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MANAGEMENT OF NUISANCE AND EXOTIC VEGETATION ON PHOSPHATE MINED LANDS IN FLORIDA

FINAL REPORT

Prepared by

FLORIDA INDUSTRIAL AND PHOSPHATE RESEARCH INSTITUTE

and

KLEINFELDER
Tampa, FL

under a grant sponsored by

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The Florida Industrial and Phosphate Research Institute (FIPR Institute) was created in 2010 by the Florida Legislature (Chapter 1004.346, Florida Statutes) as part of the University of South Florida Polytechnic. The FIPR Institute superseded the Florida Institute of Phosphate Research established in 1978 but retained and expanded its mission. In April 2012 the statute was amended by the Florida Legislature, transferring the Institute to the Florida Polytechnic University as of July 1, 2012. The FIPR Institute is empowered to expend funds appropriated to the University from the Phosphate Research Trust Fund. It is also empowered to seek outside funding in order to perform research and develop methods for better and more efficient processes and practices for commercial and industrial activities, including, but not limited to, mitigating the health and environmental effects of such activities as well as developing and evaluating alternatives and technologies. Within its phosphate research program, the Institute has targeted areas of research responsibility. These are: establish methods for better and more efficient practices for phosphate mining and processing; conduct or contract for studies on the environmental and health effects of phosphate mining and reclamation; conduct or contract for studies of reclamation alternatives and wetlands reclamation; conduct or contract for studies of phosphatic clay and phosphogypsum disposal and utilization as a part of phosphate mining and processing; and provide the public with access to the results of its activities and maintain a public library related to the institute's activities.

The FIPR Institute is located in Polk County, in the heart of the Central Florida phosphate district. The Institute seeks to serve as an information center on phosphate-related topics and welcomes information requests made in person, or by mail, email, fax, or telephone.

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PERSPECTIVE

Steven G. Richardson, Ph.D. – Research Director, Reclamation

The control of exotic and native nuisance plants is a major contributor to reclamation costs on mined lands in Florida. Invasive exotic plants are also major problems in natural areas. The main purpose of this manual is to provide information that will aid in more cost-effective weed control and more successful reclamation. The information is also applicable to restoration efforts on non-mined lands. Information in the manual is based on more than 20 years of research and demonstration projects conducted by FIPR Institute staff and cooperators, plus published reports and the experience of other researchers and reclamation/restoration practitioners.

One of the first research projects on weed ecology and management conducted by the Florida Institute of Phosphate Research (FIPR, now the Florida Industrial and Phosphate Research Institute [FIPR Institute]) began in 1989. The initial research examined competitive interactions between various weeds and upland or wetland trees (see Richardson and others 1994). Early emphasis was on primrose willow and cattail competition with several wetland tree species (see Richardson and Johnson 1998, Richardson and Kluson 2000). FIPR funded the University of Florida to conduct research on the ecology and management of cogongrass in 1993, which was published in 1997 (Shilling and others 1997). In 1998, FIPR staff began a series of studies on competitive interactions of several non-native grasses and other weeds with native plants in uplands plus studies on selective herbicidal weed control; i.e., killing certain weeds with minimal or no injury to various native plants (Kluson and others 2000, Richardson and others 2003). Over the next several years, FIPR provided funding to help support several graduate students under the direction of Dr. Greg MacDonald at the University of Florida, and FIPR staff expanded research efforts on control of cogongrass and other weeds, plus tolerance of native plants to various herbicides.

Some of the research findings have been presented at various national and regional professional meetings (American Society of Mining and Reclamation, Society for Ecological Restoration, Florida Exotic Pest Plant Council, Southern Weed Science Society, Florida's Annual Regional Phosphate Conference, Florida Vegetation Management Association, etc.). Presentations about weed ecology and management from the 2008 Ecosystem Restoration Workshop are available online at the FIPR Institute website (www.fipr.state.fl.us). Several presentations were published as full papers or as abstracts in various conference or symposium proceedings. Graduate student theses have also been published through the University of Florida. Some of the Institute's research findings have not been formally published but will be published as a FIPR Institute research report (title: *Management of Cogongrass and Other Weeds on Disturbed Lands in Florida*).

ABSTRACT

Invasive exotic plants are major problems in natural areas and on reclaimed mined lands in Florida. Even some native plants can be highly competitive when re-establishing plant communities on disturbed lands and have been included in the term “nuisance plants.” There are regulatory requirements to control invasive exotic and nuisance plants on reclaimed mined lands in Florida. The control of exotic and native nuisance plants is a major contributor to reclamation costs on mined lands in Florida. The main purpose of this manual is to provide information that will aid in more cost-effective weed control and more successful reclamation of mined lands. The information is also applicable to restoration efforts on non-mined lands. Information in the manual is based on more than 20 years of research and demonstration projects conducted by FIPR Institute staff and cooperators, plus published reports and the experience of other researchers and reclamation and restoration practitioners. The recommendations in the manual are the authors’ attempts to summarize and synthesize the available published and unpublished information. A bibliography is also included for those who wish to delve into various topics in greater detail. The manual provides management methods for the various exotic and native nuisance plants but also for Florida vegetation communities and the related Florida Land Use, Cover and Forms Classification System (FLUCFCS) types.

ACKNOWLEDGMENTS

We wish to acknowledge the many contributions of Cathy Knott in the preparation of this manual. We also thank Karen Stewart for her editorial polishing. The FIPR Institute Reclamation Technical Advisory Committee encouraged undertaking this project and provided much valuable feedback.

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INTRODUCTION

State, federal, and county rules and regulations and permit conditions for mine reclamation include requirements for managing invasive exotic and nuisance plants. Invasive exotic and nuisance plants are problems on non-mined lands as well as reclaimed mined lands. Even plants not listed as invasive exotic and nuisance plants can be competitive weeds when trying to re-establish native plant communities or other desirable vegetation on mined or non-mined lands. The cost and effort expended to control these problem plants are enormous.

A need was felt by the FIPR Institute's Reclamation Technical Advisory Committee that the available information from recent and ongoing research, published literature, and the experience of practitioners, should be assembled to help guide the management of problem plants in a more effective and efficient manner. The emphasis of the manual is on managing problem plants on reclaimed phosphate mined lands, but the information applies to managing problem plants on non-mined lands as well. The information in the manual is based on research and experience gained on both mined and non-mined lands.

The manual includes a reference list to allow the reader to delve more deeply into various subjects if desired. These references were consulted, but we decided *not* to use the format commonly used for literature reviews (citing each reference in the text and summarizing the results or main points of each reference) because it would be too cumbersome in a guidance manual. However, we have tried to synthesize the information into the text presented.

The tables and lists of "nuisance" species were derived from FDEP (Florida Department of Environmental Protection), FLEPPC (Florida Exotic Pest Plant Council) and county documents plus the collective experience of the authors, various regulators, consultants and land managers. The manual addresses "problem" species, which include invasive exotic and nuisance plant species in various official lists, plus other plants, even native ones, which may be competitive weeds in the early stages of re-establishment of vegetation communities or that have been observed to dominate some sites. The manual is not a legal document listing species that must be controlled; please consult the state and local authorities for the up-to-date lists and control requirements. The manual is intended to be a guide for managing plants that can be competitive weeds. We have attempted to provide the best recommendations and information available, but we expect methodology to improve (become more cost effective) as we gain new knowledge in the future.

Definitions:

- *Exotic plants* are plants listed as non-native in the University of South Florida's online Florida Plant Atlas web site (http://florida.plantatlas.usf.edu/).

- *Invasive exotic plants* are plants listed by the Florida Exotic Pest Plant Council (FLEPPC) (http://fleppc.org/list/list.htm).
- *Nuisance plants* include certain native plants that can be invasive or highly competitive on reclaimed or restored sites. Some have been designated as nuisance plant species by the FDEP or other agencies.

The U.S. Army Corps of Engineers classifies invasive exotic and nuisance species as those identified by the FLEPPC. The Hillsborough County Environmental Protection Commission (HCEPC) has a nuisance species list that includes invasive exotic plants (on FLEPPC list) and certain native nuisance plants. It can be viewed online at http://www.epchc.org/DocumentCenter/Home/View/161.

For permitting, the Florida phosphate industry and the agencies regulating the industry use the Florida Land Use, Cover and Forms Classification System (FLUCFCS) to describe the pre-mining land uses and post-mining reclamation land uses. The FLUCFCS was established in order to provide a uniform land classification system that would satisfy a wide range of users and be compatible with national classifications while allowing flexibility for regional and local agencies. The FLUCFCS Handbook (Department of Transportation 1999) provides a list of each land use code along with a description of typical vegetation or other coverage for the specified land use. This manual attempts to provide guidance not only for controlling individual problem weeds but also for managing weeds in various plant communities (groupings of similar FLUCFCS codes).

INDUSTRY REQUIREMENTS

The phosphate industry is subject to the reclamation requirements and standards of Chapter 378 of the Florida Statutes (FS) and Chapter 62C-16, Florida Administrative Code (FAC) – Bureau of Mine Reclamation (now the Bureau of Mining and Minerals Regulation) – Mandatory Phosphate Mine Reclamation. The intent of FS Chapter 378 and FAC 62C-16 is to ensure these lands are safe and productive following completion of mining activities. Productive land uses may include agricultural lands or lands suitable for future development, but they may also include land uses that will transition to natural vegetation communities that can be utilized by an assortment of wildlife for foraging, cover, nesting, and denning. The key to reclaiming a safe and productive natural vegetative community is the development of an appropriate vegetative cover. Chapter 62C-16.0051, (FAC) stresses the importance of restoration of an adequate soil suitable for revegetation as well as an appropriate hydrological regime including the appropriate drainage basin, ground and surface water elevation. In addition to State requirements, the affected counties also have regulations.

RECLAMATION AND MITIGATION REQUIREMENTS

Reclamation

Reclamation of mined lands is generally discussed under the terms reclamation and mitigation. The following definitions from Chapter 62C-16.0021, (FAC) are provided:

Reclamation shall mean the reshaping of lands in a manner which meets the reclamation standards, including revegetation, contained in this chapter.

Two additional terms often used are Restoration and Revegetation.

Restoration

Restoration shall mean the recontouring and revegetation of lands in a manner, consistent with the criteria and standards established under this chapter, which will maintain or improve the water quality and function of the biological systems present at the site prior to mining or mining operations. In requiring restoration of an area, the department must recognize technological limitations and economic considerations. For example, restoration shall be considered accomplished when immature trees are used; mature trees are not required to be replanted in areas where mature trees were removed to allow for mining.

Revegetation

Revegetation shall mean, in reclaimed areas, a cover of vegetation consistent with the standards established pursuant to this chapter and consistent with the land form created and the future land uses. In restored areas, it means a cover of vegetation that is designed to return the restored area to a condition that maintains or improves the function of the biological system present at the site prior to mining or mining operations.

Mitigation

The phosphate industry is also subject to the regulations outlined within Chapter 373 of the Florida Statutes (FS). Under Part IV of Chapter 373, (FS) and Chapters 40B-4, 40B-400, 40D-4, 40D-40 and 40D-400, (FAC), the Suwannee River Water Management District (SRWMD) and the Southwest Florida Water Management District (SWFWMD) are responsible for permitting construction and operation of surface water management systems within their jurisdictional boundaries. Pursuant to Operating Agreements between the Florida Department of Environmental Protection (FDEP) and the Districts, the Department is responsible for review and final action on permits for construction and operation of surface water management systems for this industry.

Pursuant to Chapter 1.7.24 of the Southwest Florida Water Management District's, Basis of Review (BOR) for Environmental Resource Permits and Chapter 12.2.1 of the Suwannee River Water Management District's BOR, mitigation is generally required for adverse impacts to wetlands and other surface waters. Mitigation is defined as follows pursuant to Chapter 62-346.030, (FAC):

Mitigation means an action or series of actions to offset the adverse impacts that would otherwise cause an activity regulated under Part IV of Chapter 373, F.S., to fail to meet the criteria set forth in Section 373.414(1), F.S. Mitigation usually consists of restoration, enhancement, creation, preservation, or a combination thereof.

The phosphate industry is also subject to Section 404 of the Clean Water Act (CWA). Section 404 of the CWA establishes regulations for the discharge of dredged and fill material into waters of the United States, including jurisdictional wetlands. The U.S. Environmental Protection Agency (EPA) and the U.S. Army Corps of Engineers (Corps) administer Section 404 of the CWA. The EPA and Corps require mitigation for impacts to both surface waters and wetlands which are under federal jurisdiction.

WETLAND RESOURCE PERMITS, CONCEPTUAL RECLAMATION PLANS AND ENVIRONMENTAL RESOURCE PERMITS

This section summarizes the reclamation and mitigation revegetation requirements. The preparation of this manual included the review of the phosphate industry's Wetland Resource Permits (WRP), Conceptual Reclamation Plans (CRP), and Environmental Resource Permits (ERP) issued by the FDEP. CRP's are plans that describe how and when lands disturbed by mining are to be reclaimed. WRP and ERP permits authorize surface water management systems and adverse impacts to wetlands and other surface waters. CRP's, WRP's, and ERP's outline reclamation and mitigation requirements.

The reclamation process generally begins with the backfilling of mined areas with overburden, sand tailings or a sand/clay mix. It has become more common in recent years to place a layer of topsoil over the overburden or sand tailings. The CRP's and ERP's stress the relocation of topsoil from areas to be disturbed to areas to be reclaimed in order to utilize the natural seed bank. Topsoil includes upland sandy soil and also organic muck or sod from wetlands. The operator relocates topsoil when feasible, based upon location, condition of the material (i.e., limited nuisance cover) and timing of the relocation.

Reclamation Release Criteria

Chapter 62C-16.0051, (FAC) Reclamation and Restoration Standard requires restoration of disturbed wetlands at least acre for acre and type for type. Type for type restoration will follow the Florida Land Use, Cover and Forms Classification system (FLUCFCS) (DOT 1999).

Chapter 62C-16.0051, (10), (FAC) provides details on revegetation requirements. This chapter requires the operator to achieve permanent revegetation with the following goals:

1. Minimize soil erosion.
2. Conceal the effects of surface mining.
3. Recognize the appropriate habitat for fish and wildlife.

The following requirements must be met:

(a) The operator shall develop a plan for the proposed revegetation, including the species of grasses, shrubs, trees, aquatic and wetlands vegetation to be planted, the spacing of vegetation, and, where necessary, the program for treating the soils to prepare them for revegetation.

(b) All upland areas must have established ground cover for one year after planting over 80% of the reclaimed upland area, excluding roads, groves, or row crops. Bare areas shall not exceed one-quarter (1/4) acre.

(c) Upland forested areas shall be established to resemble premining conditions where practical and where consistent with proposed land uses. At a minimum, 10% of the upland area will be revegetated as upland forested areas with a variety of indigenous tree species. Upland forested areas shall be protected from grazing, mowing, or other adverse land uses to allow establishment. An area will be considered to be reforested if a stand density of 200 trees/acre is achieved at the end of one year after planting.

(d) All wetland areas shall be restored and revegetated in accordance with the best available technology.

1. Herbaceous wetlands shall achieve a ground cover of at least 50% at the end of one year after planting and shall be protected from grazing, mowing, or other adverse land uses for three years after planting to allow establishment.
2. Wooded wetlands shall achieve a stand density of 200 trees/acre at the end of one year after planting and shall be protected from grazing, mowing, or other adverse land uses for five years or until such time as the trees are ten feet tall.

(e) All species used in revegetation shall be indigenous species except for agricultural crops, grasses, and temporary ground cover vegetation.

Examples of CRP and ERP General Conditions

- Ground cover established in all upland forests shall include one or more of the following native plant types: fruit-bearing shrubs, low-growing legumes, native grasses and sedges.
- Native grasses and shrubs should be used when creating/restoring grasslands and shrub and brush land habitats.

Mitigation Release Criteria

Release from mitigation requirements varies among the ERP permits but generally consists of the following requirements:

For All Mitigation Areas

1. Cover by non-nuisance, non-exotic wetland species (Facultative Wetland or Obligate Wetland) listed in rule 62-340.450, (FAC), in the ground cover shall be at least 80% of the total wetland area or shall be within the range of values documented within the reference wetlands of the target community type.

Desirable ground cover plant species shall be reproducing naturally, either by normal vegetative spread or through seedling establishment, growth and survival.

2. Cover by nuisance vegetation species, including, but not limited to *Typha* spp. (cattails), *Ludwigia peruviana* (primrose willow), and *Mikania* spp. (climbing hemp vine) shall be limited to less than 10% of the total wetland area. Invasive exotic vegetation including, but not limited to *Melaleuca quinquenervia* (melaleuca), *Sapium sebiferum* (Chinese tallow) and *Schinus terebinthifolius* (Brazilian pepper) shall not be considered an acceptable component of the vegetative community.

For Forested Wetlands

1. The canopy layer shall have an average of at least 400 live trees per acre that area either at least 12 feet tall, have greater than four inches at Diameter Breast Height or shall meet or exceed the range of canopy and subcanopy tree densities in the reference wetlands. No area greater than an acre in size shall have less than 200 trees per acre.

2. The tree cover shall exceed 33% of the total area and in no area of one half acre in size shall the tree cover be less than 20% of total cover. Cover measurements shall be restricted to those trees exceeding the herbaceous stratum in height and those indigenous species listed as wetland vegetation in Chapter 62-340, (FAC).

3. The shrub layer shall have an average of at least 100 live shrubs per acre or shall meet or exceed the range of shrub densities in the reference wetlands. Early successional species such as *Salix caroliniana* (Carolina willow), *Baccharis* spp. (saltbush), *Myrica cerifera* (wax myrtle), and *Sambucus canadensis* (elderberry) do not count toward meeting this requirement.

The canopy and shrub strata shall each have species richness values and dominance regimes within the range of values documented in the reference wetlands of the target community type.

FLORIDA LAND USE, COVER AND FORMS CLASSIFICATION SYSTEM

For permitting, the Florida phosphate industry and the agencies regulating the industry use the Florida Land Use, Cover and Forms Classification System (FLUCFCS) to describe the pre-mining land uses and post-mining reclamation land uses. The FLUCFCS was established in order to provide a uniform land classification system that would satisfy a wide range of users and be compatible with national classifications while allowing flexibility for regional and local agencies. The FLUCFCS is arranged in four hierarchical levels with each level increasing in specific land information. For example, a Level I code of 400 indicates an upland forest land cover, whereas a more specific Level IV code of 4411 refers to a sand pine plantation. The FLUCFCS Handbook (Department of Transportation 1999) provides a list of each land use code along with a description of typical vegetation or other coverage for the specified land use. The following provides a general description of the various land uses within each FLUCFCS group included in this manual:

GROUP A: FLUCFCS 211 AND 213 (PASTURES)

The 200 level FLUCFCS code refers to agriculture, which is defined as lands that are cultivated to produce crops and/or livestock.

211 – Improved Pastures. This category generally includes lands which have been cleared of natural vegetation and reseeded with pasture grasses, such as bahiagrass (*Paspalum notatum*). These areas may be periodically improved with mowing, fertilizer applications, and/or brush removal. In many cases cow trails, cattle ponds, and feeding stations are evident within this category.

213 – Woodland Pastures. These areas consist of a forested canopy [often pine (*Pinus* spp.) and/or oak species (*Quercus* spp.)] with an open understory and evidence of cattle grazing and trails.

GROUP B: FLUCFCS 320, 321, 330, AND 411 (SHRUB AND BRUSHLAND, PALMETTO PRAIRIES, MIXED RANGELAND, PINE FLATWOODS)

The 300 level FLUCFCS code refers to rangeland, which is defined as land where the dominant cover consists of native grasses, forbs, and shrubs that are capable of being grazed. Any management activities are generally limited to brush control and managing cattle grazing intensity and season.

320 Shrub and Brushland. Subcategory 320 refers to shrub and brushland, which consists of saw palmetto (*Serenoa repens*), gallberry (*Ilex glabra*), wax myrtle, and other shrub species. Saw palmetto is generally the dominant species with other woody shrubs and various broadleaf species and grasses.

321 – Palmetto Prairies. This treeless community is often found on well-drained sandy areas and is dominated by saw palmetto. Additional species associated with this category include fetterbush (*Lyonia lucida*), tarflower (*Bejaria racemosa*), gallberry, wiregrass (*Aristida* spp.), pawpaw (*Asimina* spp.), and broomsedge (*Andropogon virginicus*).

330 – Mixed Rangeland. Mixed rangeland is identified as an area where more than one-third of the area is an intermixture of grassland and shrub-brushland.

411 – Pine Flatwoods. Although this is an upland forested land use (400), this category is grouped within Group B because the understory is composed of species very similar to that described for palmetto prairies (321) and would be managed similarly. The primary difference is that pine flatwoods are dominated by either slash pine (*Pinus elliottii*) or longleaf pine (*P. palustris*) in the canopy layer.

GROUP C: FLUCFCS 410, 414, 420, 421, 425, 427, 430, 434, AND 438 (HARDWOOD AND MIXED FORESTS)

The 400 level FLUCFCS code refers to upland forests, which are defined as upland areas that consist of tree canopy coverage of at least 10% and may consist of both xeric and mesic forest communities. Upland forests are further divided into those dominated (at least 66% of total canopy coverage) by conifers (410) and those dominated by hardwoods (420 and 430).

414 – Pine – Mesic Oak. This conifer-dominated community occurs on relatively moist sites where pines, such as slash pine, longleaf pine, and loblolly pine (*P. taeda*), grow in association with mesic oak species, such as water oak (*Quercus nigra*), laurel oak (*Q. laurifolia*), as well as sweetgum (*Liquidambar styraciflua*) and hickories (*Carya* spp.). Typical understory species include wax myrtle, gallberry, and saw palmetto.

421 – Xeric Oak. This forested community is dominated by xeric oak species such as sand live oak (*Quercus geminata*), bluejack oak (*Q. incana*), and turkey oak (*Q. laevis*) and may contain scattered longleaf pine. Typical shrub species include gallberry, rusty staggerbush (*Lyonia ferruginea*) and coastalplain staggerbush (*L. fruticosa*). Groundcover species generally include wiregrass and other xeric grasses and forbs.

425 – Temperate Hardwood. This community is also referred to as either low or temperate hammock and may consist of a canopy dominated by various oak species, red bay (*Persea borbonia*), southern magnolia (*Magnolia grandiflora*), sweetgum, sugarberry (*Celtis laevigata*), cabbage palm (*Sabal palmetto*), and hickories. Temperate hardwood land uses often have various pine species mixed throughout. Typical shrub species may include fetterbush, gallberry, and saw palmetto.

427 – Live Oak. This community is also referred to as upland temperate hammock and live oak (*Quercus virginiana*) occurs as either the dominant canopy species or in pure stands. Other species associated with this category include sweetgum, southern magnolia, and laurel oak. This community is common along the upper banks of lakes and streams.

434 – Hardwood – Conifer Mixed. This category is used for forest communities that include a mix of conifers and hardwoods, with neither contributing more than 66% of the total canopy.

438 – Mixed Hardwoods. This hardwood forested community type is dominated by a variety of hardwood species where no one single species or group contributes more than 66% of the total canopy cover.

GROUP D: FLUCFCS 610, 611, 615, 617, 620, 621, 625, 630, AND 631 (FORESTED WETLANDS)

The 600 level FLUCFCS code corresponds to all wetland communities within Florida. Group D includes all the forested wetlands, which are generally broken down to wetland hardwood forests (610), wetland coniferous forests (620), and wetland forested mixed (630) with more species specific land uses.

610 – Wetland Hardwood Forests. This community includes wetland areas that contain at least 10% canopy cover, of which at least 66% must be hardwood species. These systems are further divided as follows:

611 – Bay Swamps. Bay swamp communities are those dominated by evergreen species such as sweetbay (*Magnolia virginiana*), swamp bay (*Persea palustris*), and loblolly bay (*Gordonia lasianthus*) as well as other species including dahoon holly (*Ilex cassine*), slash pine, and loblolly pine. Typical shrub species include fetterbush, wax myrtle, titi (*Cyrilla racemiflora*), and gallberry. Cinnamon fern (*Osmunda cinnamomea*), lizard's tail (*Saururus cernuus*), netted chainfern (*Woodwardia areolata*), and Virginia chainfern (*W. virginica*) are common groundcover species.

615 – Stream and Lake Swamps (Bottomland). This community is also referred to as bottomland or stream hardwoods and is generally associated with stream, river, and lake floodplain areas. These include a large variety of wetland hardwood species including red maple (*Acer rubrum*), cypress (*Taxodium* spp.), water oak, sweetgum, tupelos (*Nyssa* spp.), water hickory, dahoon holly, and bay trees. Common shrub species include southern willow (*Salix caroliniana*) and buttonbush (*Cephalanthus occidentalis*).

617 – Mixed Wetland Hardwoods. This community type is composed of a variety of wetland hardwood species and may include red maple, sweetgum, various bays, dahoon holly, water and laurel oaks, water hickory (*Carya aquatica*), and popash

(*Fraxinus caroliniana*). Typical shrub species may include southern willow, wax myrtle, and buttonbush. These areas are found in large, irregularly-shaped basins which may or may not be associated with river floodplains.

620 – Wetland Coniferous Forests. This community includes wetland areas that contain at least 10% canopy cover, of which at least 66% must be coniferous species. These systems are further divided as follows:

621 – Cypress. This community is characterized as having stands of either pure or predominantly bald cypress (*Taxodium distichum*) or pond cypress (*T. ascendens*). Species commonly associated with cypress systems include swamp tupelo (*Nyssa sylvatica* var. *biflora*), red maple, popash, southern willow, and buttonbush. Ferns such as cinnamon fern, royal fern (*Osmunda regalis*), swamp fern (*Blechnum serrulatum*), lizard's tail, pickerelweed (*Pontederia cordata*), netted chainfern, and Virginia chainfern are common groundcover species. These systems may occur along rivers, lake margins, sloughs and strands, or interspersed throughout other communities.

625 – Hydric Pine Flatwoods. This community is also referred to as wet flatwoods and is characterized as having a sparse to moderate canopy of slash pine, pond pine (*Pinus serotina*), and sweetbay with a diverse understory of various grasses, wiregrass, and wetland forb species, including bog buttons (*Lachnocaulon* spp.), meadow-beauty (*Rhexia* spp.), butterworts (*Pinguicula* spp.), milkworts (*Polygala* spp.), and yellow-eyed grass (*Xyris* spp.). Typical shrubs include gallberry, dahoon holly, fetterbush, wax myrtle, and a sparse coverage of saw palmetto. These areas occur on flat, poorly drained soils.

630 – Wetland Forested Mixed. This community includes a mix of both hardwood and coniferous wetland species in which no group achieves more than 66% canopy dominance.

631 – Wetland Scrub. This depressional community occurs on poorly-drained soils and is often composed of pond cypress, swamp tupelo, titi, fetterbush, willow species (*Salix* spp.), and other low shrub species with no one species dominating.

GROUP E: FLUCFCS 640, 641, 6417, 643, AND 646 (FRESH WATER MARSHES, WET PRAIRIES, HYDRIC SAVANNAS)

The 640 level FLUCFCS code refers to Vegetated Non-Forested Wetlands. These wetland community types include marshes and seasonally flooded basins and meadows with less than 10% canopy cover. These areas are generally found in relatively flat, low-lying areas within the landscape.

641 – Freshwater Marshes. Freshwater marshes generally remain inundated between 50 to 200 days per year, with water levels fluctuating between wet and dry seasons. Typical dominant species within marshes include sawgrass (*Cladium* *jamaicensis*), cattail, arrowhead (*Sagittaria* spp.), maidencane (*Panicum hemitomon*), buttonbush, sand cordgrass (*Spartina bakeri*), bulrush (*Schoenoplectus* spp.), softrush (*Juncus effusus*), and alligator flag (*Thalia geniculata*). Additional species include buttonbush, primrose willows (*Ludwigia* spp.), St. John's wort (*Hypericum* spp.), willows (*Salix* spp.), bladderworts (*Utricularia* spp.), and yellow-eyed grass (*Xyris* spp.).

6417 – Freshwater Marsh with Shrubs, Brush, and Vines. This wetland community is characterized as having at least 66% cover by various shrub, brush, and/or vine species.

643 – Wet Prairies. This community is composed primarily of grassy vegetation on poorly drained areas and is distinguished from freshwater marshes by a shorter hydroperiod with less water and generally shorter herbaceous species. Typical species include sawgrass, maidencane, sand cordgrass, spike rushes (*Eleocharis* spp.), beaksedges (*Rhynchospora* spp.), St. John's wort, swamplily (*Crinum americanum*), and various sedges (*Cyperus* spp.).

646 – Treeless Hydric Savanna. This community type typically occurs on flat, poorly-drained lands and is dominated by wiregrass and/or cutthroat grass (*Panicum abscissum*) and no trees. Other species typically include bluestem (*Andropogon* spp.), bog buttons, meadow-beauty, yellow-eyed grass, sundews (*Drosera* spp.), spikerush, dogfennel (*Eupatorium capillifolium*), gayfeather (*Liatris* spp.), butterworts, sedges, and beakrushes.

GROUP F: FLUCFCS 511 AND 520 (NATURAL STREAMS AND LAKES)

The 500 level FLUCFCS code corresponds to surface waters and for the purposes of this manual, includes linear water bodies such as streams and waterways (510) and extended, non-linear water bodies such as lakes (520).

511 – Natural Streams. This category includes non-man-made, linear water bodies with intermittent or perennial flow.

520 – Lakes. This category includes extensive inland water bodies, with the exception of reservoirs, and is further broken down based upon acreage of the lake.

PHOSPHATE MINING AND RECLAMATION PROCESS

This section describes the mining and reclamation process. It is important to understand the phosphate mining process so that the reclamation manager is familiar with the types of soil profiles found within reclaimed phosphate mine lands, as soils have a significant role in the hydrology and vegetative cover of a given area. The soil profile can affect plantings and natural vegetation recruitment within the different reclamation land uses. The phosphate mining process is generally described in three phases: excavation, beneficiation, and reclamation.

EXCAVATION

The phosphate ore (matrix) is typically located between 15-50 feet below land surface. The matrix is generally composed of phosphate rock, sand, and clay. The earthen materials found above the matrix are often referred to as overburden. The uppermost portion of the overburden where plant roots are found is soil (the upper layer of soil is termed topsoil and the lower is subsoil). To simplify, we will refer to topsoil and subsoil together as topsoil. Topsoil is of two types: upland soils and wetland muck soils. The mine operator first exposes the matrix by removing overburden, which is cast aside into "spoil" piles. The overburden is used to reclaim the landscape topography following mining. Prior to removing overburden to expose the matrix, the mine operator may remove the topsoil, often with the aid of scrapers. The mine operator may stockpile the topsoil for later use or move it directly to a reclamation site as a top-dressing and medium for plant establishment. The topsoil is also a source of plant propagules and microorganisms. Segal and others (2001) and Bissett and others (2000) describe studies of vegetation establishment utilizing the plant propagules contained in upland topsoil moved directly and spread on a reclaimed site.

