
AND VIR	14	17.5	9	2.6	9	4
ARI BEY	5	6.3	12	2.6	9	2
DIC POR	21	26.3	5	2.6	9	4
PAS SET	11	13.8	11	2.6	9	4
AND GLO	2	2.5	18	2.5	13	1
AXO AFF	2	2.5	18	2.5	13	1
DAC AEG	2	2.5	18	2.5	13	1
DIG SER	2	2.5	18	2.5	13	1
PIT GRA	3	3.8	17	2.5	13	1
SER REP	5	6.3	12	1.5	18	2
ERA ELL	5	6.3	12	1.4	19	2
BUL BAR	4	5.0	15	1.0	20	3
EUP CAP	4	5.0	15	1.0	20	3
AND GCP	1	1.3	22	0.3	22	1
ARI SPI	1	1.3	22	0.3	22	1
CRO ROT	1	1.3	22	0.3	22	1
HET SUB	1	1.3	22	0.3	22	1
LEC SES	1	1.3	22	0.3	22	1
PIL RIG	1	1.3	22	0.3	22	1
POL PRO	1	1.3	22	0.3	22	1
RHU COP	1	1.3	22	0.3	22	1

Topsoil Augmentation Study

SAND TAILINGS SOIL TYPE ONLY

Unburned Treatment on Thin Topsoil						
Species	Tot. Freq.	Rel. Freq.	Freq.** Rank	Avg. Cover	Cover ** Rank	No. Quads Occur.
BAR GRO	80	100.0	---	23.1	---	4
CYP RET	78	97.5	1	21.3	1	4
PAN REP	33	41.3	4	17.5	2	3
IND HIR	32	40.0	5	15.0	3	3
ARI PUR	35	43.8	3	11.3	4	4
DIO TER	10	12.5	11	6.3	5	2
DIC ACI	24	30.0	7	5.0	6	3
VIT ROT	8	10.0	12	5.0	6	1
DIC POR	41	51.3	2	4.4	8	4
PAS SET	22	27.5	9	4.4	9	4
EUT TEN	7	8.8	13	4.3	10	3
DIG CIL	24	30.0	7	4.2	11	3
AMP ARB	2	2.5	16	2.5	12	1
AXO AFF	2	2.5	16	2.5	12	1
CHA NIC	2	2.5	16	2.5	12	1
ERA ELL	3	3.8	15	2.5	12	1
RHU COP	2	2.5	16	2.5	12	1
RHY REP	7	8.8	13	2.5	12	3
HET SUB	31	38.8	6	1.8	18	3
SER REP	18	22.5	10	1.6	19	4

Topsoil Augmentation Study

SAND TAILINGS SOIL TYPE ONLY

Unburned Treatment on Thick Topsoil

Species	Tot. Freq.	Rel. Freq.	Freq.** Rank	Avg. Cover	Cover ** Rank	No. Quads Occur.
BAR GRO	80	100.0	---	20.0	---	4
DIC POR	69	86.3	2	16.9	1	4
CYP RET	80	100.0	1	16.3	2	4
ARI PUR	56	70.0	3	10.6	3	4
PAN REP	9	11.3	13	10.0	4	1
AXO AFF	18	22.5	7	8.8	5	2
EUT TEN	13	16.3	10	7.6	6	3
DIC ACI	46	57.5	4	5.0	7	4
DIG CIL	15	18.8	8	5.0	7	2
DIO TER	10	12.5	11	5.0	7	1
PAS SET	24	30.0	5	4.4	10	4
ERA REF	15	18.8	8	4.2	11	3
IND HIR	10	12.5	11	3.9	12	2
SER REP	19	23.8	6	2.6	13	4
ARI SPI	2	2.5	15	2.5	14	1
EUP CAP	2	2.5	15	2.5	15	1
HET SUB	4	5.0	14	2.5	16	1
RHU COP	2	2.5	15	2.5	17	1
LEC DIV	1	1.3	18	0.3	18	1
SOL FIS	1	1.3	18	0.3	19	1

