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A Community-Based Regional Plan for Managing Threatened and Endangered Species on Military Installations in the Southeastern United States

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Preface

The work described in this report was authorized by the Strategic Environmental Research and Development Program (SERDP), Washington, DC. The work was performed under the SERDP study entitled "Regional Guidelines for Managing Threatened and Endangered Species Habitats." The technical monitor was Mr. Michael Hathaway, Conservation Program. Mr. Bradley Smith was Executive Director, SERDP.

This report was prepared by Mr. Chester O. Martin and Dr. Richard A. Fischer, Ecosystem Evaluation and Engineering Division (EEED), Environmental Laboratory (EL), U.S. Army Engineer Research and Development Center (ERDC), Vicksburg, MS; and Ms. Mary G. Harper and Ms. Ann-Marie Trame Shapiro, Land Management Laboratory, USA ERDC. Mr. Martin and Ms. Shapiro were Principal Investigators for the regional guidelines work unit. Ms. Harper was employed as a research associate under an Interagency Personnel Agreement with the U.S. Forest Service, Rocky Mountain Range and Forest Experiment Station, and Colorado State University. Other ERDC contributors included Messrs. Kevin Robertson, William R. Whitworth, Mike Woolery, Matthew G. Hohman, Bruce MacAllister, Ms. Sophia Gehlhausen, Dr. Wilma A. Mitchell, and Ms. Monica Wolters.

Numerous other Department of Defense (DOD) and non-DOD personnel contributed information and provided recommendations for this report. These individuals are cited in reports on community management plans and species profiles prepared as products of this work unit. In-house technical review was provided by Dr. Mitchell, Dr. David J. Tazik, and Mr. John Tingle, EL.

This report was prepared under the general supervision of Dr. Michael F. Passmore, Chief, Ecological Analysis and Restoration Branch, EL; Dr. David J. Tazik, Chief, EEED; and Dr. James R. Houston, Acting Director, EL.

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1 Introduction

The conservation and management of Threatened and Endangered Species (TES)[1] and their habitats are recognized as major concerns on Department of Defense (DOD) installations nationwide. To date, most efforts to address TES issues have been conducted on a species-by-species basis on separate installations. Various methods and information have been used by different installations to determine TES monitoring and management requirements. Consequently, there is unnecessary duplication of effort, and methods for evaluation and monitoring are often inconsistent. Reliable procedures are needed to evaluate TES habitats and manage available resources for a variety of species on DOD lands in concert with the military mission.

Goals and Objectives

This report is designed to provide a regionalized approach to TES management on DOD lands within the southeastern United States. The primary technical objective is to develop strategies for assessing and managing TES and their habitats, emphasizing (a) regional and plant community-based strategies, (b) methods that apply collectively to several species (instead of single species), and (c) use of consistently reliable methods within geographic regions. Although consistency is desirable, there is need for flexibility in methods due to subregional variation in biotic and abiotic factors. Major components of this approach are to:

a. Compile available information on TES occurring on installations in selected regions.

b. Assess habitat requirements for selected species.

c. Develop management and monitoring strategies that apply collectively to groups of species within plant communities.

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[1] The acronym "TES" instead of "T&E Species" will be used in this report to conform to standard DOD terminology. Also included are Candidate Species (former C1 species), defined as those plants and animals species that, in the opinion of the U.S. Fish and Wildlife Service (USFWS) or National Marine Fisheries Service, may qualify for listing as threatened or endangered pursuant to the Endangered Species Act (ESA); and "Species of Concern" (SOC), a term that refers to those species determined by the USFWS to be in need of concentrated conservation actions.

d. Assess potential impacts of military operations on species and their habitats.

e. Develop a prototype community-based assessment and management plan.

The benefit to installations will include (a) the accessibility of information on available, up-to-date TES management practices and any known effects on rare species; (b) reduction of unnecessary duplication of effort among installations; (c) significant cost savings over time; and (d) improved credibility of DOD TES efforts. Potential users include all DOD installations with known or probable populations of TES. The project also has widespread application to other Federal and state agencies. The approach provides a template for similar efforts in other regions of the country.

Approach

This investigation utilized a regionalized, community-based approach to TES management. Primary steps to achieve this objective were to (a) designate geographic regions for development of plans, (b) locate DOD installations occurring within designated regions, (c) select a region of emphasis for developing a prototype assessment and management plan, (d) identify ecosystems and plant communities occurring within this region and determine their distribution on military installations, (e) determine listed and candidate animal and plant species, and species at risk actually or potentially occurring on installations within this region, (f) evaluate habitat requirements and community associations for selected species, (g) assess potential impacts of military operations on plant communities and associated TES, and (h) develop a prototype assessment and management plan.

Military training and testing mission requirements are the highest priority land uses on DOD lands. Although training takes precedence over all other concerns, the military mission and TES management can be compatible and should not be thought of as mutually exclusive interests (Trame and Harper 1997). The protection and maintenance of natural resources on training lands, including TES, is essential for the continued use of these lands to carry out the military mission and will help keep DOD in compliance with environmental laws (Boice 1996). By managing at the community or ecosystem level, DOD has the opportunity to conserve multiple TES simultaneously. Plant communities are less ambiguous than complete ecosystems and have been variously described and catalogued for decades by ecologists and biogeographers. Thus, they provide a useful basis for managing natural systems that support military training and other land uses.

The southeastern United States was selected for investigation because this region contains a large number of installations, many of which have actual or potential TES concerns. Also, extensive studies on selected species and their habitats have been conducted in this region by DOD, other Federal and state agencies, universities, and private organizations. Figure 1 shows military installations in the Southeastern Region. Installations are listed in Appendix A. Appendixes B through E present specific information concerning TES plants and animals and their habitats.

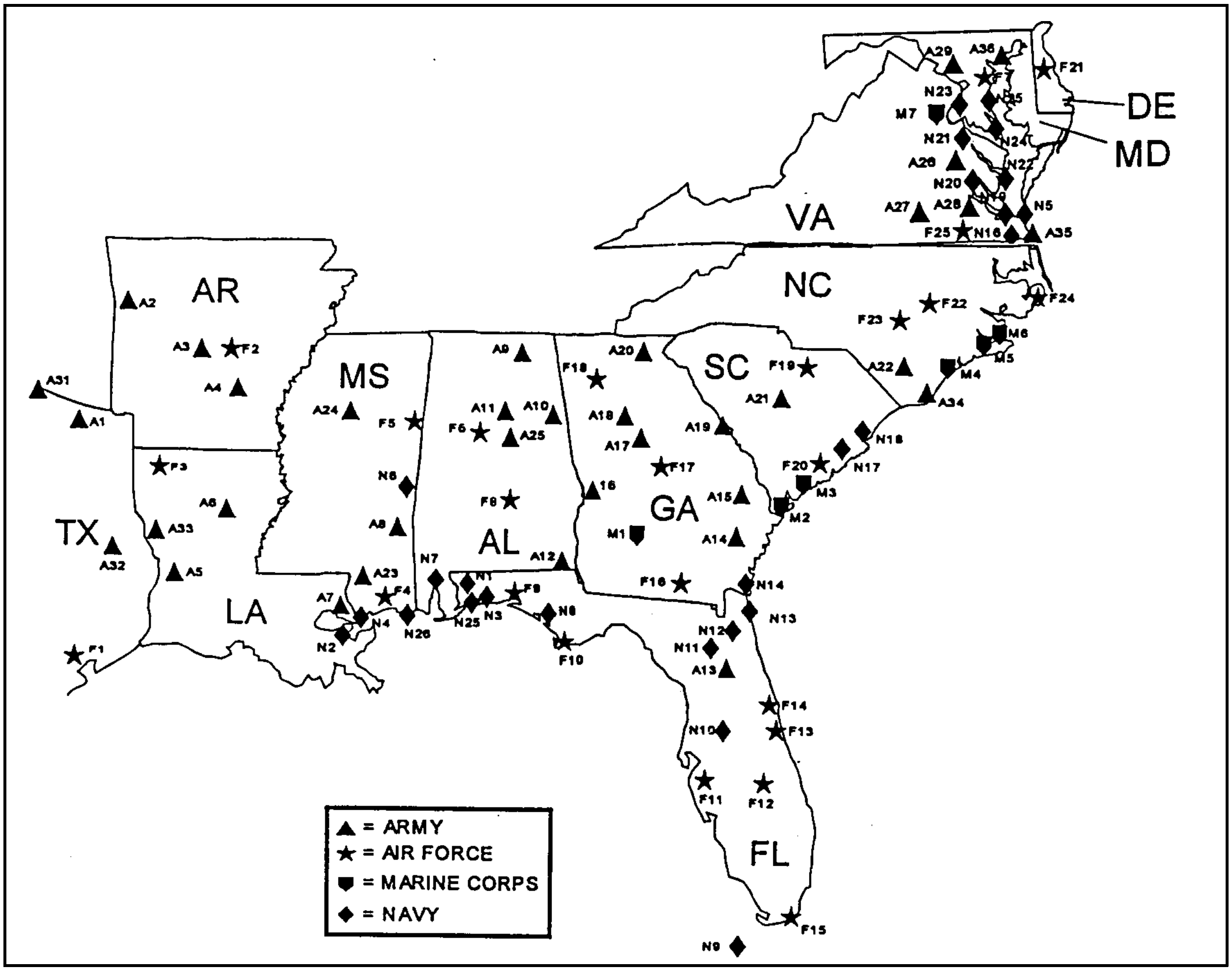

Figure 1. The Southeastern Region, showing military installations included in this report (Table A1 for list of installation codes)

A database was developed for plant communities and TES occurring or potentially occurring on installations in the Southeast. Project investigators reviewed the available literature and conducted interviews with ecologists and installation personnel to obtain information on plant communities, their associated TES, and potential impacts to these communities. Emphasis was placed on interviewing personnel who have been involved in TES and plant community survey work on military installations. Potential impacts were also discussed with military natural resources personnel, botanists, community ecologists, and military contractors such as The Nature Conservancy (TNC) and associated state Natural Heritage Program (NHP) staff. Land Condition Trend Analysis (LCTA) reports, Land Rehabilitation and Maintenance (LRAM) data, and Federal agency and academic literature on logging and recreational impacts to plant communities were also used. Visits were made to selected installations to obtain site-specific information on TES communities and to assess potential impacts of military installations.

A large, computer-based bibliographic database of TES literature was compiled using the Pro-Cite software program. Information obtained through the literature survey, installation documents and files, personal communications, and site visits was used to develop community management plans and faunal species profiles. These reports are discussed in the following text.

Products

Twenty-nine products were completed for the study. These include a concept plan (Martin et al. 1996), a report on potential military impacts (Trame and Harper 1997), 6 plant community management plans, 18 faunal profiles, 2 bulletin articles, and the final community-based regional plan. Additionally, eight presentations on the study were made at professional meetings and workshops. A complete listing of products for the work unit is provided as Appendix F.

The emphasis of the project has been on the development of plant community management plans and faunal species profiles. Community management plans include detailed information on community characterization, ecological quality, land-use practices, impacts, and management of selected plant communities that potentially support populations of threatened and endangered species. In-depth discussions are provided on potential impacts and management recommendations regarding fragmentation and land use conversion, silvicultural practices, agriculture, alteration of hydrology, fire management, grazing/animal damage, and military training. Plant communities addressed were longleaf pine woodlands, herbaceous seeps and wet savannas, Florida scrub, peatland shrub- and forest-dominated communities, bottomland hardwoods and deepwater swamps, and maritime communities. Citations for these reports are shown in Table 1.

Although other plant communities (e.g., coastal prairies, upland pine-hardwoods, and estuarine marshlands) also support populations of TES, addressing all communities occurring in the Southeast was beyond the scope of this study. Therefore, communities selected for study were those known to support the greatest number of TES on military lands.

Faunal profiles prepared for the study contain information on species status and distribution, occurrence on military installations, life history and ecology, species habitat requirements, inventory and management needs, impacts and causes of decline, and recommendations for habitat restoration and management. Copies of these reports have been distributed at numerous professional meetings and conferences. A SERDP TES Web Page on faunal species was created for the WES home page (**http://www.wes.army.mil/el/tes**) in FY98. To date, over 25,000 hits have been recorded, indicating high use of these documents. Species

Table 1 **Plant Community Management Plans Published for This Study**	
Title	**Authors**
Management of longleaf pine woodlands for threatened and endangered species	Harper et al. (1997)
Management of herbaceous seeps and wet savannas for threatened and endangered species	Harper, Trame, and Hohmann (1998)
Management of Florida scrub for threatened and endangered species	MacAllister and Harper (1998)
Management of peatland shrub- and forest-dominated communities for threatened and endangered species	Robertson, Harper, and Woolery (1998)
Management of bottomland hardwoods and deepwater swamps for threatened and endangered species	Fischer et al. (1999)
Management of maritime communities for threatened and endangered species	Gehlhausen and Harper (1998)

for which profiles were developed are listed in Table 2. Plant community plans can be accessed on line at CERL's home page (**http://www.cecer.army.mil**).

Numerous other sensitive animal species occur in the "Southeastern Region." However, it was not feasible to prepare profiles on all TES species. Chapter 3 and Table E1 provide additional information on such species as the red wolf (*Canis rufus*), Rafinesque's big-eared bat (*Corynorhinus rafinesquii*), Florida and Louisiana black bear (*Ursus americanus floridanus* and *U. a. luteolus*), bald eagle (*Haliaeetus leucocephalus*), and peregrine falcon (*Falco peregrinus*). Although information was provided on some aquatic and

Table 2 **Species for Which TES Faunal Profiles Were Developed**	
Species	**Author**
Indiana bat (*Myotis sodalis*) Gray bat (*Myotis grisescens*) Southeastern myotis (*Myotis austroriparius*)	Evans, Mitchell, and Fischer (1998) Mitchell (1998b) Reynolds and Mitchell (1998)
Southeastern American kestrel (*Falco sparverius paulus*) Cerulean warbler (*Dendroica cerulea*) Florida scrub jay (*Aphelocoma coerulescens*) Loggerhead shrike (*Lanius ludovicianus*) Least tern (*Sterna antillarum*) Wood stork (*Mycteria americana*) Henslow's sparrow (*Ammodramus henslowii*) Bachman's sparrow (*Aimophila aestivalis*)	Lane and Fischer (1997) Evans and Fischer (1997) Mitchell (1997) Hall, Legrand, and Fischer (1997) Mitchell (1998d) Mitchell (1999) Mitchell (1998c) Mitchell (1998a)
Gopher tortoise (*Gopherus polyphemus*) Alligator snapping turtle (*Macroclemys temminckii*) Eastern indigo snake (*Drymarchon corais couperi*) Pine snake (*Pituophis melanoleucus* spp.) Southern hognose snake (*Heterodon simus*) Gopher frog (*Rana capito*) Flatwoods salamander (*Ambystoma cingulatum*)	Wilson, Muchinsky, and Fischer (1997) Lane and Mitchell (1997) Hallam, Wheaton, and Fischer (1998) Jordan (1998a) Jordan (1998b) Palis and Fischer (1997) Palis (1997)

semiaquatic species potentially influenced by upland land-use practices (e.g., alligator snapping turtle (*Macroclemys temminckii*) and several amphibians), aquatic species were generally not addressed in community assessments.