The phosphate processing plants, or beneficiation plants, are often some distance from an active excavation area. The typical practice for the industry is to hydraulically transport the phosphate matrix via pipeline to one of the beneficiation plants for processing. Hydraulic transfer using water to slurry the matrix for pumping is the most economical method for materials management during all phases of the mining process. The mine operator excavates the matrix and places the material within an earthen sump, where a high pressure water stream is used to slurry the matrix for pumping to one of the beneficiation plants for processing.

BENEFICIATION

The beneficiation process separates the matrix into three main components: phosphate rock, sand, and clay. The mine operator first washes the clay from the matrix and sends it to large settling ponds (referred to as clay settling areas or CSAs). The remaining sand and phosphate rock are separated via a two stage froth flotation process (fatty acid reagent in one stage and amine reagent in the second stage). The phosphate rock is sent to a chemical processing plant and the sand is returned to backfill the mine cuts. A common reclamation practice is to backfill the mine cuts with sand tailings and then push the overburden from the spoil piles over the top of the sand (overburden capped sand tailings fill). This results in a landscape with areas of overburden only (where the spoil piles were located) interspersed with areas of sand tailings covered with a layer of overburden (where the mine cuts were). In some cases, the reclamation landscape may consist solely of regraded overburden, or a layer of sand tailings may be placed on top of the overburden, depending on the materials available or the hydrologic and reclamation goal. A practice that has become quite common in wetlands reclamation and is being used more frequently in upland reclamation is the application of topdressing of topsoil.

Phosphatic clay is most commonly sent as dilute slurry to a diked impoundment, known as a CSA, where it is allowed to settle and consolidate. Another approach has been to mix sand tailings with thickened clay dredged from a CSA and then to send the mixture to an impoundment to settle. As the clay or sand-clay mixture settles, the clarified water at the surface is recycled back to the beneficiation plant. After the CSA or sand-clay area is filled to capacity, the reclamation process begins with removal of the remaining surface water, followed by the process of crust formation. Evaporation of water promotes the development of a surface crust of consolidated clay. Crust development is further enhanced via a network of surface drainage ditches that connect to a larger rim ditch dug on the inside of the dike. The clay or sand-clay beneath the crust is initially quite soft and fluid, but gradually consolidates over many years. When the surface crust is sufficiently thick and strong to support heavy equipment and the clay or sand-clay has subsided somewhat through consolidation, the dike, which usually consists of overburden (and sometimes sand), is lowered by dozing the dike material both onto the clay adjacent to the dike and just outside the impoundment.

RECLAMATION

The reclamation process entails returning the disturbed landscape to a productive land use. The Industry uses the overburden and the materials separated from the phosphate matrix during the beneficiation process to reclaim the disturbed landscape. As described above, the excavation and beneficiation processes generate different soil materials. These soil materials are often referred to as reclamation media. Information on these materials as revegetation media can be found in Segal and others (2001), Mushinsky and others (1996 and 2001), Nair and others (2000), Bissett and others (2000), and FIPR unpublished.

Five types of soil materials have been used for reclamation:

1. Overburden – Overburden is the earthen material located above the matrix. Overburden is mostly sand, but also includes layers of clay. Some mixing occurs as the mine operator moves the overburden during the mining and

reclamation processes, producing materials that vary in texture. The resulting overburden contains more clay than the native sandy upland soils but is still mostly sand. Overburden soil textures as described by soil scientists may range from loamy sand to sandy loam or sometimes clay loam.

2. Topsoil – The upper portion of the overburden that contains plant roots is often referred to as topsoil and includes upland soils and wetland soils. The upland soils are mostly sandy in texture. The wetland topsoils are usually high in organic matter and are often referred to as muck.

3. Sand tailings – Sand tailings are sands separated during the flotation process.

4. Phosphatic clay – Phosphatic clays are the fine clay and other clay-sized minerals separated from the matrix during the washing process.

5. Phosphatic clay and sand mix – Some operators have remixed the phosphatic clay and tailing sands together to form a sand/clay mix.

The reclaimed landscape may have one or a combination of these soil materials as the growing medium for re-vegetation. Some older reclaimed excavation areas (mine cuts) may have been filled with phosphatic clay rather than sand. Also, sand tailings have been disposed in surface piles on some old mine sites. In more recent times, mine operators pump sand tailings to a completed mine excavation area to fill the mine cuts and either leave the sand tailings as the base reclamation medium or cover the sand tailings with overburden from the adjacent spoil piles. At other times, the mine operator may grade the overburden directly into the excavated area. The mine operator may choose to also back fill excavated areas with overburden and then pump sand tailings on top of the overburden if the reclamation plan calls for very sandy, well-drained upland surface soils or a highly permeable material in a wetland. Prior to mining an area, the higher quality upland soils from Florida native plant communities with little to no exotic and nuisance vegetation, may be transported immediately following excavation to an active reclamation area. This same practice has been done more commonly with wetland topsoil. These topsoils serve as sources of seed, rhizomes, soil microbes and organic matter, and their use has resulted in documented success in vegetating reclamation areas. The mine operators generally apply 3-12 inches of upland topsoil or 4-6 inches of wetland topsoil over a reclaimed area.

Native upland soils are usually mostly sand, with pH values often in the range of 5.0 to 5.6, while flatwoods soils often have pH values of about 4.3 to 4.9 (Mushinsky and others 1996 and 2001). Upland and flatland minesoils derived from overburden or overburden plus sand tailings are usually sandy, but have higher clay content than natural soils. The tailing sands themselves are mainly quartz with traces of phosphate minerals. The pH values for overburden or tailing sand are commonly in the range of 5.3 to 6.1 (see Nair and others 2000; also Mushinsky and others 1996 and 2001). The minesoils often have higher pH values and higher concentrations of calcium, potassium and phosphorus than native soils. Phosphatic clays have pH values initially near 7.5-8.0, but the values may reduce to 6.5-7.0 as the clays age and are modified by plants, water, etc. The phosphatic clays have a high water-holding capacity, high cation exchange capacity and are very high in phosphorus, potassium, calcium and other nutrients.

Topsoil management: Movement of topsoil directly from the area to be mined and spreading it on an area being reclaimed is better than stockpiling the topsoil for some length of time before use in reclamation. During the stockpiling period, viability of desirable plant propagules (seed, rhizomes, etc.) may be reduced, and the stockpile can become infested with weeds. The phosphate industry often places clean overburden over stockpiled topsoils to reduce encroachment by nuisance and exotic vegetation and also preserve the seed and vegetative propagule sources. The overburden cap may also become colonized by weeds but the cap is removed before the stockpiled topsoil is utilized. The organic matter in wetland muck soils may oxidize if stored above ground, so it has been suggested that wetland topsoil be stored where it can be kept wet – if it has to be stored, care should be taken to not allow rotting of propagules if kept too wet. If the topsoil donor site (or stockpile) is infested with weeds, movement of the topsoil will move weeds to the new reclamation site. Thus, a weed control program may be necessary at the donor site or the stockpile, perhaps even for an entire year prior to topsoil salvage from the donor site or before movement out of a stockpile. Similarly, movement of overburden spoil piles that are infested with weeds may spread weeds (we are especially concerned about spreading rhizomes of cogongrass, torpedograss, bermudagrass, etc.) throughout the reclaimed area. Revegetation through reapplication of topsoil is most successful when the topsoil is moved to the same hydrologic regime from which it came.

It has been observed by many and demonstrated by Segal and others (2001) that aggressive exotic and nuisance grasses and other weeds tend to be more problematic on soils or “minesoils” (‘minesoils” derived from overburden, etc.) with higher pH, higher clay content and higher fertility. Broadcast application of fertilizer is not generally recommended on reclaimed mine sites, especially if the goal is establishment of native vegetation communities. Fertilizer may be appropriate for sites used in agriculture, commercial forestry, and pastures where plant productivity is a goal. However, the added fertility may require additional weed control measures commonly used in commercial agriculture and forestry.

VEGETATION-BASED MANAGEMENT METHODS

The reclamation manager should prepare the site to create as weed-free an environment as practical, which greatly aids in the survival of planted vegetation and reduces later weed control efforts. Thorough site preparation is needed prior to planting. Whenever possible, invasive weeds, especially the aggressive invasive rhizomatous grasses such as cogongrass, should be controlled on the site, even before grading and contouring, to prevent inadvertent spreading and replanting of rhizomes and other propagules. Consideration should also be given to controlling weeds, especially the most troublesome ones, in surrounding areas to reduce weed infestation from off site. The surrounding area could be a source of weed seeds that may move by wind, water, gravity, wildlife or human (including vehicular) traffic. Soil clinging to equipment may also be sources of weed seed or rhizomes. Vehicles and implements should be cleaned to minimize transport of weed propagules to the planting area from off site. Topsoil intentionally moved to a site may also contain weed propagules, so consideration should be given to controlling weeds on a topsoil donor site before removal of the soil. Following recontouring, further tillage may be needed to reduce compaction (important for tree establishment and growth) and to prepare a seed bed. If there is a time lag between recontouring the site and planting, then weed establishment, reproduction and spread should be curtailed through planting of cover crops, tillage and perhaps herbicide application to any aggressive perennial weeds.

Using topsoil as a natural propagule (seed, rhizomes, etc.) source for establishing vegetation communities on reclaimed phosphate mine lands has been mentioned in a previous section. Vegetation is also established from seed, cuttings, or containerized or bare root planting stock. Planting plans depend on the vegetation community that is to be established, the availability of planting material, legal/regulatory requirements, and the hydrologic and soil conditions on any given site. The foremost key to successful plant establishment is adequate soil moisture–avoiding drought or flooding. Other considerations include: topography; erosion control (the need for mulch or cover crops); the type and size of the plant material; density of planting; timing of planting; and the availability of and need for irrigation. The success of a planting is enhanced by choosing the right plant for the right location and planting at the right time.

SEEDING

The industry has employed direct seeding for erosion control and native vegetative restoration where practical. Reclamation construction managers often seed browntop millet (*Urochloa ramosa*, also known as *Brachiaria ramosa*) in the warm season and ryegrass (*Lolium perenne*) in the cool season as temporary cover crops to control erosion and suppress weeds (refer to Appendix B for seeding rates). Some have shortened the names to “millet” and “rye,” which has occasionally led to confusion and planting of grain-type millet or cereal rye. The grain crops of millet and rye are generally too tall, robust and competitive, compared to browntop millet and ryegrass. Cover crops can be competitive weeds, so a balance must be struck between their erosion control value and their competition during initial establishment of the desired plant community. Non-native perennial pasture grasses, such as bahiagrass, have been used extensively in reclamation in the past because of seed availability, but more emphasis is being placed on seeding and planting native species. Direct seeding for native vegetation restoration has been done successfully with advanced planning (including burning of donor sites to encourage seed production) and follow-up management, but the practice has been hampered by a shortage of commercial seed sources.

The industry and various contractors purchase available native plant seed and also collect seed from native habitats on their own lands or lands managed by private or public cooperators. Seed is collected by hand or by mechanical means. Two mechanical devices for collecting seed are used: the green silage cutter and the Flail Vac harvester. The green silage cutter harvests the entire tops of the plants to produce seed-laden hay. The material is air dried like hay and is spread by a hay blower and pressed into the soil with a cultipacker roller, or it can be planted with a sprigger and cultipacker roller. The Flail Vac harvester removes seed with a large rotating brush (as on a street sweeper), and the seed is collect in a bin. The seed is planted with a seed drill equipped with a "trashy or fluffy" seed box (mechanical stirring provided to keep the fluffy seed flowing). Collection times are the most critical components to harvesting and vary depending upon the species type. Direct seeding is usually conducted in central Florida soon after harvesting, from the middle of November through the end of January. Seeding has also been done successfully just prior to, or at the beginning of, the summer rainy season, but this approach requires longer seed storage time. See Pfaff and Maura (2002), Bissett (2006), and Dwyer and others (2010) for guidance on direct seeding of native ground cover vegetation for rangelands, prairies, flatwoods, etc.

MULCHING

Mulch (dead plant material spread on the soil surface) has value for erosion control, for weed control, and for conservation of soil moisture. Sources of mulch could include chipped trees and brush from clearing operations prior to mining or from yard waste, dried grass (hay) and straw, or an annual cover crop that has matured. Hay, straw, and yard waste may contain weed seeds, so it is important to know your source and try to obtain weed-free material. An instance when we found a grain cover crop could be advantageous as a mulch was when winter rye was planted in the late fall or early winter and allowed to mature before trees were planted in the following summer wet season. The abundant dead straw provided a good mulch, which aided in weed suppression and holding of soil moisture. It is preferred that the cover crop in this application not produce seeds, which can be accomplished by planting a sterile hybrid grain crop or herbiciding the cover crop prior to seed set. Some plants naturally do not set seed if flowering occurs during hot weather (such as in Florida summers) or in very dry weather (such as in mid to late springtime in central and southern Florida). When seed-laden hay collected from a native site with a silage cutter is planted, the hay in the mixture acts as mulch.

WETLAND SOD

The phosphate industry uses wetland sod when available. Prior to mining an area, the reclamation manager harvests the top few inches of soil and vegetation from a wetland that is scheduled to be disturbed. The phosphate industry has had success using this technique, and it can provide rapid growth and establishment of desirable plants and limit encroachment of nuisance and exotic species. The practice is most successful when the sod is moved directly from the donor site to the site to be reclaimed. Wetland sod infested with nuisance and exotic vegetation should not be used.

PLANTING

The industry installs both herbaceous and woody plants (trees and shrubs). Appendix B includes lists of species planted in each land use; these lists are not all inclusive. The type of material installed varies in size. Table 1 provides a list of the types of planting material generally installed by the industry.

Table 1. Planting Material Types.

Plant Type	Material Type
Herbaceous	Cuttings, bare root, liners, tubelings, and one gallon
Trees and shrubs	Bare root, tubelings, one gallon, three gallon, and even cuttings in moist areas (e.g., willow “whips”)

Vegetation is often planted in a manner to somewhat mimic the species diversity, spacing and distribution of plants (semi-random or occasionally clumped) in a native habitat. Initial planting densities need to compensate for expected mortality, although supplemental planting may sometimes be required. Both hand planting and mechanical planting of smaller tubeling container stock or bare root stock have been done. Mechanical planting requires soil moisture and terrain conditions suitable for tractors and has the disadvantage of creating rows of plants, whereas hand planting can be done in more difficult terrain and can result in more random spacing of plants. Table 2 provides a list of the planting densities based upon the spacing arrangements used during installation.

Table 2 summarizes the range of planting densities for both uplands and wetlands as provided by in the industry or as described in the CRP’s and other authorizations reviewed for this manual. Table 3 provides the range of quantities of plant materials in various planting plans. In some cases, the reclamation manager may not plant herbaceous materials when natural recruitment is expected.

The most important factors for successful tree establishment and survival are adequate soil moisture and development of an adequate root system that will facilitate absorption of moisture and nutrients. For example, planting upland sandy sites in central Florida during or just prior to the generally dry period of March, April and May is risky.

An adequate root system to supply sufficient water and nutrients to the top is especially important for container grown trees planted in uplands. In wetlands, a taller tree that can keep a portion of its top above water during a flood is often important. Taller trees may also be more competitive with tall weeds.

Table 2. Planting Spacing and Quantities.

Plant Type	Spacing Distances	Plants/Acre
Herbaceous	5'	1742
	3'	4840
	2'	10480
Shrubs	30'	50
	20'	100
	15'	200
	12'	300
	10'	400
Trees	20'	100
	17'	150
	15'	200
	12'	300
	10'	400
	9'	500
	8.5'	600
	7’	889
	6.6’	1,000

Additional factors for successful tree establishment include ameliorating soil compaction through soil ripping, using tree-compatible ground cover (legumes vs. grasses, bunch vs. rhizomatous grasses, short vs. tall cover crops), herbicides to control weeds, mulch (winter rye planted in fall, trees planted into dead rye straw in summer rainy season), season of planting (wet season vs. dry season–soil moisture issues), adequate tree density. The quality, condition and size of the planting stock are important; old, root-bound trees do poorly.

Research in Florida, the eastern U.S. and Midwest has identified factors important to the establishment, survival and growth of trees on mined lands. Those factors include: prevention or amelioration of soil compaction; tree compatible ground covers; herbicides to control competitive weeds, especially during the early establishment phase; season of planting to take maximum advantage of favorable moisture conditions; adequate tree density; the quality, type and size of planting stock; and soil fertility management. Minesoils (soils developed from overburden, overburden plus sand tailings, or phosphatic clay) or natural soils that contain some clay may become compacted by heavy equipment. Compacted soils inhibit root growth, are difficult to plant into, and may have reduced water infiltration rates and greater runoff. Compaction can be ameliorated by soil ripping and prevented by minimizing heavy equipment traffic over the soil, especially when wet. Any plants growing adjacent to young trees will tend to inhibit tree growth, but some type of ground cover is needed for erosion control. Soil roughness (contour furrows, pitting, imprinting, etc.) and use of mulch can also help control erosion. In mine reclamation research in the Midwest and Appalachian region, legumes were found to be less competitive to young trees than grasses, bunch grasses were generally less competitive than rhizomatous grasses, and short vegetation was generally less competitive than tall vegetation. However, in central Florida, FIPR Institute research found in one study that tall saltbush was more detrimental to tree growth than bermudagrass, and in another study that hairy indigo (*Indigofera hirsuta*), dogfennel (*Eupatorium capillifolium*), and saltbush were nearly as detrimental to tree growth as was cogongrass.

Table 3. Planting Densities Described in the Industry CRPs and Other Authorizations.

Habitat Type	Trees Per Acre	Shrubs Per Acre	Herbaceous Per Acre	Seeding Per Acre
211				30-40 lbs
213	150-350	100-300		30-40 lbs
320		100-300		30-40 lbs
321		100-300		30-40 lbs
330		100-300		30-40 lbs
411	100-200	100		30-40 lbs
414	200-400	100-200		30-40 lbs
420	300-600	100-300		30-40 lbs
421	300-600	100-300		30-40 lbs
425	300-600	100-300		30-40 lbs
427	300-600	100-300		30-40 lbs
430	300-600	100-300		30-40 lbs
434	300-600	100-300		30-40 lbs
438	300-600	100-300		30-40 lbs
610	500-600	50-100	1742-10890	
611	400-600	50-200	1742-4840	
615	400-600	50-200	1742-4840	
617	400-600	50-200	1742-4840	
620	400-500	50-400	1742-4840	
621	400-600	50-200	1742-4840	
625	400-600	50-200	1742-4840	
630	400-500	50-400	1742-4840	
631	400-500	50-400	1742-4840	
640		100-200	1742-10890	
641			1742-10890	
6417		50-900	1742-10890	
643			1742-10890	
646			1742-10890	

KEY MANAGEMENT PRACTICES

We have identified several key best management practices that have contributed to successful native plant restoration projects:

- Site preparation to create as weed-free an environment as practical greatly aids survival of planted vegetation and reduces later weed control efforts. Thorough site preparation is needed prior to planting. Whenever possible, the reclamation manager should control invasive weeds on the site and the surrounding area before grading/contouring and planting. Weeds, especially the most troublesome ones, should also be controlled in surrounding areas to reduce weed infestation from off site. The purpose is to prevent, or at least minimize, the spreading of live rhizomes (underground stems) and other propagules onto or throughout the site to be planted. The surrounding area could be a source of weed seeds that may move by wind, water, gravity, wildlife or human (including vehicular) traffic. Vehicles and implements should be cleaned to minimize transport of weed propagules to the planting area from off site.
- Begin weed control efforts early and repeat as inspection reports indicate the necessity. The old adage, "an ounce of prevention is worth a pound of cure," applies here. This applies to weed control before and after planting and weed management on soil stockpiles and donor areas. Effective inspections and treatment require good plant identification skills.
- Competition from desired plants is an important aspect of controlling invasive and nuisance plants. A dense tree canopy will effectively control cogongrass and many other weeds. A wetland tree canopy will control primrose willow. Higher density herbaceous and shrub plantings compete better against exotic and nuisance species and may be more cost-effective than lower density plantings because of the often greater need for more herbicide treatment with lower density plantings.
- The size, type, root-shoot ratio, condition of transplanting stock, and site conditions need to be considered. Adequate root to shoot ratio and even the shape (especially depth) of the root system is important in uplands. Bare root, tubeling, and one gallon upland shrubs and trees have been more successful in upland restoration than three gallon sizes. Better establishment in uplands has been found using "sack" trees, which have a deeper root system, than "gallon" trees, which have the same root volume, but lesser root depth. Container-grown plants whose roots have just filled the pots (so the root ball doesn't fall apart), but have not become root bound and deformed, establish and grow better than old pot bound plants. Deep ripping to reduce soil compaction and planting in a season with adequate soil moisture and lower evapotranspiration potential are other important factors that enhance tree and shrub planting success. In wetlands, using tall enough planting stock to avoid extended submergence is important. Larger transplants, including three gallon stock have done well in wetlands, but planting smaller bare root or container stock has been successful in wetlands if the tops remained above water (or

submergence was minimal). Appropriate water management in wetlands will help avoid excess flooding or drought.

- For fire-adapted habitats, plant fire-carrying herbaceous understory first. Weed control is much easier without trees and can be handled with mechanized sprayers. After herbaceous cover is established and weeds are under control, then plant trees. However, the herbaceous plants can compete with trees, and application of mulch or spot treatment of vegetation with glyphosate or other appropriate herbicide around the base of each tree will promote tree survival and growth.
- For establishing a densely forested habitat, an argument could be made for planting an annual cover crop, or using mulch to control erosion, and planting trees at high density as soon as feasible. The idea is to promote rapid canopy closure and let shade and root competition from the trees control the weeds. Any early weed control efforts would be aimed at reducing weed competition to promote tree survival and growth. Shade-tolerant understory could be planted after the tree canopy has developed.
- Supplemental planting is desirable in bare areas and areas where exotic and nuisance species treatment or removal has occurred. This practice reduces the regrowth or reinvasion of the exotic and nuisance species. Additional time may be necessary following treatment with certain herbicides to allow for soil activity to diminish to levels tolerated by the planted material. Also, it makes sense to be sure perennial weeds are really dead before supplemental planting in treated areas.
- Maidencane, a rhizomatous grass, provides competition for torpedograss and cogongrass in mesic to wet areas. Densely planted bunch grasses, such as eastern gamagrass (*Tripsacum dactyloides*), sand cordgrass, and muhlygrass (*Muhlenbergia capillaris*) are good competitive species for use in both uplands and around wetlands. Beaked panicum (*Panicum anceps*) and splitbeard bluestem (*Andropogon ternarius*) provide competition to natalgrass and other upland weeds. Blue maidencane (*Aphicarpum muhlenbergiana*) is a rhizomatous native grass for use in mesic areas. Broadleaf plants coupled with a grass herbicide such as fluazifop (Fusilade) can be used to control grasses, and broadleaf herbicides (triclopyr, 2,4-D) can be coupled with grasses for broadleaf weed control.

This manual is aimed particularly at managing invasive and nuisance plants. Prevention is often easier than later control measures. It is easier to control weeds in simple plant communities than in more complex, multiple-species communities. In some cases, it may be desirable to emphasize ground cover establishment before planting trees. Cover crops are often planted to help control erosion and inhibit colonization of weeds; however, the cover crops themselves can compete with desirable vegetation, so mulches and surface roughness might also be considered, especially on flatter ground. For relatively dense forest establishment, consider a tree-compatible (less competitive) cover crop or use mulch and surface roughness.

PHYSICAL AND MECHANICAL MANAGEMENT METHODS

Land management for exotic and nuisance vegetation includes physical and mechanical methods. The land manager can use these techniques in combination with herbicide treatments. This section describes what physical and mechanical methods are generally used in exotic and nuisance species management.

MANUAL METHODS

Manual removal of exotic and nuisance vegetation is generally done by hand or using small tools (e.g., weed wrench). Manual removal is labor intensive, but often is an integral component of an exotic and nuisance species management program. This technique is best used for small infestations and in situations where exotic and nuisance species are intermixed with desirable species. Land managers also employ manual removal when there are concerns with herbicides causing harm to non-target plants.

Some plants are difficult to remove by hand, and parts of the root system may be left behind or parts of the stems can break off and sprout. Manual removal can also cause the spreading of viable seeds, so care should be taken when moving this material around a management area. Some species, if left lying on the ground, can re-root after being removed. Many times, the land manager will need to remove all the plant material from a management area or pile the material within one area to monitor for regrowth. The land manager should limit the disturbance to the soils as this can increase the germination and spread of exotic and nuisance species.

MECHANICAL METHODS

Mechanical methods to remove exotic and nuisance vegetation include the use of heavy machinery (e.g., mowers and bulldozer). Land managers use logging equipment to cut and remove large exotic and nuisance woody species. Bulldozers scrape away exotic and nuisance vegetation and sometimes remove the upper soil layer when there is concern for an undesirable vegetation seed source in the upper soil profile. Mowing can be effective at reducing the cover of some exotic and nuisance plants; however, many species are stimulated to grow when cut and often require a follow-up herbicide treatment after mowing. Mowing is not as good as burning as a pre-treatment for herbicide treatment of plant regrowth because of the thatch left after mowing. Vehicles and machinery are potential vectors for moving weed seeds, rhizomes, etc., from infested areas to other sites and should be cleaned thoroughly.

Land managers use chainsaws to cut down nuisance species and often combine this method with herbicide treatments (cut-stump herbicide treatment).

Aquatic species management is often conducted using heavy machinery: cutter boats, shredding boats, rotovators, dredges, and harvesting equipment. Mechanical removal is not entirely effective because the equipment often leaves the roots and other plant parts behind.

TILLING/DISKING/RIPPING

Tilling/disking/ripping is used during site preparation especially when seeding. A reclamation manager may rip the soil to reduce soil compaction prior to planting trees. Tilling and disking is used to control many exotic and nuisance species as well, but should be limited due to the potential to release and cause germination of additional exotic and nuisance species. Repeated tillage can help manage exotic and nuisance vegetation by exposing the plants rhizomes to the atmosphere where they can be desiccated. Tillage also acts to starve the plants as rhizome or root reserves are depleted through regrowth of tops while not allowing sufficient leaf area to replenish rhizome or root reserves via photosynthesis. Disking cuts rhizomes into smaller pieces, which promotes sprouting of dormant rhizome buds and thus increases the ratio of leaf area to rhizome for potentially greater translocation of herbicide to the rhizome. Tilling to promote desiccation of roots and rhizomes is best accomplished during dry periods.

The chisel plow is probably the most cost effective implement for separating rhizomes from the soil and bringing them to the surface to desiccate. The rototiller is the next most effective implement, followed by the disk plow. A moldboard or turning plow tends to bury the rhizomes again.

WATER LEVEL CONTROL

Water level control is a management tool used in wetland restoration to reduce the encroachment of many exotic and nuisance species. Water levels can be either increased or decreased. It is essential to ensure wetlands have appropriate water levels, as extensive dry conditions in reclaimed wetlands has led to increased exotic and nuisance species cover. A reclamation manager may choose to lower the water levels in a wetland to allow easier access for applying selective herbicides and/or mowing to manage cattail or other nuisance and exotic species. The reclamation manager may also flood an area during extensive drought conditions when feasible. Flooding can reduce the encroachment of upland and transitional exotic and nuisance species known to recruit in reclaimed wetlands during dry periods, but care should be taken as wetland nuisance and exotic species can recruit as well.

PRESCRIBED FIRE

Fire is a force that has molded natural plant communities in Florida and is a tool often recommended for managing vegetation communities. Fire can be used to control exotic and nuisance species (especially woody vegetation), but some exotic and nuisance species thrive after fire (especially grasses). Most often land managers use fire to remove the exotic and nuisance species biomass, and then treat the regrowth with herbicides. Fire management must be conducted by a certified burn manager for notable safety concerns. Reclamation managers conduct site wide burns and also smaller spot burns. Fire, in addition to water level management, can be used to control woody vegetation and maintain marshes.

CHEMICAL CONTROL FOR WEED MANAGEMENT

This section summarizes general information on herbicides and their use in controlling weeds (exotic and native nuisance plant species). Information is provided on chemicals commonly used in weed management on reclaimed mined lands, natural areas, forests, rangelands and pastures, but also on some potentially useful chemicals tested experimentally. Information is also provided on selective control, application methods, calibration of sprayers, use of adjuvants (e.g., surfactant additives), and information on herbicide use in various vegetation communities. Additional information on controlling specific weeds is found in the section on Management of Specific Exotic and Nuisance Plants and in the References list.

HERBICIDE APPLICATION METHODS AND CALIBRATION

Herbicides may be broadcast over larger areas or applied as spot treatments. Broadcast treatments are often applied with a boom sprayer (e.g., several fan type nozzles attached to a bar) or with a so-called "boomless" sprayer that has one to three nozzles that may point upward at an angle and spray a wide area. The boom sprayer provides a more even spray pattern and can be adapted for more precise application rates required in research and in commercial agriculture. The boom sprayer attached to a tractor or ATV can be used on rangelands, pastures or new reclamation sites where all vegetation is relatively short, but a boom sprayer is difficult to use where there are trees or brush. The "boomless" sprayer on an ATV can be used more easily in brushy areas. Spot treatments may be applied by a backpack or a mechanized sprayer with a "wand" or "gun" that has a single nozzle. Spot treatments may be applied to foliage or stems. Stem treatments include basal stem treatment, "hack and squirt" and cut stem. Herbicides may be applied to foliage via wiping with wet gloves or other hand-held devices, or with a "ropewick" or similar type device mounted on a tractor or ATV.

Broadcast sprayers are calibrated based on width of spray swath, rate of flow and vehicle speed to determine the volume of liquid applied per acre. The amount of herbicide applied per acre is then determined by the amount of herbicide added to a given volume of water plus herbicide in the spray tank. When spot spraying with a backpack sprayer, an applicator commonly mixes an herbicide in the spray tank on a percentage basis or as fluid ounces (or ml) of a liquid herbicide per gallon of water. It is desirable that an applicator with a backpack sprayer also calibrate himself or herself through determining the volume of water applied to a given area. It is not uncommon to apply about one gallon per 1000 square feet, but this can vary depending on the height of the vegetation (amount of leaf area to be covered) and degree of wetness produced. A dye added to the spray solution can aid in making an even application, in determining areas hit or missed and in gauging the application rate by the degree of color intensity of the dye on the foliage.

Woody plants can be treated by basal bark application, by the hack and squirt method or by cut stump application. Basal bark application usually employs an ester formulation of an herbicide at fairly high concentration in oil sprayed on the entire circumference of the lower foot or so of a green stem or a stem with relatively thin bark. Larger stems with thicker bark may require the hack and squirt method, which involves making several cuts through the bark and into the sapwood with an axe or machete and squirting a fairly concentrated aqueous solution of the herbicide (water soluble amine herbicide formulations work fine) into the cuts. The herbicide is translocated through the xylem (sap wood) to the foliage and through the phloem (in the inner bark) to the roots. Complete girdling of the stem is not absolutely necessary but it helps with larger trees. In the event a tree or large shrub is cut down, the herbicide solution can be applied immediately to the outer ring of the cut stump to make contact with the cambium and phloem to promote translocation of the herbicide to the roots to prevent resprouting of the plant.