SAND TAILINGS SOIL TYPE ONLY

Control Plots with No Topsoil Applied

Species	Tot. Freq.	Rel. Freq.	Freq.** Rank	Avg. Cover	Cover ** Rank	No. Quads Occur.
BAR GRO	80	100.0	---	40.0	---	4
PAN REP	40	50.0	3	65.0	1	2
HET SUB	80	100.0	1	10.6	2	4
IND HIR	41	51.3	2	9.5	3	4
RHY REP	11	13.8	6	7.5	4	2
CON CAN	5	6.3	8	5.0	5	1
CYN DAC	21	26.3	4	5.0	5	2
DAC AEG	5	6.3	8	5.0	5	1
DIG CIL	20	25.0	5	3.8	8	2
SPO IND	3	3.8	10	3.8	8	2
AND VIR	6	7.5	7	2.6	10	3
AES AME	2	2.5	12	2.5	11	1
CYP RET	2	2.5	12	2.5	11	1
DIO TER	3	3.8	10	2.5	11	1
PAN DIC	2	2.5	12	2.5	11	1
BID ALB	2	2.5	12	0.3	15	1
CHA HYS	2	2.5	12	0.3	15	2
EUP CAP	1	1.3	17	0.3	15	1
STR GES	1	1.3	17	0.3	15	1

* Full scientific names can be found in Appendix B.

** Total frequency and % cover data are shown to 1 decimal place, however, corresponding rankings have been calculated to 3 significant digits.

Appendix L

POOLED VEGETATION DATA FROM THE 1998 TOPSOIL AUGMENTATION STUDY SITE AT CF INDUSTRIES

Topsoil Augmentation Study
August 1998

OVERBURDEN SOIL TYPE ONLY

Burned Treatment on Thin Topsoil

Species*	Tot. Freq.	Rel. Freq.	Freq.** Rank	Avg. Cover	Cover ** Rank	No. Quads Occur.
BAR GRO	80	100.0	---	21.9	---	4
IND HIR	44	55.0	5	26.9	1	4
DIC ACI	59	73.8	2	16.9	2	4
EUT TEN	29	36.3	7	15.2	3	3
CHA NIC	20	25.0	8	14.3	4	3
DIO TER	56	70.0	3	12.5	5	3
PAS SET	55	68.8	4	12.5	5	4
CYP RET	67	83.8	1	8.8	7	4
RHY REP	36	45.0	6	6.9	8	4
PTE PYC	4	5.0	27	5.0	9	1
SAB BRE	5	6.3	21	5.0	9	1
DIC POR	17	21.3	10	4.4	11	4
ARI BEY	11	13.8	15	4.2	12	3
VAC MYR	5	6.3	21	3.8	13	2
SCL CIL	8	10.0	19	3.8	13	2
CRO ROT	7	8.8	20	3.8	13	2
LUD MAR	15	18.8	12	3.8	13	2
HEL COR	12	15.0	14	3.8	13	2
CON CAN	20	25.0	8	3.5	18	3
LEC TOR	15	18.8	12	3.3	19	3
HED SP.	9	11.3	17	2.8	20	2
SCO DUL	9	11.3	17	2.6	21	2
ARI PUR	16	20.0	11	2.6	22	4
ELE ELA	11	13.8	15	2.6	22	4
SET GEN	3	3.8	31	2.5	24	1
AND GLA	2	2.5	32	2.5	24	1
TEP SP.	2	2.5	32	2.5	24	1
PIT TRA	1	1.3	37	2.5	24	1
RHY PLU	1	1.3	37	2.5	24	1
AND GLO	4	5.0	27	2.5	24	1
MAC LAT	4	5.0	27	2.5	24	1
HED UNI	5	6.3	21	2.5	24	1
GAY DUM	5	6.3	21	2.5	24	1
ERA REF	5	6.3	21	2.5	24	1
DIG CIL	5	6.3	21	1.4	34	2
QUE MIN	2	2.5	32	1.4	34	2
POL PRO	4	5.0	27	1.0	36	3
PIT GRA	1	1.3	37	0.3	37	1
CHA FLO	2	2.5	32	0.3	37	1
XYR BRE	2	2.5	32	0.3	37	1
ARI SPI	1	1.3	37	0.3	37	1