Report Organization

The remaining chapters of this report address plant communities, TES components, and management strategies and recommendations. Chapter 2, Plant Communities, provides a general characterization of the six communities for which management plans were developed. Chapter 3 provides an overview of plant and animal TES that occur in the six featured communities. Chapter 4 discusses management alternatives for plant communities with respect to fragmentation, forestry practices, fire management, hydrologic concerns, and military training. Management practices and their impacts on various species are compared among community types, and recommendations are made to optimize management for TES. Conclusions and community-based guidelines are provided in Chapter 5.

Citations

This report primarily represents a synthesis of information provided in detail in Plant Community Management Plans and other documents prepared for the SERDP regional TES study. Therefore, internal references used in previous documents are not repeated in this report unless they are critical to the meaning of statements made in the text. This action was taken to improve readability of the final report for installation personnel and is justified on the basis that the final report represents a summary and assessment of information in other reports readily retrievable at the U.S. Army Engineer Research and Development Center (ERDC), Vicksburg, MS, and Construction Engineering Research Laboratory (CERL), Champaign, IL, home pages. For more specific information, the reader should refer to the original literature cited in Plant Community Management Plans, Faunal Species Profiles, and other reports referenced in this document.

2 Plant Communities

A variety of classification schemes have been used to delineate plant communities occurring in the southeastern United States. For this study, the three-volume series *Biodiversity of the Southeastern United States* (Hackney, Adams, and Martin 1992; Martin, Boyce, and Echternacht 1993a,b) was chosen as the primary reference for classifying and describing plant communities. This scheme was considered to be most appropriate because communities are classified on a regional basis (and information on regional variation in vegetation, structure, and nomenclature is provided), the scale of classification appears to be at a level that is useful for natural resource managers, and communities occurring on installations are often described at a scale that is easily adapted to this classification.

Information on plant communities was gathered from approximately 40 installation reports, many of which have had community surveys. Initially 11 plant communities were identified as representing the major communities that occur on military installations in the southeastern United States. To make the number of communities manageable, these major communities often represent groupings of subcommunities that have similar management needs. For greater detail on the communities, see the series of *Biodiversity of the Southeastern United States* (Hackney, Adams, and Martin 1992; Martin, Boyce, and Echternacht 1993a,b). Also see *Ecosystems of Florida* (Myers and Ewell 1990), and "Vegetation of the Southeastern Coastal Plain" (Christensen 1988) in *North American Terrestrial Vegetation* (Barbour and Billings 1988).

The following six plant communities were determined to support the greatest numbers of TES on military installations in the Southeast and were selected for development of Plant Community Management Accounts: Longleaf pine woodlands, herbaceous seeps and wet savannas, Florida scrub, peatland shrub- and forest-dominated communities, bottomland hardwoods and deepwater swamps, and maritime communities. Characteristics of these communities are summarized in the following text. For greater detail refer to the SERDP Plant Community Management Plans shown in Table 1.

Longleaf Pine Woodlands

For management purposes, pine flatwoods and sandhills communities were combined because they have several shared features. Descriptions provided in this section are summarized from Harper et al. (1997). Historically, pine flatwoods and sandhills dominated many upland areas of the southeastern Coastal Plain, forming a matrix in which other community types were embedded. Sandhills are located on well-drained xeric ridges and rolling uplands that grade into flatwoods, which occur on poorly drained flats or terraces. Both communities require frequent fire for maintenance and have a number of plant and animal species in common. Frequently burned flatwoods and sandhills are similar in structure, both having a sparse canopy of pines — usually longleaf pine (*Pinus palustris*) — and a diverse understory dominated by wiregrasses (*Aristida stricta* or *A. betrichiana*) or bluestems (*Andropogon* spp. and *Schizachyrium* spp.). The ranges of pine flatwoods and sandhills generally follow the distribution of longleaf pine in the southeastern United States.

Sandhills. Longleaf pine-dominated sandhills occur along the outer Coastal Plain from eastern Virginia to Florida and west to the Mississippi River. The community generally occurs in areas with rolling topography that have well-drained, dry-to-xeric sandy soils. Examples occur on more than 20 military installations (Table B1). Community structure is characterized by an open, sparse canopy of pine, an open midstory dominated by scrubby oaks (*Quercus* spp.), and a herbaceous ground layer consisting of various grasses and forbs (Figure 2). Physiognomy varies with moisture, fire regime, and geographic location. Longleaf pine dominates the canopy, except in southeastern and

Figure 2. Longleaf pine sandhill habitat, Fort Bragg, North Carolina

southcentral Florida stands, which may consist of slash pine (*P. elliottii*) or both longleaf and slash pine, and in eastern Texas north of the range of longleaf pine, where shortleaf (*P. echinata*) and loblolly pine (*P. taeda*) dominate. There is usually a diverse understory dominated by wiregrasses or bluestems (Harper et al. 1997).

Pine flatwoods. Pine flatwoods occur on the Coastal Plain from southeastern Virginia south to Florida and west to Texas and have been documented on more than 20 military installations (Table B1). These communities occur on extensive flats or terraces and have low, usually flat to gently undulating topography. There is typically a ground layer of low vegetation and an emergent tree layer of pines with limbless lower trunks, but physiognomy varies markedly with fire regime and moisture. Soils are usually poorly drained sands with varying amounts of clay. Longleaf pine, slash pine, and pond pine (*P. serotina*) usually dominate the canopy in pure stands or various combinations. Dominant grasses are similar to those noted above for sandhills. Understory species are listed in Harper et al. (1997).

Herbaceous Seeps and Wet Savannas

Wetland communities such as herbaceous seeps and wet savannas occur on military installations throughout the Southeast (Table B2), usually as pockets of wet habitat within a matrix of drier longleaf pine woodlands. They usually occur as imbedded (or inclusional) wetland communities within the matrix (Harper, Trame, and Hohmann 1998). Coastal Plain depression ponds, seeps, bogs, and wet savannas are included in this community type. Herbaceous seeps and wet savannas are ecosystems dominated by grasses, sedges, and composites with an absence of a shrub layer or a tree canopy (although scattered trees or shrubs may occur). They are characterized by frequent fire, acidic soils, seasonal flooding or frequent saturation, and the occurrence of carnivorous plants. Coastal Plain depression pond complexes are complexes of small, isolated, seasonally, or permanently flooded depressions in pinelands. These communities are considered together as a unit here because they have hydrologic properties similar to seep and bog communities and provide important breeding sites for amphibians. They support high-species diversity, including several rare species, and generally have unique soil and hydrologic characteristics, which make them more sensitive to human-related disturbances than their surrounding communities.

The range of herbaceous seeps and wet savannas generally follows the distribution of longleaf pine occurring throughout most of the Coastal Plain of the southeastern United States. Hillside seeps are most common from Texas to southwestern Georgia, but are also abundant along the western Florida panhandle. The largest wetland savanna areas are along the Gulf coast; however, southern Florida, Georgia, and the Carolinas also support considerable acreage. Hillside seeps of the West Gulf Coastal Plain are generally less than 2 hectares (ha) in size, and many are less than 0.4 ha, but often several sizes occur close together, forming a complex. The largest wet savannas known in the West Gulf

Coastal Plain are about 200 ha, but most remnants are between 4 and 20 ha. The following descriptions are taken from Harper, Trame, and Hohmann (1998).

Herbaceous seeps. The herb-dominated communities combined in this synthesis vary widely and are known by many names. As a group they have been referred to as grass-sedge-rush communities and graminoid-dominated wetlands. Seepage communities have been called hillside bogs, pitcher-plant bogs, grass-sedge bogs, and green-heads in Louisiana; pitcher-plant bogs, Coastal Plain herb bogs, sphagnum bogs, and moist pine barrens in Georgia; hillside herb bogs and seepage herb bogs in South Carolina; and sandhill seeps, hillside seepage bogs, and low-elevation seeps in North Carolina. On the eastern Coastal Plain, hillside seeps are associated with the slopes of former dune systems. On the western Coastal Plain, this community can be found on short steep slopes, generally near midslope of the headwater of small ravines. Hillside seepage wetlands are hydrologically unique in that they are almost constantly saturated, but never inundated.

Wet savannas. Wet savannas once occurred over broad expanses of flat to gently rolling, imperfectly drained interstream areas along the outer Coastal Plain, occupying many areas except depressions, stream valleys, and hill rises. Wet savannas have been called wet prairies, wet meadows, low marshes, moist savannas, plant lands, wet pine savannas, coastal meadows, pine barrens, and pine meadows in Louisiana; sphagnum bogs and moist pine barrens in Georgia; pitcher-plant flats and wet prairies in Florida; pine savannas in South Carolina; and depression ponds in North Carolina. Cypress savannas, listed in classifications for Georgia and the Carolinas, appear to be intermediate in moisture between wet savannas and depression ponds.

Coastal Plain depressions. On the eastern Gulf Coastal Plain and northern Florida peninsula, small depression ponds often occur in limesink complexes, and along other areas of the southeastern Coastal Plain in clusters of depressions. Small depression ponds may be fed either by rainfall or groundwater, or both. Most are seasonally flooded, drying out during summer droughts. Coastal Plain small depression pond complexes are given the same name in North Carolina and are also called vernal pools. In Louisiana, they are called flatwood ponds. In Georgia, these are the small examples of cypress or gum ponds. In South Carolina, depression meadows, limestone sinks, and smaller swamp tupelo (*Nyssa aquatica*) or pond cypress (*Taxodium ascendens*) ponds are types of small depression pond complexes. In Florida, small depression pond complexes are called depression marshes and dome swamps, and in Mississippi, they are named grady pond swamp forests.

Florida Scrub

Florida scrub is a rare and rapidly disappearing community that can be found on dry, sandy soils lying within a matrix of associated xeromorphic plant communities (longleaf pine, sandhill, and xeric hammock (a forest type dominated by broadleaf evergreens)) and surrounding wetland areas. All of these associated ecosystems are dependent on fire for persistence and are interconnected physiographically. Scrub communities have numerous synonyms, many of which describe the dominant shrub that occurs in each area. Oak scrub, rosemary (*Ceratiola ericoides*) scrub, palmetto (*Serenoa repens* and *Sabal etonia*) scrub, sand pine (*P. clausa*) scrub, and in some cases coastal scrub and scrubby flatwoods are all used to describe this habitat. Differences in microclimate, fire regime, and stages of succession are responsible for the variety of forms characteristic of this community (MacAllister and Harper 1998).

This rare community type is limited mainly to Florida, although similar communities occur elsewhere. Florida scrub still occupies excessively well-drained soils associated with ancient coastal dune systems. Coastal and inland scrub communities can be found on the peninsula, but stands also occur in the Florida panhandle along the Gulf Coast. A few examples exist as far west as Mobile Bay in Alabama. A single stand of Florida scrub has been discovered in Mississippi, and similar communities occur in parts of southern Georgia. In Florida, scrub communities always occupy dry, sandy, nutrient-poor soils that are found in a number of locations. The range of inland peninsular scrub is generally restricted to a complex of sand ridges and ancient dunes running north and south from Clay and Putnam counties to Highland county with a few fragments persisting in areas such as military installations where residential development and citrus cultivation have been limited. Peninsular coastal scrub is found on both the Atlantic and Gulf Coasts. Panhandle scrubs are restricted to a narrow strip along the Gulf Coast and on some barrier islands. Most remaining scrub communities range in area from 40 to 242 ha. The largest block of Florida scrub (84,987 ha) is an inland scrub area referred to as the Big Scrub complex, which occurs in and around the Ocala National Forest in north-central Florida. Florida scrub communities are found on a number of military installations in the region (Table B3) (MacAllister and Harper 1998).

Peatlands

Plant communities found on peatland soils include forests, basin shrublands, and seepage communities. The plant communities included can be categorized as forest/woodland types (Atlantic white cedar (AWC) (*Chamaecyparis thyoides*) forest, pond pine woodland, cypress domes, streamhead pocosins and bay forest) and basin shrub-dominated types (low, high, and depression pocosins). All occur on peatland soils and may replace each other through time and space due to the influence of hydroperiod and fire return interval. Consequently, these communities often form a mosaic on the landscape. The ecotones near cypress domes and streamhead pocosins, and portions of high-quality basin pocosins, are important sites dominated by a rich herbaceous layer and support many rare plants. Although these sites are ecologically similar to bogs, larger expanses of herbaceous seeps and bogs on peatland soils were considered separately by Harper et al. (1997). Nineteen DOD installations provided information stating that they have at least one of the six peatland communities. Information below is synthesized from Robertson, Harper, and Woolery (1998).

Bay forests. The bay forest community type occurs on the Atlantic Coastal Plains from Virginia south to Florida, and west to Arkansas and eastern Texas. Bay forests occur on 12 military installations in the southeastern United States (Table B4). Bay forests may generally be divided into those that occur on seepage slopes and those that occupy basins or nonalluvial wetlands. Those on seepage slopes share many physical characteristics with streamhead pocosins, and those in basins share characteristics with the other pocosin types and peatland forests. Community structure is characterized by a dense, short canopy made up of broad-leaved evergreens, a vine-shrub subcanopy, a dense-to-somewhat-open shrub layer, and a sparse herbaceous layer. Bay forests are extremely susceptible to fire, and when burned, usually revert to an earlier successional community such as pond pine woodland, AWC forest, or sedge bog. The bay forest community is characterized by the canopy dominance of loblolly bay (*Gordonia lasianthus)*, sweet bay (*Magnolia virginiana)*, and swamp red bay (*Persea palustris*) with other associated species varying across the region.

Atlantic white cedar forests. AWC forests are found on peatlands throughout the Coastal Plain, where they occur in a narrow coastal range 80-210 km (50-130 miles) wide from southern Maine to northern Florida and west to southern Mississippi. AWC is found on shallow, frequently flooded organic soils on interstream flats and peat-filled Carolina bays and swales. This plant community is dependent upon fire for persistence and requires open conditions with little to no competing vegetation to regenerate. These conditions are best created through stand-killing crown fires at intervals of 25 to 250 years. Under such a fire regime, this community exhibits a dense, even-aged canopy dominated by AWC, with a relatively open shrub and herbaceous layer. AWC does not form even-aged stands in areas without the appropriate type of catastrophic disturbance. In these cases, AWC shares dominance with several other species, and a more dense shrub layer forms. In mixed stands, characteristic subdominants include red maple *(Acer rubrum),* sweet bay, and swamp tupelo.