In addition to herbicides applied to foliage and stems (post-emergent), others are applied to the soil to kill germinating seeds or seedlings (pre-emergent). Some pre-emergent herbicides, such as pendimethalin or oryzalin, have little to no activity on emerged plants, but other herbicides, such as imazapyr, hexazinone and aminopyralid, have soil and foliar activity (they are post-emergent and pre-emergent herbicides). Pre-emergent herbicides need rain or irrigation to wash them into the soil to be effective. Pre-emergent herbicides can be used effectively to prevent annual weed infestation from seed if applied to bare soil immediately or shortly after a rainy season burn, while allowing established perennials to resprout and expand. Pendimethalin (Pendulum) or oryzalin (Surflan) and certain other pre-emergent herbicides can be sprayed over the top of newly planted perennials transplanted into bare or nearly bare ground.

ADDITIVES/ADJUVANTS AND HERBICIDE MIXTURES

Most post-emergent (foliar) applied herbicides require addition of a nonionic surfactant (NIS, usually 0.3-0.5%) or methylated seed oil (MSO, usually 1.0%) or other combination of nonphytotoxic oil and surfactant. Some additives include silicone compounds that promote spreading on the leaf surface and also quicker drying (quicker drying increases "rain-fastness" [resistance to being washed off by rain], but too rapid drying may reduce uptake). See herbicide label for specific requirements and recommendations. For example, addition of NIS or MSO is recommended for most uses with Arsenal but not when spraying over the top of pines. NIS or MSO increases herbicide uptake and thereby increases effectiveness in killing weeds but may also reduce the selectivity of the herbicide, thus increasing injury to otherwise tolerant plants.

The effects of urea ammonium nitrate (UAN), ammonium sulfate (AMS), and various other water conditioners, on herbicide uptake and preventing herbicide deactivation (e.g., hard water effects on glyphosate) are more important when optimizing effectiveness of lower rates of herbicide (especially glyphosate). They are less important if consistently higher herbicide rates are used. This also generally applies to use of nonionic surfactants (NIS) versus methylated seed oils (MSO) or crop oil concentrates (COC). At 0.75 lb or more of imazapyr or 4.0 lb or more of glyphosate per acre, we generally have seen very little or no differences in the effects of the adjuvants, even with our hard water. We have occasionally observed greater effects with MSO than with NIS under suboptimal environmental and plant physiological conditions, but mostly the NIS additive has been sufficient for foliar applied herbicides. MSO or other oil or penetration enhancing adjuvant may be useful in enhancing herbicide uptake by plants with thick waxy coatings on their leaves.

Clean water should be used for applying herbicides. Clays or organic matter can cause adsorption and deactivation of some herbicides. Even clean water can affect the performance of some herbicides. For example, glyphosate activity is reported to be best from pH 3.5 to 5.0 but can be reduced in hard, alkaline water (containing CA, Mg, Fe, with pH greater than 7.0). FIPR Institute tests using Bartow city water, with a pH of 7.5, produced a pH value of 4.5 when 3 qt AquaStar (a generic glyphosate similar to Rodeo) were mixed with 20 to 25 gallons of water, and produced a pH value of 6.7 when 1.5 qt Arsenal (imazapyr) were mixed in the same way. Addition of a product containing a pH buffer plus ammonium sulfate (to counteract effects of high pH and hard water minerals) at 0.5% to the water before adding the herbicides resulted in AquaStar mixtures with a pH of 4.0 and Arsenal mixtures with a pH of 4.3. Addition of the water conditioning product to AquaStar or Arsenal solutions had no effect on cogongrass control, compared to the herbicides without the water conditioner. We suspect that any deactivation of glyphosate in hard water may be less of a factor at the high rates or concentrations used for cogongrass control (4-5 lb glyphosate [3-3.3 qt AquaStar] per acre), plus the herbicide formulation alone may have a pH buffering effect without a water conditioning additive.

Mixtures of herbicides are sometimes recommended to give a broader spectrum of weed control. Care must be taken in mixing the chemicals according to herbicide label instructions to avoid possible problems from chemical reactions or physical incompatibility of various formulations. Another thing to consider with herbicide mixtures is that the broader spectrum of weed control also means reduced selectivity.

HERBICIDE RESISTANCE

The use of glyphosate year after year on annual weeds on agricultural croplands has resulted in the development of glyphosate resistant populations in some annual weed species (see Alder 2011, for example, cited below). This has come about as the repeated use of only one herbicide has created a selection pressure that favored survival and reproduction of individuals within the original population that had natural resistance to the herbicide. It is more likely to occur on croplands than on reclaimed or natural areas, but caution is warranted. Glyphosate resistance (or resistance to any other herbicide) can be prevented by rotating the use of herbicides (i.e., killing the resistant weeds with an herbicide with a different mode of action). Another approach is to use a mixture of herbicides with different modes of action. The problem in reclaimed and natural areas is finding an herbicide that can effectively substitute for glyphosate, particularly with regard to glyphosate's characteristic of minimal to no soil activity, which is valuable for directed application to weeds beneath trees without the worry of root uptake by the trees. Herbicides with no soil activity include fluazifop (somewhat effective on actively growing annual and perennial grasses with little to no activity on broadleaved plants) and diquat (a non selective contact herbicide that is effective on many annual plants).

Alder J. 2011. The growing menace from superweeds. Scientific American 304(5): 74-9.

SELECTIVE CONTROL

Selective control involves killing the target weed(s) without killing or severely injuring other desired plants in the plant community. Many selective herbicides have been developed for crops that control certain weeds but have little or no effect on the crop because of tolerance of the particular crop plant to a specific herbicide. Selective control of weeds in a mixed native plant community is more complicated than selective control in an agricultural crop, because the latter depends on tolerance of a single plant species or genotype to an herbicide, whereas tolerance of several species to an herbicide is required in a mixed native species plant community. Nevertheless, means to selectively control certain weeds in mixed species native plant communities have been developed. Several factors that influence selective control are listed below:

- Plant species/genotype
- Chemical type
- Additives (e.g., surfactants)
- Rate
- Timing (season or growth stage)
- Directed application (include ropewick)

The most common method of selective chemical weed control is through directed application, i.e., hitting the target weed while trying to miss the desirable plants. This includes basal bark application or "hack and squirt" methods, carefully pointing a narrow spray stream at the target weed, or "ropewick" (or variations, which take advantage of height differences in vegetation—taller vegetation receives herbicide while shorter vegetation does not). Herbicides may even be wiped on leaves with a sponge or a saturated cotton glove worn over a rubber glove. Other selective chemical techniques take advantage of differences in tolerance of various plants to certain herbicides. Those tolerance differences include differences in uptake of the chemical and metabolic mechanisms to detoxify the chemical. Uptake affects the dose of the herbicide received internally by the plant and can be affected by surfactants and the season or growth stage of the plant. Selectivity is usually greater at lower application rates. Some herbicides, such as imazapyr, may kill nearly all plants at higher rates of application, but at lower rates of application, imazapyr selectively kills or severely injures certain plant species (e.g., cogongrass) while other species exhibit some tolerance. Plants that are dormant (or nearly so) are likely to be less susceptible to herbicides than plants that are metabolically active (making possible the selective control of metabolically active torpedograss or cogongrass in stands of dormant maidencane). Plants with fully expanded leaves or that have set resting buds are usually more tolerant than plants with new growth. Surfactants and crop oils help increase herbicide uptake and thus may reduce selectivity. For example, although pines have some tolerance to imazapyr, surfactants are not recommended when imazapyr is sprayed over the top of pines. Plants that have some tolerance to an herbicide may still be injured slightly, such as exhibiting some temporary stunting or minor foliar symptoms. Thus, “herbicide tolerance” is a relative term; tolerant plants are less susceptible to an herbicide than a non-tolerant plant.

Broadleaf herbicides, such as aminopyralid, clopyralid, fluroxypyr, triclopyr, and 2,4-D, kill or injure many broadleaved plants, while many grasses are tolerant. Aminopyralid and clopyralid have more activity on plants of the legume, composite and nightshade families than on other broadleaved species. Grass herbicides, such as fluazifop, clethodim, and sethoxydim, kill or injure many grasses with little to no injury to most broadleaved plants. Imazapyr, imazapic, imazamox, metsulfuron, sulfometuron, and hexazinone also can be used to selectively control certain plant species with minimal injury to certain other species (see herbicide labels, other sections of this report, and other publications for further information on selective uses and precautions with these herbicides).

PLANT IDENTIFICATION

An important aspect of selective control of weeds is proper and careful identification of exotic and nuisance plants and also desirable native plants at various growth stages. Some plant genera include both native and exotic species. Some desirable native plants may somewhat resemble exotic and nuisance plants, so appropriate training and closer inspection may be required to avoid killing the desirable plants along with undesirable plants, particularly when using directed spray (“point and squirt”) applications. See the first portion of the References section for a list of useful plant identification publications and websites.

VEGETATION COMMUNITIES

Pastures

Dense infestations of cogongrass or other weeds that have little or no desirable plant species within the patch that are worth saving, probably should be spot-sprayed with a high rate of imazapyr or glyphosate. Larger areas should be broadcast sprayed with a higher rate of imazapyr or glyphosate. If the weed infestation is less dense and there are desirable plant species worth saving, lower rates of selective herbicides can be used. Cogongrass can be selectively controlled with 12 fluid oz Arsenal or Habitat/acre broadcast sprayed in a Bahiagrass pasture in the late fall or early winter. Bermudagrass has greater tolerance to imazapyr, so 16 fluid oz Habitat/acre can be used for cogongrass control in bermudagrass in the fall. Broadleaf weeds can be controlled with triclopyr and several other broadleaf herbicides (2,4-D, fluroxypyr, aminopyralid) during the growing season. However, higher rates of triclopyr may injure bermudagrass. Smutgrass and natalgrass can be controlled with 1.0 to 1.5 qt Velpar L/acre during the rainy season. Injury to limpograss (*Hemarthria altissima*) has been reported with 2,4-D.

Native Rangelands, Prairies

Cogongrass can be selectively controlled by broadcast spraying 16 oz Arsenal or Habitat/acre. Wiregrass, beardgrasses, many composites (*Pityopsis, Liatris, Helianthus,* etc.), many legumes (*Lupinus, Desmodium,* etc.), and pines are tolerant of that rate of Arsenal or Habitat applied in the fall. Smutgrass and natalgrass can be controlled with 1.0 to 1.5 qt Velpar L/acre during the rainy season. Wiregrass, beardgrasses and pines have some tolerance to 1.0 to 1.5 qt Velpar L/acre, but many broadleaf plants will be injured. Seedling or very young natalgrass and bahiagrass can be selectively killed with 12 oz Plateau/acre or 12 to 16 oz Arsenal or Habitat/acre. Wiregrass, beardgrasses, many composites (*Pityopsis, Liatris, Helianthus, etc.*), and many legumes (*Lupinus, Desmodium*, etc.) are generally tolerant of Plateau, although they may exhibit some initial stunting. Lopsided indiangrass is quite susceptible to Plateau.

Pine Forests

Pines tolerate lower rates of imazapyr and also metsulfuron, sulfometuron, and hexazinone. The labels for Arsenal AC, Escort, Oust and Velpar L give much useful information on use of theses herbicides on loblolly, slash and longleaf pines. Pines are most tolerant of these herbicides after buds have set in the late summer and fall, although lower rates can be applied over the top of pines in the growing season in some cases (see labels for details). Pines can also be planted into sites treated with imazapyr (see Arsenal AC and Chopper labels). Fluazifop (Fusilade DX) can be used for grasses in young pine plantings. Vista (fluroxypyr) can be sprayed on broadleaved plants beneath pines (do not spray pine foliage, except after resting buds have been set in the fall). Milestone (aminopyralid) can be spot sprayed under pines but not on foliage. Glyphosate can also be used as a directed spray treatment under pines.

Oak, Broadleaf-Dominated Upland Forests

Container grown oaks can be planted in summer following site preparation treatment with imazapyr the previous fall. Otherwise, it is not safe to use imazapyr around oak and many other broadleaf trees. Fusilade (fluazifop-p-butyl) can be used safely to kill young and actively growing grasses without injury to broadleaved herbaceous and woody plants. Foliar application of Clearcast (imazamox) can be used to selectively control Brazilian pepper, Chinese tallow, chinaberry, and camphor tree (many desired tree species are tolerant). Research on plantations indicate that Goal (oxyfluorfen) can be sprayed over the top of young oaks and some other tree species to control a variety of herbaceous weeds (see Goal 2XL label—has pre-emergent plus some contact foliar activity on herbaceous weeds, several tree species are tolerant). Oust XP (sulfometuron) can be applied at 3-5 oz/acre prior to planting or 1-4 oz/acre after planting sycamore, ash, bald cypress, oaks, red maple and sweetgum, but before the trees break dormancy (prior to bud swell). Pendulum (pendimethalin) and Surflan (oryzalin) can be used for pre-emergent weed control in new plantings of many tree species. A dense canopy of oaks, wax myrtle or mixed plantings of various evergreen or deciduous broadleaf trees will control many sun requiring weeds, so increasing the density of planting to promote more rapid canopy closure is an important non-chemical means of weed management. Vine control is addressed in the section on Management of Specific Exotic and Nuisance Plants.

Herbaceous Wetlands

The following herbicides are used for emergent wetland species: glyphosate, imazapyr, triclopyr, imazamox, 2,4-D, diquat, and, for seasonally dry wetlands, aminopyralid. Formulations differ, so check label for aquatic use. FIPR Institute research has shown that Fusilade (fluazifop) can be used to selectively control torpedograss without injury to broadleaved herbaceous or woody plants; however, Fusilade labels do not currently permit application to wetlands because of possible effects on aquatic organisms. The environmental risk or safety of using fluazifop to control torpedograss in wetlands (particularly in seasonally dry wetlands or wetlands with no standing water) on reclaimed lands and the possibility or desirability of modifying the herbicide labels to allow greater use should be further examined.

Information on the effectiveness of various herbicide active ingredients on aquatic and wetland weeds can be found in Langeland and others (2009).

Forested Wetlands

Glyphosate is a non-selective systemic herbicide (translocated through the plant), while diquat is a non-selective contact herbicide. Care must be taken to direct the spray of these herbicides away from desirable plants (e.g., beneath trees away from foliage), but fortunately there is little or no root uptake from the soil under most uses. Imazamox is useful for controlling cattail, primrose willow and sedges. Red maple, bald cypress, wax myrtle, and perhaps some other trees, have some tolerance to imazamox, as do other species in the composite and legume families. A dense canopy of wetland trees, such as water hickory, popash, and bald cypress, will shade out primrose willow and other sun-requiring weeds. Increasing the density of tree plantings and promoting more rapid tree growth will speed canopy closure and will thus aid weed control. Wetland trees grow better when soils are saturated but not inundated for long periods of time, so control of water levels is important. Triclopyr can be used to control primrose willow and other broadleaves, but root uptake of triclopyr and 2,4-D by desirable trees is possible in saturated and inundated soils. We have observed some stunting of popash and red maple with triclopyr, even when foliage was protected from the spray; however, there was no measurable effect on bald cypress under the same conditions, suggesting that bald cypress has some degree of tolerance to triclopyr.

FIPR Institute research has shown that clopyralid is effective in selectively controlling climbing hempvine (*Mikania scandens*) and some other herbaceous plants in the composite/sunflower and legume families (e.g., young dogfennel and *Sesbania*) in seasonally dry wetland areas with minimal to no injury to many trees (e.g., red maple, bald cypress, wax myrtle) and many desirable herbaceous species. Unfortunately, **clopyralid** (Transline, Stinger, etc.) is **not labeled** for use in wetlands, and most uses in Florida are currently restricted, except for kudzu control in some northern counties (Transline) and for commercial ornamental nurseries, landscapes and turf (Lontrel). **Aminopyralid (Milestone) is labeled for use in seasonally dry wetlands** and will kill *Mikania*, *Sesbania*, and dogfennel (*Eupatorium capillifolium*), but it will cause more injury than clopyralid to other plants. Further research is needed on the tolerance or susceptibility of various wetland plant species to aminopyralid. The environmental risk or safety of using clopyralid on reclaimed lands and natural areas and the possibility or desirability of modifying the herbicide labels to allow greater use should be further examined.

Aquatic

See Langeland and others (2009) [University of Florida IFAS Extension Publication SS-AGR-44] for information on aquatic herbicides and their uses. Also see section on Management of Specific Exotic and Nuisance Plants.

Table 4. Herbicides and Their Uses.

Product	Chemical	Rates of Product	Comments
Non-Selective			
Rodeo Roundup	Glyphosate 5.4 lb a.i./gal 53.8% 4.0 lb a.i./gal 41%	1-3% v/v	Non-selective, no soil activity or residual, applied to foliage (post-emergent). Liquid. Rodeo for aquatic or terrestrial use. Liquid. Roundup Pro not for aquatic use contains surfactant. Liquid.
Reward	Diquat 2.0 lb a.i./gal 37.3%	0.5% v/v 0.75 fl oz/gal	Contact killer. Non-selective. Terrestrial and aquatic use. Liquid.

Table 4 (Cont.). Herbicides and Their Uses.

Product	Chemical	Rates of Product	Comments
Imidazolinone Herbicides			
Clearcast	Imazamox 1.0 lb a.i./gal 12.1%	2-5% v/v Maximum 2 qt/acre	2% solution of product controls cattail, primrose willow, sedges, camphor tree, Chinese tallow, chinaberry, Brazilian pepper. Several tree species are somewhat tolerant, including red maple, bald cypress, oaks, pines, wax myrtle. 4-5% solution required for torpedograss or climbing ferns. Foliar and soil activity. Liquid. Terrestrial and aquatic use.
Plateau	Imazapic 2.0 lb a.i./gal 23.6%	6-12 fluid oz/acre Maximum 12 oz/ac/yr	Selective control of seedling natalgrass and Bahiagrass and sedges. Many legumes, composites, wiregrass, *Andropogon* spp are tolerant. Foliar and soil activity. Soil residual. Liquid.
Arsenal Habitat Arsenal AC	Imazapyr 2.0 lb a.i./gal 28.7% 4.0 lb a.i./gal 53.1%	1.5-2.0 qt/acre 0.75-1.0 qt/acre	Non-selective at higher rates (1.5 to 2.0 qt/acre of Habitat) but selective at lower rates (8 to 16 fluid oz/acre Habitat. Many legumes, composites, wiregrass, *Andropogon* spp and pines are tolerant at lower rates. Foliar and soil activity. Soil residual. Liquid. Habitat for aquatic or terrestrial use. Arsenal and Arsenal AC terrestrial only
Broadleaf Herbicides			
Milestone MilestoneVM	Aminopyralid 2.0 lb a.i./gal 40.6%	3-7 fl oz/acre 0.1-0.2 fl oz (or 2-9 ml) /gal	Broadleaf control, especially legume, sunflower and night shade families. Foliar and some pre-emergent soil activity. Can be used in seasonally dry wetlands. Maximum 7 fl oz/acre/year; 14 oz/acre allowed for spot spray, but only 50% of acre can be treated. Can be spot sprayed beneath pines and some other trees. Soil residual. Liquid.
Vista	Fluroxypyr 1.5 lb a.i./gal 26.2%	0.5-1.3 qt/acre 0.3-1oz/gal Maximum 1.3 qt/ac/yr	Broadleaf control, more effective on lantana than triclopyr. Liquid emulsifiable concentrate. Foliar. Vista may be sprayed as a directed spray beneath pines, or over the top of <u>dormant</u> pines. Vista XRT contains 2.8 lb a.i./gal (45.5%) and should be applied at half the rate of Vista.

Table 4 (Cont.). Herbicides and Their Uses.

Product	Chemical	Rates of Product	Comments
Garlon 3A Renovate 3	Triclopyr 3.0 lb a.i./gal 44.4%	Foliar 1-4 qt/acre 1-3 oz/gal Max. 6 gal/ac/yr	Broadleaves, brush. Garlon 3A & Renovate 3 are aquatic or terrestrial amine formulations for foliar, cut stump, and hack and squirt. Liquid.
Garlon 4 Remedy	Triclopyr 4.0 lb a.i./gal 61.6%	Max. 4 gal/ac/yr	Garlon 4 & Remedy are ester formulations of triclopyr for terrestrial use, including foliar application and basal bark (with oil) application. Liquid emulsifiable concentrate.
DMA 4 IVM Weedar 64 Weedone LV4	2,4-D amine 3.8 lb a.i./gal 2,4-D ester 3.8 lb a.i./gal	2-4 qt/acre 2-3 fl oz/gal	Herbaceous broadleaves. Many amine formulations may be used for aquatic and terrestrial (check label for aquatic use). Most ester formulations only for terrestrial use. 2,4-D amine Liquid. Foliar. Maximum rate of 1 gal/acre/yr. 2,4-D ester liquid emulsifiable concentrate.
Velpar L Velpar ULW	Hexazinone 2 lb a.i./gal 25% liquid 75% granular	1-1.5 qt/acre	At 1.0 to 1.5 qt Velpar L/ acre kills smutgrass, natalgrass, lovegrass, many broadleaves. Wiregrass, bahiagrass, pines tolerant. 1.0 qt Velpar L equivalent to 0.67 lb Velpar ULW. Foliar and soil. Soil residual.
Sulfonylurea Herbicides			
Escort	Metsulfuron 60% granular	0.03-0.25 lb/acre	Broadleaf and brush killer. Pines tolerant but broadleaf trees may be injured. Many grasses tolerant, but bahiagrass injured. Mostly foliar but some soil activity. Granular.
Oust	Sulfometuron 75% granular	0.125-0.5 lb/acre	Kills natalgrass, injures bahiagrass. Enhances glyphosate kill of cogongrass when tank-mixed. Foliar and soil. Some soil residual. Granular.
Grass Herbicides			
Fusilade DX	Fluazifop 2.0 lb a.i./gal 24.5%	0.75 qt/acre 1.0 fl oz/gal	Grass herbicide. Kills/injures cogongrass and torpedograss without injury to broadleaved herbaceous plants and trees. Most effective when grass is actively growing. May require repeat application. Foliar. Liquid Emulsifiable concentrate.

Table 4 (Cont.). Herbicides and Their Uses.

Product	Chemical	Rates of Product	Comments
Select 2 EC	Clethodim 2.0 lb a.i./gal 26.4%	0.25-0.5 qt/acre 0.75 fl oz/gal	Grass herbicide. Less effective on perennial grasses than fluazifop. Most effective when grass is actively growing. May require repeat application. Liquid emulsifiable concentrate. Foliar.
Poast	Sethoxydim 1.5 lb a.i./gal 18%	0.5-1.25 qt/acre 1.0 fl oz/gal	Grass herbicide. Less effective on perennial grasses than fluazifop. Most effective when grass is actively growing. May require repeat application. Liquid emulsifiable concentrate. Foliar.
Pre-Emergent Herbicides			
Surflan	Oryzalin 4.0 lb a.i./gal 40.4%	2-4 qt/acre	Pre-emergent applied to soil. Inhibits seed germination. Soil residual. Liquid.
Pendulum	Pendimethalin 3.3 lb a.i./gal 38.7%	2-4 qt/acre	Pre-emergent applied to soil. Inhibits seed germination. Soil residual. Liquid.

Note: Other brands of products with the same or similar concentrations or formulations of chemical are often available but are not listed here for the sake of simplicity. For all herbicides, the reclamation manager must EXAMINE AND FOLLOW THE LABEL for restrictions and recommendations on uses, application methods and rates, appropriate additives (surfactants, etc.), and plant species' susceptibility or tolerance, etc. Herbicides should be used under the direction of a licensed professional.

MANAGEMENT OF SPECIFIC EXOTIC AND NUISANCE PLANTS

This section summarizes information on methods for controlling or managing individual exotic and nuisance plant species or on plant life-form (plant type) groupings (grasses, woody broadleaves, etc.). Information has come from FIPR Institute research, various research or management publications and the experience of researchers and practitioners. There is more information on some species than others. For those species with little or no information available on specific management methods, we have grouped these species by plant type (broadleaf herbaceous, vine, etc.) and provided the most appropriate herbicides for control. Emphasis here is on chemical control, because it is the most effective method for removing unwanted plants from an established vegetation community. Other management methods, such as fire, tillage, mowing, grazing, plant competition and water level control, are discussed here to some extent but also in the sections on Physical and Mechanical Management Methods, Planting and Vegetation Based Management Methods, and Management Methods by Florida Land Use and Cover Classes.

COGONGRASS (*Imperata cylindrica*)

Cogongrass is among the world's worst weeds. It infests thousands of acres in the southeastern United States, especially Florida, Alabama and Mississippi. It is a vigorous, rhizomatous perennial grass that is adapted to a wide range of soil fertility and moisture conditions in tropical and subtropical climates. It spreads by seed and by rhizomes. Tillage, mowing, grazing, biocontrol (insects or disease), fire, soil fertility management, plant competition (shade, etc.), and herbicides are among the management tools that might be used to help control cogongrass. Cogongrass is a vigorous competitor in its area of origin in Southeast Asia, so the likelihood of finding insect or disease organisms for biocontrol seems slim. Some research has been done on the use of fungi as bioherbicides, with some success in causing top kill of cogongrass, but with limited effect on the rhizomes. Unfortunately, the fungi do not seem to spread on their own, which would be a desirable trait for a true biocontrol organism. Thus, the fungi must be produced and sprayed, analogous to chemical herbicides.

Tillage

Repeated tillage can help manage cogongrass by bringing rhizomes to the surface and separating them from the soil to cause death by desiccation, by killing the tops to starve the plants, and by cutting rhizomes into pieces and promoting sprouting of the pieces. Plants are starved when rhizome reserves are depleted through regrowth of tops but sufficient leaf area is not allowed to replenish rhizome reserves via photosynthesis. The cutting of rhizomes into smaller pieces and their increased sprouting may reduce the number of dormant rhizome buds and increase the ratio of leaf area to rhizome, thus promoting a greater dose of herbicide being translocated to the rhizomes. The chisel plow is probably the most cost effective implement for separating rhizomes from the soil and bringing them to the surface for death by desiccation (most effective in the dry season). The rototiller is the next most effective implement, followed by the disk plow. A moldboard or turning plow tends to bury the rhizomes again.

Rolling or Flattening

Rolling or pressing of cogongrass swards to lay the plants flat upon the ground has been used in developing countries in Africa and Asia to help control cogongrass (see Terry and others 1997, Friday and others 1999, Bourgoing and Boutin 1987). Logs and barrels have been used to roll the cogongrass, and boards or planks have also been used to flatten the grass. The measure is temporary, particularly if the culms are broken in the process, so plants will resprout from rhizomes. However, the flattened swards of cogongrass are much less susceptible to wildfires, or at least the fires are less intense, and they do provide a thick mulch that will continue to control erosion and suppress other weeds. The concept has been tried in central Florida using a tractor drawn roller or using the tractor wheels alone. Because the cogongrass resprouts, herbicide application (glyphosate or imazapyr) has been necessary also. Herbicide has been sprayed immediately after rolling (either in a second separate operation or using a spray attachment behind the roller) or just prior to rolling (with a spray attachment mounted on the tractor before the roller). Spraying before rolling may provide better foliar coverage (both sides of the leaves) than after rolling (one side of the leaves with some portions of the leaves shielded by leaves on top of them). Breaking of the culms by rolling may reduce the amount of herbicide translocated to the rhizomes. The flattened cogongrass may also retard a soil active herbicide such as imazapyr from reaching the soil.

Mowing, Grazing and Competition

Various factors or treatments may competitively inhibit cogongrass, or conversely, favor it. Some research has indicated that repeated mowing can tip the competitive balance between cogongrass and bahiagrass in favor of bahiagrass. Similarly, the application of lime and fertilizer may also tip the competitive balance in favor of bahiagrass. However, increased fertility may favor cogongrass over less vigorous species such as wiregrass. Grazing, superficially, might seem to be similar to mowing, but cogongrass is not very palatable except for new sprouts immediately following burning or mowing. Unless a cogongrass-infested pasture is intensively managed, livestock grazing could promote an increase in cogongrass as animals selectively choose more palatable plants. One aspect of managing plant competition that does work on controlling cogongrass is the shade provided by a dense tree or shrub canopy. Trees not only compete for light but also for moisture and nutrients. Wax myrtle is known to exude chemicals and competes through the process of allelopathy, in addition to shade effects.

Prescribed Fire

Fire is a force that has molded natural plant communities in Florida and is a tool often recommended for managing vegetation communities. Unfortunately, cogongrass is very tolerant of fire. The large quantity of fuel produced results in very hot fires that often destroy the trees and shrubs that could potentially compete with cogongrass. In other words, fire tends to favor cogongrass. The main value of fire is as a pretreatment to remove the standing dead matter often found in a field of mature cogongrass and to promote the production of green leaf tissue that is more susceptible to effective herbicide uptake. Mowing has been tried as a pre-treatment before applying herbicide to the regrowth; however, our research has shown that herbicidal control was better without mowing, even for a tall, old stand of cogongrass. Our hypothesis is that the large amount of thatch or "trash" following mowing may intercept herbicide and keep it from reaching the soil (important for root uptake with imazapyr) and may shield newer shoots and reduce foliar uptake of glyphosate or imazapyr. The flattened cogongrass following rolling may also inhibit herbicide contact with foliage and the soil. Standing dead cogongrass following herbicide treatment is still a wildfire hazard. Thus, there may be some value in rolling, mowing or tilling the dead cogongrass stand as part of a firebreak.

Chemical Control

Several chemical herbicides have some value in controlling cogongrass, including imazapyr (e.g., Arsenal, Habitat), glyphosate (e.g., Round-up, Rodeo), fluazifop-butyl (Fusilade), and sulfometuron-methyl (e.g., Oust). Imazapyr is the most effective herbicide for cogongrass and has both foliar and soil activity, including soil residual. Imazapyr at higher rates tends to be non-selective, but at lower rates it is selective, meaning some plants have greater tolerance than cogongrass. Glyphosate is the next most effective herbicide available. Glyphosate is non-selective but has no soil residual. Fluazifop-butyl is a grass herbicide that has little to no effect on most broadleaved plants. Fluazifop is not as effective as imazapyr or glyphosate but is useful when trying to control cogongrass in stands of young trees or other broad-leaved plants. The fluazifop tips the competitive balance in favor of the trees and herbaceous broadleaved plants, which in turn then help further suppress the cogongrass. Sulfometuron-methyl has been shown in our research to enhance the effectiveness of glyphosate when tank-mixed, and other researchers have reported sulfometuron enhancement of imazapyr as well.