OVERBURDEN SOIL TYPE ONLY

Burned Treatment on Thick Topsoil

Species	Tot. Freq.	Rel. Freq.	Freq.** Rank	Avg. Cover	Cover ** Rank	No. Quads Occur.
BAR GRO	80	100.0	---	30.1	---	4
EUT TEN	60	75.0	3	23.8	1	4
PAS SET	63	78.8	1	20.1	2	4
DIC ACI	61	76.3	2	18.8	3	4
CYP RET	56	70.0	4	12.5	4	4
RHY REP	51	63.8	5	10.6	5	4
PAN ANC	4	5.0	16	10.3	6	1
ELE ELA	15	18.8	10	5.1	7	3
PIT GRA	4	5.0	16	5.0	8	1
DIC POR	38	47.5	6	4.4	9	4
ARI BEY	24	30.0	7	4.2	10	3
RHU COP	10	12.5	11	3.8	11	2
CON CAN	17	21.3	9	3.4	12	3
DIO TER	24	30.0	7	2.8	13	4
HED UNI	5	6.3	15	2.8	13	1
SCH STO	3	3.8	21	2.5	15	1
PTE PYC	2	2.5	25	2.5	15	1
GAY DUM	1	1.3	29	2.5	15	1
ARI PUR	1	1.3	29	2.5	15	1
ERA SP.	3	3.8	21	2.5	15	1
YUC FIL	1	1.3	29	2.5	15	1
ERA REF	3	3.8	21	2.5	15	1
SET GEN	4	5.0	16	2.5	15	1
AND GLO	9	11.3	13	2.5	15	2
AND VIR	10	12.5	11	2.5	15	2
LUD MAR	3	3.8	21	1.4	25	2
SCL CIL	6	7.5	14	1.4	25	2
QUE MIN	4	5.0	16	1.4	25	2
HED SP.	2	2.5	25	0.5	28	1
HEL COR	2	2.5	25	0.5	28	1
CRO ROT	1	1.3	29	0.3	30	1
RUM SP.	1	1.3	29	0.3	30	1
LEC TOR	1	1.3	29	0.3	30	1
POL PRO	2	2.5	25	0.3	30	1
ACA GRA	1	1.3	29	0.3	30	1
IND HIR	4	5.0	16	0.3	30	3
SCO DUL	1	1.3	29	0.3	30	1

OVERBURDEN SOIL TYPE ONLY

Unburned Treatment on Thin Topsoil

Species	Tot. Freq.	Rel. Freq.	Freq.** Rank	Avg. Cover	Cover ** Rank	No. Quads Occur.
BAR GRO	80	100.0	---	28.8	---	4
DIC POR	80	100.0	1	35.0	1	4
EUT TEN	42	52.5	4	12.5	2	4
PAS SET	73	91.3	2	8.8	3	4
CYP RET	71	88.8	3	6.9	4	4
SER REP	42	52.5	4	5.2	5	4
HED SP.	6	7.5	13	5.0	6	1
FIM PUB	29	36.3	6	3.9	7	4
SOL FIS	12	15.0	8	3.9	7	2
ARI PUR	22	27.5	7	3.8	9	4
RHU COP	8	10.0	10	3.8	10	2
HED UNI	9	11.3	9	2.6	11	2
AND BRA	2	2.5	22	2.5	12	1
AND GLO	4	5.0	15	2.5	12	2
ARI BEY	2	2.5	22	2.5	12	1
DIO TER	3	3.8	18	2.5	12	1
ERA SP.	1	1.3	27	2.5	12	1
PTE PYC	3	3.8	18	2.5	12	1
DIC ACI	7	8.8	12	1.8	18	3
RHY REP	6	7.5	13	1.8	19	3
AND VIR	2	2.5	22	1.4	20	2
SAB BRE	3	3.8	18	1.4	20	2
SCH STO	3	3.8	18	1.4	20	2
SCL CIL	8	10.0	10	1.1	23	3
ARI SPI	4	5.0	15	1.0	24	3
VAC MYR	4	5.0	15	1.0	24	3
AND GCP	1	1.3	27	0.3	26	1
CON CAN	1	1.3	27	0.3	26	1
CYP GLO	1	1.3	27	0.3	26	1
ERA REF	1	1.3	27	0.3	26	1
HYP TET	2	2.5	22	0.3	26	1
IND HIR	1	1.3	27	0.3	26	1
PAS NOT	2	2.5	22	0.3	26	1
RHY FAS	1	1.3	27	0.3	26	1