Pond pine woodlands. Pond pine woodlands are found on the outer Coastal Plain from Florida to Virginia. There are six known occurrences of pond pine woodlands on military lands in the Southeastern United States. These communities occur on poorly drained sites over shallow organic soils that undergo temporary flooding. This community exhibits an open-to-nearly-closed canopy, with a tall (>5 m), dense shrub layer and sparse understory. Highest quality pond pine woodlands are characterized by an understory dominated by cane (*Arundinaria gigantea* or *A. tecta*), which requires burning at intervals of 3 to 5 years. Under fire return intervals of 10 to 20 years, the community experiences a shift in the understory vegetation, from dominance by cane to shrubs that slowly replace the cane. The canopy is dominated by pond pine and may include codominant loblolly bay (within its range), sweet bay, red maple, loblolly pine, and AWC in the canopy and understory. The subcanopy or shrub layer is dominated by titi (*Cyrilla racemiflora*), fetter-bush (*Lyonia lucida*), sweet gallberry (*Ilex coriacea*), and swamp red bay.

Basin pocosins. The three basin pocosins (low, high, and depression pocosins) are discussed together because they often grade into one another in the landscape, and have similar physical and floristic characteristics. Low pocosin communities occur on the Coastal Plain from Virginia to Florida but are mostly restricted to the outer Coastal Plain of North Carolina. Small depression pocosins are found in isolated areas throughout the Coastal Plain and sandhills in North and South Carolina. Eleven military installations in the Southeastern United States support basin pocosin communities (Table B4). Low pocosins occur on deeper peat (usually 1 to 5 m deep) than high pocosins ($\leq$1.5 m); both communities occur on oligotrophic wet sands. Pocosin communities are seasonally flooded, and almost all of the water is received as direct rainfall. Basin pocosin communities are maintained by fire; natural ignitions are thought to have occurred at 3- to 8-year intervals in areas with the highest species diversity. In the past, fires burned over large areas during a fire event and recovery of the vegetation was rapid. Species diversity and productivity are highest following fire. Low pocosins are dominated by shrubs less than 1.5 m in height but may include widely spaced, stunted, and gnarled pond pine. High pocosins have a shrub layer ranging from 1.5 to 3 m tall, a subcanopy formed by scattered bay shrubs and hardwood species, and may exhibit an open canopy of pond pine. Small-depression pocosins may resemble either low or high pocosins in their physiognomy.

Streamhead pocosin. Streamhead pocosins occur in scattered locations throughout the upper Coastal Plain and fall-line sandhills from southeastern Virginia to northern Florida and west to southeastern Alabama. Streamhead pocosins occur on wet, acidic soils overlying clay or sand in the headwaters of small streams, flat bottoms, and sometimes seepage slopes. They have historically burned along with the surrounding plant community, which was often longleaf pine sandhills. The edges of the pocosin burn more frequently than the interior, due to a strong gradient in moisture. Many of the species found in the herbaceous layer are adapted to the open light conditions maintained by frequent fire. Infrequently burned streamhead pocosins tend to have greater concentrations of trees and shrubs and fewer herbs than those frequently burned. Streamhead pocosin communities are characterized by having a scattered to very dense canopy, a dense shrub layer, and a less sparse herb layer than other pocosin types. Primary species are pond pine and sweet bay, but may also include slash pine, loblolly pine, swamp red bay, tulip tree (*Liriodendron tulipifera),* red maple, swamp tupelo, black gum (*N. sylvatica*), and AWC. The shrub layer is dominated by titi, buckwheat tree (*Cliftonia monophylla)*, and fetter-bush (Martin 1992).

Cypress domes. Cypress domes are distributed throughout Florida and along the Atlantic Coastal Plain and occur in shallow depressions that are underlain by drainage-impeding clay layers within the pine flatwoods ecosystems. These depressions contain stagnant water levels with a low pH (3.6 to 4.4). These communities appear to have a dome shape because the tallest cypress trees grow in the center of the depression, with tree height decreasing outward from the center. The herbaceous and shrub layers may range from very sparse to dense. Typically, shrubs are most dense on mats of organic matter accumulated at the base of cypress trees and are infrequent on the peaty mud in between. A herbaceous layer of ferns, forbs, and grasses is typical. Fire historically occurred in cypress domes during the dry season, and was an important factor for maintaining the dominance of cypress in the community and the diverse herbaceous layer near the edge of the community. Periodic surface fires will not alter the vegetation composition of a normally wet dome, but these fires will help to kill newly established slash pines and hardwoods (see Robertson, Harper, and Woolery 1998). Most cypress domes are floristically similar; pond cypress is the dominant canopy tree while swamp tupelo occurs occasionally and may be the dominant subcanopy tree. Other tree species sometimes present in the domes are slash pine, swamp red bay, sweet bay, and sweet gum (*Liquidambar styraciflua*).

Bottomland Hardwoods and Deepwater Swamps

Bottomland hardwood forests (BLH) and deepwater alluvial swamps are forested wetlands that include stream and river floodplain forests and mixed hardwood forests in basins of the southeastern United States. Bottomland hardwood and deepwater alluvial swamps can be found within the Gulf Coastal Plain and Atlantic Coastal Plain from Virginia southward and have been documented on at least 29 DOD installations in the southeastern United States (Table B5). Although the exact total acreage of these communities is uncertain, their occurrence on installations appears to represent a significant source of biological diversity and forest productivity. Southeastern floodplain forests are generally nutrient rich because of their dynamic nutrient cycling caused by changing hydrology and the import of nutrients with deposited sediment. They are characterized by open-nutrient cycles with large inputs and outputs from frequent flooding. Community descriptions below are summarized from Fischer et al. (1999).

Bottomland hardwoods. Bottomland hardwoods are dominated by a variety of woody plant species adapted to survival in an environment where soils within the root zone may be either inundated or saturated during various times of the growing season (Figure 3). These floodplain forests are characterized by high biomass, relatively high stem density of mature trees, and large individual trees forming a high canopy. On persistently inundated sites, BLH communities generally have low stem density. Most BLH are marked by low density of shrubs and understory plants, particularly in wetter areas. Bottomland hardwoods were classified as Palustrine Wetlands in the National Wetlands Classification System and Inventory (Cowardin et al. 1979), as Riverine Wetlands by Brinson (1993), and are considered a type of riparian community (Sharitz and Mitsch 1993). Processes in BLH are controlled by flood regime; the physical processes that drive productivity of these wetlands center around hydrological events upstream and in the watershed and the subsequent groundwater levels. The differing hydrologic regimes in BLH often produce a high interspersion of wet and dry areas that are very important for providing high-quality habitat for a diverse animal community.

Figure 3. Bottomland hardwood forest

The dominant trees found in natural BLH communities are a reflection of several variables, including the depth of water and the duration and timing of flood events. For example, deepwater swamps and the wetter portions of flood-plain forests are usually dominated by baldcypress (*Taxodium distichum*) and/or water (swamp) tupelo. Mesic portions of the floodplain (semipermanently flooded) habitats are typically dominated by species such as black willow (*Salix nigra*), eastern cottonwood (*Populus deltoides*), silver maple (*A. saccharinum*), overcup oak (*Q. lyrata*), water hickory (*Carya aquatica*), red maple, green ash (*Fraxinus pennsylvanica*), and river birch (*Betula nigra*). Other species are noted in Fischer et al. (1999). The species composition and relative abundance of species in various communities within forested wetlands is extremely variable over short distances. This variation is due to the dynamic and spatially heterogeneous nature of the floodplain's environmental factors, including flooding, changes in geomorphology, and occurrence of tree-fall gaps.

Deepwater swamps. Deepwater swamps are freshwater depressions that contain standing water for most or all of the year (Figure 4). Stands of baldcypress, pond cypress, water tupelo, swamp tupelo, and Atlantic white cedar (included here as a subtype of peatlands) occur throughout the southern United States in a variety of geomorphic settings ranging from broad, flat floodplains to isolated basins. Alluvial swamps are dominated by baldcypress and occur throughout much of the range of southern BLH in depressions (e.g., abandoned river channels, elongated sloughs) that are inundated during most or all of the growing season. Swamps often are highly productive because they usually are found along the floodplains of rivers having soils with ample nutrients (Conner and Buford 1998).

Figure 4. Deepwater swamp

Maritime Communities

Maritime communities typically are found within 400 m of the Atlantic and Gulf coasts, both on the mainland and on barrier islands. These communities have been documented on seven southeastern military installations (Table B6). Four types of maritime communities were grouped because of similar influences of climate and proximity to the ocean. Differences are caused primarily by the effect of early-successional, stabilizing vegetation on the location and character of different maritime communities. Overwash communities develop in interdunal swales or depressions on barrier islands in areas where overwash (sand, organic debris, and salt water) is deposited during hurricanes and storms. Dunes are formed by the constant accumulation of sand, which becomes stabilized by beach grass (*Ammophila breviligulata*) north of Cape Hatteras, and sea oats (*Uniola paniculata*) to the south. As dunes stabilize, they protect areas behind them from salt spray and blowing sand, which allows for the development of shrub-dominated communities. Maritime forests develop in the coastal zone on stabilized dune systems located on the bay side of islands whose width and topography provide sufficient protection from storm exposure. Information in this section was taken from Gehlhausen and Harper (1998).

Overwash. Overwash communities occur in moisture-rich areas such as interdunal swales, mud flats, and sheltered depressions. They may grade into other maritime communities such as sand dunes, shrub complexes, or barrier island pond complexes, and may also grade into brackish or salt marshes. Plants that can withstand constant sand burial and other harsh conditions (e.g., erosion, salt spray, blowing sand, deposition) form the vegetation characteristic of this community. This community is dominated by a dense cover of grasses in wetter areas; in drier areas, grass cover is less dense and grasses are evenly distributed.

Sand dune. Sand dune communities develop on the foreslope, crest, and rear slope of frontal dune ridges on both mainland and barrier island foredunes. Sand dunes are characterized by having sparsely to densely populated patches of grassy perennials. Vegetation cover on sand dunes develops in the absence of overwash. Dunes are formed by an accumulation of sand deposits, and once plants are established, sand accumulates around their bases. A more diverse sand dune community is then formed as other species colonize the dune. These dune colonizers are adapted to the harsh environmental conditions of sand burial and salt spray. The amount of ground cover varies with the stability of the dune, and there may be a few widely scattered shrubs. The sand dune community is populated by specialized species adapted to the shoreline environment and is fairly uniform in composition throughout the southeastern region. Dune panic grass (*Panicum amarum*) is the dominate dune-building plant on some small islands in South Carolina and is common throughout Florida.

Maritime shrub. Protected areas immediately behind sand dunes typically are shrub communities. On the Atlantic Coast, these communities are dominated by wax myrtle (*Myrica* spp.) and yaupon holly (*I. vomitoria*). Slash pine and loblolly pine may succeed the shrub stage and precede the climax forest. On the coast of the Florida panhandle, the community is characterized by woody goldenrod (*Chrysoma pauciflosculosa*) and rosemary. Maritime shrub communities occur on old stable dunes. They may also develop in interdunal sand flats that are protected from salt spray and water flooding. A community of similar composition may develop above the salt marsh community, but infrequent flooding will prevent trees from establishing. This community is characterized by having a dense layer of shrub-size woody plants. Within this thicket, many lianas (woody vines) also occur.

Evergreen maritime forest. Maritime forests once covered extensive areas along the Atlantic Coast, but never represented a large proportion of coastal area. Maritime forests occur on relic dune ridges and old stable dunes. They occupy a narrow band along the coast and also occur on interior uplands of barrier islands. The vegetation of maritime forests (Figure 5) is adapted to severe conditions such as salt spray, bright sunlight, wind shear, low water availability, and nutrient-poor soils. Evergreen maritime forests have low to moderately high, mostly closed canopies. Live oak (*Q. Virginiana*), a dominant coastal species, rarely grows more than 5 to 15 m tall when it develops in old ocean-facing dunes subject to salt spray (but it can grow from 20 to 25 m tall farther inland). The subcanopy/shrub layer is usually well developed and also dominated by evergreen shrubs; lianas are common throughout. The herbaceous layer is generally sparse. Since colonial times, these areas have been exploited for timber and have suffered from habitat modification by free-ranging livestock.

Figure 5. Evergreen maritime forest, Georgia coastline

Other Communities

Other southeastern plant communities that support sensitive species include mixed forests, freshwater and coastal marshes, rock outcrops, and prairies. Although community management plans were not developed for these communities, their potential importance as habitat for rare species is recognized. The community report descriptions below are summarized primarily from M. G. Harper (unpublished).

Southern hardwood/pine forests. Southern hardwood/pine forests occur on at least 28 installations throughout the southeastern United States. They support at least three federally threatened plants (Mohr's Barbara's buttons (*Marshallia morhii*); Price's potatoe bean (*Apios priceana*); small whorled pogonia (*Isotria medeoloides*)), two federally endangered plants (relict trillium (*Trillium reliquum*); Tennessee yellow-eyed grass (*Xyris tennesseensis*)), and nine former candidate plant species. Included under this heading are southern mixed hardwood forests, mixed mesophytic forests, and oak-hickory-pine forests. Many of the animal species reported for BLH communities also occur in upland hardwood forests.

Freshwater marshes. Freshwater marshes occur on at least 12 military installations in the southeastern United States. Freshwater marshes are wetlands dominated by a variety of grasses, sedges, and rushes (*Panicum, Muhlenbergia, Carex, Rhynchospora, Cladium, Scirpus,* and *Juncus* spp.). They support at least two former candidate (C2) species. Losses of freshwater marshes in the Southeast are discussed in Mazzotti et al. (1992), Smith (1993), and Noss, LaRoe, and Scott (1995).

Coastal marshes. Coastal marshes occur on at least 10 installations in the Southeast. Based on available information, no federally listed plants (threatened, endangered, or former candidates) occur in these communities. Coastal marshes include both saltwater and brackish marshes. Dominant marsh plants include smooth cordgrass (*Spartina alterniflora*) in the intertidal zone, black needlerush (*Juncus roemerianus*) at edge of high-tide line, and seashore saltgrass (*Distichlis spicata*), saltmeadow cordgrass (*Spartina patens*), several species of glass wort (*Salicornia*), and common reed (*Phragmites communis*) near and above the high tide line (Reimold 1977). The importance of southeastern Atlantic and Gulf coastal marshes are discussed in Gosselink (1984) and Wiegert and Freeman (1990). Losses to estuarine communities (including salt marsh, brackish marsh, intermediate marsh, and intertidal salt flats) are described by Smith (1993) and Noss, LaRoe, and Scott (1995). Maritime communities and coastal marshes share many threatened and endangered animal species.