Where possible in solid stands of cogongrass, we recommend burning in late summer to remove the standing dead matter and promote a flush of fresh green growth. The regrowth should be sprayed in the fall when it reaches a height of about 18 to 30 inches. The effectiveness of imazapyr and glyphosate on cogongrass has been shown to be greater in the fall than at other times of the year. This is hypothesized to be related to greater translocation of the absorbed herbicide to the rhizomes in conjunction with greater translocation of photosynthate to rhizome storage in the fall. We have had greater success when spraying taller cogongrass regrowth (up to 48 inches) than shorter (8-12 inches). We presume this is related to greater herbicide uptake because of greater leaf area and also to greater translocation to rhizomes from fully expanded mature leaves versus young expanding leaves that may initially draw reserves from the rhizomes. We recommend imazapyr rates of 0.75 to 1.0 lb of active ingredient (a.i.) per acre and 4.0 to 5.0 lb glyphosate a.i./acre. This is equivalent to 1.5 to 2.0 quarts of Habitat (or Arsenal) or 4.0 to 5.0 quarts of Round-up Pro (3.0 to 3.7 quarts Rodeo) per acre (or equivalent rates of other brands with equivalent ingredients). We have often observed percent control after one year approaching about 99% with imazapyr and about 75% with glyphosate. The soil residual of imazapyr not only provides more complete and longer control of cogongrass but also suppresses other weeds longer than with glyphosate treatment. However, even with 99% control, follow-up treatment is needed. It is most certainly needed with 75% control. Because of no soil residual, follow-up treatment using glyphosate is desirable if there is an intention to plant soon after treatment. When imazapyr was applied in the fall, we observed no obvious signs of injury or inhibition when container plants were transplanted in the summer following treatment. We must stress the importance of coming as close to eradication of cogongrass as possible before planting permanent vegetation to help avoid the headaches of reinfestation from the remaining living rhizomes.

We have given some attention to improving herbicide effectiveness. Uptake and translocation are two avenues where effectiveness may be increased. Uptake is affected by several factors that include: the amount of green leaf area; various adjuvants such as surfactants; the concentration or amount of active herbicide reaching the leaves; and root uptake. Translocation to the rhizomes is affected by season of the year, as already mentioned, but also to the rate of kill of the leaves. Rapid kill of the leaves will tend to reduce translocation to the rhizomes, while slower leaf kill should allow greater translocation to the rhizomes. We have seen many recommendations for tank mixing glyphosate and imazapyr. We question the value of the practice. In our studies of lower rates of imazapyr (12 to 24 oz Habitat or Arsenal/acre) we often got cogongrass control equivalent to high rates of glyphosate (3 lb or more per acre). Adding imazapyr to glyphosate almost always improves cogongrass control, but adding glyphosate to imazapyr usually has no positive effect and may be detrimental. The apparent detrimental effect may be related to more rapid leaf kill with glyphosate that could reduce imazapyr translocation to the rhizomes. We feel this warrants further study, but currently think it may be a waste of herbicide in most cases to add glyphosate to even low rates of imazapyr to kill cogongrass. Lower rates of imazapyr (12 to 16 oz Habitat/acre) also selectively injure cogongrass more than several species in the legume family, the aster (or sunflower) family, pines and several grasses such as wiregrass, beardgrasses, lovegrasses, and bahiagrass. The tolerance of these plants to imazapyr is often greatest in the fall when cogongrass is most effectively controlled. For example, pines are more tolerant after their resting buds have set in the fall. As mentioned previously, research also indicates that sulfometuron enhances cogongrass control when tank mixed with glyphosate. We have not carefully examined the effects of sulfometuron alone on cogongrass, but pines have some tolerance.

The effects of urea ammonium nitrate (UAN), ammonium sulfate (AMS), and various other water conditioners, on herbicide uptake and preventing herbicide deactivation (e.g., hard water effects on glyphosate) are more important when optimizing effectiveness of lower rates of herbicide (especially glyphosate). They are less important if consistently higher herbicide rates are used. This also generally applies to use of non-ionic surfactants (NIS) versus methylated seed oils (MSO) or crop oil concentrates (COC). At 0.75 lb or more of imazapyr or 4.0 lb or more of glyphosate per acre, we generally have seen very little or no differences in the effects of the adjuvants, even with our hard water. We have occasionally observed greater effects with MSO than with NIS under suboptimal environmental and plant physiological conditions, but mostly the NIS additive has been sufficient for foliar applied herbicides.

Selective Chemical Control

Selective control (killing the target weed without killing desirable species) is affected by several factors: plant species or genotype, chemical type, rate of application, additives (e.g., surfactants), timing (season or growth stage), and directed application (e.g., ropewick to take advantage of height differences). We have found that at 12 to 16 fluid ounces per acre of Arsenal or Habitat (0.188 to 0.250 lb imazapyr per acre) several plant species exhibit tolerance while cogongrass is severely injured. The tolerant species include *Andropogon ternarius* (and other *Andropogon* species), *Aristida beyrichiana*, *Eragrostis* spp., *Galactia* spp., *Helianthus angustifolius*, *Liatris* spp., *Pityopsis graminifolia*, *Pinus elliottii*, and longleaf pine (*Pinus palustris)* (some stunting of the desirable native plants may occur but they recover following lower rates of imazapyr). Bahiagrass and bermudagrass (*Cynodon dactylon*) also have some tolerance. As previously mentioned, Fusilade (fluazifop butyl) is useful in controlling cogongrass without injuring young trees (including hardwoods and pines) or other broadleaved plants and seems to be most effective when combined with competition from trees (Fusilade is most effective on cogongrass and other grasses when they are actively growing in the summer). We have had some success in controlling cogongrass by spraying imazapyr (up to 0.38 lb a.i./acre) or glyphosate over the top of dormant maidencane, while cogongrass is still green and physiologically active. Surfactants increase herbicide effectiveness but may reduce selectivity (increase injury to tolerant plants). The Arsenal label recommends that no surfactant be added if the herbicide is sprayed over the top of pines.

Selective rates of 12 to 16 oz Habitat/acre were developed and tested with a calibrated boom sprayer in which the speed of travel and the flow rate were carefully controlled. This can be adapted to a backpack sprayer and “wand” or “gun.” If, for example, a person with a backpack sprayer applies 40 gallons per acre, 12 to 16 fluid oz of product per acre translates to 0.3-0.4 fluid oz (9 to 12 ml) per gal. In practice, an applicator can spray cogongrass plants heavily while trying to minimize overspray on desirable plants. The relatively small amount of overspray should have only a small effect on those desirable plants that have some tolerance to imazapyr. Overspray from a non-selective herbicide, such as glyphosate (or perhaps imazapyr at a high rate), can be more damaging.

Caution must be used when applying herbicides for cogongrass control around trees. As previously stated, fluazifop-butyl is safe to use around trees and can even be sprayed over the top of most young trees with little or no injury. Glyphosate will injure or kill trees if sprayed on the foliage but can be sprayed on cogongrass beneath trees if contact with tree leaves or green stems is avoided. Because of root uptake, imazapyr may cause severe injury to many tree species if sprayed beneath their canopies and perhaps even a little beyond the drip-line. Pines have some tolerance to low rates of imazapyr, so with care it is possible to use imazapyr around pines.

NATALGRASS (*Melinis repens, Synonym: Rhynchelytrum repens*)

Natalgrass behaves much like an annual plant. It grows rapidly from seed and is a prolific seed producer. However, in central and southern Florida it may also behave like a short-lived perennial. A hard frost may kill the plants, but with a slightly milder winter, the plants may resprout from roots and stem nodes. It can also spread vegetatively by producing roots and new shoots at stem nodes.

The key to controlling natalgrass is to prevent seed production and to inhibit seed germination. Natalgrass can be killed by higher rates of glyphosate (e.g., 3-4 qt Round-up/acre), imazapyr (1-2 qt Habitat or Arsenal/acre) or hexazinone (e.g., 1-1.5 qt Velpar L/acre). Fluazifop is not very effective on natalgrass even at the higher labeled rates, except on very young seedlings. Diquat is a contact herbicide that can kill natalgrass, but it is more effective on younger plants at the higher labeled rates and with greater carrier water volumes (e.g., 40 gallons/acre or more) to provide complete foliar coverage. Many of the pre-emergent herbicides commonly used in agriculture, such as pendimethalin (Pendulum) and oryzalin (Surflan), effectively inhibit seed germination. Imazapyr and imazapic at lower rates (e.g., 12 fluid oz Habitat or Plateau per acre) can control seedlings or young plants and also inhibit seed germination of natalgrass. Hexazinone also has pre-emergent activity on natalgrass seed germination. Hexazinone and other herbicides with pre-emergent germination inhibiting properties may also affect germination of various native species. These pre-emergent herbicides are most effective when applied to bare soil after a burn when perennial species are present. Weed seeds are inhibited, but the perennials will resprout and fill-in.

A renovation technique used effectively on a natalgrass-infested xeric scrub reclamation site involved burning the site in June and applying pre-emergent herbicides to the bare ground to inhibit germination of natalgrass seeds in the soil. Natalgrass germination was effectively controlled by pendimethalin, but there was no effect on the resprouting perennial species. Hexazinone, imazapyr and imazapic also gave good pre-emergent control of natalgrass following the burn. These three herbicides also have post-emergent activity, but because of virtually no herbaceous leaf area after a burn, the uptake would be via roots. Fortunately, many native species in the legume and composite families, plus wiregrass and beardgrasses have some tolerance to imazapyr and imazapic at lower rates. Wiregrass, beardgrasses and pines have some tolerance to hexazinone.

Natalgrass is a problem particularly in xeric habitats where one expects to have some bare ground. It may be a temporary problem on newly seeded/planted mesic sites where the later establishing herbaceous vegetation may be more competitive. Trees, shrubs and taller vegetation can shade-out natalgrass if their densities are great enough.

TORPEDOGRASS (*Panicum repens*)

Imazapyr (Habitat) is the most effective herbicide for controlling torpedograss. Glyphosate is less effective than imazapyr but has no soil residual. Imazamox (Clearcast), in our preliminary tests, provided some control of torpedograss at the highest rates listed on the label. Imazamox is tolerated by several wetland tree species, but we observed some injury to some broadleaved wetland herbaceous species. Fluazifop (Fusilade) is a grass herbicide that has little or no activity on non-grasses, including most trees and broadleaved herbaceous species. It is most effective on younger, actively growing grasses in the spring and summer. FIPR Institute research indicates fluazifop has good potential to kill or suppress torpedograss and encourage growth of broadleaved wetland plants that may further compete with the weakened torpedograss. CAUTION: Current Fusilade labels do not allow application to wetlands because of concerns over possible effects on aquatic organisms. We think the potential for selective control of torpedograss is valuable enough to warrant further evaluation of the environmental risk or safety of using fluazifop on torpedograss in wetlands (particularly in seasonally dry wetlands or wetlands with no standing water) and of the possibility or desirability of modifying the herbicide labels to allow greater use.

Broadleaved plants like *Pontederia* and *Sagittaria* may compete well with torpedograss, especially if a grass herbicide such as fluazifop can be used. Test plantings indicate that maidencane may also be a good competitor to retard or prevent reinfestation of torpedograss. The propensity of maidencane to go dormant in the winter may also allow a window of opportunity to selectively control torpedograss with glyphosate or imazapyr, because torpedograss tends to remain active at slightly lower temperatures than maidencane. A canopy of wetland trees provides shade that will help control torpedograss, but the canopy needs to be fairly extensive and dense; scattered trees are ineffective.

SMUTGRASS (*Sporobolus indicus*)

Smutgrass can be controlled with high rates of imazapyr or glyphosate. It can be selectively controlled by applying 1.0-1.5 qt Velpar L (hexazinone) per acre. Wiregrass, pines, beardgrasses and Bahiagrass are tolerant of hexazinone at these rates.

BAHIAGRASS (*Paspalum notatum*)

Seed germination is inhibited and seedlings and young plants can be selectively killed by imazapic (Plateau) or imazapyr (Habitat) at rates near 12 oz of product (Plateau or Habitat) per acre. More mature bahiagrass requires higher rates of imazapyr (32 to 48 oz/acre of Habitat) or glyphosate (3-4 qt Roundup Pro per acre) for control. Bahiagrass is most susceptible to imazapyr or imazapic in the spring or early summer before it flowers and is most tolerant in late fall or winter. Bahiagrass is more tolerant of imazapyr (12 fluid oz Habitat/acre) than is cogongrass, which allows selective control of cogongrass in a bahiagrass stand. Bahiagrass is tolerant of hexazinone at rates of 1.0-1.5 quart Velpar L per acre. Bahiagrass is injured by, and can be controlled or suppressed with, metsulfuron and sulfometuron.

BERMUDAGRASS (*Cynodon dactylon*)

Bermudagrass is best controlled before other vegetation is planted. Tillage alone does not effectively control bermudagrass but may serve to spread rhizomes and stolons. It can be killed with higher rates of imazapyr or glyphosate, and imazapyr is more effective than glyphosate. As we learned with cogongrass, imazapyr does a better job alone than when glyphosate is applied in tank-mix with imazapyr (Boyd and Rogers 1999). Bermudagrass has some tolerance to imazapyr, imazapic and hexazinone at lower rates. Fluazifop can be used to selectively control it without harming broadleaved plants. Triclopyr, a broadleaf and brush killer, at higher rates causes some injury and suppresses bermudagrass (McCullough 2011).

OTHER GRASSES (*Poaceae* Family)

Our review has identified several other exotic and nuisance grass species. In general, grass species can be controlled by glyphosate or imazapyr, but the grass specific herbicides fluazifop, clethodim, and sethoxydim, can be used to help control many grasses, especially when young and actively growing. Our experience is that fluazifop is a stronger herbicide for perennial grasses than are clethodim and sethoxydim.

Table 5. Other Exotic and Nuisance Grass Species.

Scientific Name	Common Name
Cynodon nlemfuensis	Stargrass or African Bermudagrass
Chloris cucullata	Hooded Windmillgrass
Chloris gayana	Rhodesgrass
Chloris virgata	Feather Fingergrass
Dactyloctenium aegyptium	Crowfootgrass
Digitaria longiflora	Indian Crabgrass
Digitaria bicornis	Asian Crabgrass
Digitaria eriantha	Pangolagrass
Echinochloa colona	Jungle-rice
Echinochloa crusgalli	Barnyardgrass
Eleusine indica	Indian Goosegrass
Eragrostis atrovirens	Thalia Lovegrass

Table 5 (Cont.). Other Exotic and Nuisance Grass Species.

Scientific Name	Common Name
Eragrostis ciliaris	Gophertail Lovegrass
Hemarthria altissima	Limpograss
Hymenachne amplexicaulis	Trompetilla
Panicum maximum	Guineagrass
Paspalum acuminatum	Brook Paspalum
Paspalum urvillei	Vaseygrass
Pennisetum purpureum	Elephantgrass or Napiergrass
Sacciolepis indica	Indian Cupscale
Urochloa plantaginea	Creeping Signalgrass
Urochloa platyphylla	Broadleaf Signalgrass
Urochloa mutica	Paragrass

WOODY BROADLEAVED PLANTS

Many woody plants can be controlled by basal bark treatment with 15-20% Garlon 4 (triclopyr ester) in oil or with the hack and squirt or frill girdling methods using a concentrated (30-40%) aqueous solution of Garlon 3A (triclopyr amine) (see Ferrell and others 2006, Osiecka and others 2005, Langeland and others 2011). Foliar uptake of herbicide by plants with waxy (shiny) leaves is often better with triclopyr ester than with triclopyr amine, and uptake can often be improved with 1% methylated seed oil (MSO) in the spray solution.

Table 6. Woody Broadleaf Management Methods.

Scientific Name	Common Name	Management Method
Ardisia crenata	Coral Ardisia or Scratchthroat	Foliar treatment using a 2-3% solution of triclopyr-ester or glyphosate. Basal application using triclopyr-ester in a basal oil surfactant is recommended for mature plants. 2,4-D has provided control of seedlings or regrowth following mowing or burning.
Casuarina spp.	Australian Pine	Cut stump with 50% Garlon 3A or 10-20% Garlon 4. Basal bark 10-20% Garlon 4. Frill treatment with a combination of 20% Garlon 4 and 3% Stalker (imazapyr).

Table 6 (Cont.). Woody Broadleaf Management Methods.

Scientific Name	Common Name	Management Method
Cinnamomum camphora	Camphor Tree	Continuous mowing will control smaller trees. Foliar treatment is effective on young trees (10 ft tall or less) using either a 2-3% solution of Garlon 3A, or a 0.5-2% solution of Garlon 4. Camphor trees can be selectively controlled using a foliar treatment of 2% Clearcast (imazamox). Basal bark treatment is effective on trees up to six inches in diameter. Use a 30% solution of Garlon 4 with oil, treat entire base of tree up to 12 inches from the ground. For trees with thick bark, frill treatment will be necessary. Cut stump treatment is effective on all size trees when using a 50% solution of triclopyr (Garlon 4), ensure herbicide is applied within two minutes of cutting.
Lantana camara	Lantana	Prescribed fire followed by herbicide treatment for large coverage by lantana. Herbicide treatment on resprouts after mowing if fire is impractical. After mowing or fire, treat lantana with 1% Arsenal (imazapyr) solution. Foliar treatment with 2 pt Vista (fluroxypyr) plus7 oz Milestone (aminopyralid) per acre is effective but expensive. Triclopyr does not control lantana well. Glyphosate spot treatment controls lantana better than triclopyr. Cut stump treatment with 10% Arsenal.
Leucaena leucocephala	Lead Tree	Repeated mowing will control young trees. Basal bark or cut stump treatments with a 30% solution of Garlon 4 is effective. Foliar treatment with triclopyr on smaller trees.
Melaleuca quinquenervia	Melaleuca	Hand pulling young trees is effective on young trees, but care must be taken to remove all root material. Foliar treatment with 5% glyphosate is effective for young trees. Cut stump treatments with 25% imazapyr or 50-100% glyphosate. Cut stump treatments using a 40% glyphosate and 10% imazapyr combination works the best. Frill treatments work well using 20-50% imazapyr or the 40/10% glyphosate/imazapyr combination.

Table 6 (Cont.). Woody Broadleaf Management Methods.

Scientific Name	Common Name	Management Method
Melia azederach	Chinaberry Tree	Mowing is effective at controlling seedlings only. Foliar treatment on trees less than 10 ft tall is somewhat effective when using either a 2-3% solution of Garlon 3A, a 0.5-2% solution of Garlon 4, or a 2-3% solution of glyphosate. Chinaberry trees can be selectively controlled using a foliar treatment of 2% Clearcast (imazamox). Hack and squirt with 30% Garlon 3A. Basal bark treatments using 15% solution of Garlon 4 is effective, but a cut stump treatment using a 50% solution of triclopyr is most effective. Foliar treatments should occur during the fall but specifically prior to seed shed. Cut stump and basal bark work well year round.
Psidium guajava	Guava	Basal bark treatments with a combination of 2% triclopyr and 4% 2,4-D ester with basal oil or a 20% triclopyr ester product in basal oil.
Ricinus communis	Castor Bean	Foliar treatments using triclopyr. Basal bark or cut stump is the most effective treatment. Use 10% Garlon 4, a 5% solution of glyphosate can be used for retreatments.
Sapium sebiferum	Chinese Tallow Tree	Mowing is effective on controlling seedlings. Burning is effective at controlling all sizes. Foliar treatments are effective on young trees when using a 1% solution of imazapyr or Garlon 3A. Basal bark is effective, a 15% solution of Garlon 4 for trees less than six inches DBH and a 15-20% solution of triclopyr for trees with a DBH greater than six inches. Cut stump treatments are most effective when using a 50% solution of Garlon 3A or 10% imazapyr, herbicide should be applied within a half hour of the cutting. Chinese tallow trees can be selectively controlled using a foliar treatment of 2% Clearcast (imazamox). Foliar treatments should be done during the summer or fall prior to seed set.

Table 6 (Cont.). Woody Broadleaf Management Methods.

Scientific Name	Common Name	Management Method
Schinus terebinthifolius	Brazilian Pepper	Mechanical removal of mature shrubs with entire plant including roots removed where feasible. Prescribed fire is effective at destroying seeds. The most effective treatment plan may include burning followed by spot or broadcast herbicide treatments using Garlon 3A, Garlon 4, Roundup, Rodeo, Arsenal, or Habitat. (Cont. next page) Cut stump with 50% Garlon 3A or 25% Garlon 4, application must be made within five minutes of cutting. Basal bark treatments are effective when using a triclopyr ester formulation (Garlon 4 and Remedy) at 44% solution. Brazilian pepper can be selectively controlled using a foliar treatment of 2% Clearcast (imazamox).
Sesbania punicea	Rattlebox	Foliar herbicide with 1% glyphosate solution or 1% triclopyr amine solution. Cut stump treatments with 30% triclopyr.

NOTE: A reference to a solution percentage of glyphosate, or 2,4-D, etc., should be interpreted as % glyphosate product concentrate (e.g., Rodeo) or % 2,4-D product concentrate (e.g., Weedar 64), etc., rather than % active ingredient. Use of a product brand name is done for simplicity; there may be other brands with equivalent active ingredients that may also be suitable.

VINES

Many vines can be controlled with triclopyr, glyphosate or metsulfuron. The problem is controlling them selectively without severely injuring the trees upon which they are climbing. When the vines and trees are small, the labor-intensive method of untwining the vines from the trees and spraying the pile of vines can be used. For larger vines and trees, the vines can be cut a few feet above the ground and the vines below the cuts can be sprayed. In some cases, careful directed application of the herbicide spray or wiping the herbicide on the leaves can be used effectively. Clopyralid has activity on many legumes and composites, while many tree species are tolerant. Kudzu (*Pueraria montana*) is a legume that can be controlled selectively with clopyralid (Transline labeled for this use in some northern Florida counties including Hamilton County). FIPR Institute tests have shown that climbing hempvine, a member of the composite family, can be selectively controlled with clopyralid with minimal to no injury to several tree species, but the herbicide is not currently labeled for this use. Aminopyralid (Milestone or Milestone VM) also has more activity on legumes, composites and nightshades than many other plants, but it appears to cause more injury to other species than does clopyralid. Additional research on selectivity of aminopyralid is needed. Rosary pea

(*Abrus precatorius*) is another legume vine that might be selectively controlled with clopyralid or aminopyralid, but further tests or label changes may be needed.

Some native vines, such as peppervine, grapevine and passionvine (maypop), can become nuisances, especially in young tree plantings. Grapevine and peppervine can be controlled with triclopyr. Passionvine can be controlled with imazapyr or hexazinone, or to some extent with triclopyr.

Table 7. Vine Species Management Methods.

<table>
<tr><th>Scientific Name</th><th>Common Name</th><th>Management Method</th></tr>
<tr><td>Abrus precatorius</td><td>Rosary pea</td><td>2-3% triclopyr amine or glyphosate on foliage. Hand-pulling for small infestations, roots must be removed. Cut stump treatment using 10% solution of Garlon 4. Treat before seed set.</td></tr>
<tr><td>Dioscorea alata</td><td>White yam
Winged yam</td><td rowspan="2">All bulbils (aerial tubers) should be removed from the area as feasible. Foliar application of 2% solution of Garlon 3A or Garlon 4. If feasible, as much of the biomass should be pulled from trees and shrubs and treated. Cut stump treatment using a 50% solution of Garlon 3A or 10% solution of Garlon 4; ensure herbicide is applied immediately following cutting. Treat before new bulbils form.</td></tr>
<tr><td>Dioscorea bulbifera</td><td>Air-potato</td></tr>
<tr><td>Lygodium japonicum</td><td>Japanese climbing fern</td><td>2% glyphosate or triclopyr amine. 1-2 oz Escort (metsulfuron) per acre, 0.5% Habitat (imazapyr) around pines. Metsulfuron and imazapyr can damage broadleaf trees via root uptake. 4-5% Clearcast.</td></tr>
<tr><td>Lygodium microphillum</td><td>Old world climbing fern</td><td>Glyphosate, metsulfuron, imazapyr, triclopyr. Metsulfuron and imazapyr can damage broadleaf trees via root uptake.</td></tr>
<tr><td>Mikania scandens</td><td>Climbing hempvine</td><td>Untwine the vines from trees and treat with a broadleaf herbicide (triclopyr, 2,4-D, aminopyralid) or cut at the base. Clopyralid provides selective control with minimal injury to several tree species but is not labeled for this use in Florida.</td></tr>
<tr><td>Paederia foetida</td><td>Skunkvine</td><td>Foliar treatments with 1-3% solution of Garlon 3A or Garlon 4, or 2-3% solution of glyphosate. Where feasible, vines should be pulled down and treated. Cut stump treatments with 10% Garlon 4. During active growth (spring and summer)</td></tr>
</table>

Table 7 (Cont.). Vine Species Management Methods.

Scientific Name	Common Name	Management Method
Pueraria montana	Kudzu	Foliar treatment using metsulfuron (Escort 4 oz/acre), aminopyralid (Milestone VM 7 fl. oz/acre or spot treatment of 7 oz/half acre), or 2% triclopyr ester. Pines are tolerant to Escort, but potential injury to non-target hardwood species when applied over the rootzone. Clopyralid (21 fl. oz/acre of Transline) is safe around most native non-legume trees, but only labeled for use in certain north Florida counties, including Hamilton. Cut stump 20% Garlon 4.

NOTE: A reference to a solution percentage of glyphosate, or 2,4-D, etc., should be interpreted as % glyphosate product concentrate (e.g., Rodeo) or % 2,4-D product concentrate (e.g., Weedar 64), etc., rather than % active ingredient. Use of a product brand name is done for simplicity; there may be other brands with equivalent active ingredients that may also be suitable.

For further information on the control of Japanese climbing fern (*Lygodium japonicum*), old world climbing fern (*Lygodium microphyllum*), skunkvine (*Paederia foetida*), and air potato (*Dioscorea bulbifera*), see Langeland and others (2011) and Demers and others (2008).

BROADLEAF HERBACEOUS SPECIES

In general, broadleaved herbaceous weeds such as hairy indigo, dogfennel (*Eupatorium capillifolium*), horseweed (*Conyza canadensis*), ragweed (*Ambrosia artemisifolia*) and *Sesbania* can be controlled with triclopyr. Aminopyralid and 2,4-D are often effective on younger plants, but in our experience, triclopyr is generally more effective on older plants. Glyphosate and imazapyr provide control as well. A combination tank mixture of glyphosate and 2,4-D also provides control.

In addition to the general broadleaf herbaceous species treatments identified above, the following table provides management methods that are known for specific broadleaf herbaceous species identified in this manual.

Table 8. Broadleaf Herbaceous Species Management Methods.

Scientific Name	Common Name	Management Method
Aeschynomene indica	India Joint-Vetch	Foliar treatment with an aminopyralid herbicide is effective. Glyphosate or imazapyr provide control. Alternatively a broadleaf specific herbicide such as 2,4-D amine or triclopyr, are suitable for control. A combination of glyphosate and 2,4-D amine has been effective as well.
Alternanthera ficoidea	Slender Jointweed	Good control with a foliar treatment of 0.5% solution of imazapyr (Habitat), 1% Clearcast, partial control with triclopyr or a combination of 2,4-D and glyphosate.
Alternanthera philoxeroides	Alligator Weed	
Alternanthera sessilis	Sessile Joyweed	
Begonia cucullata	Wax Begonia	Mowing young growth is effective, mature growth will require herbicide treatment. Foliar application with glyphosate or a broadleaf herbicide (triclopyr) can be used.
Bidens pilosa	Spanish Needles	Glyphosate provides control. Alternatively a broadleaf specific herbicide such as 2,4-D or triclopyr, are suitable for control. A combination of glyphosate and 2,4-D amine has worked well. Aminopyralid herbicides are known to be effective on this species as well.
Colocasia esculenta	Wild Taro	Hand pulling where feasible, large underground structure creates difficulty in treatment and must be removed to avoid regrowth. Foliar treatment with 2% Clearcast (imazamox), 2% Rodeo, 0.5% Renovate, 0.5% Weedar 64, 0.5% Habitat, may require retreatment. Cut stem treatment with 10% solution of Garlon 4.
Commelina diffusa	Dayflower	Hand pulling and mowing not effective due to roots. Foliar treatment using a solution of either 2,4-D or triclopyr is most effective.
Commelina gambiae	Gambian Dayflower	
Crotalaria lanceolata	Rattlebox	Glyphosate is effective at controlling this species or hexazinone, triclopyr, or 2,4-D can be used.
Crotalaria pallida	Rattlebox	
Crotalaria spectabilis	Rattlebox	

Table 8 (Cont.). Broadleaf Herbaceous Species Management Methods.

Scientific Name	Common Name	Management Method
Desmodium incanum	Zarzabacao Comun	2 quarts/acre triclopyr are suggested for this species, however glyphosate can be used. Aminopyralid has been shown to be effective in controlling this species as well.
Desmodium tortuosum	Dixie Ticktrefoil	
Desmodium triflorum	Beggarweed	
Eupatorium capillifolium	Dogfennel	A combination of glyphosate (2% solution) and 2,4-D amine (3/4% solution) works well to control young plants. 1-4 qt/acre triclopyr is effective on larger, more mature plants.
Indigofera hirsuta	Hairy Indigo	Foliar treatment with a 2% solution of glyphosate. 1-4 qt/acre triclopyr.
Kummerowia striata	Japanese Clover	2 quarts/acre triclopyr are suggested for this species, however glyphosate can be used. Aminopyralid has been shown to be effective in controlling this species as well.
Ludwigia octovalvis	Large Seedbox	Glyphosate or imazapyr provide control. 2% Clearcast. Alternatively a broadleaf specific herbicide such as 2,4-D or triclopyr, are suitable for control. A combination of glyphosate and 2,4-D amine has worked well.
Ludwigia peruviana	Primrose Willow	
Nephrolepis cordifolia	Tuberous Swordfern	Foliar treatment with 1.5% solution of glyphosate is effective.
Nephrolepis multiflora	Asian Swordfern	
Polygonum lapathifolium	Pale Smartweed	Control using a 2% solution of triclopyr, partial control with a combination of glyphosate and 2,4-D.
Polygonum orientale	Kiss-Me-Over-Garden-Gate	
Senna obtusifolia	Sicklepod	2 quarts/acre triclopyr are suggested for this species, however a non-selective herbicide can be used. Aminopyralid has been shown to be effective in controlling this species as well.

Table 8 (Cont.). Broadleaf Herbaceous Species Management Methods.

Scientific Name	Common Name	Management Method
Sesbania herbacea	Danglepod	Foliar treatment with a combination of 2% glyphosate and 3/4% 2,4-D Amine. Triclopyr and aminopyralid are effective alternative herbicides. Key concerns with this species are their ability to overtop young trees which creates a situation where herbicides may impact vegetation growing below the danglepod. This may be overcome by treating early in the season while the plants are still small in stature. Hand cutting and removal may be necessary for mature plants within forested reclamation areas with juvenile trees. Herbicide treatments should be conducted in spring through early summer prior to seed pod production. Clopyralid can selectively control *Sesbania* when young, without injury to many tree species, but is not currently labeled for this use.
Sesbania vesicaria	Bladderpod	
Sesbania virgata	Wand Riverhemp	
Solanum viarum	Tropical Soda Apple	Mowing followed by foliar treatment using triclopyr-ester formulation at one quart per acre. Triclopyr-ester should be applied 50-60 days following mowing. Foliar treatment using an aminopyralid (Milestone VM at 7 fl. oz/acre) is effective with both existing plants, but also has residual soil activity which can have non target effects.
Trifolium repens	White Clover	Foliar treatment with an aminopyralid herbicide is effective. Glyphosate provides control. Alternatively a broadleaf specific herbicide such as 2,4-D, aminopyralid, or triclopyr, are suitable for control. A combination of glyphosate and 2,4-D amine has worked well.
Typha spp.	Cattail	Foliar application provides good control with 0.5% solution of imazapyr (Habitat) or 2% solution of Clearcast, partial control with a combination of 2,4-D and glyphosate.
Urena lobata	Caesar-Weed	Hand pulling where feasible. Mowing effective but limited to young plants. Foliar applications of 1-2% triclopyr are best but a 2% solution of glyphosate can be effective. Treat just prior to flowering

NOTE: A reference to a solution percentage of glyphosate, or 2,4-D, etc., should be interpreted as % glyphosate product concentrate (e.g., Rodeo) or % 2,4-D product concentrate (e.g., Weedar 64), etc., rather than % active ingredient. Use of a product brand name is done for simplicity; there may be other brands with equivalent active ingredients that may also be suitable.