OVERBURDEN SOIL TYPE ONLY

Unburned Treatment on Thick Topsoil

Species	Tot. Freq.	Rel. Freq.	Freq.** Rank	Avg. Cover	Cover ** Rank	No. Quads Occur.
BAR GRO	80	100.0	---	9.6	---	4
DIC POR	80	100.0	1	55.0	1	4
EUT TEN	65	81.3	2	37.6	2	4
SOL FIS	39	48.8	5	12.5	3	4
MYR CER	3	3.8	15	10.0	4	1
PAS SET	41	51.3	4	6.3	5	4
SCL CIL	3	3.8	15	5.0	6	1
RHU COP	10	12.5	10	4.5	7	4
CYP RET	45	56.3	3	4.4	8	4
FIM PUB	30	37.5	6	4.3	9	3
DIC ACI	11	13.8	8	4.2	10	3
HED UNI	7	8.8	11	2.8	11	1
RHY REP	12	15.0	7	2.6	12	3
AND GLA	1	1.3	24	2.5	13	1
AND GLO	2	2.5	20	2.5	13	1
DIG CIL	2	2.5	20	2.5	13	1
EUP CAP	1	1.3	24	2.5	13	1
JUN SCI	2	2.5	20	2.5	13	1
PTE PYC	4	5.0	14	2.5	13	1
SOR SEC	3	3.8	15	2.5	13	1
VAC MYR	5	6.3	13	2.5	13	3
HYP TET	3	3.8	15	1.4	21	2
SCH STO	3	3.8	15	1.4	21	2
SER REP	11	13.8	8	1.2	23	3
ARI PUR	6	7.5	12	1.0	24	3
ARI SPI	2	2.5	20	0.3	25	1
LYO FRU	1	1.3	24	0.3	25	1

OVERBURDEN SOIL TYPE ONLY

Control Plots with No Topsoil Applied

Species	Tot. Freq.	Rel. Freq.	Freq.** Rank	Avg. Cover	Cover ** Rank	No. Quads Occur.
BAR GRO	80	100.0	---	50.0	---	4
IND HIR	52	65.0	3	20.6	1	4
RHY REP	79	98.8	1	16.3	2	4
SCO DUL	34	42.5	4	3.9	3	2
CON CAN	61	76.3	2	2.8	4	4
BUL BAR	10	12.5	8	2.6	5	2
AND GLO	2	2.5	13	2.5	6	1
AXO AFF	1	1.3	17	2.5	6	1
CRO ROT	1	1.3	17	2.5	6	1
CYP SP.	2	2.5	13	2.5	6	1
CYP RET	21	26.3	5	2.2	10	4
AND VIR	7	8.8	9	1.9	11	3
CYP POL	3	3.8	10	1.5	12	2
CHA NIC	3	3.8	10	1.4	13	2
EUP CAP	18	22.5	6	1.4	13	4
HED UNI	3	3.8	10	0.5	15	1
HET SUB	15	18.8	7	0.5	15	2
AMP ARB	1	1.3	17	0.3	17	1
DIO TER	2	2.5	13	0.3	17	1
HED SP.	2	2.5	13	0.3	17	1
MAC LAT	1	1.3	17	0.3	17	1
RUM SP.	1	1.3	17	0.3	17	1
SOL FIS	1	1.3	17	0.3	17	1
XYR ELL	1	1.3	17	0.3	17	1

SAND TAILINGS SOIL TYPE ONLY

Burned Treatment on Thin Topsoil

Species	Tot. Freq.	Rel. Freq.	Freq.** Rank	Avg. Cover	Cover ** Rank	No. Quads Occur.
BAR GRO	80	100.0	---	35.0	---	4
RHY REP	59	73.8	1	21.3	1	4
DIO TER	58	72.5	2	18.1	2	4
PAS SET	13	16.3	8	12.5	3	1
ERA REF	14	17.5	7	11.3	4	2
AMB ART	7	8.8	11	10.0	5	1
CON CAN	12	15.0	10	7.5	6	2
HET SUB	21	26.3	5	5.7	7	4
IND HIR	30	37.5	3	5.7	7	4
CYP RET	25	31.3	4	3.8	9	4
BUL STE	13	16.3	8	3.8	10	2
DIG CIL	18	22.5	6	3.3	11	3
EUP CAP	4	5.0	14	2.8	12	1
AND GLO	2	2.5	18	2.5	13	1
ARI BEY	4	5.0	14	2.5	13	2
ARI PUR	3	3.8	16	2.5	13	1
DIC ACI	5	6.3	12	2.5	13	1
PAN REP	5	6.3	12	2.5	13	2
POL PRO	3	3.8	16	2.5	13	1
FIM PUB	1	1.3	19	0.3	19	1