Rock outcrops. Rock outcrop communities have been documented on at least six military installations in the southeastern United States, where they occur as inclusions in upland hardwood or pine forests. Since these communities are inclusional, it is possible that they occur, but have not been documented, on other installations. Rock outcrops may consist of limestone, sandstone, or granite formations. All are characterized by having extreme temperatures in relation to the surrounding area, xeric to near xeric substrates, shallow soil, severe erosion, and potential dominant vegetation that is primarily herbaceous; plant species include several endemics (Quarterman, Burbank, and Shure 1993). Rock outcrops support the federally endangered Tennessee yellow-eyed grass.

Prairies. In the Southeastern Region, the tall-grass prairie communities occur in Arkansas, Texas, Louisiana, Mississippi, and Alabama (Allard 1990). Prairies occur on at least three installations in Louisiana. They are not known to support any TES plant species on installations. However, southern prairies have been severely disturbed and remaining tracts are small, isolated remnants on the landscape. Extensive (95 to 100 percent) losses of native prairie have been reported for inland and coastal prairies throughout the Gulf Coast states (DeSelm and Murdock 1993; Smith 1993, Noss, LaRoe, and Scott 1995). Therefore, all natural prairies in the southeastern United States should be considered as sensitive communities.

Community Quality

Assessment of community quality is considered beneficial for TES conservation planning and is important for determining opportunities for TES management in various plant communities (Harper et al. 1997). For example, low-quality communities do not provide the same habitat quality for TES as higher-quality communities and should be treated differently in terms of protection, restoration, and allowable land uses. Use of a quality-ranking system for management purposes can ensure that priority is given to the highest-quality TES habitat. Furthermore, use of this system can ensure that restoration activities are used for communities that have the potential to become high-quality TES habitat with minimum restoration efforts and will prevent efforts from being wasted on low-quality communities. Also, plant communities on installations are subject to multiple land uses, and use of a quality-ranking system in combination with an assessment of impacts of various land uses can allow managers to determine which activities are appropriate in which communities, based on the potential to provide quality habitat for TES (Harper et al. 1997).

Managers at Eglin Air Force Base, Florida, have developed a ranking system to classify community quality known as the **Ecological Tier System** (Department of the Air Force 1993). This procedure has also been used at Camp Blanding, Florida (Florida Natural Areas Inventory (FNAI) and The Nature Conservancy (TNA) 1995). The Ecological Tier System has been adapted for this study and was applied to the Strategic Environmental Research and Development Program (SERDP) Community Management Reports. This ranking system below is summarized from the Department of the Air Force (1993) and Harper et al. (1997).

TYPE I - High-Quality Community. This community type includes communities or portions of communities that are in their natural state or a condition that closely approximates their natural state. These areas have experienced relatively few disruptive events. Examples are old growth areas or sites that have ben subjected to minimal disturbance and support vegetation representative of historical conditions. Management activities in Type I areas should be predominantly of a maintenance nature, utilizing methods that mimic natural forces such as prescribed fire.

TYPE II - Intermediate-Quality Community. Type II includes portions of vegetative communities that still retain a good representation and distribution of associated species and which have been exposed to moderate amounts and intensities of disruptive events. These are areas where ecosystem function and viability can be restored through careful, responsible management. Management direction will integrate appropriate management activities to accomplish restoration and maintenance objectives. Restoration activities may include practices that will accelerate change in the desired direction (e.g., use of herbicides, mechanical methods, supplemental plantings).

TYPE III - Moderately Low-Quality Community. Type III quality includes portion of vegetative communities that do not retain a good representation and distribution of associated species and which have been exposed to severe amounts and intensities of disruptive events. These are areas where restoration of ecosystem function might be possible but would require significant and intensive management commitments over extended periods of time. Depending on land-use priorities, management direction may encourage a return to a more natural vegetation association over the long term and/or may include intensive use of traditional management techniques.

TYPE IV - Lowest-Quality Community. Type IV consists of sites that can not realistically be restored because of dedicated land use. These areas include cleared test ranges, sewage disposal spray fields, urban areas, main roads, designated clay pits, power line rights-of-way, and possibly some wildland interface areas.

In addition to giving a quality ranking to a community based on naturalness, managers may wish to use other parameters to determine what kind of activities should occur in communities, and which communities should be protected from them. For example, presence of rare species, overall diversity, unusual species combinations, and diverse physical features (e.g., soil types, hydrologic regimes, and topographic situations) should be considered. Some systems consider all of these parameters, and sites are based on these parameters (Harper et al. 1997).

3 Threatened and Endangered Species Components

This chapter provides an overview of TES plant and animal species occurring in each community type addressed in this investigation. The known occurrence of plant and animal species occurring in these communities in the Southeast is provided in Appendix C. Appendix D and E provide additional information on habitat requirements of TES plants and animals occurring in the region. Refer to plant community management plans and species profiles for detailed information on these species. Information in each section below was taken primarily from the plant community management plan cited in parenthesis at the beginning of each community type.

Longleaf Pine Woodlands (Harper et al. 1997)

The longleaf pine-bunchgrass (either wiregrass or bluestem) ecosystem was once dominant throughout the Coastal Plain of the southeastern United States. The distribution of this ecosystem has been reduced by approximately 90 to 95 percent (99.9 percent if only remaining old growth examples are considered). At the time of European settlement, longleaf pine communities covered at least 24.5 to 36 million ha; today these communities cover less than 1.6 million ha, and most of this is degraded second growth. This ecosystem type is considered by some to be critically endangered.

Communities within the longleaf pine ecosystem are extremely diverse, often supporting numerous rare and endemic plant and animal taxa, making this one of the most important natural systems in the southeastern United States. Hardin and White (1989) listed 191 rare plant taxa occurring in the wiregrass ecosystem. Six of these taxa have been listed as federally endangered, one has been proposed for listing as endangered, and 61 are state listed as threatened or endangered in three states. In addition, the authors estimated that the wiregrass ecosystem supports 66 rare, locally endemic plant taxa, including 33 from Florida, 2 from North Carolina, 14 from North and South Carolina, 5 from

Florida and Georgia, and 5 from Alabama and Florida. Longleaf communities on military installations support several rare plant species including the federally endangered Chapman's rhododendron (*Rhododendron chapmanii*), Michaux's sumac (*Rhus michauxii*), American chaffseed (*Schwalbea americana*), and rough-leaved loosestrife (*Lysimachia asperulaefolia*).

Flatwoods and sandhills provide seasonal and year-round habitats for a variety of animals, many of which are associated with both plant communities. Although limited in distribution and abundance, the two plant communities support a number of animal TES, including the threatened gopher tortoise (*Gopherus polyphemus*), considered a keystone species for the community, and the endangered red-cockaded woodpecker (RCW) (*Picoides borealis*). According to Krusac and Dabney (1994), 53 animal species (17 mammals, 7 birds, 13 reptiles, 6 amphibians, 7 insects, and 1 arachnid) co-occur with RCWs, for which there are viability concerns because of fire suppression, habitat degradation, and habitat fragmentation. The degradation and loss of flatwoods and sandhills also have directly contributed to decreasing populations and reduced distribution of the eastern indigo snake (*Drymarchon corais couperi*), gopher frog (*Rana capito*), and pine snake (*Pituophis melanoleucus*).

Herbaceous Seeps and Wet Savannas (Harper, Trame, and Hohmann 1998)

Herbaceous hillside seeps and wet savannas of the Southeastern Coastal Plain are very diverse and support several endemic species. The combination of low nutrients, acid soils, seasonally high water tables, and high fire frequency limits the establishment of woody species; these factors provide a unique habitat for wetland species tolerant of these extreme conditions. The distinctive biota of herbaceous seeps and wet savannas includes more than 260 characteristic vascular plant species. These communities support over 20 species of carnivorous plants (e.g., pitcher-plants (*Sarracenia* spp.), sundews (*Drosera* spp.), bladderworts (*Utricularia* spp.), butterworts (*Pinguicula* spp.), and Venus flytrap (*Dionaea muscipula*) (Figure 6), making them some of the most diverse carnivorous plant communities in the world. Many plants associated with hillside seeps and wet savannas are under review by the U.S. Fish and Wildlife Service (USFWS) to determine if they should receive protection under the ESA. Several rare plant species have been documented in these communities on military installation lands. In addition, pitcher-plants are the obligate associates of at least 12 insect species.

Depressional pond complexes often serve as important breeding and foraging sites for a variety of amphibians and birds. Many rare faunal species have been documented in these communities on military installation lands in the Southeast; these include the Florida black bear (*Ursus americanus floridanus*), Bachman's sparrow (*Aimophila aestivalis*), red-cockaded woodpecker, eastern indigo snake, pine snake, gopher frog, and flatwoods salamander (*Ambystoma cingulatum*).

Figure 6. Venus flytrap (*Dionaea muscipula*), Fort Bragg, North Carolina

Florida Scrub (MacAllister and Harper 1998)

Florida scrub communities are known for their unique species. About 300 native plant taxa have been collected from Florida scrubs, many of which (10 to 40 percent, depending on how scrub is delineated) are not found in other habitats. At least 13 federally listed endangered or threatened scrub plants and 22 state listed plants occur on these remnant scrub patches throughout Florida (Myers 1990). Thirteen federally threatened, endangered, and SOC plant taxa occur in Florida scrub communities on DOD installations.

Florida scrub is also home to a variety of invertebrates, a number of which have only recently been identified. Many insects are endemic to xeric scrub communities; these include flightless grasshoppers and beetles that are limited in range because they have poor dispersal mechanisms. These include the scrub anomala (*Anomala eximia*), Florida deepdigger scarab (*Peltotrupes profundus*), Florida hypolichia (*Hypolichia sissipes*), and the Sand pine scrub ataenius (*Ataenius saramari*) (Deyrup and Franz 1994). Little is known about the basic biology and ecology of these species, and they have not been listed by the State of Florida or the USFWS because of this lack of information.

Approximately 70 species of vertebrates have been collected in scrub habitats; some of them are not known to occur elsewhere. TES that are found in scrub on DOD lands include the Florida mouse (*Podomys floridanus*) and the Florida scrub lizard (*Sceloporus woodi*), both species of special concern in Florida; the Florida scrub jay (*Aphelocoma coerulescens,* federally listed as threatened); the sand skink (*Neoseps reynoldsi,* federally listed as threatened), and the blue-tailed mole skink (*Eumeces egregius lividus,* federally listed as threatened). Some federally listed endangered species are found on only one protected scrub site, and a few have no formal protection at all.

Peatlands (Robertson, Harper, and Woolery 1998)

Peatland communities are important to regional biodiversity because these communities are sometimes the last extensive natural areas found in the surrounding landscape. The value of peatland communities often lies in their position or extent at the landscape scale. Basin pocosin communities often comprise the last remaining natural areas among developed land, so they provide important refuge habitat for native plants and animals (Sharitz and Gresham 1998). Since bay forests often develop during long fire return intervals in basin pocosin areas, they support similar species and often serve to connect areas of basin pocosin vegetation. Streamhead pocosins add to landscape biodiversity because of their ecotonal position within watersheds. Pond pine woodlands are important because they provide habitat for the red-cockaded woodpecker as well as offer cover to many other species. Cypress domes are generally smaller than pocosins but provide important avian and amphibian habitat for several endangered species. Remaining AWC forests are important for regional biodiversity because this community is so uncommon. AWC forests have decreased by more than 90 percent in the Carolinas alone.

Several rare and endangered species are found in pocosins, including spoonflower (*Peltandra sagittifolia),* northern white beaksedge (*Rhynchospora alba*), tawny cottongrass (*Eriophorum viginicum),* red wolf, black bear (Schafale and Weakley 1990) and the rough-leaved loosestrife (*Lysimachia asperulaefolia*). Pocosin communities are especially important to black bear populations. The black bear was once found throughout the Coastal Plain but now relies heavily on pocosin communities for cover.

Bay forests on DOD lands support two plant species federally listed as “candidates for threatened status”: bog spicebush (*Lindera subcoriacea*) and pondspice (*Litsea aestivalis*). Bay forests also provide habitat for the endangered red wolf and the black bear. Bay forests will grade into other pocosin types, providing important connectivity across the landscape for species that require large home ranges or long-term dispersal opportunities. Streamhead pocosins support a high species diversity (due to their ecotonal nature) and thus harbor more rare and endangered plants than the other peatland communities discussed here. Two SOCs, the Carolina asphodel (*Tofieldia glabra*) and Carolina goldenrod (*Solidago pulchra*), and one endangered plant species, the rough-leaved loosestrife, occur in this community on southeastern military installations. Populations of rough-leaved loosestrife in streamhead pocosin habitat have declined from 19 to 10 populations in recent years, warranting close monitoring and aggressive management efforts.

Bottomland Hardwoods and Deepwater Swamps (Fischer et al. 1999)

Although BLH typically comprise a very small proportion of a total landscape, they provide a variety of wildlife habitats, ranging from permanently flooded swamps and bogs to infrequently flooded forests, beaver ponds, and scrub communities. Both the vertical structure and distribution of riparian vegetation contribute to the number of ecological niches available to wildlife species. This habitat complexity usually supports rich and diverse wildlife communities, including both vertebrates and invertebrates.

Southern BLH forests support a diverse avian community, including breeding and wintering species, and birds that “stop over” during migration. Many of these species, primarily neotropical migrant land birds, are undergoing declines in abundance and distribution concurrent with decreases in forest area. Cerulean warblers (*Dendroica cerulea*), a former candidate species (C2) for listing by the USFWS, have experienced a more precipitous decline in abundance in North America than most other breeding songbirds. This species prefers large and contiguous forested hardwood tracts and is often found in BLH in the Southeast. Although cerulean warblers may not breed on many southern DOD installations, the species may use hardwood stands on these installations as stopover habitat during spring and fall migration between North and South America. The bald eagle is often associated with riparian zones near rivers and lakes and usually nests adjacent to the bodies of water where it feeds. In the southeastern United States, most nests are constructed in dominant or codominant pines or cypress. The wood stork (*Mycteria americana*) is North America’s only native stork and is a federally endangered species restricted to marshes, bottomland swamps, and other freshwater and brackish wetland communities in the extreme southeastern United States.

A variety of large and small mammals are found in BLH. Although they are an important component of the ecosystem, many species (especially small mammals) have not been well studied. Summer maternity colonies of Indiana bats (*Myotis sodalis*) are most often located in floodplain deciduous forests or upland stands adjacent to riparian or floodplain forests. Indiana bats require closed canopy, riparian forests for foraging and hardwood stands with open to partially closed canopies for roosting. Gray bats (*M. grisescens*) forage primarily over water along rivers or lake shores where flying insects are abundant. Summer colonies of gray bats inhabit areas in which open water and the banks of streams, lakes, or reservoirs are reasonably close to roosting sites and maternal caves. Although southeastern myotis (*M. austroriparius*) primarily inhabit caves, a maternity colony in Illinois was found in a hollow tupelo tree within a mature cypress-tupelo swamp, and a colony was recently located in a sweetgum tree in west-central Mississippi. Southeastern myotis use a variety of habitats for feeding but have often been reported to forage along water courses.