Other broadleaf herbaceous plants have been listed as nuisance plants, but usually in minor amounts (<10% of aerial cover), in various monitoring reports. Most can be controlled with 2% glyphosate product, labeled rates of 2,4-D amine or triclopyr amine, or 2,4-D plus glyphosate, or 0.5% imazapyr product.

Additional research is needed with regard to other herbicides and/or selective rates for the herbicides listed above as well as the use of other management methods such as mowing or the use of prescribed fire.

Table 9. Additional Potentially Nuisance Broadleaf Herbaceous Species.

Scientific Name	Common Name
Alysicarpus ovalifolius	False Moneywort
Amaranthus spinosus	Spiny Amaranth
Anagallis arvensis	Scarlet Pimpernel
Centella asiatica	Asian Coinwort
Ceratopteris thalictroides	Watersprite
Chamaesyce mendezii	Mendez Sandmat
Chenopodium ambrosioides	Mexican-Tea
Cichorium intybus	Chicory
Cuphea carthagenensis	Columbia Waxweed
Drymaria cordata	West Indian Chickweed
Emilia spp.	Tasselflower
Fumaria officinalis	Drug Fumitory
Gamochaeta pensylvanica	Pennsylvania Everlasting
Gomphrena serrata	Arrasa Con Todo
Heteranthera limosa	Blue Mudplantain
Hyptis mutabilis	Tropical Bushmint
Hyptis verticillata	John Charles
Ipomoea quamoclit	Cypressvine
Ipomoea triloba	Littlebell
Lindernia crustacea	Malayan False Pimpernel
Macroptilium lathyroides	Phaseolus
Medicago lupulina	Black Medic
Melochia corchorifolia	Chocolate-Weed
Mollugo verticillata	Carpetweed
Momordica balsamina	Southern Balsam Pear
Momordica charantia	Wild Balsam Apple
Morrenia odorata	Latexplant
Murdannia nudiflora	Doveweed, Naked-Stem Dewflower
Oldenlandia corymbosa	Flattop Mille Graines
Oxalis dillenii	Sorrel
Phyllanthus tenellus	Mascarene Island Leaf-Flower
Phyllanthus urinaria	Chamberbitter
Portulaca amilis	Purslane
Richardia brasiliensis	Brazil Pusley
Richardia grandiflora	Largeflower Mexican Clover, Largeflower Pusley
Richardia scabra	Florida Pusley

Table 9 (Cont.). Additional Potentially Nuisance Broadleaf Herbaceous Species.

Scientific Name	Common Name
Sonchus asper	Spiny-Leaved Sow Thistle
Sonchus oleraceus	Common Sowthistle
Sphenoclea zeylandica	Chickenspike
Stellaria media	Common Chickweed
Stylosanthes hamata	Cheesytoes
Verbena brasiliensis	Verbena
Wahlenbergia marginata	Southern Rockbell
Xyris jupicai	Richard's Yellow-Eyed Grass
Zeuxine stratematica	Lawn Orchid

SEDGES (*Cyperaceae* Family)

Thirteen species from the sedge family were identified for consideration in this manual. Physical removal of sedges does not generally control these species because of the potential for root material to be left behind and grow back. Sedges are best controlled with herbicide application with imazapyr, imazapic, imazamox, and glyphosate.

Table 10. Sedge Species.

Scientific Name	Common Name
Bulbostylis barbata	Watergrass
Cyperus alopecuroides	Foxtail Flatsedge
Cyperus difformis	Variable Flatsedge
Cyperus esculentus	Yellow Nutsedge
Cyperus involucratus	Umbrella Plant
Cyperus iria	Rice Flatsedge
Cyperus lanceolatus	Epiphytic Flatsedge
Cyperus pumilus	Low Flatsedge
Cyperus rotundus	Nutgrass
Fimbristylis littoralis	Grasslike Fimbry
Fimbristylis schoenoides	Ditch Fringe Rush
Kyllinga brevifolia	Shortleaf Spikesedge
Oxycaryum cubense (synonym: *Scirpus cubense*)	Cuban Bulrush

AQUATIC SPECIES

For this discussion, aquatic species are separated from emergent wetland species. Aquatic plants grow in deeper water than emergent plants and are of two types. The first type of aquatic plant includes those species that are rooted in the substrate and are either submerged below the water surface or are partially emerged above the water surface. The second type of aquatic plant floats on the water surface with its roots suspended in the water column. Ten aquatic weed species were identified in reclaimed wetlands and water bodies.

Ditches, streams, and other water bodies can transport floating aquatic species into a reclamation area. There are physical barrier structures that can be installed to catch and trap floating aquatic species before they can enter into a reclamation area. Physical barriers can be a boom, floating turbidity curtain, or other skimming device. The land manager may frequently need to clean out and treat or otherwise dispose of the material. The federal, state, and/or local regulatory agencies may require a permit for structures that may alter the hydrology or cause dredge and fill within wetlands or other surface waters.

Management for aquatic species can be accomplished by drawing down the water level to desiccate the plants (Gettys and others 2009). Gettys reports that drawdown events are generally used in the northern United States. The land manager must completely draw the water level down and maintain the level long enough (generally 6-8 weeks) to kill the plants. This method does not work well on all species, and hydrilla can expand when the water level is drawn down. The land manager should combine drawdown events with herbicide treatment to effectively manage aquatic species.

Aquatic species control is also accomplished by hand and mechanical removal. Hand and mechanical removal can work where feasible, but care should be taken as loose or broken roots and sometimes other plant parts can lead to new plant growth. Hand tools such as specialized aquatic hand rakes can be used. Two types of aquatic rakes are available: one version rakes the material to the shore and the second cuts the vegetation instead of pulling the material to shore. Gettys and others (2009) noted that the rake which cuts the vegetation can exacerbate the problem by allowing parts of the plants to escape and establish new plants. Aquatic species management is often conducted using heavy machinery, such as cutter boats, shredding boats, rotovators, dredges, and harvesting equipment. Mechanical removal is not entirely effective because the equipment often leaves the roots and other plant parts behind, which again can exacerbate the problem. Suction harvesting may be the most appropriate mechanical option. Modified dredging equipment acts like a vacuum to remove the exotic and nuisance species off the surface of the water or from the sediments. This technique can be laborious but more effective than other mechanical devices because it reduces the quantity of material left behind or released to other areas. Divers working along the bottom of a water body can selectively remove unwanted vegetation. Caution: the federal, state, and/or local regulatory agencies may require a permit for this technique.

Herbicide treatment provides the best and most economical management method. Several aquatic herbicides are available for aquatic plant management. Herbicides available for aquatic plant control are applied by foliar treatment, but are also applied directly to the water as concentrated liquids, granules, or pellets. A list of exotic and nuisance species and the applicable herbicides is provided here. Each of these herbicides has specific plant concentrations and exposure timeframes, so pay special attention to the label for appropriate concentration rates and periods of exposure. The reclamation manager must apply the correct amount of herbicide based upon the volume of the body of water, which is calculated in acre-feet by multiplying the area by the depth of the body of water.

CAUTION: Decaying plant material depletes the dissolved oxygen levels in a body of water that can cause fish kills (Thayer and others 2003). According to this source, most approved aquatic herbicides are safe at the labeled application rates, but copper sulfate ($CuSO_4$) can be toxic to several fish species at the labeled rates and caution should be taken.

Table 11. Aquatic Species Management Methods.

Scientific Name	Common Name	Management Method
Azolla filiculoides	Mosquito Fern	Diquat and fluridone applied as a liquid directly to the water. Foliar treatment with carfentrazone, and penoxsulam
Egeria densa	Brazilian Elodea	Diquat and copper applied as a liquid directly to the water.
Eichhornia crassipes	Water-Hyacinth	Diquat applied as a foliar treatment or as a liquid directly to the water. Foliar treatment with 2,4-D, imazapyr, penoxsulam, imazamox, or triclopyr.
Hydrilla verticillata	Hydrilla	Diquat, copper and penoxsulam applied as a liquid directly to the water. Endothall and fluridone applied directly to the water as a liquid or granular.
Hygrophila polysperma	East Indian Hygrophila	Diquat and copper applied as a liquid directly to the water.
Ipomoea aquatica	Water Spinach	Foliar treatments with 2,4-D.
Myriophyllum aquaticum	Parrot's Feather	Foliar treatment with triclopyr, glyphosate, or imazapyr.
Pistia stratiotes	Water-Lettuce	Diquat applied as a foliar treatment or as a liquid directly to the water. Foliar treatment with imazapyr, carfentrazone, or penoxsulam.
Salvinia spp.	Water Spangles	Diquat applied as a liquid directly to the water. Foliar treatment with imazapyr or glyphosate.
Wolffia globosa	Asian Watermeal	Foliar treatment with penoxsulam.

Langeland K, Netherland M, Haller W. 2009. Efficacy of herbicide active ingredients for aquatic weeds. Gainesville (FL): University of Florida. IFAS Extension Publication nr SS-AGR-44.

Thayer DD, Langeland KA, Haller WT, Joyce JC. 2003. Weed control in Florida ponds. Gainesville (FL): University of Florida. IFAS Extension Publication nr CIR 707.

MANAGEMENT METHODS FOR FLORIDA LAND USE AND COVER CLASSES

As discussed previously in this manual, we cannot stress enough the importance of site preparation. By creating as weed-free an environment as practical prior to planting, the long term management and timeframe to reach the targeted success for a reclamation area should be decreased. The next most important factor is the monitoring and management schedule. Good plant identification is a key at this point. Incorrect identification of a plant can cost time and money by leading to a major infestation or by spraying native plants that will have to be replanted. It is important to have a solid understanding of plant identification at all stages of the plant's life (i.e., seedling to adult). Common names often lead to confusion and miscommunication. It is best to use the scientific name. Many native plants can be mistaken for exotic weeds or nuisance species so identification beyond major genera becomes necessary. Some plant families may have both native and exotic species within the same genus. Site monitoring and management should be initiated immediately following completion of construction. The reclamation manager should monitor the site a minimum of two times per year, but it is more advantageous to conduct site inspections more frequently with inspections being completed prior to herbicide treatment or other management events, and then a follow up inspection should be conducted two to three weeks following the management event. The data collected during these inspections can then be used to plan the next management event.

Management may include combinations of mowing, tillage, water level control, prescribed fire, application of herbicides, and supplemental seeding and planting. The reclaimed land uses/vegetation communities that the reclamation manager may encounter will vary from newly created sites to mature systems and areas with minimal exotic and nuisance species cover (<10%) to areas with up to 100% exotic and nuisance cover. We have provided management methods that can be incorporated into site specific plans. High exotic and nuisance cover, with little or no native plants worth saving, could require complete restoration of the site. Complete restoration may include a treatment of the entire site with a broad spectrum herbicide plus tilling and replanting. However, methods are available for selective control of exotic and nuisance plants when there are desirable plants worth saving. The following discussion of management methods for various FLUCFCS groupings emphasizes management after grading, tilling, seeding and planting has been accomplished.

AGRICULTURAL LAND USES (FLUCFCS GROUP A)

FLUCFCS Group A includes agricultural pasture lands (FLUCFCS 211 and 213). Nuisance vegetation found in pastures includes annual and perennial herbaceous species, annual and perennial grasses, and woody species. Appendix A provides a list of exotic and nuisance vegetation typically found within reclaimed pastures.

Management Plan

This FLUCFCS group includes pastures with or without widely spaced trees. The land use emphasis is on grazing and forage production, often with non-native grasses. Because these are classified as agricultural lands, herbicide labels are often less restrictive than for lands being reclaimed or restored to function as various natural areas. Thus, additional herbicides are available, but the herbicides used in the other FLUCFCS groupings are also useful here. Mowing and broadcast application of selective broadleaf herbicides (triclopyr, 2,4-D, fluroxypyr, aminopyralid) are practical methods of weed control on these mostly grasslands. Triclopyr is generally most effective for more mature herbaceous annual or perennial broadleaves or brush. However, higher rates of triclopyr may injure bermudagrass. Injury to limpograss has been reported with 2,4-D. Metsulfuron (Escort, etc.) can be used for broadleaf weed control in stands of several pastures grasses, but not for bahiagrass, which is injured by metsulfuron. Sedges can be controlled with imazapic (Plateau) or imazapyr (Arsenal). A few exotic and nuisance grasses can be selectively controlled with broadcast herbicide applications. Smutgrass and natalgrass can be controlled with hexazinone (1 to 1.5 qt Velpar L/acre) while bahiagrass and bermudagrass are tolerant. It is also possible to selectively control cogongrass in bahiagrass or bermudagrass pastures with broadcast applications of lower rates of imazapyr (12 oz/acre Arsenal/Habitat for bahiagrass and 16 oz/acre Arsenal/Habitat for bermudagrass) in the late fall or early winter. Treatment of cogongrass with these lower rates of imazapyr may require follow-up treatment the next year, but the desirable tolerant plants will have been saved and will have had time to grow and expand in the absence of, or much reduced degree of, competition from cogongrass. It is also possible to spot spray patches of exotic and nuisance plants with higher rates of glyphosate (2-3% Roundup, etc.) or imazapyr (1% Arsenal or Habitat) (soil residual must be considered with imazapyr). Even with application of higher herbicide rates, some follow-up management will be necessary, possibly including additional herbicide treatment and supplemental planting. Prescribed fire may also be used for control of woody invasives and is a recommended pretreatment for effective cogongrass control with herbicides. The role of tillage is mainly for site preparation prior to reseeding.

Where feasible, broadcast treatments with selective herbicides reduce the labor required to treat an area, compared to spot treatment with non-selective herbicides. As indicated above for pastures, there are selective herbicides for control of broadleaves and sedges, and certain herbicides can be used to control particular grasses with minimal injury to other desired grasses. Most broadcast equipment can be used within woodland pastures (FLUCFCS 213), including ATV or tractor for the open areas between trees. Broadcast treatment should be followed by spot treatment with appropriate herbicides for smaller patches of weeds around trees or other desirable species. Imazapyr sprayed in the rootzone can kill or seriously injure various broadleaf tree species, so other herbicides such as glyphosate should be used around the root zone of trees. Pine species are tolerant of lower rates of imazapyr (12 to 16 oz/acre), after their buds have set in the fall. We don't generally recommend fertilization when reclaiming or restoring native vegetation communities, because the added nutrients tend to encourage greater weed competition with the native plants. However, adding fertilizer is recommended for pastures to increase forage grass production and increase the competitiveness of the desired grasses.

Herbicide treatments should be followed by supplemental seeding and plantings to reduce bare ground created by weed control. Additional plantings will compete with exotic and nuisance species and reduce the need for follow-up herbicide treatments. Because some herbicides have soil residual, this needs to be taken into account if there are to be supplemental plantings.

Managers should plan and budget for frequent management events during the first two years following construction, with events scheduled for March, May, June, August and October/November. The management schedule should include a minimum of two herbicide treatments to occur in late spring (May) and late summer or early fall (August/September). Herbicide treatments can be reduced for years three and beyond, depending upon nuisance coverage, but should include a minimum of two events per year (late spring and late summer or early fall). Budget and plan for several management events, but depend on scouting to determine the true extent of problems and the appropriate actions needed.

Many broad leaf annuals are best treated with herbicides early in their growth cycle prior to setting seed. The spring treatments are critical to reduce the threat of recruitment the second year from seed. The fall treatments are critical to reduce the perennial species which have rhizomes and other underground root systems that persist from year to year. Fall treatments are the most effective for dealing with large perennial grass species as well. In addition, refer to the section on Management of Specific Exotic and Nuisance Plants.

UPLAND PRAIRIES AND PINE FLATWOODS LAND USES (FLUCFCS GROUP B)

FLUCFCS Group B includes several different land uses/vegetative communities that have somewhat similar groundcover species, including dominant cover of saw palmetto. The vegetative cover within these land uses/vegetative communities includes native grasses, forbs, and other shrubs interspersed with pines and/or oaks. This FLUCFCS management plan includes the following land uses:

- 320 Shrub & Brushland
- 321 Palmetto Prairie
- 330 Mixed Rangeland
- 411 Pine Flatwoods

Nuisance vegetation found in this FLUCFCS group includes annual and perennial herbaceous species, annual and perennial grasses, sedges, and woody species. Appendix A provides a list of exotic and nuisance vegetation typically found within this FLUCFCS group.

Management Plan

Vegetation communities with trees and shrubs are more complicated to manage than purely herbaceous communities. However, broadcast spraying of selective herbicides, prescribed fire and perhaps mowing may be applied to the more open areas of FLUCFCS Group B. Fire is a natural occurrence in these vegetation communities, but high fuel loads from cogongrass, natalgrass and other exotic grasses may burn much hotter than native grasses and put trees at greater risk. Although fire is a desirable pretreatment for enhanced herbicidal control of cogongrass (imazapyr or glyphosate sprayed on regrowth), good control of cogongrass can be attained without pre-burning. Broadcast rates of imazapyr (12 to 16 oz Habitat/acre) for selective cogongrass control can be used around pine trees, but spot spraying of glyphosate should be used around broadleaf trees. In areas away from trees, 0.3 to 0.5% Habitat (imazapyr) can be used to spot spray cogongrass, natalgrass, young bahiagrass and other exotic grasses and sedges. Several native species will tolerate a minor amount of overspray of imazapyr at these rates, including wiregrass and several species in the composite and legume families. The idea is to heavily spray cogongrass or other exotics while trying to minimize overspray on surrounding desirable plants. Fluazifop-p-butyl (Fusilade DX) can be used at the highest labeled rate to broadcast spray or spot spray young weedy grasses without injury to broadleaved plants, but native grasses will be injured or killed. Broadcast spraying of broadleaf herbicides risks injury to the native broadleaf components of these vegetation communities, so careful spot spaying of broadleaf weeds may be necessary. A high infestation of broadleaved weeds may prompt a decision to broadcast spray with broadleaf herbicides to reduce competition and save the grass component.

Because these areas have a tree and shrub component, herbicide selectivity becomes critical. In large open areas where trees and shrubs can be avoided, broadcast vehicular treatment with a target herbicide for specific plant groups (grasses versus broadleaves) can be used. Pines tolerate lower rates of imazapyr and also metsulfuron, sulfometuron, and hexazinone. The labels for Arsenal AC, Escort, Oust and Velpar L give information on the use of these herbicides on slash pine or longleaf pine. Pines are most tolerant of these herbicides after buds have set in the late summer and fall, although lower rates can be applied over the top of pines in the growing season in some cases (see labels for details). Pines can also be planted into sites treated with imazapyr (see Arsenal AC and Chopper labels). Fluazifop (Fusilade DX) can be used for grasses in young pine plantings. Vista (fluroxypyr) can be sprayed on broadleaved plants beneath pines (do not spray pine foliage until after resting buds have set). Glyphosate can also be used as a directed spray treatment under pines. Aminopyralid can be sprayed under several tree and shrub species not in the legume or composite families.

Where feasible, broadcast treatments with selective herbicides reduce the labor required to treat an area. Most broadcast equipment can be used within open areas of forested uplands, including ATV or tractor, but will be limited by density of trees and shrubs. Broadcast treatment should be followed by spot treatments around trees and shrubs and smaller groupings within and around desirable species.

Herbicide treatments should be followed by supplemental seeding and plantings to reduce bare ground created by the above management techniques. Additional plantings will compete with exotic and nuisance cover and reduce the need for subsequent herbicide treatments.

Managers should plan and budget for frequent management events during the first two years following construction, with events scheduled for March, May, June, August and October/November. The management schedule should include a minimum of two herbicide treatments to occur in late spring (May) and late summer or early fall (August/September). Herbicide treatments can be reduced to two to four times per year for years three and beyond depending upon nuisance coverage, but should include a minimum of two events per year (late spring and late summer or early fall). Budget and plan for several management events, but depend on scouting to determine the true extent of problems and the appropriate actions needed.

Many broadleaf annuals are best treated with herbicides early in their growth cycle prior to setting seed. The spring treatments are critical to reduce the threat of recruitment the second year from seed. The fall treatments are critical to reduce the perennial species, which have rhizomes and other underground roots systems that persist from year to year. Fall treatments are the most effective for dealing with large perennial grass species as well. In addition, refer to the section on Management of Specific Exotic and Nuisance Plants.

UPLAND FORESTED LAND USES (FLUCFCS GROUP C)

FLUCFCS Group C includes several different land uses/vegetative communities that share the common characteristic of having either/or both conifer and hardwood tree species. This FLUCFCS management plan includes the following land uses:

410 Upland Coniferous Forests
414 Pine–Mesic Oak
420 Upland Hardwood Forests
421 Xeric Oak
425 Temperate Hardwoods
427 Live Oak
430 Upland Harwood Forest
434 Hardwood–Conifer Mixed
438 Mixed Hardwoods

Vegetation communities in FLUCFCS Group C are dominated by trees. A decision must be made by the manager on whether to establish the desired ground cover first and then plant trees or to establish a tree canopy as quickly as possible and then plant understory species. The latter approach involves planting trees fairly densely and controlling weeds to promote rapid tree growth. Where the tree canopy is sufficiently dense, shade and root competition will help control exotic and nuisance species. The other approach is to establish the groundcover first and treat the exotic and nuisance species by broadcast spraying of selective herbicides and using fire as would be done in a pasture or rangeland. Trees would be planted later with herbicide spot treatments around each tree to reduce competition and promote tree establishment and growth.

Nuisance vegetation found in forested upland communities includes annual and perennial herbaceous species, annual and perennial grasses, sedges, and woody species. Appendix A provides a list of exotic and nuisance vegetation typically found within reclaimed forested upland land uses/vegetative communities.

Management Plan

Forested areas are challenging to manage due to the mix of woody trees and shrubs with herbaceous plants. Physical and mechanical methods can be used. Where practical, the reclamation manager may hand remove species, but mowing and tillage may be limited due to existing trees and shrubs. Prescribed fire may be used, but caution must be used to avoid killing young trees. A prescribed burn may burn hotter than normal in an area with a dense fuel source killing any trees and shrubs present. The reclamation manager will have to weigh the benefit of burning off a dense cover of cogon grass and injuring/killing trees and shrubs for example. Refer to the species specific management plan for cogon grass for specifics on the use of prescribed fire. Spot burning may be used to remove patches of exotic and nuisance species intermixed with native species or when large prescribed fires are impractical.

Pine Forests

Pines tolerate lower rates of imazapyr and also metsulfuron, sulfometuron, and hexazinone. The labels for Arsenal AC, Escort, Oust and Velpar L give much useful information on use of theses herbicides on slash pine or longleaf pine. Pines are most tolerant of these herbicides after buds have set in the late summer and fall, although lower rates can be applied over the top of pines in the growing season in some cases (see labels for details). Pines can also be planted into sites treated with imazapyr (see Arsenal AC and Chopper labels). Fluazifop (Fusilade DX) can be used for grasses in young pine plantings. Vista (fluroxypyr) can be sprayed on broadleaved plants beneath pines (do not spray pine foliage, except after resting buds have been set in the fall). Milestone (aminopyralid) can be spot sprayed under pines but not on foliage. Glyphosate can also be used as a directed spray treatment under pines.

Oak, Broadleaf-Dominated Upland Forests

Container-grown oaks can be planted in summer following site preparation treatment with imazapyr the previous fall. Otherwise, it is not safe to use imazapyr around oak and many other broadleaf trees. Fusilade (fluazifop-p-butyl) can be used safely to kill young and actively growing grasses without injury to broadleaved herbaceous and woody plants. Foliar application of Clearcast (imazamox) can be used to selectively control Brazilian pepper, Chinese tallow, chinaberry, and camphor tree (many desired tree species are tolerant). Research on plantations indicate that Goal (oxyfluorfen) can be sprayed over the top of young oaks and some other tree species to control a variety of herbaceous weeds (see Goal 2XL label—has pre-emergent plus some contact foliar activity on herbaceous weeds, several tree species are tolerant). Oust XP can be applied at 3-5 oz/acre prior to planting or 1-4 oz/acre after planting sycamore, ash, bald cypress, oaks, red maple and sweetgum, but before the trees break dormancy (prior to bud swell). Pendulum (pendimethalin) and Surflan (oryzalin) can be used for pre-emergent weed control in new plantings of many tree species. Milestone (aminopyralid) can be spot sprayed under trees but not on foliage. Glyphosate can also be used as a directed spray treatment under trees. A dense canopy of oaks, wax myrtle or mixed plantings of various evergreen or deciduous broadleaf trees will control many sun-requiring weeds, so increasing the density of planting to promote more rapid canopy closure is an important non-chemical means of weed management. Vine control is addressed in the section on Management of Specific Exotic and Nuisance Plants.

Where feasible, broadcast treatments with selective herbicides reduce the labor required to treat an area. Most broadcast equipment can be used within open areas of forested uplands, including ATV or tractor, but will be limited by density of trees and shrubs. Broadcast treatment should be followed by spot treatments around trees and shrubs and smaller groupings within and around desirable species.

Herbicide treatments should be followed by supplemental seeding and plantings to reduce bare ground created by the above management techniques. Additional plantings will compete with exotic and nuisance cover and reduce the need for subsequent herbicide treatments.

Managers should plan and budget for frequent management events during the first two years following construction, with events scheduled for March, May, June, August and October/November. The management schedule should include a minimum of two herbicide treatments to occur in late spring (May) and late summer or early fall (August/September). Herbicide treatments can be reduced to two to four times per year for years three and beyond depending upon nuisance coverage, but should include a minimum of two events per year (late spring and late summer or early fall). Budget and plan for several management events, but depend on scouting to determine the true extent of problems and the appropriate actions needed.

Many broad leaf annuals are best treated with herbicides early in their growth cycle prior to setting seed. The spring treatments are critical to reduce the threat of recruitment the second year from seed. The fall treatments are critical to reduce the perennial species, which have rhizomes and other underground roots systems that persist from year to year. Fall treatments are the most effective for dealing with large perennial grass species as well. In addition, refer to the section on Management of Specific Exotic and Nuisance Plants.

FORESTED WETLAND LAND USES (FLUCFCS GROUP D)

FLUCFCS Group D includes several different forested wetland land uses/vegetative communities that share the common characteristic of having either/or both conifer and hardwood tree species. This FLUCFCS management plan includes the following land uses:

610	Wetland Hardwood Forest
611	Bay Swamp
615	Bottomland
617	Mixed Wetland Hardwood
620	Wetland Coniferous Forest
621	Cypress
625	Hydric Pine Flatwoods
630	Mixed Forest Swamps
631	Wetland Scrub

Nuisance vegetation found in forested wetland land use/vegetative communities includes annual and perennial herbaceous species, annual and perennial grasses, sedges, and woody species. Appendix A provides a list of exotic and nuisance vegetation typically found within reclaimed forested wetland land uses/vegetative communities.

Management Plan

The mix of woody trees and shrubs with herbaceous plants in forested wetlands complicates the control of exotic and nuisance plants. A dense tree canopy, however, is valuable in shading out full-sun-requiring weeds. Spot spraying with herbicides and hand-pulling or cutting have often been necessary for exotic and nuisance plant removal. Mechanical methods can be used, but are often limited due to the presence of standing water and a soft substrate found in wetlands. Spot burning has been used to remove patches of exotic and nuisance species intermixed with native species.

In large open areas where trees and shrubs can be avoided, broadcast vehicular treatment with a target herbicide for specific plant groups (grasses versus broadleaves) can be used. Airboats and other amphibious (e.g., Argo) vehicles are often used to access wetlands for broadcast and spot herbicide treatment. Wheeled vehicles can sometimes be used in seasonally dry wetlands if the soils are not too soft.

Herbicide use is more limited in wetlands than in uplands. Glyphosate (Rodeo) and imazapyr (Habitat) are systemic herbicides (translocated through plant) approved for use in wetlands. These chemicals are non-selective at high rates, but imazapyr has been shown to be selective at lower rates in uplands and may show selectivity in wetlands with further tests. Caution is recommended when using imazapyr around wetland trees. Imazamox (Clearcast) is chemically related to imazapyr but has been shown to be selective and to be safe around several native trees. Imazamox is useful for controlling cattail, primrose willow and sedges. Red maple, bald cypress, wax myrtle, and perhaps some other trees, have some tolerance to imazamox, as do other species in the composite and legume families. Diquat (Reward) is a non-selective contact herbicide approved for use in wetlands. Care must be taken to direct the spray of these herbicides away from desirable plants (e.g., beneath trees away from foliage), but fortunately there is little or no root uptake under most uses. Triclopyr (Garlon 3A) can be used to control primrose willow and other broadleaves, but root uptake of Garlon 3A and 2,4-D by desirable trees is possible in saturated and inundated soils. We have observed some stunting of popash and red maple with triclopyr, even when foliage was protected from the spray; however, there was no measurable effect on bald cypress under the same conditions, suggesting that bald cypress has some degree of tolerance to triclopyr. In addition, refer to the section on Management of Specific Exotic and Nuisance Plants.

Bare areas resulting from herbicide treatments should receive supplemental plantings to compete with, and help prevent reinfestation with, exotic and nuisance species cover and help reduce the need for subsequent herbicide treatments. A dense canopy of wetland trees, such as water hickory, popash, and bald cypress, will shade out primrose willow and other full-sun-requiring weeds. Increasing the density of tree plantings and promoting more rapid tree growth will thus aid weed control. Wetland trees grow better when soils are saturated but not inundated for long periods of time, so control of water levels is important. As discussed in the Planting and Vegetation Based Management section, wetland and transitional bunch grasses such as cordgrass, muhlygrass, eastern gamagrass, and others, as well as rhizomatous species such as maidencane, are effective at competing with exotic and nuisance species. Pickerel weed is also a good competitor with many herbaceous exotic and nuisance species.

Managers should plan and budget for frequent management events during the first two years following construction, with events scheduled for March, May, June, August and October/November. The management schedule should include a minimum of two herbicide treatments to occur in late spring (May) and late summer or early fall (August/September). Herbicide treatments can be reduced to two to four times per year for years three and beyond depending upon nuisance coverage, but should include a minimum of two events per year (late spring and late summer or early fall). Budget and plan for several management events, but depend on scouting to determine the true extent of problems and the appropriate actions needed.

HERBACEOUS WETLAND LAND USES (FLUCFCS GROUP E)

FLUCFCS Group E includes several different herbaceous wetland land uses/vegetative communities that share the common characteristic of being dominated by annual and perennial herbaceous broadleaf and grass species, but may include wetland shrub species. Appendix A provides a list of exotic and nuisance vegetation typically found within reclaimed herbaceous wetlands.