SAND TAILINGS SOIL TYPE ONLY

Burned Treatment on Thick Topsoil

Species	Tot. Freq.	Rel. Freq.	Freq.** Rank	Avg. Cover	Cover ** Rank	No. Quads Occur.
BAR GRO	80	100.0	---	19.4	---	4
RHY REP	40	50.0	3	55.0	1	2
PAN REP	20	25.0	4	50.0	2	1
DIO TER	57	71.3	1	40.8	3	3
ERA REF	16	20.0	7	9.2	4	3
CYP RET	47	58.8	2	6.9	5	4
BUL STE	17	21.3	6	5.1	6	3
HET SUB	19	23.8	5	5.1	6	3
DIC ACI	8	10.0	10	5.0	8	1
IND HIR	3	3.8	14	5.0	8	1
DIG CIL	12	15.0	9	3.8	10	2
PAS SET	14	17.5	8	3.3	11	3
AND GLO	7	8.8	11	2.5	12	2
ARI BEY	5	6.3	12	2.5	12	2
AXO AFF	2	2.5	16	2.5	12	1
CHA FLO	1	1.3	19	2.5	12	1
DIC POR	2	2.5	16	2.5	12	1
ERA ELL	3	3.8	14	2.5	12	1
LEC SES	1	1.3	19	2.5	12	1
LEC TOR	2	2.5	16	2.5	12	1
POL PRO	1	1.3	19	2.5	12	1
ARI PUR	4	5.0	13	1.4	21	2
RHU COP	1	1.3	19	0.3	22	1

SAND TAILINGS SOIL TYPE ONLY

Unburned Treatment on Thin Topsoil

Species	Tot. Freq.	Rel. Freq.	Freq.** Rank	Avg. Cover	Cover ** Rank	No. Quads Occur.
BAR GRO	80	100.0	---	35.0	---	4
PAN REP	46	57.5	2	16.9	1	4
HET SUB	49	61.3	1	15.6	2	4
RHY REP	46	57.5	2	12.5	3	3
DIG CIL	34	42.5	4	11.7	4	3
CRO PAL	4	5.0	16	10.0	5	1
ERA SP.	3	3.8	17	10.0	5	1
DIO TER	12	15.0	7	6.4	7	2
PAS SET	9	11.3	9	5.0	8	1
EUT TEN	8	10.0	10	3.8	9	2
CYP RET	19	23.8	5	3.4	10	3
IND HIR	15	18.8	6	3.4	10	3
BID ALB	6	7.5	12	2.8	12	1
AMB ART	5	6.3	14	2.5	13	1
AMP ARB	2	2.5	18	2.5	13	1
ARI PUR	5	6.3	14	2.5	13	2
BUL STE	6	7.5	12	2.5	13	1
COM ERE	2	2.5	18	2.5	13	1
ERA REF	2	2.5	18	2.5	13	1
SER REP	10	12.5	8	1.8	19	3
CON CAN	7	8.8	11	1.0	20	3
CHM SP.	1	1.3	21	0.3	21	1
IMP CYL	1	1.3	21	0.3	21	1