The Florida panther (*Felis concolor coryi*), restricted to southern Florida, often occupies mixed swamp forests and hardwood hammocks during daylight hours to avoid detection. The American black bear is the most abundant and widespread bear in North America, but there is concern for both the Florida and Louisiana subspecies, which require very large, contiguous tracts of habitat (including BLH). The endangered red wolf once ranged throughout southeastern BLH, especially in coastal areas. The Sherman's fox squirrel (*Sciurus niger shermani*; former C2 candidate species), often uses edge habitats, including bottomland forests, during winter.

Bottomland hardwoods have a diverse herpetofauna that inhabit the array of flood/habitat conditions. Amphibians associated with BLH habitat tend to use lower zones for reproductive purposes but may exploit drier or seasonally flooded sites for other needs. Many reptiles use lower BLH zones for food and cover and migrate to higher locations to lay eggs. Amphibians are often most abundant in moist conditions provided by a closed canopy and abundant leaf litter, and reptiles usually are most abundant where understory vegetation is dense and there is an abundant prey base. The alligator snapping turtle (*Macroclemys temmincki*) is a species of concern associated with riverine areas throughout the Mississippi River Valley and Gulf Coast states.

Maritime Communities (Gehlhausen and Harper 1998)

Approximately 12,100 ha of maritime communities occur on at least seven military installations. These areas support at least 13 rare species, which continue to exist on DOD installations because their native habitats remain relatively undisturbed compared to privately owned coastal land. For example, Eglin Air Force Base supports the major panhandle population of Florida perforate cladonia (*Cladonia perforata*), a federally endangered plant species, and Marine Corps Base (MCB), Camp Lejeune, had the only known extant representative of the calcareous coastal fringe forest community type until it was destroyed by Hurricane Fran in September 1996.

Maritime communities support several federally endangered and threatened plant and animal species and Species at Risk. Most of the rare species occur in beach and dune communities, but some occur in maritime shrub and evergreen forest communities. Seabeach amaranth (*Amaranthus pumilus*), a federally threatened plant that grows on foredunes and the upperbeach, has been reduced to one-third of its original range of Atlantic beaches from Massachusetts to South Carolina. Florida perforate cladonia occurs in rosemary scrub on dunes in the Florida panhandle. Animals such as federally threatened sea turtles (e.g., loggerhead turtle (*Caretta caretta*) and green turtle (*Chelonia mydas*)), and the federally endangered snowy plover (*Charadrius melodus*) winter on coastal beaches throughout the southeastern United States. The peregrine falcon uses barrier islands and other coastal habitats as stopover habitat during autumn migration. The endangered interior populations of least tern (*Sterna antillarum*) may use coastal beaches as stopover habitat en route from South America wintering habitat to breeding habitats in the interior United States.

Many species at risk inhabit maritime communities as well. These include Godfrey's golden aster (*Chrysopsis godfreyi*) found on foredunes and dune crests, Chapman's sedge (*Carex chapmanii*) found in evergreen maritime forests, and the Santa Rosa beach mouse (*Peromyscus polionotus leucocephalus*) which occurs in beach dune habitat. State-listed species include moundlily yucca (*Yucca gloriosa*, NC-significantly rare), which grows in the maritime evergreen forest; Cruise's golden aster (*C. gossypina* spp. *cruiseana*, FL-endangered), which grows behind foredunes and in blowouts and other disturbed areas in the evergreen forest; and the Florida population of least tern (FL-threatened), which nests on beaches.

Community Comparisons

Tables C1 and C2 show the known occurrence of plant and animal TES in each plant community. Longleaf pine woodlands support the largest number of TES animal species (15), followed by bottomland hardwoods (13), maritime communities (12), Florida scrub (11), herbaceous seeps (9), and peatland communities (8). Longleaf pine woodlands and herbaceous seeps shared the most species (9). Red-cockaded woodpeckers were reported from all communities that supported significant stands of pine, but were by far most representative of longleaf pine ecosystems. Most sensitive reptiles and amphibians in the region appear to depend on longleaf pine, herbaceous seeps, and either Florida scrub or peatland communities. TES bats were reported only from bottomland hardwoods but probably also occur in pine communities and mixed woodlands.

Longleaf pine woodlands support the largest number of TES plant species (48), followed by herbaceous seeps and wet savannas (36), peatlands (11), Florida scrub and bottomland hardwoods (8), and maritime communities (5). Longleaf pine and herbaceous seep communities had the greatest number of shared plant species (21), and peatlands had several species in common with these communities. Florida scrub, bottomland hardwoods, and maritime communities had very different species compositions and shared few species with each other or any other community. TES plants in longleaf pine communities were composed primarily of forb species (34), with several woody plants (9) and graminoids (5). Herbaceous seeps supported 29 forbs, 7 graminoids, and only 1 woody species. TES plants in Florida scrub, peatlands, and bottomland hardwoods were primarily forbs (five to six); each of these communities had two woody species and one to three graminoids. Maritime communities supported three forbs and two graminoids.

4 Management Considerations

Information is provided below on management considerations and recommendations for each plant community addressed in the study. Topics covered include fragmentation and land-use conversion, erosion and sedimentation control, forestry practices, pinestraw harvest, fire management, hydrology management, agriculture, control of nuisance species, wildlife management, and military training. Emphasis is placed on forest management, prescribed burning, and hydrology, because recent efforts to modify management practices on military installations have focused on these issues. For further details on management practices specific to each community, refer to the appropriate TES plant community management plan. It is important to note that all recommendations made below must be considered in the context of military land-use needs that support the DOD mission.

Fragmentation and Land-Use Conversion

Natural communities on installations often are fragmented by roads, firebreaks, and dropzones, and may be converted for other land uses (Russo et al. 1993; TNC 1995). General effects of land-use conversion to TES populations include habitat loss, population isolation, change in community composition, and changes in predation, parasitism, and herbivory patterns (Trame and Tazik 1995). Fragmentation can be especially detrimental to animals that require large, continuous areas of habitat.

From a management perspective, further fragmentation of TES habitat should be avoided whenever possible. If such areas (or nearby areas) must be cleared or developed these activities should be concentrated in one area, preferably adjacent to sites already developed, and not spread throughout natural communities. This strategy will help minimize edge effects brought about by fragmentation. Furthermore, activities that have the potential to interrupt TES populations or ecosystem processes should be avoided, or an alternative for the activity should be sought. For example, activities should be avoided that will interrupt water flow patterns in high- and intermediate- (Types I and II) wetland communities or create barriers between connected habitats used by TES species (Harper et al. 1997).

Type I communities that have been selected to be managed as TES habitat should be connected as much as possible into “Type I management units.” This can be encouraged by planning intensive land uses in “development zones” of various types (such as intensive mechanized training, low-intensity mechanized training, or urban development zones) on the installation. Over time, such landscape-level, long-term, land-use planning can increase the connectivity of high-quality TES management areas (Harper et al. 1997).

To minimize effects of fragmentation, managers may wish to restore degraded areas that separate high-quality natural communities. If restoration efforts are successful, they will result in a less fragmented landscape, which will allow for better management at the landscape level (e.g., landscape-level burns) and will provide a continuation of physical and ecological processes across the landscape (Harper et al. 1997).

Inclusional wetlands and high-quality TES sites should be protected from negative impacts such as erosion, sedimentation, compaction, and intensive trampling or other ground disturbances. An off-limits zone that extends well beyond surrounding ecotones should be established to prevent sedimentation into wetlands and other changes to the hydrology of the site and surrounding uplands. A buffer of at least 60 m on slopes and approximately 30 m on level terrain is recommended (Harper, Trame, and Hohmann 1998). New borrow pits should not be constructed in Type I or II natural communities that provide habitat for TES.

The creation of large patches of scrub habitat should be the emphasis of Florida scrub restoration efforts (MacAllister and Harper 1998). Managers should attempt to restore degraded areas that are adjacent to high-quality habitat, even if these areas cannot connect larger patches. Depending on the species present within the community, corridors may or may not be desirable. In any case, further fragmentation of natural communities should be avoided whenever possible.

Urbanization and industrial development have been main factors responsible for fragmenting forests in the Southeast, and this pattern is expected to continue. Forested riparian corridors are especially vulnerable to fragmentation. In altered BLH systems, remaining fragments can be connected to provide larger, contiguous tracts of forest, and attempts should be made to restore degraded stands. Installations should strive to produce a range of BLH stand conditions with respect to species composition, age, and structure. Further fragmentation of existing BLH habitats should be discouraged.

Managers should avoid placing wildlife food plots in high- or intermediate-quality communities where TES management is a priority. Furthermore, the gradual elimination of food plots that interrupt Type I or Type II communities is recommended. If such plots are considered necessary, they should be planted in native species and subjected to prescribed burns consistent with the rest of the natural community.

Fragmentation problems can be reduced by evaluating the existing network of improved and secondary roads on an installation and closing all secondary roads not identified as essential to mission-related activities. Abandoned roads should be stabilized and replanted to native vegetation. Any new proposed road construction should be carefully evaluated to ensure that TES habitats are not impacted. Additionally, design and construction of new roads should consider natural contours, hydrologic flows, soil erosion potential, slope, wetland conditions, and animal movements.

Erosion and Sedimentation Control

Managers should strive to maintain quality wetlands, stream courses, and natural impoundments throughout TES communities. If wetlands and waterways are of high quality, adjacent uplands are also likely to be in good condition. Activities should be avoided that might increase erosion of uplands and resulting sedimentation into lower-lying flatwoods, ecotones, or adjacent wetlands. These activities may include timber harvest, pinestraw raking, and clay and sand removal on adjacent uplands (Harper et al. 1997). Erosion and sedimentation problems should be corrected immediately. Damage should be repaired before it becomes an obstacle to training or a threat to the integrity of TES habitat. This will be more cost-effective and sustainable in the long run.

Roads that transect ecotones should be improved or otherwise stabilized to prevent unnecessary erosional problems. Logging roads and skid trails should not be designated on slopes with highly erodible soils or within 30 m of streams. When logging is completed, access roads should be blocked off and revegetated with native species. Plowed fire lines should not be constructed near stream corridors. Emergency fire lines should be stabilized and revegetated immediately after fire suppression.

All stream crossings should be evaluated for their contribution to erosion. Crossings that are not essential and those that are potentially damaging to sensitive species and their habitats should be closed. A flat concrete pad that does not alter natural water flow and prevents soil disruption is an inexpensive alternative to using culverts.

Additional information on erosion and sedimentation is provided by Harper at al. (1997) and within sections on hydrology management, agriculture, and military training in this chapter.

Forestry Practices

The information on forestry practices below is taken primarily from sections provided by Harper at al. (1997). The manager should consult with the installation forester to determine applicability of TES recommendations to forest management objectives and mission requirements.

Longleaf pine woodlands. High-quality (Type I) flatwoods and sandhills that provide important TES habitat should not be clearcut or subjected to soil disturbances associated with the use of heavy equipment. Removing canopy trees with chainsaws rather than traditional logging operations can be used as a low-disturbance method to restore high-quality sites that have developed a dense canopy after years of fire suppression. If this is not feasible, careful use of light-weight, maneuverable, rubber-tire vehicles (e.g., feller-bunchers) is recommended for dry soils (Harper et al. 1997).

Intermediate-quality (Type II) flatwoods and subxeric sandhills are candidates for selective logging of the stand, if timing is such that damage to groundcover is minimal. Examination of wetland inclusions should be made prior to cutting so that loggers can be directed to avoid these areas. Intermediate-quality xeric sandhills should not be subjected to logging using heavy equipment, because the groundcover may be slow to recover in these nutrient-deficient and water-stressed sites.

In Types III and IV sites, use of heavy logging equipment to thin the understory is acceptable, using least-disturbance methods. Erosion problems caused by logging should be corrected immediately. Moderately low-quality flatwoods and sandhill sites are candidates for overstory cutting using group selection or shelterwood cuts if (a) no significant wetlands will be impacted, and (b) cutting will not lead to significant erosion. Seed tree regeneration systems (leaving a few reproductive trees on site) are not recommended for longleaf pine sites because the site can become overgrown with hardwoods and brush while waiting for an adequate seed crop, subsequently increasing costs of regeneration. In sites that are cut, managers must ensure adequate spacing of trees, proper thinning, and frequent use of fire, so that later stages of development do not shade out native groundcover species.

Existing Types I and II natural communities and lower-quality communities that have potential for improvement or serve to connect sensitive habitats should not be converted to plantations. Sites that currently support native ground cover should be considered good candidates for restoration if it is important to reduce habitat fragmentation. In this case, native groundcover species can be enhanced by thinning the forest canopy to increase light levels at the forest floor and by burning the area on a 3-year rotation. Tree species of commercial value should be replaced with longleaf pine through time.

Mechanical site preparation in Types I and II quality sites should be minimized, and nonmechanical methods should be used if possible. When feasible, frequent prescribed burning should be used instead of mechanical site preparation to control hardwoods and regenerate native pines. In Types III and IV sites, mechanical site preparation activities using the least destructive methods may not harm TES species, providing that wetlands and adjacent buffer areas are not subjected to these activities. Erosion problems caused by these methods should be corrected. Generally, damage will be less extensive if activities are scheduled when soils are dry (Harper at al. 1997).

Recommendations for minimizing soil disturbance during logging operations are as follows (primarily from Harper et al. 1997):

a. Soil survey maps, which include descriptions of drainage and other soil properties, can be used to locate and design roads, landings, and skid trails at the most resilient sites. Maps can also be used to provide TES locations and significant natural features that should be avoided.

b. Using designated skid trails, rather than traveling from stump to stump, will reduce disturbance by limiting machine travel to fewer trails.

c. Soil disturbance can be minimized by selecting the proper type of logging equipment and scheduling the season of logging to avoid operations when the water table is high.

d. Site preparation through prescribed burning before logging can improve operator visibility and help the operator avoid wet areas.

e. Equipment operators should minimize the number of skid roads used and the number of turns made.

f. Loggers should use lightweight, maneuverable equipment, such as rubber-tired feller-bunchers, to transport cut trees to a main skid trail, rather than skidding the trees out.

g. Loggers should use whole tree skidding, rather than removing the top of the tree and only skidding the trunk. The tree top will cushion the trunk and cause less damage to the soil. However, leaving the top attached may cause damage to the residual stand (Mr. John Tingle, Forester, personal communication, Environmental Laboratory (EL), ERDC, Vicksburg, MS).

h. Placement of delimbing gates should be planned carefully to avoid the impact of falling debris to sensitive areas (e.g., wetland inclusions such as hillside seeps).

i. For selective cuts, loggers should not cut trees in a straight line. Cutting in a straight line will encourage future use of the logged areas as a road, which will discourage natural regeneration. Proper marking of harvestable timber by the forestry staff will help preclude this from happening.

j. If logging operations must occur in areas harboring sensitive plant species, population boundaries should be marked with flags, and operators should be required to avoid the flags. However, if there will be more than 6 months delay in cutting, or if prescribed burning is planned, it may be necessary to use painted tree blazes, steel posts with signs, or other more permanent markers (Mr. John Tingle, Forester, personal communication, EL, ERDC, Vicksburg, MS).