This FLUCFCS management plan includes the following land uses:

640 Vegetated Non-Forested Wetlands
641 Freshwater Marshes
6417 Freshwater Marshes with Shrubs, Brush, and Vines
643 Wet Prairies
646 Treeless Hydric Savanna

Management Plan

Herbaceous wetland land use/vegetative communities do not have trees to avoid but may have some desirable shrub species, so care should be taken to avoid non-target damage from herbicides. Spot burning has been used to remove patches of exotic and nuisance intermixed with native species. Hand pulling and use of small hand tools to cut and remove unwanted plants is often used where feasible. Mechanical methods can be used but are often limited due to the presence of standing waters and a soft substrate found in wetlands. Airboats and other amphibious vehicles (e.g., Argo) are often used to access wetlands for broadcast and spot herbicide treatment. Wheeled vehicles can sometimes be used in seasonally dry wetlands, although the soils may often be too soft. The following herbicides are used for emergent wetland species: glyphosate, imazapyr, triclopyr, imazamox, 2,4-D, diquat, and, for seasonally dry wetlands, aminopyralid. Formulations differ, so check label for aquatic use. In addition, refer to the section on Management of Specific Exotic and Nuisance Plants. Information on the effectiveness of various herbicide active ingredients on aquatic and wetland weeds can be found in Langeland and others (2009).

OTHER SURFACE WATERS LAND USES (FLUCFCS GROUP F)

FLUCFCS Group F includes other surface waters or open bodies of water typically with no emergent vegetation (FLUCFCS 510 and 520). Nuisance vegetation found in this FLUCFCS group includes submerged and floating species, but can include emergent vegetation. Appendix A provides a list of exotic and nuisance vegetation typically found within reclaimed pastures.

Management Plan

The best management practice for managing exotic and nuisance aquatic plant species in this FLUCFCS group is by herbicide treatment. Physical and mechanical methods, such as hand pulling and mechanical harvesting, work well to remove the majority of the exotic and nuisance species biomass but often can exacerbate the problem because seeds, roots, and stems are left behind (see physical and mechanical management methods section). The plant parts remaining after physical and mechanical removal often grow into new plants negating the work. Often, physical and mechanical removal releases seeds, roots, and stems into the water column, which can float into new areas, spreading the problem. Suction harvesting equipment may be the most appropriate mechanical method for control of exotic and nuisance aquatic vegetation.

As discussed previously, ditches and streams can transport floating aquatic species and plant parts and seeds into a larger water body. Physical barrier structures can be installed to catch and trap floating aquatic species before they can enter into a reclamation area. Caution, the federal, state, and/or local regulatory agencies may require a permit for structures that may alter the hydrology or cause dredge and fill within wetlands or other surface waters.

As discussed previously, management for aquatic species can be accomplished by drawing down the water level to desiccate the plants. The land manager must completely draw the water level down and maintain the level long enough (generally 6-8 weeks) to kill the plants. This method does not work well on all species, and hydrilla can expand when the water level is drawn down. The land manager should combine drawdown events with herbicide treatment to effectively manage aquatic species.

Herbicide treatment provides the best and most economical management method. Several aquatic herbicides are available for aquatic plant management. Herbicides available for aquatic plant control are applied by foliar treatment, but are also applied directly to the water as concentrated liquids, granules, or pellets. A list of exotic and nuisance species and the applicable herbicides is provided under the Management of Specific Exotic and Nuisance Plants section of this manual. Information on the effectiveness of various herbicide active ingredients on aquatic and wetland weeds can be found in Langeland and others (2009).

RECOMMENDATIONS

The authors of this document have critically assessed the current status of nuisance and exotic species management and offer the following recommendations.

PREVENTION

We reiterate the need for prevention of weed contamination of a reclamation or restoration site and the need for early detection and prompt action to control invasive plants before they become significant problems. This could include a year or more of effort to virtually eradicate tough perennial invasive weeds such as cogongrass before planting the desired vegetation. Where feasible, to minimize weed colonization from offsite, invasive weeds in the surrounding area should also be controlled, and vigilance should be exercised to avoid bringing in weed propagules with contaminated equipment or soil.

SELECTIVE HERBICIDES

A goal in vegetation management is to be able to kill the undesirable exotic and nuisance plant species without also killing the desirable plants. This selective control is most often attempted by directed application of a non-selective herbicide, such as glyphosate (point the spray stream of glyphosate at the undesired vegetation and try to miss the desired vegetation). The method is labor intensive and requires split-second ability to distinguish the undesired from the desired plants. The use of selective herbicides takes advantage of differences in tolerance of various plants to certain herbicides. A well-known example is broadcast spraying of herbicides that kill broadleaved weeds, while most grasses in a pasture receive little to no injury (e.g., 2,4-D, triclopyr, fluroxypyr, aminopyralid). The FIPR Institute and others have conducted research on the selectivity of several herbicides, including imazapyr, imazapic, imazamox, hexazinone, metsulfuron, sulfometuron, fluazifop, and aminocyclopyrachlor. More research needs to be done to determine the tolerance of a greater number of native plant species to various herbicides, as well as the toxicity to exotic and nuisance plants. The use of selective herbicides increases the possibility of broadcast application, which is less labor intensive than point and squirt, backpack methods. The use of selective herbicides can also minimize the unintended injury to many desirable plants from over-spray while using the point and squirt method, or the broadcast spray method, if the desirable plants have some tolerance to the herbicide.

Labor is the largest component of managing nuisance and exotic species. The reclamation manager can significantly reduce labor costs when using broadcast spray equipment as compared to spot treatments with a backpack sprayer. If the reclamation manager can treat larger areas with mixed vegetation and use selective herbicide formulations, the labor cost could be significantly reduced.

AQUATIC HERBICIDES

There are fewer herbicides labeled for use in wetlands and other aquatic habitats (e.g. streams and lakes), than are available for upland use. We recommend further studies on new or existing herbicides for use in aquatic sites. Aquatic herbicides that are selective for broadleaved plants or for grass species would be greatly beneficial and allow for broadcast treatments for specific nuisance and exotic broadleaved or grass species when found intermixed with desirable, non-target species. Selective herbicides could reduce injury to desirable plant species. We also suggest that the labeling of potentially useful selective herbicides should be re-examined. FIPR Institute research indicates that Fusilade (fluazifop), a grass herbicide which is labeled for use in uplands, could be useful for selective control of torpedograss in forested and broadleaved herbaceous wetlands. The main concern with fluazifop is its toxicity to aquatic organisms, but it seems reasonable that it could be used in seasonally dry wetlands. FIPR Institute research also indicates that Transline (clopyralid) could be useful for selective control of *Mikania* or *Sesbania* in forested wetlands, but current labeling restricts its use in Florida. The concern with clopyralid is the possibility of moving into groundwater, especially in sandy soils, but it seems reasonable that it could be used at low foliar application rates on seasonally dry wetlands with organic muck and clay soils that have low transmissivity.

HERBICIDE RESISTANCE POSSIBILITY

Increased resistance to glyphosate has been found in populations of some weeds on agricultural lands where glyphosate has been used almost exclusively. We are not aware of any signs of herbicide resistance developing in weed populations on reclaimed mined lands or natural areas, but we haven't really been looking. The simplest solution for preventing the development of herbicide resistance is to use different herbicides with different modes of action and to rotate the use of these different herbicides. The problem comes in finding appropriate substitutes that are effective yet have similar environmental characteristics as glyphosate (glyphosate has little to no soil residual or root uptake under most field situations). To illustrate, cogongrass can be very effectively controlled with imazapyr, but imazapyr has residual soil activity and can be taken up by tree roots that extend into the treated area, resulting in injured or dead trees. Glyphosate, although not quite as effective as imazapyr, is a valuable herbicide for cogongrass control, and there is little to no danger of uptake by tree roots. An alternative to glyphosate that can be used safely around trees is fluazifop, but it is not as effective on cogongrass as is glyphosate and has minimal to no activity on broadleaved weeds. Many of the broadleaf herbicides pose some risk to root uptake and injury to trees. There is a need to evaluate methods to minimize possible development of herbicide resistance, including finding alternatives to glyphosate that have different modes of action, but are equally effective and environmentally compatible, and that could be used in rotation with glyphosate. The same principle applies to possible resistance being developed to other herbicides.

REASONABLE REQUIREMENTS FOR EXOTIC AND NUISANCE PLANT CONTROL

A policy or sentiment has been expressed by some regulatory agencies to control all exotic plant species on mined lands. Efforts to control all exotic plant species (including minor, non-invasive ones) often cause mortality to non-target desirable vegetation and can lead to additional encroachment by nuisance species, some of which may be truly problem invasives. Many of the exotic plant species found on reclaimed phosphate mine lands are not invasive and are found in low densities (1-3% or often much less than 1.0%). Various exotic or native plant species may become abundant and competitive during the early stages of vegetation community establishment and may require control to promote desirable plant establishment. However, in well established plant communities awaiting regulatory release, perhaps emphasis should be placed on controlling Florida Exotic Pest Plant Council (FLEPPC) category I and II invasive plant species.

PLANTING DENSITY

Planting at low density intuitively seems less expensive, and if there were no exotic invasive plants or other weeds to worry about, those spaced plantings should eventually fill-in. Unfortunately, there are numerous invasive plants poised to invade disturbed sites and fill-in the spaces between the intentionally planted plants. Planting at greater density fills more space immediately and also provides greater competition to help keep out or eliminate weeds. Because of the high cost of repeated weed control efforts, it may be more cost effective to plant at greater density and reduce the amount of weed control efforts. The question not completely answered is: what are the optimum cost effective planting densities for various plant species in various reclaimed plant communities?

This manual recommends higher density vegetation plantings for new reclamation projects. Lower densities of nuisance and exotic vegetation encroachment have been observed within reclaimed areas that have included higher density plantings during initial construction. Careful research has not yet been conducted to quantify or confirm these observations or the cost effectiveness of higher density planting during initial reclamation construction.

TOPSOIL STOCKPILING

Some research and field demonstrations (much of it unpublished) have been done throughout the country on stockpiling of topsoil prior to spreading on a reclaimed site. The general observation has been reduced viability of plant propagules (seeds, rhizomes, root fragments, etc.) with time and contamination with propagules of weeds that invade the stockpiles. Direct transfer of topsoil is better than stockpiling for avoiding problems of desirable plant propagule mortality and invasion of nuisance plants while the soil is stockpiled. Short-term stockpiling is better than long term stockpiling. An interesting concept that has been tried is burning a site that is to be mined to promote flowering and seed production of desirable, fire-adapted plant species and then directly transferring the topsoil with the enhanced seed content to a reclamation site.

PLANT IDENTIFICATION

Correct plant identification is critical to the management of nuisance and exotic plants. Several references useful for identification of exotic and nuisance plants and also desirable native plants are available and listed in the first portion of the References section. The land manager is often faced with the problem of identifying various undesirable and desirable plants at various growth stages. Unfortunately, most identification references deal with more mature plants with flowers or fruits/seeds present. An additional manual that provides information for identifying plants using vegetative characteristics at earlier growth stages would be very helpful. It is also essential that those conducting nuisance and exotic plant management obtain the necessary training to be able to accurately identify nuisance and exotic plant species and to be able to distinguish them from the native desirable vegetation.

BIOCONTROL

The development of biological controls for various exotic invasive plants is a long term process because of the need to not only find insect or disease organisms that are effective on the target weeds but are also safe to release into the environment with no harm to related desirable plants. We encourage research on development of biological controls but recognize that chemical control will likely be the mainstay for invasive and nuisance plant control for the near future. It may also be difficult to find effective biological controls for plants that tend to be dominant in their native home ranges.

SOIL AND HYDROLOGIC CONDITIONS

Efforts should be made when reclaiming mined lands to produce soil and hydrologic conditions that favor the desired vegetation communities. This is accomplished on mined lands by appropriate placement of sand tailings, overburden and topsoil, and by careful attention to appropriate contours and elevations in relation to the water table and the watershed. On sites where such construction or modification efforts are not feasible, it is particularly important that vegetation with the appropriate ecological and hydrological characteristics and adaptations be matched to the site conditions. Questions have arisen as to the possibility and feasibility of modifying minesoils or fertilized and limed agricultural soils that may have higher pH and nutrient levels than many native upland soils. On sites being restored to native plant communities throughout the country, methods have been tried to reduce available nitrogen (such as adding sawdust or sugar to the soil to encourage tie-up of nitrogen by microorganisms) with the idea of favoring establishment of native vegetation with relatively lower nutrient requirements over weeds that may flourish under high nutrient conditions. The results of such efforts have been somewhat mixed but mostly not very successful or practical. The pH of soils can be reduced by adding elemental sulfur and allowing microbes to produce more acidic conditions. Increases in organic matter are often associated with decreases in pH. Natural weathering processes also lead to pH reductions. Many exotic weeds seem to do well on a wide variety of native soils and mine-derived soils with pH values ranging from 4 to nearly 8, so we think that pH modification may have minimal beneficial effect on weed management. Nutrient and water holding capacity (and site hydrology) are more important than pH.

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APPENDIX A

NUISANCE AND EXOTIC SPECIES TABLES

The following is a key to codes listed in the following tables.

FDEP STATUS

UPL	Upland plant
FAC	Facultative plant
FACW	Facultative wetland plant
OBL	Obligate wetland plant
AQU	Aquatic plant
NL Vine	Not listed vine per Ch. 62-240, FAC
NL	Not listed per Ch. 62-340, FAC

ACOE STATUS

UPL	Upland plant
FACU	Facultative upland plant
FAC	Facultative plant
FACW	Facultative wetland plant
OBL	Obligate wetland plant
AQU	Aquatic plant
NL	Not listed on the 2012 National Wetland Plant List

NUISANCE LISTING

I	FLEPPC category I nuisance species
II	FLEPPC category II nuisance species
H	Hillsborough County, Florida nuisance species

*All species not provided nuisance listings are considered exotic per the University of South Florida Plant Atlas.

Table A-1. Total Exotic and Nuisance Species Identified on Reclaimed Phosphate Lands.

Scientific Name	Common Name	FDEP Status	ACOE Status	Nuisance Listing*
Abrus precatorius	Rosary Pea	UPL	UPL	I
Abutilon theophrasti	Velvetleaf	UPL	FACU	
Aeschynomene indica	India Jointvetch	FACW	FACW	
Agrostis stolonifera	Redtop	FACW	FACW	
Alternanthera ficoidea	Slender Joyweed	UPL	UPL	
Alternanthera philoxeroides	Alligatorweed	OBL	OBL	II
Alternanthera sessilis	Sessile Joyweed	OBL	FACU	
Alysicarpus ovalifolius	False Moneywort	UPL	UPL	
Amaranthus spinosus	Spiny Amaranth	UPL	FACU	
Anagallis arvensis	Scarlet Pimpernel	UPL	FACU	
Ardisia crenata	Scratchthroat	FAC	UPL	I
Azolla filiculoides	Mosquito Fern	AQU	OBL	H
Begonia cucullata	Wax Begonia	UPL	UPL	II
Bidens pilosa	Spanish Needles	FAC	FACW	
Bulbostylis barbata	Watergrass	UPL	FAC	
Casuarina spp.	Australian Pine	FAC	FACU	I
Centella asiatica	Asian Coinwort	FACW	FACW	H
Ceratopteris thalictroides	Watersprite	NL	OBL	
Chamaesyce mendezii	Mendez's Sandmat	UPL	UPL	
Chenopodium ambroisoides	Mexican-Tea	UPL	FACU	
Chloris spp. (except *C. elata*)	Fingergrass	UPL	UPL	
Cichorium intybus	Chicory	UPL	UPL	
Cinnamomum camphora	Camphor Tree	UPL	FACU	I
Colocasia esculenta	Wild Taro	OBL	FACW	I
Commelina diffusa	Dayflower	FACW	FACW	
Commelina gambiae	Gambian Dayflower	FACW	FACW	
Crotalaria lanceolata	Lanceleaf Rattle-Box	UPL	UPL	
Crotalaria pallida var. *obovata*	Smooth Rattlebox	UPL	UPL	
Crotalaria spectabilis	Showy Rattlebox	UPL	UPL	
Cuphea carthagenensis	Colombian Waxweed	FAC	FACW	
Cynodon dactylon	Bermudagrass	UPL	FACU	
Cyperus alopecuroides	Foxtail Flatsedge	FACW	FACW	
Cyperus difformis	Variable Flatsedge	OBL	OBL	

Table A-1 (Cont.). Total Exotic and Nuisance Species Identified on Reclaimed Phosphate Lands.

Scientific Name	Common Name	FDEP Status	ACOE Status	Nuisance Listing*
Cyperus esculentus	Yellow Nutsedge	FAC	FAC	
Cyperus involucratus	Umbrella Plant	OBL	OBL	II
Cyperus iria	Ricefield Flatsedge	FACW	FACW	
Cyperus lanceolatus	Epiphytic Flatsedge	OBL	FACW	
Cyperus pumilus	Low Flatsedge	FACW	FACW	
Cyperus rotundus	Nutgrass	FAC	FACW	
Dactyloctenium aegyptium	Crowfootgrass	UPL	UPL	II
Desmodium incanum	Zarzabacoa Comun	UPL	UPL	
Desmodium tortuosum	Dixie Ticktrefoil	UPL	UPL	
Desmodium triflorum	Threeflower Ticktrefoil	UPL	FACU	
Digitaria longiflora	Southern Crabgrass	UPL	UPL	
Digitaria violascens	Violet Crabgrass	UPL	UPL	
Dioscorea alata	White Yam	UPL	UPL	I
Dioscorea bulbifera	Air-Potato	NL	UPL	I
Drymaria cordata	West Indian Chickweed	FAC	FAC	
Echinochloa colona	Jungle Rice	FACW	FACW	
Echinochloa crusgalli	Barnyard Grass	FACW	FACW	
Egeria densa	Brazilian Waterweed	AQU	OBL	
Eichhornia crassipes	Water-Hyacinth	AQU	OBL	I
Eleusine indica	Indian Goosegrass	UPL	FACU	
Emilia spp.	Tasselflower	UPL	UPL	
Eragrostis atrovirens	Thalia Lovegrass	FAC	FAC	
Eragrostis ciliaris	Gophertail Lovegrass	FAC	FACU	
Eupatorium capillifolium	Dogfennel	FAC	FACU	H
Fimbristylis littoralis	Grasslike Fimbry	OBL	OBL	
Fimbristylis schoenoides	Ditch Fimbry	OBL	FACW	
Fumaria officinalis	Drug Fumitory	UPL	UPL	
Gamochaeta pensylvanica	Pennsylvania Everlasting	UPL	FACU	
Gomphrena serrata	Prostrate Globe Amaranth	UPL	UPL	
Hemarthria altissima	Limpograss	UPL	UPL	II
Heteranthera limosa	Blue Mudplantain	UPL	OBL	
Hydrilla verticillata	Hydrilla	AQU	OBL	I

Table A-1 (Cont.). Total Exotic and Nuisance Species Identified on Reclaimed Phosphate Lands.

Scientific Name	Common Name	FDEP Status	ACOE Status	Nuisance Listing*
Hygrophila polysperma	Indian Swampweed	OBL	OBL	I
Hymenachne amplexicaulis	Trompetilla	OBL	OBL	I
Hyptis mutabilis	Tropical Bushmint	UPL	FAC	
Hyptis verticillata	John Charles	UPL	UPL	
Imperata cylindrica	Cogongrass	UPL	UPL	I
Ipomoea aquatica	Water-Spinach	AQU Vine NL	AQU Vine NL	I
Indigofera hirsuta	Hairy Indigo	UPL	UPL	
Ipomoea quamoclit	Cypressvine	NL Vine	FACU	
Ipomoea triloba	Littlebell	NL Vine	UPL	
Kummerowia striata	Japanese Clover	UPL	FACU	
Kyllinga brevifolia	Shortleaf Spikesedge	FACW	FACW	
Lantana camara	Lantana	UPL	UPL	I
Leucaena leucocephala	White Leadtree	UPL	FACU	II
Lindernia crustacea	Malaysian False Pimpernel	FAC	FACU	
Ludwigia octovalvis	Mexican Primrose Willow	OBL	OBL	H
Ludwigia peruviana	Primrose Willow	OBL	OBL	I
Lygodium japonicum	Japanese Climbing Fern	NL Vine	FAC	I
Lygodium microphyllum	Small-Leaf Climbing Fern	NL Vine	UPL	I
Macroptilium lathyroides	Wild Bushbean	UPL	FACU	
Melaleuca quinquenervia	Melaleuca	FAC	FAC	I
Melia azedarach	Chinaberry Tree	UPL	UPL	II
Medicago lupulina	Black Medic	UPL	FACU	
Melinis repens Syn. *Rhynchelytrum repens*	Rose Natalgrass	UPL	UPL	I
Melochia corchorifolia	Chocolateweed	FAC	FAC	
Mikania scandens	Climbing Hempvine	NL	FACW	
Mollugo verticillata	Indian Chickweed	UPL	FAC	
Momordica balsamina	Southern Balsampear	UPL	UPL	
Momordica charantia	Balsampear	NL	UPL	
Morrenia odorata	Latexplant	NL	UPL	
Murdannia nudiflora	Nakedstem Dewflower	FAC	FAC	

Table A-1 (Cont.). Total Exotic and Nuisance Species Identified on Reclaimed Phosphate Lands.

Scientific Name	Common Name	FDEP Status	ACOE Status	Nuisance Listing*
Myriophyllum aquaticum	Parrot Feather Watermilfoil	AQU	OBL	
Nephrolepis cordifolia	Tuberous Swordfern	FAC	UPL	I
Nephrolepis brownie	Asian Swordfern	FAC	UPL	I
Oldenlandia corymbosa	Flattop Mille Graines	FACW	FACW	
Paederia foetida	Skunkvine	NL Vine	FACU	I
Panicum maximum	Guineagrass	UPL	FAC	II
Panicum repens	Torpedograss	FACW	FACW	I
Paspalum acuminatum	Brook Crowngrass	FACW	OBL	
Paspalum notatum	Bahiagrass	UPL	FACU	
Paspalum urvillei	Vaseygrass	FAC	FAC	
Pennisetum purpureum	Elephantgrass	FAC	FAC	I
Phyllanthus tenellus	Mascarene Island Leafflower	UPL	UPL	
Phyllanthus urinaria	Chamber Bitter	FAC	FAC	
Pistia stratiotes	Water-Lettuce	AQU	OBL	I
Polygonum lapathifolium	Pale Smartweed	OBL	FACW	H
Polygonum orientale	Kiss-Me-Over-Garden-Gate	UPL	FACU	
Portulaca amilis	Paraguayan Purslane	UPL	UPL	
Psidium guajava	Guava	UPL	FACU	I
Pueraria montana var. *lobata*	Kudzu	UPL	UPL	I
Richardia brasiliensis	Tropical Mexican Clover	UPL	UPL	
Richardia grandiflora	Largeflower Mexican Clover	UPL	UPL	
Richardia scabra	Rough Mexican Clover	UPL	UPL	
Ricinus communis	Castorbean	UPL	FACU	II
Sacciolepis indica	Indian Cupscale	FAC	FAC	
Salvinia spp.	Water Spangles	AQU	OBL	I
Sapium sebiferum	Chinese Tallowtree	FAC	FAC	I
Schinus terebinthifolia	Brazilian Pepper	FAC	FAC	I
Oxycaryum cubensis	Cuban Bulrush	OBL	OBL	
Senna obtusifolia	Sicklepod	UPL	UPL	
Sesbania herbacea	Danglepod	FAC	FACW	

Table A-1 (Cont.). Total Exotic and Nuisance Species Identified on Reclaimed Phosphate Lands.

Scientific Name	Common Name	FDEP Status	ACOE Status	Nuisance Listing*
Sesbania punicea	Rattlebox	FAC	FAC	II
Sesbania vesicaria	Bladderpod	FAC	FAC	
Sesbania virgata	Wand Riverhemp	FAC	UPL	
Solanum viarum	Tropical Soda Apple	NL	UPL	I
Sonchus asper	Spiny Sowthistle	UPL	FAC	
Sonchus oleraceus	Common Sowthistle	UPL	FACU	
Sphenoclea zeylanica	Chickenspike	FACW	OBL	
Sporobolus indicus	Smutgrass	UPL	FACU	
Stellaria media	Common Chickweed	UPL	FACU	
Trifolium repens	White Clover	UPL	FACU	
Typha spp.	Cattail	OBL	OBL	
Urena lobata	Caesarweed	UPL	FACU	I
Urochloa mutica	Paragrass	FACW	FACW	I
Verbena brasiliensis	Brazilian Verbena	UPL	FAC	
Wahlenbergia marginata	Southern Rockbell	UPL	UPL	
Wolffia globosa	Asian Watermeal	AQU	AQU	
Zeuxine strateumatica	Lawn Orchid	UPL	FAC	

Table A-2. Exotic and Nuisance Species List—FLUCFCS Group A (211 and 213).

Scientific Name	Common Name	FDEP Status	ACOE Status	Nuisance Listing*
Abrus precatorius	Rosary Pea	UPL	UPL	I
Ardisia crenata	Scratchthroat	FAC	UPL	I
Casuarina spp.	Australian Pine	FAC	FACU	I
Chamaesyce mendezii	Mendez Sandmat	UPL	UPL	
Cinnamomum camphora	Camphor Tree	UPL	FACU	I
Dioscorea alata	White Yam	UPL	UPL	I
Dioscorea bulbifera	Air-Potato	NL	UPL	I
Eleusine indica	Indian Goosegrass	UPL	FACU	
Eupatorium capillifolium	Dogfennel	FAC	FACU	H
Hemarthria altissima	Limpograss	UPL	UPL	II
Hyptis mutabilis	Tropical Bushmint	UPL	FAC	
Hyptis verticillata	John Charles	UPL	UPL	
Imperata cylindrica	Cogongrass	UPL	UPL	I
Indigofera hirsuta	Hairy Indigo	UPL	UPL	
Lantana camara	Lantana	UPL	UPL	I

Table A-2 (Cont.). Exotic and Nuisance Species List—FLUCFCS Group A (211 and 213).

Scientific Name	Common Name	FDEP Status	ACOE Status	Nuisance Listing*
Leucaena leucocephala	Lead Tree	UPL	FACU	II
Lygodium japonicum	Japanese Climbing Fern	NL	FAC	I
Lygodium microphyllum	Small-Leaf Climbing Fern	NL	UPL	I
Melaleuca quinquenervia	Melaleuca	UPL	FACU	I
Melia azedarach	Chinaberry Tree	UPL	UPL	II
Melinis repens syn. *Rhynchelytrum repens*	Natalgrass	UPL	UPL	I
Momordica balsamina	Southern Balsam Pear	UPL	UPL	
Momordica charantia	Wild Balsam Apple	NL	UPL	
Nephrolepis cordifolia	Tuberous Swordfern	FAC	UPL	I
Nephrolepis brownii	Asian Swordfern	FAC	UPL	I
Paederia foetida	Skunkvine	NL Vine	FACU	I
Panicum maximum	Guineagrass	UPL	FAC	
Paspalum urvillei	Vaseygrass	FAC	FAC	
Pennisetum purpureum	Napiergrass	UPL	UPL	I
Pueraria montana	Kudzu	UPL	UPL	I
Richardia brasiliensis	Tropical Mexican Clover	UPL	UPL	
Richardia grandiflora	Largeflower Mexican Clover	UPL	UPL	
Richardia scabra	Rough Mexican Clover	UPL	UPL	
Ricinus communis	Castorbean	UPL	FACU	II
Sapium sebiferum	Chinese Tallow Tree	FAC	FAC	I
Schinus terebinthifolius	Brazilian Pepper	FAC	FAC	I
Sesbania punicea	Rattle-Bush	UPL	UPL	II
Solanum viarum	Tropical Soda Apple	NL	UPL	I
Sonchus asper	Spiny-Leaved Sow Thistle	UPL	FAC	
Sporobolus indicus	Smutgrass	UPL	UPL	
Urena lobata	Caesar-Weed	UPL	FACU	I

Table A-3. Exotic and Nuisance Species List—FLUCFCS Group B (320, 321, 330, 410, and 411).

Scientific Name	Common Name	FDEP Status	ACOE Status	Nuisance Listing*
Abrus precatorius	Rosary Pea	UPL	UPL	I
Alternanthera ficoidea	Slender Joyweed	UPL	UPL	
Alysicarpus ovalifolius	False Moneywort	UPL	UPL	
Amaranthus spinosus	Spiny Amaranth	UPL	FACU	
Anagallis arvensis	Scarlet Pimpernel	UPL	FACU	
Ardisia crenata	Scratchthroat	FAC	UPL	I
Bidens pilosa	White Beggar-Ticks	UPL	UPL	
Bulbostylis barbata	Watergrass	UPL	FAC	
Casuarina spp.	Australian Pine	FAC	FACU	I
Chamaesyce mendezii	Mendez Sandmat	UPL	UPL	
Chenopodium ambrosoides	Mexican-Tea	UPL	FACU	
Chloris spp. (except *C. elata*)	Fingergrass	UPL	UPL	
Cinnamomum camphora	Camphor Tree	UPL	FACU	I
Crotalaria pallida	Rattle-Box	UPL	UPL	
Crotalaria spectabilis	Rattle-Box	UPL	UPL	
Cuphea carthagenensis	Columbia Waxweed	FAC	FACW	
Cynodon dactylon	Bermuda Grass	UPL	FACU	
Cyperus esculentus	Yellow Nutsedge	FAC	FAC	
Dactyloctenium aegyptium	Crowfootgrass	UPL	UPL	
Desmodium incanum	Zarzabacao Comun	UPL	UPL	II
Desmodium tortuosum	Dixie Ticktrefoil	UPL	UPL	
Desmodium triflorum	Beggarweed	UPL	UPL	
Digitaria longifloria	Indian Crabgrass	UPL	UPL	
Dioscorea alata	White Yam	UPL	UPL	I
Dioscorea bulbifera	Air-Potato	NL	UPL	I
Eleusine indica	Indian Goosegrass	UPL	FACU	
Emilia spp.	Tasselflower	UPL	UPL	
Eragrostis atrovirens	Thalia Lovegrass	FAC	FAC	
Eragrostis ciliaris	Gophertail Lovegrass	FAC	FACU	
Eupatorium capillifolium	Dogfennel	FAC	FACU	H
Fumaria officinalis	Drug Fumitory	UPL	UPL	
Gamochaeta pensylvanica	Pennsylvania Everlasting	UPL	FACU	
Gomphrena serrata	Arrasa Con Todo	UPL	UPL	
Hemarthria altissima	Limpograss	UPL	UPL	II

Table A-3 (Cont.). Exotic and Nuisance Species List—FLUCFCS Group B (320, 321, 330, 410, and 411).