SAND TAILINGS SOIL TYPE ONLY

Unburned Treatment on Thick Topsoil

Species	Tot. Freq.	Rel. Freq.	Freq.** Rank	Avg. Cover	Cover ** Rank	No. Quads Occur.
BAR GRO	80	100.0	---	17.5	---	4
PAN REP	19	23.8	6	30.0	1	2
DIG CIL	49	61.3	1	28.2	2	4
IND HIR	28	35.0	3	20.8	3	3
AXO AFF	14	17.5	9	12.5	4	2
HET SUB	26	32.5	4	9.4	5	4
EUT TEN	18	22.5	8	7.5	6	3
PAS SET	14	17.5	9	7.5	6	2
CYP RET	34	42.5	2	6.9	8	4
RHY REP	19	23.8	6	6.7	9	3
EUP CAP	8	10.0	12	6.4	10	2
ARI PUR	20	25.0	5	6.3	11	4
DIO TER	10	12.5	11	5.0	12	1
AND GLO	3	3.8	17	2.5	13	1
AND VIR	3	3.8	17	2.5	13	1
ARI BEY	5	6.3	14	2.5	13	2
BUL STE	2	2.5	21	2.5	13	1
CON CAN	3	3.8	17	2.5	13	1
DIC ACI	1	1.3	23	2.5	13	1
DIC POR	1	1.3	23	2.5	13	1
ERA REF	5	6.3	14	2.5	13	2
ERA SP.	2	2.5	21	2.5	13	1
LEC TOR	3	3.8	17	2.5	13	1
PTE PYC	1	1.3	23	2.5	13	1
SER REP	7	8.8	13	1.5	24	2
FIM PUB	5	6.3	14	1.1	25	3
MOM CHA	1	1.3	23	0.3	26	1

SAND TAILINGS SOIL TYPE ONLY

Control Plots with No Topsoil Applied

Species	Tot. Freq.	Rel. Freq.	Freq.** Rank	Avg. Cover	Cover ** Rank	No. Quads Occur.
BAR GRO	80	100.0	---	35.6	---	4
PAN REP	40	50.0	3	50.0	1	2
CYN DAC	19	23.8	7	15.0	2	3
RHY REP	20	25.0	6	11.8	3	3
AMB ART	58	72.5	1	11.3	4	4
IND HIR	53	66.3	2	8.2	5	4
SPO IND	5	6.3	12	3.9	6	2
DIG CIL	14	17.5	8	3.8	7	2
CON CAN	22	27.5	5	3.4	8	3
BID ALB	10	12.5	9	3.3	9	3
AES AME	3	3.8	16	2.8	10	1
FRO FLO	5	6.3	12	2.8	10	1
AND GLO	5	6.3	11	2.6	12	2
CYP RET	4	5.0	14	2.6	12	2
HET SUB	24	30.0	4	2.6	14	3
DIO TER	3	3.8	16	2.5	15	1
PAS NOT	2	2.5	18	2.5	15	1
CHA HYS	6	7.5	10	1.5	17	2
AND VIR	4	5.0	14	1.4	18	2
CHM SP.	1	1.3	20	0.3	19	1
EUP CAP	1	1.3	20	0.3	19	1
EUS PET	1	1.3	20	0.3	19	1
IMP CYL	2	2.5	18	0.3	19	1
SET GEN	1	1.3	20	0.3	19	1

* Full scientific names can be found in Appendix B.

** Total frequency and % cover data are shown to 1 decimal place, however, corresponding rankings have been calculated to 3 significant digits.

Appendix M

POOLED VEGETATION DATA FOR BURNED/DISKED AND DISKED ONLY PLOTS AT THE SITE PREPARATION STUDY SITE AT GOPHER HILLS

Site Preparation Study
October 1997

Disked and Burned Treatment

Data are Sorted by Decreasing % Cover

Species*	Total Freq.	Relative Freq.	Freq.** Rank	Avg. % Cover	Cover** Rank	No. Quads Occur.
BAR GRO	500	100.0	---	25.6	---	10
IND HIR	355	71.0	3	21.5	1	10
SPO IND	193	38.6	5	18.2	2	5
RHY REP	419	83.8	1	16.6	3	10
HET SUB	414	82.8	2	14.8	4	10
PAS NOT	257	51.4	4	13.3	5	9
AXO AFF	123	24.6	7	9.3	6	4
CHA FAS	10	2.0	28	5.1	7	1
DIG LON	123	24.6	7	4.6	8	6
RIC SCA	22	4.4	22	4.0	9	1
POL PRO	48	9.6	13	3.7	10	3
DIC POR	9	1.8	29	3.2	11	1
CYP GLO	165	33.0	6	3.0	12	8
PAS SET	81	16.2	12	2.9	13	8
RIC BRA	122	24.4	9	2.7	14	9
AMB ART	85	17.0	11	2.4	15	9
ERA REF	30	6.0	17	2.4	16	3
DIO TER	103	20.6	10	2.3	17	8
ABU THE	40	8.0	14	2.2	18	6
HED UNI	6	1.2	32	2.2	19	1
SMI LAU	2	0.4	38	2.0	20	1
EUP CAP	24	4.8	21	1.9	21	5
ACA GRA	29	5.8	19	1.8	22	4
DAC AEG	37	7.4	15	1.7	23	5
DIG SER	28	5.6	20	1.7	23	5
SET GEN	30	6.0	17	1.7	25	6
HED COR	8	1.6	31	1.6	26	2
DIG CIL	22	4.4	22	1.5	27	4
CON CAN	33	6.6	16	1.4	28	9
POR PIL	6	1.2	32	1.2	29	1
ARI BEY	12	2.4	27	1.1	30	3