Herbaceous seeps and wet savannas. Harvest operations should generally not be allowed in sensitive seep or wet savanna communities. Removal of woody vegetation may be needed where fire has been suppressed in Types II and III seeps. If removal is required, trees should be removed by hand or with the use of approved stem-selective herbicides. Broadcast herbicides are not recommended under any circumstance due to the effects on nontarget vegetation and amphibian populations. Prescribed fire can be used in Types I and II areas to control encroaching woody vegetation (Harper, Trame, and Hohmann 1998).

Removal of timber in the zone upslope from a seep can restore natural seepage patterns in Type II habitat. Noninvasive practices such as directional tree falling should be used when harvesting timber near herbaceous seeps and wet savannas (Harper, Trame, and Hohmann 1998).

Florida scrub. Historical records indicate that longleaf pine once grew in many areas that are presently in Florida scrub habitat. Sand pine has become the dominant species in this ecosystem and longleaf pine has been slow to reinvade. Commercial timber harvest is generally unsuitable for Florida scrub areas on military installations (MacAllister and Harper 1998).

Peatlands. In peatland communities, intensive management for maximum wood production should not be practiced near ditches, streams, or other bodies of water because of potential erosion and sedimentation problems. Where harvest is allowed, buffer strips should be established and monitored adjacent to nearby water courses. Only selective harvesting should take place within these buffer zones. The use of heavy equipment, prescribed burning, and the application of herbicides in these areas should be avoided when possible. If pesticides must be used, they should not be applied during periods of heavy rainfall or runoff from storm events (Robertson, Harper, and Woolery 1998).

The size of any clearcut should be limited to no more than 2 ha. Following a harvest, logging roads should be closed and seeded with vegetation. Buffer zones of 30 m should be maintained between existing roads and streams or ditches. Existing roads that are not used for logging, military activity, or designated recreational purposes should be closed and allowed to recover, further minimizing erosional problems. If a road must be built next to a canal in shrub-dominated pocosins, an auxiliary ditch should be created between the road and the canal and filled with vegetation to intercept runoff (Robertson, Harper, and Woolery 1998).

Felling can be accomplished during harvest operations using a swing feller-buncher on tracks to minimize travel on the site. New technology has yielded machines that are long-reaching and light weight and can combine high production with low disturbance. Grapple saws can also aid in the reduction of extraction impacts. Vehicles with wide tires or tracks should be used for extraction to reduce the rutting associated with thin tires and subsequent hydrological impacts. The use of flexible, tracked skidders resulted in lower overall impacts in peat soils. Large payloads reduce the number of passes logging equipment must make over any single trail; therefore, large, wide-track skidders are recommended to reduce soil disturbance while increasing productivity. Refer to Robertson, Harper, and Woolery (1998) for more specific information on logging methods and equipment.

Bay forests that serve as TES habitat and occur on seepage slopes should not be harvested because any of the machinery involved could permanently alter the soil structure and hydrology required to maintain this community. Old-growth bay forests should receive high priority for conservation. Remnant stands of high-quality habitat should be maintained to increase species diversity and improve the probability of survival following catastrophic events (e.g., fire, storms, or disease). Mature stands may require 200 to 300 years or more to develop.

AWC forests are considered a rare community type, and remnants of these forests should receive high priority for conservation and maintenance of old-growth timber. Although the oldest stands are most attractive for harvesting, substantial amounts of AWC climax communities should be protected because they require from 200 to 300 years to mature. If logging is desirable in an AWC stand that does not presently provide TES habitat, the following recommendations should be followed to increase the probability of regenerating a stand that will be used by TES species (Robertson, Harper, and Woolery 1998):

a. Cut no more than 2 ha at one time and leave a thick band of mature AWC on the western edge of the harvest site, allowing these trees to serve as a seed source for repropagating the clearcut area. Cutting in strips, checkerboard patterns, or in small areas within a larger forest will facilitate satisfactory reseeding and is consistent with management goals that preserve older stands for wildlife.

b. Minimize roads within stands.

c. Remove all brush and slash piles from the area. Under appropriate conditions, a light prescribed burn can eliminate remnant slash.

d. Control competing hardwoods early in stand formation.

Bottomland hardwoods. Forest management practices in BLH communities can alter stand-level habitats for TES by affecting the availability of mast, browse, invertebrates, ground-level vegetation, arboreal cavities, vertical structure, and downed woody material. Reducing canopy cover often lowers the immediate availability of hard mast and cavities and the amount of vertical structure. Habitat changes will continue to occur after the harvesting operation as plant succession proceeds. The direction, magnitude, and rate of habitat changes depend on such factors as: (a) structure and composition of the residual stand and woody vegetation, (b) flooding regime, (c) browsing by herbivores, and (d) subsequent management practices (Fischer et al. 1999).

Some silvicultural practices should be prohibited in BLH forests on military installations. Large-scale, even-aged timber management, widespread application of insecticides and herbicides, and skidding practices that run parallel to the streambed are detrimental to habitat quality and TES sustainability. There is considerable disagreement in the literature regarding the prescription of no-cut buffer zones. Palik, Zasada, and Hedman (2000) stated that no-cut buffer zones do not accommodate the natural range of variability in riparian forests and ignore the fact that disturbance is a natural aspect of riparian systems. Nevertheless, a

5- to 8-m-wide no-cut buffer should be established adjacent to streams to maintain a vegetated corridor and prevent erosion. A minimum-cut buffer should then be established in the surrounding BLH community; this area should be managed to provide vegetation composition similar to natural riparian forests in the region (Fischer and Fischenich 2000).

If timber is harvested, the use of uneven-aged systems are generally recommended from a wildlife habitat perspective. However, there is considerable disagreement on the proper method for managing BLH timber resources. Some managers have reported that shelterwood cuts (or some modification thereof) are generally most appropriate for bottomland hardwoods. Group selection cuts, where small openings are created, also work well. Small group selection harvests that emulate natural disturbances can be conducted in high-quality BLH. Recent studies in Arkansas BLH reported success using uneven-aged regeneration cuts (openings <0.20 ha) and thinnings of trees in all diameter classes to maintain forest diversity. The result of this treatment was a multilayered forest that provided good habitat diversity for neotropical migratory birds (Fischer et al. 1999).

Seed tree cuts and single-tree selection cuts (which favor intolerant species) are generally not suitable for bottomland hardwoods. Thinning alluvial floodplain stands is discouraged because some depressions remain wet and boggy for long periods. The use of logging machinery in these areas is difficult and often results in damage to the roots and boles of trees unless logging crews are extremely careful. Meadows and Goelz (in preparation) recommended thinning to enhance stand quality and improve species composition in BLH but reported the following disadvantages: (a) logging damage to the boles of trees caused by careless operation of logging trucks (in some cases over 60 percent of the trees in a stand experiences some amount of logging damage), and (b) defects in boles of trees resulting from epicormal branching (branching along the mainstem beginning near the base of the tree).

Interactions among machines, soil, and soil moisture are primarily contributors of site disturbance during forestry operations (Reisinger and Aust 1990; Mattson et al. 2000). Felling in BLH stands can be done by feller-bunchers on tracks. Although costly, disturbance is reduced due to the wide tracks of the feller-buncher and the limited amount of travel on site. Wide tires are also important on extraction equipment to reduce disturbance to soil and groundcover. Logging during dry periods is recommended to further reduce erosion caused by road-building activities. Soil disturbances may be reduced by the use of special equipment that can haul timber on lower-quality roads or transport trees further without using improved roads. Detailed information on the use of felling, extraction, and processing equipment is provided in Mattson et al. (2000).

Sediment may continue to enter riparian and aquatic ecosystems for many years after logging. Excessive siltation from upslope logging operations often causes damage or destruction to rare plant populations in bottomlands. Losses of populations of several species have been attributed to soil disturbance associated with timber harvest and subsequent siltation in bottomland forests as well as to changes in hydrology due to rutting by machinery. It is recommended that logging in adjacent uplands be closely monitored to ensure that the quality of lowland forests is not affected. An adequate buffer should always be maintained between upland harvested sites and streamside ecosystems. Refer to Table 3 for recommendations on riparian buffer strip widths for various objectives (Fischer and Fischenich, in preparation).

Table 3
General Recommendations for Buffer Strip Widths in Riparian Zones (Fischer and Fischenich, in preparation)

Function	Description	Recommended Width[1]
Water quality protection	Buffers, especially dense grassy or herbaceous buffers on gradual slopes, intercept overland runoff, trap sediments, remove pollutants, and promote groundwater recharge. For low to moderate slopes, most filtering occurs within the first 10 m, but greater widths are necessary for steeper slopes, buffers comprised of mainly shrubs and trees, where soils have low permeability, or where NPSP leads are particularly high.	5 to 30 m
Riparian habitat	Buffers, particularly diverse stands of shrubs and trees, provide food and shelter for a wide variety of riparian and aquatic wildlife.	30 to 500 m +
Stream stabilization	Riparian vegetation moderates soil moisture conditions in streambanks, and roots provide tensile strength to the soil matrix, enhancing bank stability. Good erosion control may only require that the width of the bank be protected, unless there is active bank erosion, which will require a wider buffer. Excessive bank erosion may require additional bioengineering techniques.	10 to 20 m
Flood attenuation	Riparian buffers promote floodplain storage due to backwater effects, they intercept overland flow and increase travel time, resulting in reduced flood peaks.	20 to 150 m
Detrital input	Leaves, twigs, and branches that fall from riparian forest canopies into the stream are an important source of nutrients and habitat.	3 to 10 m

[1] Synopsis of values reported in the literature, a few wildlife species require much wider riparian corridors.

Snag management should be considered an essential element of any timber management program in bottomland areas. Snag objectives are highly variable, depending on management goals for the area. Snag density, forest type, species composition, longevity, and preference by wildlife species should be considered when managing forest stands for selected species or communities. Management practices that alter the snag resource should include altering stand rotation length, leaving snags where they would traditionally be removed, killing trees to create snags, and creating artificial snags and nests. Silvicultural practices that produce stands of uneven-aged classes are recommended to enhance regeneration of cavity-bearing trees, and selective harvest to leave some mature trees is preferred to other treatments.

Maritime communities. Forest management is generally not an issue in maritime communities. Although maritime forests were historically exploited for timber (Gehlhausen and Harper 1998), they do not presently represent a significant part of the timber management program on military installations.

Pinestraw Harvest

Pinestraw harvest should not be allowed in Type I communities that harbor plant TES. Frequent raking reduces longleaf pine regeneration, alters species composition, and removes fuel that may be necessary to carry a fire throughout the community. Where pinestraw removal is allowed, taking should be manual rather than mechanized. The following recommendations, summarized from Harper et al. (1997), are made regarding pinestraw harvesting on any site:

a. Avoid raking during the growing season. Harvest straw during late autumn, winter, and early spring when the understory vegetation is dormant. This will remove less live material than raking during other times of the year.

b. Avoid raking when heavy dew is present or when the vegetation is wet from rainfall. More vegetation is removed under these conditions, and rutting may occur when heavy equipment is used on wet soil.

c. Avoid raking in heavily vegetated areas because they may support more rare plant species and more live vegetation will be lost.

d. Sufficient measures should be taken at all harvesting sites to assure that pinestraw removal does not lead to soil erosion problems or interfere with the ability to execute prescribed burns.

e. Only the current year's straw should be removed, without disturbing the decomposing duff layer.

f. Managers should monitor the long-term effects of raking on wiregrass and rare species populations.

g. To avoid adverse impacts to TES or their habitats, pinestraw harvesters should be educated on the locations of sensitive species.

Fire Management

Prescribed burning is an important management tool that should be considered for most southeastern plant communities (Figure 7). Recommendations given below are based on current knowledge, but this is limited information on the effects of burning on many TES species and communities. Also, conditions will vary considerably from site to site. Therefore, managers should carefully monitor the effects of burning activities on elements of concern, and they should be willing to change management schedules based on new information and responses of TES species to fire frequency and timing (Harper at al. 1997).

Figure 7. Prescribed fire is recommended to maintain certain plant communities for TES

Natural firebreaks, such as wetlands and streams, should be used whenever possible to contain fires. Fire should usually be allowed to spread through ecotones and into edges of adjacent wetland communities. If it is necessary to prevent the spread of fires into adjacent communities, existing trails and roads should be cleared and used as control lines if possible. Otherwise, fire can be controlled using spot fires, hand lines, chemical fire retardants, and as a last resort, plowlines. The following guidelines are recommended regarding the use of firebreaks and plowlines (synthesized from plant community management reports except where noted otherwise):

a. When it is necessary to control fire using plowlines, existing lines should be reused whenever possible to minimize additional soil disturbances.

b. If new plowlines must be developed, they should not be located in ecotones, because ecotones provide habitat for several TES.

c. Plowlines should not be placed immediately upland from the ecotone, because this will prevent the ecotone from burning.

d. Plowlines should not be placed around cypress/tupelo/blackgum ponds, because they will alter hydrology and the breeding cycle of reptiles and amphibians that use the ponds.

e. Plowlines that erode after a fire should be rehabilitated using native vegetation and indigenous soil. Abandoned plowlines should be rehabilitated in the same way.

f. Firebreaks should not be established in herbaceous seeps and wet savannas or their ecotones. If controlling fire is necessary and less destructive means of fire control are deemed inappropriate, firebreaks should be constructed only in the outer buffer boundary.

g. If constructing a firebreak cannot be avoided, mowing instead of plowing is recommended as a less destructive practice. Mowed firebreaks will recover faster after a fire, and it may not be necessary to restore the site.

h. Where TES are a concern, managers are encouraged to use streams and other natural firebreaks for fire control whenever possible.

Longleaf pine woodlands. Based on limited information, a fire return interval of 1 to 3 years appears compatible with most TES animal species inhabiting longleaf pine woodlands. Although there are considerable differences in the response of TES plants to various fire regimes, frequent burning also appears to be most compatible with the maintenance and enhancement of habitat for TES plant species. When RCW populations are present on an installation, there are specific guidelines for prescribed burning in longleaf pine communities. The recovery plan for this species emphasizes growing-season fires for midstory hardwood control on a 3- to 5-year cycle. The information below is summarized from Harper et al. (1997); refer to this document for specific burning recommendations for selected species.