Scientific Name	Common Name	FDEP Status	ACOE Status	Nuisance Listing*
Hyptis mutabilis	Tropical Bushmint	UPL	FAC	
Hyptis verticillata	John Charles	UPL	UPL	
Imperata cylindrica	Cogongrass	UPL	UPL	I
Indigofera hirsuta	Hairy Indigo	UPL	UPL	
Ipomoea quamoclit	Cypressvine	NL	FACU	
Kummerowia striata	Japanese Clover	UPL	FACU	
Lantana camara	Lantana	UPL	UPL	I
Leucaena leucocephala	Lead Tree	UPL	FACU	II
Lindernia crustacea	Malayan False Pimpernel	FAC	FACU	
Lygodium japonicum	Japanese Climbing Fern	NL	FAC	I
Lygodium microphyllum	Small-Leaf Climbing Fern	NL	UPL	I
Macroptilium lathyroides	Wild Bushbean	UPL	FACU	I
Melaleuca quinquenervia	Melaleuca	UPL	FACU	I
Melia azederach	Chinaberry Tree	UPL	UPL	II
Melinis repens syn. *Rhynchelytrum repens*	Natalgrass	UPL	UPL	I
Mollogo verticillata	Carpetweed	UPL	FAC	
Momordica balsamina	Southern Balsam Pear	UPL	UPL	
Momordica charantia	Wild Balsam Apple	NL	UPL	
Morrenia odorata	Latexplant	NL	UPL	
Murdannia nudiflora	Naked-Stem Dewflower	FAC	FAC	
Nephrolepis cordifolia	Tuberous Swordfern	FAC	UPL	I
Nephrolepis brownii	Asian Sword Fern	FAC	UPL	I
Oldenlandia corymbosa	Flattop Mille Graines	UPL	UPL	
Paederia foetida	Stink Vine	UPL	FACU	I
Panicum maximum	Guineagrass	UPL	FAC	II
Paspalum notatum	Bahia Grass	UPL	FACU	
Paspalum urvillei	Vaseygrass	FAC	FAC	
Pennisetum purpureum	Napier Grass	UPL	UPL	I
Portulaca amilis	Purslane	UPL	UPL	
Pueraria montana	Kudzu	UPL	UPL	I

Table A-3 (Cont.). Exotic and Nuisance Species List—FLUCFCS Group B (320, 321, 330, 410, and 411).

Scientific Name	Common Name	FDEP Status	ACOE Status	Nuisance Listing*
Richardia brasiliensis	Tropical Mexican Clover	UPL	UPL	
Richardia grandiflora	Largeflower Mexican Clover	UPL	UPL	
Richardia scabra	Rough Mexican Clover	UPL	UPL	
Ricinus communis	Castorbean	UPL	FACU	II
Sapium sebiferum	Chinese Tallow Tree	FAC	FAC	I
Schinus terebinthifolius	Brazilian Pepper	FAC	FAC	I
Sesbania punicea	Rattle-Bush	UPL	UPL	II
Solanum viarum	Tropical Soda Apple	NL	UPL	I
Sonchus asper	Spiny-Leaved Sow Thistle	UPL	FAC	
Sporobolus indicus	Smutgrass	UPL	UPL	
Stellaria media	Common Chickweed	UPL	FACU	
Urena lobata	Caesar-Weed	UPL	FACU	I
Wahlenbergia marginata	Southern Rockbell	UPL	UPL	
Zeuxine strateumatica	Lawn Orchid	UPL	FAC	

Table A-4. Exotic and Nuisance Species List—FLUCFCS Group C (410, 414, 420, 421, 425, 427, 430, 434, and 438).

Scientific Name	Common Name	FDEP Status	ACOE Status	Nuisance Listing*
Abrus precatorius	Rosary Pea	UPL	UPL	I
Abutilon theophrasti	Velvetleaf	UPL	FACU	
Aeschynomene indica	India Joint-Vetch	FACW	FACW	H
Agrostis stolonifera	Redtop	FACW	FACW	
Alysicarpus ovalifolius	False Moneywort	UPL	UPL	
Ardisia crenata	Scratchthroat	FAC	UPL	I
Bulbostylis barbata	Watergrass	UPL	FAC	
Casuarina spp.	Australian Pine	FAC	FACU	I
Chenopodium ambrosoides	Mexican-Tea	UPL	FACU	
Cinnamomum camphora	Camphor Tree	UPL	FACU	I
Colocasia esculenta	Wild Taro	OBL	FACW	
Commelina diffusa	Dayflower	FACW	FACW	
Commelina gambiae	Gambian Dayflower	FACW	FACW	

Table A-4 (Cont.). Exotic and Nuisance Species List—FLUCFCS Group C (410, 414, 420, 421, 425, 427, 430, 434, and 438).

Scientific Name	Common Name	FDEP Status	ACOE Status	Nuisance Listing*
Crotalaria lanceolata	Rattlebox	UPL	UPL	
Crotalaria pallida	Rattlebox	UPL	UPL	
Crotalaria spectabilis	Rattlebox	UPL	UPL	
Cuphea carthagenensis	Columbia Waxweed	FAC	FACW	
Cynodon dactylon	Bermudagrass	UPL	FACU	
Cyperus esculentus	Yellow Nutsedge	FAC	FAC	
Cyperus rotundus	Nutgrass	FAC	FACW	
Dactyloctenium aegyptium	Crowfootgrass	UPL	UPL	II
Desmodium incanum	Zarzabacao Comun	UPL	UPL	
Desmodium triflorum	Beggarweed	UPL	UPL	
Dioscorea alata	White Yam	UPL	UPL	I
Dioscorea bulbifera	Air-Potato	NL	UPL	I
Drymaria cordata	West Indian Chickweed	FAC	FAC	
Echinochloa colona	Jungle-Rice	FACW	FACW	
Echinochloa crusgalli	Barnyardgrass	FACW	FACW	
Eleusine indica	Indian Goosegrass	UPL	FACU	
Emilia spp.	Tasselflower	UPL	UPL	
Eragrostis atrovirens	Thalia Lovegrass	FAC	FAC	
Eupatorium capillifolium	Dogfennel	FAC	FACU	H
Hemarthria altissima	Limpograss	UPL	UPL	I
Hymenachne amplexicaulis	Trompetilla	OBL	OBL	I
Hyptis verticillata	John Charles	UPL	UPL	
Imperata cylindrica	Cogongrass	UPL	UPL	
Indigofera hirsuta	Hairy Indigo	UPL	UPL	
Ipomoea quamoclit	Cypressvine	NL	FACU	
Ipomoea triloba	Littlebell	NL	NL	
Kummerowia striata	Japanese Clover	UPL	FACU	
Kyllinga brevifolia	Shortleaf Spikesedge	FACW	FACW	
Lantana camara	Lantana	UPL	UPL	I
Leucaena leucocephala	Lead Tree	UPL	FACU	II
Lindernia crustacea	Malayan False Pimpernel	FAC	FACU	
Lindernia crustacea	Malayan False Pimpernel	FAC	FACU	

Table A-4 (Cont.). Exotic and Nuisance Species List—FLUCFCS Group C (410, 414, 420, 421, 425, 427, 430, 434, and 438).

Scientific Name	Common Name	FDEP Status	ACOE Status	Nuisance Listing*
Lygodium japonicum	Japanese Climbing Fern	NL	FAC	I
Lygodium microphyllum	Small-Leaf Climbing Fern	NL	FAC	I
Macroptilium lathyroides	Wild Bushbean	UPL	FACU	
Medicago lupulina	Black Medic	UPL	FACU	
Melaleuca quinquenervia	Melaleuca	UPL	FACU	I
Melia azederach	Chinaberry Tree	UPL	UPL	II
Melinis repens syn. *Rhynchelytrum repens*	Natalgrass	UPL	UPL	
Melochia corchorifolia	Chocolateweed	FAC	FAC	
Mikania scandens	Climbing Hempvine	NL	FACW	
Momordica charantia	Wild Balsam Apple	NL	UPL	
Murdannia nudiflora	Naked-Stem Dewflower	FAC	FAC	
Myriophyllum aquaticum	Parrot's Feather	OBL	OBL	
Nephrolepis cordifolia	Tuberous Swordfern	FAC	UPL	I
Nephrolepis brownii	Asian Swordfern	FAC	UPL	I
Oldenlandia corymbosa	Flattop Mille Graines	FACW	FAC	
Paederia foetida	Stink Vine	UPL	FACU	I
Panicum maximum	Guineagrass	UPL	FAC	II
Panicum repens	Torpedograss	FACW	FACW	I
Paspalum acuminatum	Brook Paspalum	FACW	OBL	
Paspalum notatum	Bahiagrass	UPL	FACU	
Paspalum urvillei	Vaseygrass	FAC	FAC	
Phyllanthus tenellus	Mascarene Island Leaf-Flower	UPL	UPL	
Phyllanthus urinaria	Chamberbitter	FAC	FAC	
Portulaca amilis	Purslane	UPL	UPL	
Psidium guajava	Guava	UPL	FACU	
Pueraria montana	Kudzu	UPL	UPL	I
Richardia brasiliensis	Richardia	UPL	UPL	
Richardia grandiflora	Largeflower Mexican Clover	UPL	UPL	
Richardia scabra	Richardia	UPL	UPL	
Sacciolepis indica	Glenwoodgrass	FAC	FAC	
Sapium sebiferum	Chinese Tallow Tree	FAC	FAC	I

Table A-4 (Cont.). Exotic and Nuisance Species List—FLUCFCS Group C (410, 414, 420, 421, 425, 427, 430, 434, and 438).

Scientific Name	Common Name	FDEP Status	ACOE Status	Nuisance Listing*
Ricinus communis	Castorbean	UPL	FACU	II
Schinus terebinthifolius	Brazilian Pepper	FAC	FAC	I
Senna obtusifolia	Sicklepod	UPL	UPL	
Sesbania herbacea	Danglepod	FAC	FACW	
Sesbania punicea	Rattlebush	UPL	UPL	II
Sesbania vesicaria	Bladderpod	FAC	FAC	
Solanum viarum	Tropical Soda Apple	UPL	UPL	I
Sonchus asper	Spiny-Leaved Sow Thistle	UPL	FAC	
Sonchus oleraceus	Common Sowthistle	UPL	FACU	
Sphenoclea zeylandica	Chickenspike	FACW	OBL	
Sporobolus indicus	Smutgrass	UPL	UPL	
Typha spp.	Cattail	OBL	OBL	
Urena lobata	Caesar-Weed	UPL	FACU	I
Urochloa mutica	Paragrass	FACW	FACW	I
Verbena brasiliensis	Verbena	UPL	FAC	
Wahlenbergia marginata	Southern Rockbell	UPL	UPL	

Table A-5. Exotic and Nuisance Species List—FLUCFCS Group D (610, 611, 615, 617, 620, 621, 625, 630, and 631).

Scientific Name	Common Name	FDEP Status	ACOE Status	Nuisance Listing*
Aeschynomene indica	India Joint-Vetch	FACW	FACW	
Abutilon theophrasti	Velvetleaf	UPL	FACU	
Aeschynomene indica	India Joint-Vetch	FACW	FACW	H
Agrostis stolonifera	Redtop	FACW	FACW	
Alternanthera philoxeroides	Alligatorweed	OBL	OBL	II
Alternanthera sessilis	Sessile Joyweed	FACU	OBL	
Alysicarpus ovalifolius	False Moneywort	UPL	UPL	
Azolla filiculoides	Mosquito Fern	AQU	OBL	II
Begonia cucullata	Wax Begonia	UPL	UPL	II
Bulbostylis barbata	Watergrass	UPL	FAC	
Casuarina spp.	Australian Pine	FAC	FACU	I
Centella asiatica	Asian Coinwort	FACW	FACW	H
Ceratopteris thalictroides	Watersprite	OBL	OBL	

Table A-5 (Cont.). Exotic and Nuisance Species List—FLUCFCS Group D (610, 611, 615, 617, 620, 621, 625, 630, and 631).

Scientific Name	Common Name	FDEP Status	ACOE Status	Nuisance Listing*
Chenopodium ambrosoides	Mexican-Tea	UPL	FACU	
Colocasia esculenta	Wild Taro	OBL	FACW	I
Commelina diffusa	Dayflower	FACW	FACW	
Commelina gambiae	Gambian Dayflower	FACW	FACW	
Crotalaria lanceolata	Rattlebox	UPL	UPL	
Crotalaria pallida	Rattlebox	UPL	UPL	
Crotalaria spectabilis	Rattlebox	UPL	UPL	
Cuphea carthagenensis	Columbia Waxweed	FAC	FACW	
Cynodon dactylon	Bermudagrass	UPL	FACU	
Cyperus alopecuroides	Foxtail Flatsedge	FACW	UPL	
Cyperus difformis	Variable Flatsedge	OBL	OBL	
Cyperus esculentus	Yellow Nutsedge	FAC	FAC	
Cyperus iria	Rice Flatsedge	FACW	FACW	
Cyperus lanceolatus	Epiphytic Flatsedge	OBL	FACW	
Cyperus rotundus	Nutgrass	FAC	FACW	
Dactyloctenium aegyptium	Crowfootgrass	UPL	UPL	II
Desmodium incanum	Zarzabacao Comun	UPL	UPL	
Desmodium triflorum	Beggarweed	UPL	UPL	
Dioscorea bulbifera	Air-Potato	NL	UPL	I
Drymaria cordata	West Indian Chickweed	FAC	FAC	
Echinochloa colona	Jungle-Rice	FACW	FACW	
Echinochloa crusgalli	Barnyard Grass	FACW	FACW	
Egeria densa	Brazilian Elodea	OBL	OBL	
Eichhornia crassipes	Water-Hyacinth	OBL	OBL	I
Eleusine indica	Indian Goosegrass	UPL	FACU	
Emilia spp.	Tasselflower	UPL	UPL	
Eragrostis atrovirens	Thalia Lovegrass	FAC	FAC	
Eupatorium capillifolium	Dogfennel	FAC	FACU	H
Fimbristylis littoralis	Grasslike Fimbry	OBL	OBL	
Hemarthria altissima	Limpograss	UPL	UPL	II
Hydrilla verticillata	Hydrilla	OBL	OBL	I
Hygrophila polysperma	East Indian Hygrophilla	OBL	OBL	I
Hymenachne amplexicaulis	Trompetilla	OBL	OBL	I
Hyptis verticillata	John Charles	UPL	UPL	

Table A-5 (Cont.). Exotic and Nuisance Species List—FLUCFCS Group D (610, 611, 615, 617, 620, 621, 625, 630, and 631).

Scientific Name	Common Name	FDEP Status	ACOE Status	Nuisance Listing*
Imperata cylindrica	Cogongrass	UPL	UPL	I
Indigofera hirsuta	Hairy Indigo	UPL	UPL	
Ipomoea aquatica	Water Spinach	AQU Vine NL	AQU Vine NL	I
Ipomoea quamoclit	Cypressvine	NL	FACU	
Ipomoea triloba	Littlebell	NL	NL	
Kummerowia striata	Japanese Clover	UPL	FACU	
Kyllinga brevifolia	Shortleaf Spikesedge	FACW	FACW	
Lantana camara	Lantana	UPL	UPL	I
Lindernia crustacea	Malayan False Pimpernel	FAC	FACU	
Lindernia crustacea	Malayan False Pimpernel	FAC	FACU	
Ludwigia octovalvis	Large Seedbox	OBL	OBL	H
Ludwigia peruviana	Primrose Willow	OBL	OBL	I
Lygodium japonicum	Japanese Climbing Fern	NL	FAC	I
Lygodium microphyllum	Small-Leaf Climbing Fern	NL	FAC	I
Macroptilium lathyroides	Wild Bushbean	UPL	FACU	
Medicago lupulina	Black Medic	UPL	FACU	
Melaleuca quinquenervia	Melaleuca	UPL	FACU	I
Melinis repens syn. *Rhynchelytrum repens*	Natalgrass	UPL	UPL	
Melochia corchorifolia	Chocolateweed	FAC	FAC	
Mikania scandens	Climbing Hempvine	NL	FACW	
Momordica charantia	Wild Balsam Apple	NL	UPL	
Murdannia nudiflora	Naked-Stem Dewflower	FAC	FAC	
Myriophyllum aquaticum	Parrot's Feather	OBL	OBL	
Nephrolepis cordifolia	Tuberous Swordfern	FAC	UPL	I
Oldenlandia corymbosa	Flattop Mille Graines	FACW	FAC	
Oxycaryum cubensis	Cuban Bulrush	OBL	OBL	
Paederia foetida	Stink Vine	UPL	FACU	I
Panicum maximum	Guineagrass	UPL	FAC	II
Panicum repens	Torpedograss	FACW	FACW	I
Paspalum acuminatum	Brook Paspalum	FACW	OBL	

Table A-5 (Cont.). Exotic and Nuisance Species List—FLUCFCS Group D (610, 611, 615, 617, 620, 621, 625, 630, and 631).

Scientific Name	Common Name	FDEP Status	ACOE Status	Nuisance Listing*
Paspalum notatum	Bahiagrass	UPL	FACU	
Paspalum urvillei	Vaseygrass	FAC	FAC	
Phyllanthus tenellus	Mascarene Island Leaf-Flower	UPL	UPL	
Phyllanthus urinaria	Chamberbitter	FAC	FAC	
Pistia stratiotes	Water-Lettuce	AQU	OBL	I
Polygonum lapathifolium	Pale Smartweed	OBL	FACW	H
Portulaca amilis	Purslane	UPL	UPL	
Psidium guajava	Guava	UPL	FACU	
Richardia brasiliensis	Largeflower Mexican Clover	UPL	UPL	
Richardia grandiflora	Richardia	UPL	UPL	
Richardia scabra	Glenwoodgrass	UPL	UPL	
Sacciolepis indica	Glenwoodgrass	FAC	FAC	
Salvinia spp.	Water Spangles	AQU	OBL	I
Schinus terebinthifolius	Brazilian Pepper	FAC	FAC	I
Senna obtusifolia	Sicklepod	UPL	UPL	
Sesbania herbacea	Danglepod	FAC	FACW	
Sesbania vesicaria	Bladderpod	FAC	FAC	
Solanum viarum	Tropical Soda Apple	UPL	UPL	I
Sonchus asper	Spiny-Leaved Sow Thistle	UPL	FAC	
Sonchus oleraceus	Common Sowthistle	UPL	FACU	
Sphenoclea zeylandica	Chickenspike	FACW	OBL	
Sporobolus indicus	Smutgrass	UPL	UPL	
Typha spp.	Cattail	OBL	OBL	
Urena lobata	Caesar-Weed	UPL	FACU	I
Urochloa mutica	Paragrass	FACW	FACW	I
Verbena brasiliensis	Verbena	UPL	FAC	
Wahlenbergia marginata	Southern Rockbell	UPL	UPL	
Wolffia globosa	Asian Watermeal	AQU	AQU	

Table A-6. Exotic and Nuisance Species List—FLUCFCS Group E (640, 641, 6417, 643, and 646).

Scientific Name	Common Name	FDEP Status	ACOE Status	Nuisance Listing*
Aeschynomene indica	India Joint-Vetch	FACW	FACW	H
Agrostis stolonifera	Redtop	FACW	FACW	
Alternanthera philoxeroides	Alligatorweed	OBL	OBL	II
Alternanthera sessilis	Sessile Joyweed	OBL	FACU	
Alysicarpus ovalifolius	False Moneywort	UPL	UPL	
Azolla filiculoides	Mosquito Fern	AQU	OBL	H
Begonia cucullata	Wax Begonia	UPL	UPL	II
Bulbostylis barbata	Watergrass	UPL	FAC	
Casuarina spp.	Australian Pine	FAC	FACU	I
Centella asiatica	Asian Coinwort	FACW	FACW	H
Ceratopteris thalictroides	Watersprite	OBL	OBL	
Chenopodium ambrosoides	Mexican-Tea	UPL	FACU	
Cichorium intybus	Chicory	UPL	UPL	
Colocasia esculenta	Wild Taro	OBL	FACW	I
Commelina diffusa	Dayflower	FACW	FACW	
Crotalaria lanceolata	Rattlebox	UPL	UPL	
Crotalaria pallida	Rattlebox	UPL	UPL	
Crotalaria spectabilis	Rattlebox	UPL	UPL	
Cuphea carthagenensis	Columbia Waxweed	FAC	FACW	
Cynodon dactylon	Bermudagrass	UPL	FACU	
Cyperus alopecuroides	Foxtail Flatsedge	FACW	UPL	
Cyperus difformis	Variable Flatsedge	OBL	OBL	
Cyperus iria	Rice Flatsedge	FACW	FACW	
Cyperus lanceolatus	Epiphytic Flatsedge	OBL	FACW	
Cyperus pumilus	Low Flatsedge	FACW	FACW	
Cyperus rotundus	Nutgrass	FAC	FACW	
Desmodium incanum	Zarzabacao Comun	UPL	UPL	
Desmodium triflorum	Beggarweed	UPL	UPL	
Drymaria cordata	West Indian Chickweed	FAC	FAC	
Echinochloa colona	Jungle-Rice	FACW	FACW	
Echinochloa crusgalli	Barnyardgrass	FACW	FACW	
Egeria densa	Brazilian Elodea	OBL	OBL	
Eichhornia crassipes	Water-Hyacinth	OBL	OBL	
Eleusine indica	Indian Goosegrass	UPL	FACU	
Emilia spp.	Tasselflower	UPL	UPL	

Table A-6 (Cont.). Exotic and Nuisance Species List—FLUCFCS Group E (640, 641, 6417, 643, and 646).

Scientific Name	Common Name	FDEP Status	ACOE Status	Nuisance Listing*
Eragrostis atrovirens	Thalia Lovegrass	FAC	FAC	
Eupatorium capillifolium	Dogfennel	FAC	FACU	
Hemarthria altissima	Limpograss	UPL	UPL	
Heteranthera limosa	Blue Mudplantain	UPL	OBL	
Hydrilla verticillata	Hydrilla	OBL	OBL	
Hygrophila polysperma	East Indian Hygrophilla	OBL	OBL	
Hymenachne amplexicaulis	Trompetilla	OBL	OBL	I
Hyptis verticillata	John Charles	UPL	UPL	
Imperata cylindrica	Cogongrass	UPL	UPL	
Indigofera hirsuta	Hairy Indigo	UPL	UPL	
Ipomoea aquatica	Water Spinach	AQU Vine NL	AQU Vine NL	
Ipomoea quamoclit	Cypressvine	NL	FACU	
Kummerowia striata	Japanese Clover	UPL	FACU	
Kyllinga brevifolia	Shortleaf Spikesedge	FACW	FACW	
Lantana camara	Lantana	UPL	UPL	
Lindernia crustacea	Malayan False Pimpernel	FAC	FACU	
Ludwigia octovalvis	Large Seedbox	OBL	OBL	
Ludwigia peruviana	Primrose Willow	OBL	OBL	
Lygodium japonicum	Japanese Climbing Fern	NL	FAC	
Macroptilium lathyroides	Wild Bushbean	UPL	FACU	
Medicago lupulina	Black Medic	UPL	FACU	
Melaleuca quinquenervia	Melaleuca	UPL	FACU	
Melinis repens syn. *Rhynchelytrum repens*	Natalgrass	UPL	UPL	
Melochia corchorifolia	Chocolateweed	FAC	FAC	
Mikania scandens	Climbing Hempvine	NL	FACW	
Mollogo verticillata	Carpetweed	UPL	FAC	
Momordica charantia	Wild Balsam Apple	NL	UPL	
Murdannia nudiflora	Naked-Stem Dewflower	FAC	FAC	
Myriophyllum aquaticum	Parrot's Feather	OBL	OBL	
Nephrolepis cordifolia	Tuberous Swordfern	FAC	UPL	
Oxycaryum cubensis	Cuban Bulrush	OBL	OBL	

Table A-6 (Cont.). Exotic and Nuisance Species List—FLUCFCS Group E (640, 641, 6417, 643, and 646).

Scientific Name	Common Name	FDEP Status	ACOE Status	Nuisance Listing*
Panicum maximum	Guineagrass	UPL	FAC	
Panicum repens	Torpedograss	FACW	FACW	
Paspalum acuminatum	Brook Paspalum	FACW	OBL	
Paspalum notatum	Bahiagrass	UPL	FACU	
Paspalum urvillei	Vaseygrass	FAC	FAC	
Phyllanthus tenellus	Mascarene Island Leaf-Flower	UPL	UPL	
Phyllanthus urinaria	Chamberbitter	FAC	FAC	
Pistia stratiotes	Water-Lettuce	AQU	OBL	
Polygonum lapathifolium	Pale Smartweed	OBL	FACW	
Polygonum orientale	Kiss-Me-Over-Garden-Gate	OBL	FACU	
Richardia brasiliensis	Richardia	UPL	UPL	
Richardia scabra	Richardia	UPL	UPL	
Sacciolepis indica	Glenwoodgrass	FAC	FAC	
Salvinia spp.	Water Spangles	AQU	OBL	I
Schinus terebinthifolius	Brazilian Pepper	FAC	FAC	I
Senna obtusifolia	Sicklepod	UPL	UPL	
Sesbania herbacea	Danglepod	FAC	FACW	
Sesbania vesicaria	Bladderpod	FAC	FAC	
Sesbania virgata	Wand Riverhemp	FAC	UPL	
Solanum viarum	Tropical Soda Apple	UPL	UPL	I
Sphenoclea zeylandica	Chickenspike	FACW	OBL	
Sporobolus indicus	Smutgrass	UPL	UPL	
Trifolium repens	White Clover	UPL	UPL	
Typha spp.	Cattail	OBL	OBL	
Urena lobata	Caesar-Weed	UPL	FACU	I
Urochloa mutica	Paragrass	FACW	FACW	I
Verbena brasiliensis	Verbena	UPL	FAC	
Wolffia globosa	Asian Watermeal	AQU	AQU	

Table A-7. Exotic and Nuisance Species List—FLUCFCS Group F (511 and 520).

Scientific Name	Common Name	FDEP Status	ACOE Status	Nuisance Listing*
Aeschynomene indica	India Joint-Vetch	FACW	FACW	H
Agrostis stolonifera	Redtop	FACW	FACW	
Alternanthera philoxeroides	Alligatorweed	OBL	OBL	I
Alternanthera sessilis	Sessile Joyweed	OBL	FACU	
Azolla filiculoides	Mosquito Fern	AQU	OBL	H
Bulbostylis barbata	Watergrass	UPL	FAC	
Casuarina spp.	Australian Pine	FAC	FACU	I
Centella asiatica	Asian Coinwort	FACW	FACW	H
Ceratopteris thalictroides	Watersprite	OBL	OBL	
Chenopodium ambrosoides	Mexican-Tea	UPL	FACU	
Cichorium intybus	Chicory	UPL	UPL	
Colocasia esculenta	Wild Taro	OBL	FACW	I
Commelina diffusa	Dayflower	FACW	FACW	
Crotalaria lanceolata	Rattlebox	UPL	UPL	
Crotalaria pallida	Rattlebox	UPL	UPL	
Crotalaria spectabilis	Rattlebox	UPL	UPL	
Cuphea carthagenensis	Columbia Waxweed	FAC	FACW	
Cynodon dactylon	Bermudagrass	UPL	FACU	
Cyperus alopecuroides	Foxtail Flatsedge	FACW	UPL	
Cyperus difformis	Variable Flatsedge	OBL	OBL	
Cyperus iria	Rice Flatsedge	FACW	FACW	
Cyperus lanceolatus	Epiphytic Flatsedge	OBL	FACW	
Cyperus pumilus	Low Flatsedge	FACW	FACW	
Cyperus rotundus	Nutgrass	FAC	FACW	
Desmodium incanum	Zarzabacao Comun	UPL	UPL	
Desmodium triflorum	Beggarweed	UPL	UPL	
Drymaria cordata	West Indian Chickweed	FAC	FAC	
Echinochloa colona	Jungle-Rice	FACW	FACW	
Echinochloa crusgalli	Barnyardgrass	FACW	FACW	
Egeria densa	Brazilian Elodea	OBL	OBL	
Eichhornia crassipes	Water-Hyacinth	OBL	OBL	I
Eleusine indica	Indian Goosegrass	UPL	FACU	
Emilia spp.	Tasselflower	UPL	UPL	
Eragrostis atrovirens	Thalia Lovegrass	FAC	FAC	

Table A-7 (Cont.). Exotic and Nuisance Species List—FLUCFCS Group F (511 and 520).

Scientific Name	Common Name	FDEP Status	ACOE Status	Nuisance Listing*
Eupatorium capillifolium	Dogfennel	FAC	FACU	H
Hemarthria altissima	Limpograss	UPL	UPL	II
Heteranthera limosa	Blue Mudplantain	UPL	OBL	
Hydrilla verticillata	Hydrilla	OBL	OBL	I
Hygrophila polysperma	East Indian Hygrophilla	OBL	OBL	I
Hyptis verticillata	John Charles	UPL	UPL	
Imperata cylindrica	Cogongrass	UPL	UPL	
Indigofera hirsuta	Hairy Indigo	UPL	UPL	
Ipomoea aquatica	Water Spinach	AQU Vine NL	AQU Vine NL	
Kummerowia striata	Japanese Clover	UPL	FACU	
Kyllinga brevifolia	Shortleaf Spikesedge	FACW	FACW	
Lindernia crustacea	Malayan False Pimpernel	FAC	FACU	
Ludwigia octovalvis	Large Seedbox	OBL	OBL	H
Ludwigia peruviana	Primrose Willow	OBL	OBL	I
Lygodium japonicum	Japanese Climbing Fern	NL	FAC	I
Lygodium microphyllum	Small-Leaf Climbing Fern	NL	FAC	
Macroptilium lathyroides	Wild Bushbean	UPL	FACU	
Medicago lupulina	Black Medic	UPL	FACU	
Melaleuca quinquenervia	Melaleuca	UPL	FACU	I
Melinis repens syn. *Rhynchelytrum repens*	Natalgrass	UPL	UPL	I
Melochia corchorifolia	Chocolate-Weed	FAC	FAC	
Mikania scandens	Climbing Hempvine	NL	FACW	
Mollogo verticillata	Carpetweed	UPL	FAC	
Momordica charantia	Wild Balsam Apple	NL	UPL	
Murdannia nudiflora	Naked-Stem Dewflower	FAC	FAC	
Myriophyllum aquaticum	Parrot's Feather	OBL	OBL	
Nephrolepis cordifolia	Tuberous Swordfern	FAC	UPL	I
Oxycaryum cubensis	Cuban Bulrush	OBL	OBL	
Panicum maximum	Guineagrass	UPL	FAC	II
Panicum repens	Torpedograss	FACW	FACW	I

Table A-7 (Cont.). Exotic and Nuisance Species List—FLUCFCS Group F (511 and 520).