Disked and Burned Treatment (continued)

Species[*]	Total Freq.	Relative Freq.	Freq.[**] Rank	Avg. % Cover	Cover[**] Rank	No. Quads Occur.
CYN DAC	21	4.2	24	1.1	31	3
POR AMI	17	3.4	25	1.1	31	3
CYP RET	9	1.8	29	1.1	33	3
SCO DUL	14	2.8	26	1.1	33	3
PAN DIC	6	1.2	32	1.0	35	3
CHA NIC	3	0.6	36	1.0	36	1
CRO PAL	2	0.4	38	1.0	36	1
URE LOB	4	0.8	35	0.3	38	4
AND VIR	2	0.4	38	0.1	39	2
CRO GLA	1	0.2	41	0.1	39	1
DIC SP.	1	0.2	41	0.1	39	1
LEC DIV	1	0.2	41	0.1	39	1
PAN REP	1	0.2	41	0.1	39	1
RHY SP.	1	0.2	41	0.1	39	1
STR GES	3	0.6	36	0.1	39	3

Disked Only Treatment

Data are Sorted by Decreasing % Cover

Species*	Total Freq.	Relative Freq.	Freq.** Rank	Avg. % Cover	Cover** Rank	No. Quads Occur.
BAR GRO	500	100.0	---	21.2	---	10
RHY REP	490	98.0	1	58.2	1	10
IND HIR	344	68.8	3	19.5	2	10
PAS NOT	113	22.6	5	16.3	3	4
HET SUB	361	72.2	2	9.4	4	10
AXO AFF	112	22.4	6	5.8	5	4
RIC SCA	15	3.0	15	3.2	6	1
DIO TER	206	41.2	4	2.5	7	10
ABU THE	20	4.0	14	2.4	8	3
EUP CAP	5	1.0	23	2.1	9	1
DIG CIL	40	8.0	9	1.7	10	5
RIC BRA	105	21.0	7	1.6	11	8
CHA FAS	10	2.0	17	1.6	12	2
CHA NIC	7	1.4	19	1.6	12	2
PAS SET	35	7.0	12	1.5	14	5
SPO IND	7	1.4	19	1.5	15	2
DIG LON	36	7.2	11	1.5	16	5
POR PIL	61	12.2	8	1.5	17	6
CON CAN	27	5.4	13	1.4	18	6
CYP GLO	40	8.0	9	1.3	19	6
DIG SER	6	1.2	21	1.1	20	2
CYN DAC	3	0.6	26	1.0	21	1
PTE PYC	2	0.4	28	1.0	21	1
STR GES	12	2.4	16	0.9	23	4
AMB ART	8	1.6	18	0.6	24	5
BUL CIL	4	0.8	24	0.6	25	2
FRO FLO	2	0.4	28	0.6	25	2
CYP SP.	4	0.8	24	0.3	27	1
CYP RET	6	1.2	21	0.2	28	3
DIC POR	1	0.2	31	0.1	29	1
DIC SP.	1	0.2	31	0.1	29	1
POL PRO	3	0.6	26	0.1	29	2
RHY SP.	1	0.2	31	0.1	29	1
SET GEN	1	0.2	31	0.1	29	1
URE LOB	2	0.4	28	0.1	29	1

* Full scientific names can be found in Appendix B.
** Total frequency and % cover data are shown to 1 decimal place, however, corresponding rankings have been calculated to 3 significant digits.