A longer burn interval may be best for sites where erosion is a concern. Any recommendation to burn vegetation on highly erodible soils or sloped lands must recognize that such burns may lead to erosion and sedimentation of lower areas, such as streamheads or depressional wetlands.

Early growing-season burns are recommended over late growing-season burns because the early burns are more favorable to growth and survival of longleaf pine seedlings and saplings. Also, early growing-season burns are more detrimental to hardwoods, which compete with pine for establishment. The timing of prescribed fire during the growing season may depend on specific management objectives and animal TES present on the installation. Although growing-season burns are highly desirable for maintenance of sandhill communities and are recommended for most animal TES in these communities, growing-season burns are discouraged for some species, such as pine snakes, indigo snakes, and gopher frogs.

Regular fire frequency is not natural in any community. Varying fire frequency among burn units, or among patches within large units, may be necessary to provide optimal habitat for a variety of TES; this will create a mosaic of vegetation conditions that should contribute to species diversity and provide refugia for many faunal species. Managers may wish to avoid conducting burns repeatedly during flowering periods of rare plant species. However, the degree to which populations depend on sexual versus vegetative reproduction is not known for many species (Harper et al. 1997).

In areas where fire has been suppressed for long periods of time, reduction of fuel loads may be necessary so that summer fires won't burn hot enough to damage crowns of mature pines. In these cases, winter burns are recommended to reduce fuel loads prior to the initiation of growing-season burns. When it is necessary to burn fire-suppressed areas with high fuel loads, low-intensity burns can be conducted during the growing season if fuel moisture is high. In addition, burning these sites on short fire rotations for the first several years is recommended until the vegetation and fuel loads have been reduced. In some cases, mechanical reduction of fuels may be necessary.

Herbaceous seeps and wet savannas. Despite the lack of empirical evidence to support suggestions for season and frequency of prescribed fire in herbaceous seeps and wet savannas, the most rational recommendation is to prescribe a fire regime that most closely simulates the natural occurrence of fire in these communities. Although winter burns were historically favored by managers, growing-season burns have significantly reduced the above-ground biomass of certain shrub species that encroach on herbaceous vegetation in these areas. Also, many native species depend on spring and summer burns for flowering and fruiting. Therefore, early growing season fires are recommended to ensure the establishment and survival of naturally occurring wetland species. Annual fires are important for preventing hardwood dominance in upland pine savanna and flatwood communities where shrubs and hardwoods have already become established. In areas where hardwood encroachment is not yet a problem, burns should be conducted at less frequent intervals to maintain community integrity. The fires are best timed between 1 April and 30 June (Harper, Trame, and Hohmann 1998).

Where fires have been suppressed for long periods of time, an initial burn conducted during the winter may be needed to remove excess fuel. However, winter fires are more likely to kill amphibians than growing-season fires. Dormant-season burns are best conducted before October, when salamanders begin to migrate to their breeding ponds. It is recommended that the U.S. Fish and Wildlife Service be consulted regarding the effect of winter burns on TES species and that any potentially affected population be carefully monitored during and after the burning period.

Florida scrub. Available information suggests that fire is necessary for the maintenance of most Florida scrub communities. Fires are catastrophic in scrublands (i.e., they kill off canopy trees), but without fire, pyrogenic inland scrubs will undergo succession to a different community and will no longer support scrub-dependent TES populations (MacAllister and Harper 1998). Therefore, a fire management plan that mimics natural processes is the best strategy for restoring and maintaining Florida scrub. Management guidelines should encourage the maintenance of scrub in different stages (each providing important structural attributes) across the entire landscape. Thus, managers will need to apply fire in a way that promotes all the various stages of development in large fragments of scrub.

Prescribed fires in Florida scrub communities should be designed to leave unburned patches to provide TES with refugia, forage, and cover. A fire-return interval of 8 to 20 years is generally recommended for managing Florida scrub for TES. However, if the site is one of particularly low productivity (e.g., rosemary scrub), the fire interval should be even longer. It must be stressed that recommended fire return intervals are not constant and will vary considerably based on site conditions and target species (MacAllister and Harper 1998).

A shorter fire interval than the recommended 8- to 20-year period may be necessary if the management goal is to restore scrub in areas that have been left unburned for decades and are severely overgrown. Restoration efforts should consist of frequent fires (every 2 to 4 years) during the first 10 to 15 years. This increased frequency is needed to reduce the accumulation of underground carbohydrate reserves and encourage an increase in openings. At least 2 years between burns are needed when restoring areas with abundant palmetto. At least 4 years are required between burns in areas composed of oak scrub with sparse palmettos (MacAllister and Harper 1998).

A long-term experimental approach will likely be required to determine the best methods for reestablishing openings in densely overgrown scrub growth at a site. Ignition techniques recommended for early restoration fires and advantages and disadvantages of using head fires and low-intensity backing fires to burn scrub reviewed in MacAllister and Harper (1998).

Results of several studies suggest that only fires occurring during the growing season will effectively promote scrub regeneration and halt succession to other cover types. However, data collected on fire management at Merrit Island, Florida, indicated that the intensity of the fire, rather than season of burn, dictates the success of prescribed burns at restoring and maintaining scrub. Under the proper burning conditions (i.e., appropriate fuel moisture, humidity, temperature, and wind speed), managers at Kennedy Space Center, Florida, have successfully restored long, unburned scrub by igniting high-intensity fires in November, February, April, and other times of the year. Natural resource managers at Avon Park Air Force Range have also had success with nongrowing season fires for maintaining scrub. Therefore, the need for experimentation and adaptive management is emphasized for a successful burning program in Florida scrub communities (MacAllister and Harper 1998).

Peatlands. Because different fire regimes will favor different types of peatland shrub and forest dominated communities, managers must decide which community is desired and apply a fire regimen appropriate for that choice over time. General recommendations for fire management in support of different peatland communities are summarized below from a more complete treatment within Robertson, Harper, and Woolery (1998).

a. Bay forests.

(1) Bay forests need protection from fire because they are late successional communities.

(2) Prescribed fire is appropriate in this community if managers believe that this forest type has taken the place of another more desirable community type due to unnatural changes in the fire regime at the site.

b. Atlantic white cedar (AWC) forests.

(1) Priority should be given to the conservation of old-growth AWC forests and encourage old-growth characteristics in existing stands, since much of this forest type has been logged and converted to young stands.

(2) There is no information to suggest that prescribed burning is necessary or desirable for TES conservation in this community (although data on TES requirements in AWC are not readily available). However, protecting this habitat from other disturbances is recommended.

c. Pond pine woodlands.

(1) Pond pine woodland communities should be burned at 5- to 8-year intervals. Growing season burns are recommended because they mimic the natural fire regime (Fussel et al. 1995).

(2) The entire area should be divided into discrete burn units, and these should be burned on a rotating basis to maintain insect populations. This will also aid in smoke management.

(3) Areas that have stands of switch cane should be considered high priority because they represent the highest quality pond pine woodlands. The implementation of a frequent fire regime (5 to 8 years) will preserve and encourage the spread of switch cane through clonal regeneration. If cane does not appear in the understory following a fire, it may have to be re-introduced through cuttings or seed, since it does not have a persistent seed bank. Once established, it will spread through a persistent rhizome mat.

d. Basin pocosins.

(1) Prescribed burning is recommended for low-lying pocosins. The optimal fire return interval is not known, but a rotation of approximately 20 years is suggested.

(2) A burning interval of 5 to 8 years is recommended for high pocosins. Sites should be burned on a rotating basis to maintain insect populations.

(3) Growing-season burns are preferable because they mimic the natural fire regime, but intense fires may occur in areas where years of fire suppression have resulted in heavy fuel loads. Such fires can cause the peat to burn, which can be detrimental to the community.

(4) The water level in these areas may be manipulated through pumping stations and other water control devices to inundate the peat and keep it from burning. The water level may also be raised to extinguish fires.

e. Streamhead pocosins.

(1) The fire-return interval in these communities will depend on the presence of rare plant species. A 3- to 5-year interval is recommended for installations that support populations of bog spicebush, rough-leaved loostrife, Carolina asphodel, and pondspice.

(2) A comprehensive monitoring program is recommended to determine the effects of this fire frequency on TES plant species survival and reproduction. Adjustments should be made based on results of the monitoring program.

(3) TES species inhabiting these sites require a moist substrate for survival; therefore, adherence to the natural hydrology of the site is important. The creation of plowlines and drainage ditches should not occur in areas supporting these plants. Existing ditches and plowlines should be filled with native soil and returned to their natural grade, preferably without the use of machinery that would cause further damage to the site.

f. Cypress domes.

(1) A burn interval of 2 to 5 years is recommended for the upland cypress dome ecotone. When combined with restoration of the natural hydrology and removal of firebreakes, the fire regime of cypress domes should not differ from that of the surrounding pine woodland under natural conditions. A monitoring program is recommended to determine the effects of burning on TES.

(2) Spring burns during the months of March, April, May, and June are recommended, since this is the time that most natural fires are likely to occur. During this time of year, the surrounding habitat and dome margins are dry enough to sustain a fire, and amphibians are least likely to be migrating through grassy ecotones.

(3) Cypress domes that have undergone long periods of fire exclusion may be rehabilitated with dormant season burns to reduce fuel loads that would cause smoke management problems and safety concerns during the growing season. However, winter burns should not be conducted if they will jeopardize amphibian populations such as the threatened flatwoods salamander.

(4) Temporary fire lines may be employed when fires must be restricted from nearby areas (e.g., cantonment areas). These temporary lines should be revegetated and managed to prevent erosion after the burn is conducted.

Bottomland hardwoods. Few studies have addressed the influence of fire in riparian areas, but it is generally agreed that fires can be damaging to hardwood communities. Wetter areas of bottomland hardwoods usually do not have adequate understory or litter to carry fire unless extensive clearcutting has left a large amount of slash. However, fires can occur in bottomland hardwoods during drought conditions, especially in drier portions of the community. When fires do occur in these systems, many of the tree species can be killed because most have thin bark, and trees that survive the fire may rot. Fire not only removes vegetation but may also affect riparian and aquatic ecosystems by changing a watershed's hydrological and erosional characteristics (Fischer at al. 1999).

Maritime communities. Fire management was not identified as an issue in maritime communities.

Hydrology Management

Longleaf pine woodlands. Activities that will alter hydrology in wetlands supporting TES plants (especially in Types I and II sites) should be discouraged. These include draining, ditching, filling, damming, and creation of fire plowlines, roads, and new trails. These activities should not be conducted in wetlands and their adjacent upland ecotones. Also, activities should be prohibited that create deep ruts (e.g., off-road vehicle use) through boggy communities within or adjacent to flatwoods or sandhills. The natural hydrology should be restored as much as possible to TES-inhabited areas by removing berms, filling drainage ditches, and/or removing road culverts. However, these activities must be conducted with extreme caution to prevent additional damage (Harper at al. 1997).

Existing roads, trails, and plowlines that disrupt subsurface hydrology should be improved or modified to restore waterflow patterns. In areas where restricted water flow is directly threatening TES viability, serious consideration should be given to abandoning roads, trails, and plowlines, and restoring the original topography. The site may also need to be revegetated with native species (Harper at al. 1997).

Herbaceous seeps and wet savannas. If landscape-level conservation of inclusional wetlands for TES is the goal of land managers, two rules should be applied:

a. Target land management and monitoring to maintain high-quality wetlands, stream courses, ponds, and lakes. The condition of wetlands and streams can serve as critical indicators of overall ecosystem health. Adjacent terrestrial systems should also be monitored to ensure that they are not beginning to deteriorate.

b. Correct erosion and sedimentation problems quickly. Erosion damage should be repaired before it becomes a major obstacle to training or threatens Type I or Type II areas.

Activities that can alter the hydrology in Type I or Type II herbaceous seeps or wet savannas and small depression pond complexes should be allowed only if it is determined that such alterations will benefit the community. Some enhancement of seepage may be desirable in areas that have become dominated by woody growth and historical fire suppression.

Watershed boundaries should be defined so that an adequate buffer zone protects the watershed. In general, water that maintains hillside seeps must come from positions topographically higher than the seep itself. The area extending to the top of the hill should be protected as the potential watershed, as well as the area extending to the drain below the seep. On broad, shallow slopes, it may be difficult to precisely determine the recharge area. In these cases, an outer buffer should extend to at least 60 m beyond the edge of the active seeps. A buffer surrounding the community should also be protected. The general rule is to protect a buffer that extends 30 m in all directions from the edge. However, recommendations for buffers vary. Refer to Harper, Trame, and Hohmann (1998) for more detailed information.

Activities that can leave deep ruts through herbaceous seeps and wet savannas or their surrounding buffer zones should be avoided because of the negative effects these ruts have on the hydrology of a site. Heavy machinery should never be used within the wetland itself. If machinery must be used in the buffer zone (e.g., for timber removal), only equipment with wide tracks or tires should be used. Use should be restricted to the driest time of the year to minimize rutting and compaction (Harper, Trame, and Hohmann 1998).

Florida scrub. Hydrological alterations that could dry out the surrounding wetland areas that serve as barriers protecting scrub habitats from fires ignited in more pyrogenic communities should be avoided. Also, managers should refrain from hydrological alterations that promote the germination of plants that would decrease the fire frequency in these wetland areas (MacAllister and Harper 1998).

Peatlands. Some peatland communities, such as streamhead pocosins, seepage slope bay forests, and cypress domes are spatially restricted to areas with specific hydrologic conditions. Many of these communities have been drained and converted for urban and agricultural purposes; the remaining areas on DOD lands should be carefully managed because of their significant value to regional biodiversity and hydrological processes.

Ditching and construction of firebreaks can be especially detrimental to peatland communities. It is recommended that no new ditches and firebreaks be dug, and those in existence should be filled or recontoured using native soil. In areas where TES conservation is a priority, fire rings and trenches in and around cypress domes should be closed and revegetated to maintain the moisture regime required by TES plants and the flatwoods salamander. Cypress species are adapted to periodic flooding and drying cycles, and disruption of these cycles usually reduces cypress regeneration and converts the community to mixed hardwoods. Several listed plant species found in cypress domes are sensitive to the alteration of hydrologic conditions. Lowering of the water table resulting from ditching and draining will dry peaty soils and increase fire intensities and frequencies. Maintaining the natural hydrology is necessary to implement a fire regime that supports the biota of peatland ecosystems (Robertson, Harper, and Woolery 1998).