Scientific Name	Common Name	FDEP Status	ACOE Status	Nuisance Listing*
Paspalum acuminatum	Brook Paspalum	FACW	OBL	
Paspalum notatum	Bahiagrass	UPL	FACU	
Paspalum urvillei	Vaseygrass	FAC	FAC	
Phyllanthus tenellus	Mascarene Island Leaf-Flower	UPL	UPL	
Phyllanthus urinaria	Chamberbitter	FAC	FAC	
Pistia stratiotes	Water-Lettuce	AQU	OBL	I
Polygonum lapathifolium	Pale Smartweed	OBL	FACW	H
Polygonum orientale	Kiss-Me-Over-Garden-Gate	OBL	FACU	H
Richardia brasiliensis	Richardia	UPL	UPL	
Richardia scabra	Richardia	UPL	UPL	
Sacciolepis indica	Glenwood Grass	FAC	FAC	
Salvinia spp.	Water Spangles	AQU	OBL	I
Schinus terebinthifolius	Brazilian Pepper	FAC	FAC	I
Senna obtusifolia	Sicklepod	UPL	UPL	
Sesbania herbacea	Danglepod	FAC	FACW	
Sesbania vesicaria	Bladderpod	FAC	FAC	
Sesbania virgata	Wand Riverhemp	FAC	UPL	
Solanum viarum	Tropical Soda Apple	UPL	UPL	I
Sphenoclea zeylandica	Chickenspike	FACW	OBL	
Sporobolus indicus	Smutgrass	UPL	UPL	
Trifolium repens	White Clover	UPL	UPL	
Typha spp.	Cattail	OBL	OBL	
Urena lobata	Caesar-Weed	UPL	FACU	I
Urochloa mutica	Paragrass	FACW	FACW	I
Verbena brasiliensis	Verbena	UPL	FAC	
Wolffia globosa	Asian Watermeal	AQU	AQU	

APPENDIX B

INDUSTRY PLANTING SPECIFICATION

Table B-1. FLUCFCS Group A Species Planting List.

Species		FLUCFCS Code/Habitat	
Scientific Name	Common Name	211 Improved Pastures	213 Woodland Pastures
Groundcover			
Urochloa ramosa	Browntop Millet	x	x
Lolium perenne	Rye	x	x
Paspalum notatum	Bahia Grass	x	x
Shrubs			
Asimina reticulata	Netted Pawpaw		x
Befaria racemosa	Tarflower		x
Gaylussacia dumosa	Dwarf Huckleberry		x
Hypericum tetrapetalum	St. John's Wort		x
Ilex glabra	Gallberry		x
Licania michauxii	Gopher Apple		x
Lyonia fruticosa	Coastplain Staggerbush		x
Lyonia lucida	Fetter-Bush		x
Myrica cerifera	Wax Myrtle		x
Quercus minima	Dwarf Live Oak		x
Quercus pumila	Runner Oak		x
Serenoa repens	Saw Palmetto		x
Vaccinium darrowi	Little Blueberry		x
Vaccinium myrsinites	Florida Blueberry		x
Zamia pumila	Coontie		x
Trees			
Carya glabra	Pignut Hickory		x
Ilex cassine	Dahoon Holly		x
Juniperus silicicola	Southern Red Cedar		x
Magnolia grandiflora	Southern Magnolia		x
Morus rubra	Red Mulberry		x
Persea borbonia	Red Bay		x
Pinus elliottii	Slash Pine		x
Pinus palustris	Longleaf Pine		x
Prunus caroliniana	Carolina Laurel-Cherry		x
Prunus serotina var. *serotina*	Black Cherry		x

Table B-1 (Cont.). FLUCFCS Group A Species Planting List.

Species		FLUCFCS Code/Habitat	
Scientific Name	Common Name	211 Improved Pastures	213 Woodland Pastures
Trees (Cont.)			
Quercus geminata	Sand Live Oak		x
Quercus incana	Bluejack Oak		x
Quercus laevis	Turkey Oak		x
Quercus laurifolia	Laurel Oak		x
Quercus myrtifolia	Myrtle Oak		x
Quercus virginiana	Live Oak		x
Sabal palmetto	Cabbage Palm		x

Table B-2. FLUCFCS Group B Species Planting List.

Species		FLUCFCS Code/Habitat	
Scientific Name	Common Name	321 Palmetto Prairies	411 Pine Flatwoods
Groundcover			
Urochloa ramosa	Browntop Millet	x	
Lolium perenne	Ryegrass	x	
Balduina angustifolia	Yellow Buttons	x	
Carphephorus corymbosus	Florida Paintbrush	x	
Carphephorus paniculatus	Deertongue	x	
Chamaecrista fasciculata	Partridge-Pea	x	
Commelina erecta	Sandhill Dayflower	x	
Coreopsis gladiata	Smooth Tickseed	x	
Cuthburtia ornata	Roseline	x	
Elephantopus carolinianus	Carolina Elephantsfoot	x	
Eragrostis elliottii	Elliot's Lovegrass	x	
Eragrostis spectabilis	Purple Lovegrass	x	
Eryingium yuccifolium	Rattlesnake Master	x	
Galactia elliotii	Milkpea	x	
Helianthus angustifolius	Narrow-Leaved Sunflower	x	
Liatris sp.	Blazing Star	x	
Panicum virgatum	Switchgrass	x	
Phoebanthus grandiflorus	Florida False Sunflower	x	
Pityopsis graminifolia	Narrowleaf Silkgrass	x	
Pteridium aquilinum	Bracken Fern	x	
Rhynchospora sp.	Beakrush	x	
Schizachryium stoloniferum	Creeping Bluestem	x	

Table B-2 (Cont.). FLUCFCS Group B Species Planting List.

Species		FLUCFCS Code/Habitat	
Scientific Name	Common Name	321 Palmetto Prairies	411 Pine Flatwoods
Groundcover (Cont.)			
Sorghastrum secundum	Indian Grass	x	
Stillingia sylvatica	Queensdelight	x	
Xyris sp.	Yellow-Eyed Grass	x	
Shrubs and Trees			
Asimina spp.	Pawpaw	x	x
Befaria racemosa	Tarflower	x	
Gaylussacia dumosa	Dwarf Huckleberry	x	
Hypericum tetrapetalum	St. John's Wort	x	
Ilex glabra	Gallberry	x	x
Licania michauxii	Gopher Apple	x	x
Lyonia sp.	Fetterbush/Staggerbush	x	x
Myrica cerifera	Wax Myrtle	x	x
Quercus minima	Dwarf Live Oak	x	
Quercus pumila	Running Oak	x	
Serenoa repens	Saw Palmetto	x	x
Vaccinium sp.	Blueberry	x	x
Zamia pumila	Coontie	x	
Pinus elliottii	Slash Pine		x
Pinus palustris	Longleaf Pine		x
Quercus myrtifolia	Myrtle Oak		x

Table B-3. FLUCFCS Group C Species Planting List.

Species		FLUCFCS Code/Habitat							
Scientific Name	Common Name	410	414	420/430	421	425	427	434	438
		Upland Coniferous Forests	Pine-Mesic Oak	Upland Hardwood Forests	Xeric Oak	Temperate Hardwood/ Hydric Hammock	Live Oak	Hardwood-Coniferous Mixed	Mixed Hardwoods
Groundcover									
Urochloa ramosa	Broomsedge	x		x					x
Lolium perenne	Wiregrass	x							
Berchemia scandens	Ratan Vine					x			
Carphephorus odoratissimus	Deer Tongue	x							
Chasmanthium laxum	Longleaf Chasmanthium					x			
Commelina erecta	Sandhill Dayflower			x					x
Conoclinium coelestinium	Mistflower			x					x
Coreopsis leavenworthii	Leavenworth's Tickseed	x							
Crinum americanum	Southern Swamplily			x					x
Crotalaria rotundifolia	Rabbitbells	x							
Dichanthelium sp.	Witchgrass					x			
Dryopteris ludoviciana	Southern Wood Fern			x					x
Dyschoriste sp.	Twin Flower			x					x

Table B-3 (Cont.). FLUCFCS Group C Species Planting List.

Species		FLUCFCS Code/Habitat							
		410	414	420/430	421	425	427	434	438
Scientific Name	Common Name	Upland Coniferous Forests	Pine Mesic Oak	Upland Hardwood Forests	Xeric Oak	Temperate Hardwood/ Hydric Hammock	Live Oak	Hardwood-Coniferous Mixed	Mixed Hardwoods
Groundcover (Cont.)									
Elephantopus carolinianus	Carolina Elephantsfoot	x		x					x
Eragrostis elliottii	Elliot's Lovegrass	x							
Eragrostis spectabilis	Purple Lovegrass	x							
Erigeron sp.	Fleabane	x							
Erythrina herbacea	Coral Bean			x					x
Eustachys petraea	Rock Fingergrass	x							
Gelsemium sempervirens	Yellow Jessamine					x			
Heterotheca subaxillaris	Camphorweed	x		x					x
Hypericum hypericoides	St. Andrews Cross			x		x			x
Lachnocaulon anceps	White-Head Bogbutton	x							
Liatris sp.	Blazing Star	x							
Lilium catesbaei	Pine Lily	x							
Lobelia sp.	Lobelia	x							

Table B-3 (Cont.). FLUCFCS Group C Species Planting List.

Species		FLUCFCS Code/Habitat							
Scientific Name	Common Name	410 Upland Coniferous Forests	414 Pine Mesic Oak	420/430 Upland Hardwood Forests	421 Xeric Oak	425 Temperate Hardwood/ Hydric Hammock	427 Live Oak	434 Hardwood-Coniferous Mixed	438 Mixed Hardwoods
Groundcover (Cont.)									
Lonicera sempervirens	Coral Honeysuckle			x					x
Mimosa strigillosa	Mimosa	x							
Muhlenbergia sp.	Muhly Grass	x							
Nephrolepis cordifolia	Tuberous Swordfern			x					x
Oclemena reticulata	Whitetop Aster	x							
Osmunda cinnamomea	Cinnamon Fern					x			
Panicum sp.	Panic Grass	x				x			
Passiflora incarnata	Passion Flower	x		x					x
Phoebanthus grandiflorus	Florida False Sunflower	x							
Pilobelphis rigida	Savory Pennyroyal	x							
Piriqueta caroliniana	Piriqueta	x							
Pityopsis graminifolia	Narrowleaf Silkgrass	x	x						
Psychotria sp.	Wild Coffee			x		x			x

Table B-3 (Cont.). FLUCFCS Group C Species Planting List.

Species		FLUCFCS Code/Habitat							
Scientific Name	Common Name	410 Upland Coniferous Forests	414 Pine Mesic Oak	420/430 Upland Hardwood Forests	421 Xeric Oak	425 Temperate Hardwood/ Hydric Hammock	427 Live Oak	434 Hardwood-Coniferous Mixed	438 Mixed Hardwoods
Groundcover (Cont.)									
Pteridium aquilinum	Bracken Fern	x							
Rhexia sp.	Meadow-Beauty	x							
Rhynchospora sp.	Beakrush	x							
Ruellia caroliniensis	Wild Petunia			x					x
Sabatia grandiflora	Marsh Pink	x							
Salvia lyrata	Sage	x		x					x
Schizachryium sp.	Little Bluestem	x							
Sisyrinchium atlanticum	Eastern Blue-Eyed Grass	x							
Solidago sp.	Goldenrod	x		x					x
Sorghastrum secundum	Indiangrass	x							
Sporobolus junceus	Pineywoods Dropseed	x							
Thelypteris sp.	Shield Fern			x		x			x
Tripsacum dactyloides	Fakahatchee Grass	x		x					x
Viola affinis	Sand Violet	x		x					x

Table B-3 (Cont.). FLUCFCS Group C Species Planting List.

Species		FLUCFCS Code/Habitat							
		410	414	420/430	421	425	427	434	438
Scientifici Name	Common Name	Upland Coniferous Forests	Pine Mesic Oak	Upland Hardwood Forests	Xeric Oak	Temperate Hardwood/ Hydric Hammock	Live Oak	Hardwood-Coniferous Mixed	Mixed Hardwoods
Groundcover (Cont.)									
Viola septemloba	Violet	x		x					x
Woodwardia aereolata	Netted Chain Fern			x					x
Woodwardia virginica	Virginia Chain Fern					x			
Xyris sp.	Yellow-Eyed Grass	x							
Yucca filamentosa	Adam's Needle	x							
Zamia pumila	Coontie	x							
Zephyranthes sp.	Rain-Lily	x							
Shrubs									
Asimina spp.	Pawpaw	x							
Befaria racemosa	Tarflower	x							
Bumelia reclinata	Buckthorn			x					x
Callicarpa americana	American Beauty-Berry	x		x					x
Cassia sp.	Sicklepod	x		x					x
Euonymus americanus	American Strawberrybush					x			
Ilex glabra	Gallberry	x	x					x	
Licania michauxii	Gopher Apple	x							

Table B-3 (Cont.). FLUCFCS Group C Species Planting List.

Species		FLUCFCS Code/Habitat							
		410	414	420/430	421	425	427	434	438
Scientific Name	Common Name	Upland Coniferous Forests	Pine Mesic Oak	Upland Hardwood Forests	Xeric Oak	Temperate Hardwood/ Hydric Hammock	Live Oak	Hardwood-Coniferous Mixed	Mixed Hardwoods
Shrubs (Cont.)									
Lyonia sp.	Fetterbush/ Staggerbush	x		x				x	x
Myrica cerifera	Wax Myrtle	x	x	x		x		x	x
Quercus minima	Dwarf Live Oak	x							
Quercus pumila	Running Oak	x							
Rhapidophyllum hystrix	Needle Palm			x		x			x
Rhododendron viscosum	Swamp Azalea			x		x			x
Rhus copallinum	Winged Sumac	x		x					x
Sabal minor	Dwarf Palmetto					x			
Sambucus canadensis	Elderberry			x					x
Serenoa repens	Saw Palmetto	x	x	x		x		x	x
Vaccinium sp.	Blueberry	x		x		x		x	x
Viburnum dentatum	Black-Haw			x					x
Viburnum obovatum	Black-Haw			x					x
Ximenia americana	Hog Plum			x					x

Table B-3 (Cont.). FLUCFCS Group C Species Planting List.

Species		FLUCFCS Code/Habitat							
		410	414	420/430	421	425	427	434	438
Scientific Name	Common Name	Upland Coniferous Forests	Pine Mesic Oak	Upland Hardwood Forests	Xeric Oak	Temperate Hardwood/ Hydric Hammock	Live Oak	Hardwood-Coniferous Mixed	Mixed Hardwoods
Shrubs (Cont.)									
Zanthoxylum clava-herculis	Hercules Club			x					x
Zanthoxylum fagara	Wildlime			x					x
Trees									
Acer rubrum	Red Maple			x		x		x	x
Carpinus caroliniana	Ironwood			x		x			x
Carya aquatica	Water Hickory		x	x					x
Carya glabra	Pignut Hickory		x	x		x		x	x
Celtis laevigata	Sugarberry			x		x			x
Cornus foemina	Swamp Dogwood		x	x					x
Diospyros virginiana	Persimmon	x		x				x	x
Ilex cassine	Dahoon Holly			x			x		x
Juniperus silicicola	Southern Red Cedar			x		x			x
Liquidambar styraciflua	Sweetgum						x		
Liquidambar styraciflua	Sweetgum		x	x		x		x	x

Table B-3 (Cont.). FLUCFCS Group C Species Planting List.

Species		FLUCFCS Code/Habitat							
		410	414	420/430	421	425	427	434	438
Scientific Name	Common Name	Upland Coniferous Forests	Pine Mesic Oak	Upland Hardwood Forests	Xeric Oak	Temperate Hardwood/ Hydric Hammock	Live Oak	Hardwood-Coniferous Mixed	Mixed Hardwoods
Trees (Cont.)									
Magnolia grandiflora	Southern Magnolia			x					x
Magnolia virginiana	Sweetbay						x		
Morus rubra	Red Mulberry			x				x	x
Persea borbonia	Red Bay			x					x
Persea palustris	Swamp Bay			x		x			x
Pinus clausa	Sand Pine	x							
Pinus elliottii	Slash Pine	x	x			x		x	
Pinus palustris	Longleaf Pine	x	x		x			x	
Prunus caroliniana	Carolina Laurel-Cherry			x					x
Prunus serotina var. *serotina*	Black Cherry			x					x
Quercus geminata	Sand Live Oak	x							
Quercus incana	Bluejack Oak				x				
Quercus laevis	Turkey Oak				x				
Quercus laurifolia	Laurel Oak		x	x		x	x	x	x
Quercus myrtifolia	Myrtle Oak	x							
Quercus nigra	Water Oak		x	x		x		x	x

Table B-3 (Cont.). FLUCFCS Group C Species Planting List.

Species		FLUCFCS Code/Habitat							
Scientific Name	Common Name	410	414	420/430	421	425	427	434	438
		Upland Coniferous Forests	Pine Mesic Oak	Upland Hardwood Forests	Xeric Oak	Temperate Hardwood/ Hydric Hammock	Live Oak	Hardwood-Coniferous Mixed	Mixed Hardwoods
Trees (Cont.)									
Quercus virginiana	Live Oak	x		x	x	x	x	x	x
Sabal palmetto	Cabbage Palm	x		x		x		x	x
Ulmus americana	American Elm					x			

Table B-4. FLUCFCS Group D Species Planting List.

Species		FLUCFCS Code/Habitat							
Scientific Name	Common Name	610	611	615/617	620	621	625	630	631
		Wetland Hardwood Forests	Bay Swamp	Bottomland Swamps/ Mixed Hardwoods	Wetland Coniferous Forests	Cypress Swamps	Hydric Pine Flat-woods	Wetland Forested Mixed	Wetland Scrub
Groundcover									
Urochloa ramosa	Bushy Bluestem							x	
Lolium perenne	Jack-In-The-Pulpit	x							
Aristida stricta	Wiregrass				x		x		
Aster carolinianus	Climbing Aster	x							
Axonopus furcatus	Flat-Joint Carpetgrass							x	
Bacopa monnieri	Water Hyssop	x			x	x			

Table B-4 (Cont.). FLUCFCS Group D Species Planting List.

Species		FLUCFCS Code/Habitat							
		610	611	615/617	620	621	625	630	631
Scientific Name	Common Name	Wetland Hardwood Forests	Bay Swamp	Bottomland Swamps/ Mixed Hardwoods	Wetland Coniferous Forests	Cypress Swamps	Hydric Pine Flat-woods	Wetland Forested Mixed	Wetland Scrub
Groundcover (Cont.)									
Blechnum serrulatum	Swamp Fern	x	x	x					
Boehmeria cylindrica	Small-Spike False Nettle		x						
Carex sp.	Carex	x							
Carphephorus odoratissimus	Deer Tongue				x		x		
Cladium jamaicense	Sawgrass	x							
Clematis crispa	Swamp Leather Flower		x						
Crinum americanum	Southern Swamplily	x			x	x			
Eleocharis sp.	Spikerush	x			x		x		
Eriocaulon sp.	Flattened Pipewort	x							
Hydrocotyle sp.	Pennywort	x							
Hygrophila lacustris	Lake Hicotea	x							
Iris hexagona	Iris	x							
Juncus effusus	Softrush	x							
Lachnanthes caroliniana	Carolina Redroot	x			x	x			
Lachnocaulon sp.	Bogbutton				x		x		

Table B-4 (Cont.). FLUCFCS Group D Species Planting List.

Species		FLUCFCS Code/Habitat							
Scientific Name	Common Name	610 Wetland Hardwood Forests	611 Bay Swamp	615/617 Bottomland Swamps/ Mixed Hardwoods	620 Wetland Coniferous Forests	621 Cypress Swamps	625 Hydric Pine Flat-woods	630 Wetland Forested Mixed	631 Wetland Scrub
Groundcover (Cont.)									
Nephrolepis exaltata	Boston Fern	x							
Nymphoides aquatica	Floating-Heart	x			x	x			
Orontium aquticum	Goldenclub	x							
Osmunda cinnamomea	Cinnamon Fern	x	x	x					
Osmunda regalis	Royal Fern	x	x	x	x	x			
Peltandra virginica	Arrow Arum	x	x	x					
Pinguicula sp.	Butterworts				x		x		
Polygonum sp.	Smartweed	x			x	x			
Pontederia cordata	Pickerelweed	x			x	x			
Rhexia mariana	Meadow-Beauty				x		x		
Rhynchospora sp.	Beakrush	x							
Sagittaria lancifolia	Bulltongue Arrowhead	x							
Sarracenia minor	Hooded Pitcherplant				x		x		
Saururus cernuus	Lizard's Tail	x	x	x	x	x		x	
Schizachyrium scoparium	Creeping Bluestem							x	
Thalia geniculata	Alligator Flag	x							

Table B-4 (Cont.). FLUCFCS Group D Species Planting List.

Species		FLUCFCS Code/Habitat							
Scientific Name	Common Name	610 Wetland Hardwood Forests	611 Bay Swamp	615/617 Bottomland Swamps/ Mixed Hardwoods	620 Wetland Coniferous Forests	621 Cypress Swamps	625 Hydric Pine Flat-woods	630 Wetland Forested Mixed	631 Wetland Scrub
Groundcover (Cont.)									
Thelypteris sp.	Shield Fern	x	x	x				x	
Utricularia sp.	Bladderwort	x							
Woodwardia aereolata	Netted Chain Fern	x	x		x	x			
Woodwardia virginica	Virginia Chain Fern	x	x		x	x		x	
Xyris sp.	Yellow-Eyed Grass				x		x		
Shrubs									
Befaria racemosa	Tarflower							x	
Cephalanthus occidentalis	Buttonbush	x	x	x	x	x	x		
Chionanthus Virginicus	Fringe Tree	x							
Cornus foemina	Swamp Dogwood	x	x	x				x	
Cyrilla racemiflora	Titi								x
Decodon verticillatus	Swamp -Loosestrife	x							
Hibiscus grandiflorus	Swamp Rosemallow	x							
Hypericum cistifolium	Round-Pod St. John's Wort							x	

Table B-4 (Cont.). FLUCFCS Group D Species Planting List.

Species		FLUCFCS Code/Habitat							
		610	611	615/617	620	621	625	630	631
Scientific Name	Common Name	Wetland Hardwood Forests	Bay Swamp	Bottomland Swamps/ Mixed Hardwoods	Wetland Coniferous Forests	Cypress Swamps	Hydric Pine Flat-woods	Wetland Forested Mixed	Wetland Scrub
Shrubs (Cont.)									
Hypericum hypericoides	St. Andrews Cross							x	
Ilex coriacea	Large Gallberry								x
Ilex glabra	Gallberry		x		x		x	x	
Ilex myrtifolia	Myrtle Holly				x		x		x
Itea virginica	Virginia Willow	x	x	x				x	
Lyonia lucida	Fetter-Bush		x		x	x		x	x
Myrica cerifera	Wax Myrtle	x	x	x	x	x	x	x	
Rhododendron viscosum	Swamp Azalea		x	x				x	
Rhus copallinum	Winged Sumac				x		x		
Rosea palustris	Swamp Rose	x							
Sabal minor	Dwarf Palmetto			x					
Salix caroliniana	Southern Willow	x			x	x			x
Sambucus canadensis	Elderberry	x			x	x			
Serenoa repens	Saw Palmetto				x		x		
Vaccinium arboreum	Sparkleberry				x		x		
Vaccinium corymbosum	Highbush Blueberry	x	x	x				x	
Viburnum nudum	Possum-Haw	x	x	x				x	

Table B-4 (Cont.). FLUCFCS Group D Species Planting List.

Species		FLUCFCS Code/Habitat							
		610	611	615/617	620	621	625	630	631
Scientific Name	Common Name	Wetland Hardwood Forests	Bay Swamp	Bottomland Swamps/ Mixed Hardwoods	Wetland Coniferous Forests	Cypress Swamps	Hydric Pine Flat-woods	Wetland Forested Mixed	Wetland Scrub
Trees									
Acer rubrum	Red Maple	x	x	x	x	x		x	
Carpinus caroliniana	Ironwood	x		x					
Carya aquatica	Water Hickory			x	x	x			
Celtis laevigata	Sugarberry	x	x	x	x	x		x	
Fraxinus caroliniana	Pop Ash	x		x	x	x			
Fraxinus pennsylvanica	Green Ash	x							
Gordonia lasianthus	Loblolly Bay	x	x	x				x	
Ilex cassine	Dahoon Holly	x	x	x	x	x	x	x	
Liquidambar styraciflua	Sweetgum	x		x	x	x		x	
Magnolia virginiana	Sweetbay	x	x	x	x	x	x	x	
Nyssa sylvatica var. *biflora*	Swamp Tupelo	x	x	x	x	x	x	x	x
Persea palustris	Swamp Bay	x	x	x				x	
Pinus elliottii	Slash Pine	x	x	x	x	x	x	x	
Pinus palustris	Longleaf Pine				x	x	x		
Pinus serotina	Pond Pine				x		x		x
Quercus laurifolia	Laurel Oak	x	x	x	x	x		x	
Quercus nigra	Water Oak	x	x	x				x	
Quercus virginiana	Live Oak							x	

Table B-4 (Cont.). FLUCFCS Group D Species Planting List.

Species		FLUCFCS Code/Habitat							
		610	611	615/617	620	621	625	630	631
		Wetland Hardwood Forests	Bay Swamp	Bottomland Swamps/ Mixed Hardwoods	Wetland Coniferous Forests	Cypress Swamps	Hydric Pine Flat-woods	Wetland Forested Mixed	Wetland Scrub
Trees (Cont.)									
Sabal palmetto	Cabbage Palm				x	x		x	
Taxodium ascendens	Pond Cypress			x	x	x			x
Taxodium distichum	Bald Cypress	x		x	x	x			
Ulmus americana	American Elm	x	x	x	x	x		x	

Table B-5. FLUCFCS Group E Species Planting List.

Species		FLUCFCS Code/Habitat				
Scientific Name	Common Name	640	641	6417	643	646
		Vegetated Non-Forested Wetlands	Freshwater Marshes	Freshwater Marsh with Shrubs, Brush, and Vines	Wet Prairie	Treeless Hydric Savanna
Groundcover						
Urochloa ramosa	False Foxglove				x	
Lolium perenne	Flax-Leaf False-Foxglove				x	
Andropogon glomeratus	Bushy Bluestem				x	x
Andropogon virginicus	Broomsedge				x	
Aristida stricta	Wiregrass				x	
Aster subulatus	Annual Saltmarsh Aster				x	
Axonopus furcatus	Flat-Joint Carpet Grass				x	

Table B-5 (Cont.). FLUCFCS Group E Species Planting List.

Species		FLUCFCS Code/Habitat				
		640	641	6417	643	646
Scientific Name	Common Name	Vegetated Non-Forested Wetlands	Freshwater Marshes	Freshwater Marsh with Shrubs, Brush, and Vines	Wet Prairie	Treeless Hydric Savanna
Groundcover (Cont.)						
Bacopa caroliniana	Blue Hyssop	x	x			
Bacopa monnieri	Water Hyssop	x	x			
Bidens laevis	Bur-Marigold		x	x		
Bidens sp.	Beggar-Ticks	x	x			
Canna flaccida	Golden Canna	x	x	x		
Carphephorus odoratissimus	Deer Tongue					x
Carex sp.	Sedge		x			
Cladium jamaicense	Sawgrass	x	x	x		x
Coreopsis leavenworthii	Leavenworth's Tickseed				x	
Ctenium aromaticum	Toothache Grass				x	
Cyperus odoratus	Fragrant Flatsedge	x				
Cyperus sp.	Flatsedge		x	x	x	
Eleocharis sp.	Spikerush	x	x		x	x
Eriocaulon decangulare	Ten-Angle Pipewort				x	
Fuirena scirpoidea	Umbrella-Sedge				x	
Helenium sp.	Sneezeweed				x	
Hydrocotyle sp.	Pennywort	x	x			
Iris virginica	Iris		x			
Juncus effusus	Softrush	x		x		
Juncus scirpoides	Needlepod Rush				x	
Lachnanthes caroliniana	Carolina Redroot	x	x			

Table B-5 (Cont.). FLUCFCS Group E Species Planting List.

Species		FLUCFCS Code/Habitat				
		640	641	6417	643	646
Scientific Name	Common Name	Vegetated Non-Forested Wetlands	Freshwater Marshes	Freshwater Marsh with Shrubs, Brush, and Vines	Wet Prairie	Treeless Hydric Savanna
Groundcover (Cont.)						
Lachnocaulon anceps	White-Head Bogbutton	x			x	
Liatris sp.	Blazing Star					x
Leersia hexandra	Southern Cutgrass		x		x	
Ludwigia repens	Red-Leaf Ludwigia		x	x	x	
Ludwigia suffruticosa	Shrubby Seedbox				x	
Luziola fluitans	Southern Watergrass				x	
Nelumba lutea	American Lotus	x	x			
Nuphar luteum	Spadderdock	x				
Nymphaea odorata	Fragrant Water-Lily	x	x			
Panicum hemitomon	Maidencane	x	x	x	x	x
Panicum longifolium	Tall Thin Panicum				x	
Panicum rigidulum	Red-Top Panic Grass				x	
Panicum tenerum	Bluejoint Panicum				x	
Paspalum dissectum	Mudbank Crowngrass				x	
Paspalum distichum	Knot Grass				x	
Paspalum laeve	Field Paspalum				x	
Pinguicula sp.	Butterworts					x
Pluchea rosea	Rosy Camphorweed				x	
Polygonum punctatum	Dotted Smartweed		x	x	x	
Polygonum sp.	Smartweed	x				
Pontederia cordata	Pickerelweed	x				

Table B-5 (Cont.). FLUCFCS Group E Species Planting List.

Species		FLUCFCS Code/Habitat				
		640	641	6417	643	646
Scientific Name	Common Name	Vegetated Non-Forested Wetlands	Freshwater Marshes	Freshwater Marsh with Shrubs, Brush, and Vines	Wet Prairie	Treeless Hydric Savanna
Groundcover (Cont.)						
Pontederia cordata	Pickerelweed		x	x		
Rhexia mariana	Meadow-Beauty	x			x	
Rhynchospora inundata	Horned Beakrush		x			
Rhynchospora sp.	Beakrush		x	x	x	x
Sabatia grandiflora	Marsh Pink	x			x	
Sacciolepis striata	American Cupscale		x		x	
Sagittaria graminea	Grassy Arrowhead				x	
Sagittaria lancifolia	Bulltongue Arrowhead	x	x	x		
Saururus cernuus	Lizard's Tail			x		
Sarracenia minor	Hooded Pitcherplant					x
Scirpus sp.	Bulrush	x				
Smilax sp.						x
Solidago fistulosa	Pine-Barren Goldenrod				x	
Spartina bakeri	Sand Cordgrass	x	x	x	x	x
Thalia geniculata	Alligator Flag	x	x	x		
Utricularia sp.	Bladderwort	x				
Verbesina chapmanii	Crownbeard				x	
Woodwardia virginica	Virginia Chain Fern	x	x			
Xyris sp.	Yellow-Eyed Grass	x	x	x	x	x

Table B-5 (Cont.). FLUCFCS Group E Species Planting List.

Species		FLUCFCS Code/Habitat				
		640	641	6417	643	646
Scientific Name	Common Name	Vegetated Non-Forested Wetlands	Freshwater Marshes	Freshwater Marsh with Shrubs, Brush, and Vines	Wet Prairie	Treeless Hydric Savanna
Shrubs						
Cephalanthus occidentalis	Buttonbush	x	x	x		x
Hypericum brachyphyllum	Coastal-Plain St. John's-Wort				x	
Hypericum fasciculatum	Sand-Weed St. John's-Wort		x	x	x	
Hypericum sp.	St. John's-Wort	x				x
Myrica cerifera	Wax Myrtle			x	x	
Salix caroliniana	Southern Willow		x			
Sambucus canadensis	Elderberry		x			