Bottomland hardwoods. A variety of land treatments and revegetation strategies have been applied to disturbed watersheds to improve hydrologic and hydraulic conditions so that existing riparian systems can be stabilized or new ones created. However, the causes for degradation and stage of channel evolution must be carefully diagnosed before rehabilitation strategies can be developed. Efforts should be made to prevent further alteration of natural hydrologic regimes (e.g., by drainage or unnatural flooding) and to restore those regimes that have already been altered. Consideration of impacts should include those of both large-scale watershed processes and activities such as logging and use of heavy equipment that influence specific sites (Fischer et al. 1999).

Management strategies in riparian systems, including BLH communities, are influenced primarily by hydroperiod, physical factors, and groundwater characteristics. Hydroperiod (i.e., flood frequency, timing, duration) is the most significant factor affecting management options. The best management strategies for riparian areas are usually those that are both compatible with the existing hydroperiod and maintain biodiversity. Physical characteristics of the stream and associated floodplain dictate different management strategies, but riparian zones of sufficient size must be managed to ensure maintenance of their natural buffering function (see Table 3). Groundwater characteristics control soil moisture and soil-water regime, subsequently influencing which tree species and other vegetation are present or capable of future growth (Fischer et al. 1999).

Several methods can be used to restore hydrology to a site. Intensive hydrological management may include the use of water control structures to modify water delivery into or out of a site. This will allow managers to control the hydroperiod by flooding timber at various frequencies, depths, and durations. Proper water management can allow the restoration of various wetland functions. Management emphasis should be on the restoration of natural areas and ecosystem processes rather on management of single species. Construction of greentree reservoirs may be a suitable practice where waterfowl management is a priority but should be discouraged in areas where TES management is emphasized.

Agriculture

Agriculture is not usually a dominant land use on military installations. However, resource managers should be aware that farming practices on lands adjacent to the installation and those upstream of rivers and streams that flow through the installation can be major sources of nonpoint source pollution and can adversely affect water quality. Vegetative buffer strips and forested wetlands can reduce the levels of pollutants, organic matter, and nitrogen runoff both entering and collecting in aquatic systems (Table 3). Where agriculture exists on or adjacent to military lands, adequate buffer zones should be retained between croplands and wetland/aquatic resources. In some cases, restoring marginal agricultural lands to forest can provide greater revenues through timber harvest or fees from hunting permits.

The use of fertilizers and other soil amendments should be avoided within or adjacent to Type I or II TES habitat sites. In all cases, fertilizers should be used with care to ensure that they do not enter wetlands (Harper at al. 1997). Pesticides and fertilizers used in upland areas adjacent to peatlands and other wetland sites should be applied only during dry periods. Application of fertilizers should be avoided within herbaceous seeps and wet savannas, small depression pond complexes, and surrounding buffer zones (Harper, Trame, and Hohmann 1998). Excessive nutrients in these systems can result in the eutrophication of wetlands, promoting undesirable algal blooms and other associated problems.

Livestock grazing contributes to soil disturbance, but controlled grazing may not be incompatible with managing for most pine woodland TES. While intensive grazing systems should be discouraged, especially in Type I sites, moderate grazing has not been significantly damaged upland woodland communities in the Southeast. Any grazing allowed on natural sites should be monitored so that impacts can be identified and corrected at an early stage (Harper et al. 1997). Grazing should be discouraged in most wetland communities.

Livestock grazing should be prohibited in BLH and wetland areas that are managed for TES. Although grazing may not be a major problem in most larger BLH communities, it can become a serious problem in narrower floodplains. Cattle in BLH can cause loss of and/or damage to native vegetation, directly introduce waste products into the stream, reduce infiltration, increase erosion rates, and compact wetland soils through trampling.

Control of Nuisance Species

The presence of nonnative and pest species in TES areas should be viewed as a potential threat to maintaining native plant and animal communities. The spread of nonnative species (also referred to as nonindigenous, exotic, nuisance, alien, invasive, transplanted, or feral species) has greatly accelerated over the past few centuries, and recent studies indicate that between 5,000 and 6,500 foreign species have gained a permanent foothold in the United States over the past century (Office of Technology Assessment 1993). Invasive species are presently ranked second only to habitat destruction as having the greatest impact on TES in the United States and are considered a greater threat to natural communities than pollution, over-harvesting, and disease combined (Simberloff 1996; Devine 1999; Williams and Meffe 1999).

Installations should consider implementing a monitoring program to rapidly detect invasions of new species. This should be accomplished with remote sensing technology and periodic ground truthing, especially on Types I and II sites. Ideally, primary control methods should be preventative by maintaining conditions that discourage the establishment of nuisance species. However, exotic species invasions and pest or disease outbreaks may require aggressive control methods to decrease their threat to natural communities.

Numerous nonindigenous plant and animal species occur on military installations throughout the Southeast. Some of the more common problems in southeastern communities of concern are discussed below.

Feral hogs. Populations of feral hogs (*Sus scrofa*) can be a serious threat to TES plants. A monitoring program should be established where feral hogs occur, and populations should be aggressively controlled. Daily bag limits and hunting seasons for wild hogs should be liberalized, and hogs should be trapped and removed in areas where hunting is not allowed. Hog populations should be monitored routinely to assess the progress of control efforts (Harper et al. 1997).

Beavers. Control of beavers (*Castor canadensis*) should be determined by the management goals of individual communities and sites. Where TES conservation is a management priority, beaver eradication is discouraged except where absolutely necessary. Biologists at Fort Bragg, North Carolina, have recommended that beaver impoundments be maintained because they support rare bog species (Harper, Trame, and Hohmann 1998). Beaver ponds also contribute to the overall biodiversity of bottomland hardwood communities.

Southern pine beetles and brown-spot needle blight. Methods for dealing with pine beetles (*Dendroctonus frontalis*) compatible with improving habitat for native species include (a) increase of spacing between pine trees, and (b) conversion of sites to more resistant pine species (e.g., longleaf pine). Other practices that may reduce losses from southern pine beetles (e.g., allowing for mixed pine-hardwood stands and using shorter rotations) are not recommended for TES habitat management, since these methods will not improve or maintain habitat for TES. Brown-spot needle blight can be controlled with prescribed burning (reviewed by Harper et al. 1997).

Exotic plants. Numerous nonindigenous plants have impacted natural communities and TES populations in the Southeast. These include such species as melaleuca (*Melaleuca quinquenervia*), Brazilian pepper (*Schinus terebinthifolius*), Chinese tallow (*Sapium sebiferum*), giant reed (*Arundo donax*), old-world climbing fern (*Lygodium microphyllum*), and cogon grass (*Imperica cylindrica*). Managers should obtain a copy of *Exotic Woody Plant Control* (Langeland 1990). This manuscript may be ordered by contacting C. M. Hinton, Publications Distribution Center, IFAS Building 664, University of Florida, Gainesville, FL 32611 (Harper et al. 1997). A copy of the ERDC Plant Management Information System (Grodowitz et al.1998) should also be consulted.

Where feasible, the manual removal of exotic species is the preferred control method in high-quality TES habitat. However, manual techniques may not be effective in all wetlands and seeps and may be cost-prohibitive in some areas. Mechanical removal with heavy equipment should never be employed because of the potential for severe disturbances and further damage to a site. Care should be taken not to spread plant propagules when using mechanical control methods (Harper et al. 1997).

The use of stem-selective herbicides may be the most practical control method in wetlands. Only spot treatment should be used, and herbicides should never be broadcast within or immediately adjacent to rare species or any wetland, since this can affect water quality and present a direct threat to TES. When herbicides are used, managers should monitor their effects on plants and wildlife; use must be discontinued immediately if these is a perceived threat to the community or any species of concern (Harper et al. 1997).

If chemicals must be applied, the timing and methods of application should minimize effects on nontarget vegetation and the environment. Personnel applying herbicides must be well trained and informed of the circumstances under which applications should be made. All label warnings and guidelines must be strictly followed. The applicator must also be aware of the potential effects of weather conditions on application procedures and efficacy (Harper et al. 1997).

Biological methods should also be considered for controlling exotic species. Various control agents, primarily insects and pathogens, have been field tested and released to control populations or invasive plant species. Long-term control will often require a combination of mechanical, chemical, and biological methods.

Wildlife Management

Managers are encouraged to examine their existing wildlife management programs to determine if practices implemented in the vicinity of known TES populations are compatible with management needs of species present. Management practices that should generally be avoided or modified where TES conservation is a priority include large clearcuts, edge development, food plots, wildlife food and cover plantings with introduced species, and greentree reservoirs. These practices are designed primarily to benefit selected game species but are not recommended for communities that are critical for maintaining TES.

Management practices that are often beneficial to both target species and TES populations include prescribed burning, snag management, riparian zone management, wetland creation, prairie restoration, and moist-soil management. Burning regimes will depend on the type of community and species present. Forest management practices that encourage uneven-aged stands and biodiversity will benefit numerous TES species. Snag management should be considered an essential element of any timber management program in the Southeast. Snags are extremely important as wildlife habitat, and several sensitive bat species are often found roosting in hollow trees in BLH and upland forests.

Management of wetland and prairie habitats should focus on restoration and maintenance of sites that simulate natural conditions as much as possible. Moist-soil management promotes the production of naturally occurring wetland vegetation by emulating and manipulating natural wetland functions (e.g., hydrology and successional stage). Although originally designed to improve waterfowl habitat, properly managed moist-soil units can provide high-quality wetland habitat for a diversity of nongame species.

Military Training

Longleaf pine woodlands. Planning military activities to be compatible with the spatial habitat requirements of TES is a proactive method for reducing potential landuse conflicts between TES and the training mission. Training plans and construction projects that minimize habitat destruction, degradation, and fragmentation will support more resilient TES populations and indirectly reduce local impacts. Information below is summarized from Harper et al. (1997).

Intensive foot traffic, occupational exercises, and mechanized training should be minimized in high-quality flatwoods and sandhills. Use of drier flatwoods for these activities is preferable to wetter areas of the same quality, as drier sites are generally more resilient. Also, damage resulting from foot traffic or low-intensity mechanized training may be reduced if activities are scheduled during seasons when soils are dry.

Intensive military activities such as occupation and assembly should occur on permanently improved (hardened) sites or repeatedly used unimproved sites rather than on sites that are used in a rest-recovery rotation. When additional occupation, assembly, or maneuver training sites must be used, care should be taken to minimize fragmentation of the larger community, so that landscape-level hydrologic processes and fire regimes are less impacted.

In areas used primarily for dismounted infantry training, ecotones and ephemeral ponds should be marked to protect them from off-road vehicle impacts. Fencing may sometime be necessary to protect areas that experience chronic off-road vehicle movement. Improved planning and communication by the training community can reduce impacts from these maneuvers.

In areas where intensive maneuver training will continue, traditional intervention using mesh nets, straw, rocks, and fast-growing grasses may be most appropriate, since it is critical to stabilize the soil quickly. However, the introduction of nonnative species for soil stabilization (directly or indirectly through the spreading of straw) is a serious and fast-growing threat to natural communities in the region.

Available information suggests that heavy equipment should be confined to improved roads in Type I or II areas, because soils in these areas are slow to recover from disturbance. It may be best to continue heavy equipment operations in degraded areas that have already become disturbed and compacted, because this will minimize the total area that eventually becomes damaged. If it is necessary to use heavy vehicles on sites (regardless of quality), their use should be avoided on wet sites or during wet conditions. Managers may want to consider using machines that cause less compaction or machines and management practices that affect a smaller proportion of a site.

Herbaceous seeps and wet savannas. Recommendation for longleaf pine woodlands also applies generally to herbaceous seeps and wet savannas. Inclusional wetlands and high-quality sites should be protected from trampling, compaction, and other ground disturbances that could result from military training. These sites should not be used for any mechanized training maneuvers, including occupation exercises that involve the use of vehicles. Protective buffer zones should extend at least 60 m beyond the edge of an active seep, and military vehicle operators should be trained to recognize and avoid hillside seeps and wet savannas. Low-intensity foot traffic can be tolerated in Type I seeps or bogs, while moderate levels are acceptable in Types II and III communities (Harper, Trame, and Hohmann 1998).

Florida scrub. Use of heavy machinery should be avoided in high-quality Florida scrub communities. Use of off-road vehicles can destroy native vegetation and allow the invasion of exotic species. Propagules of exotic species can be brought into scrub communities on the tires of vehicles. These sites should be able to tolerate moderate levels of foot traffic. Care should be taken not to fragment remaining stands of Florida scrub habitat through military activities (MacAllister and Harper 1998).

Peatlands. Extreme care should be taken in peatland communities to ensure that heavy machinery and vehicles do not create ruts and modify the hydrology of high-quality sites. Recommendations previously stated under Fire Management and Hydrology Management also apply to military activities (Robertson, Harper, and Woolery 1998).

Bottomland hardwoods. Mechanized training has the highest potential for erosion impacts in BLH communities. However, alluvial forests generally are not used for military training because of the high density of large trees, mucky soils, and concerns for water quality (Trame and Harper 1997). Although tracked vehicles usually are prohibited from crossing streams and tend to avoid bottomlands, they may use the edges of wooded riparian areas for concealment cover. If activities such as mechanized maneuvers remove vegetation and leave unstable, rutted soils, these soils will likely erode into streams during flood events. Also, erosion in upland areas resulting from such activities as drop-zone creation, off-road mechanized maneuvers, or occupation exercises may lead to significant sedimentation in smaller streams. Alluvial forests can usually sustain soil impacts from orienteering or cross-country marches.

The creation of an off-limits-to-training buffer zone around high-quality streams will help reduce sedimentation and changes in groundwater flow that result from intensive military training. In high-quality hilly areas, it may be appropriate to avoid the use of tactical vehicles within the entire drainage area (from the top of the slope to the stream bed itself). However, dismounted foot traffic can occur without significant negative impacts.

Roadbed stream crossings can be very damaging and should be designed in such a way that erosion and ponding are minimized. Limited crossing areas can be hardened with concrete or rock, and check dams can be constructed on either side of the crossing point to diminish sedimentation from upland areas.

Maritime communities. Military training usually does not occur in maritime evergreen forest or shrub communities, and training on beach and dune communities involves only foot traffic, except for occasional amphibious assault exercises. Dunes and beaches are well adapted to disturbance and can recover from use as long as dune-binding vegetation is not continually broken up by vehicles. Special concern should be given to areas where shorebirds and sea turtles are migrating or nesting. Beaches should be closed to off-road vehicles during critical migration and reproductive periods for sensitive species.

Dune and overwash communities can sustain infrequent intensive training exercises as long as a recovery period is provided to allow for revegetation. Recovery time will vary among sites, and studies are needed to determine the length of time required for various communities to recover from training activities. Shrub communities and maritime forests are less adapted to constant physical disruption, and thus are less resilient to intensive training activities. However, they should provide opportunities for foot training exercises without sustaining significant damage (Gehlhausen and Harper 1998).

5 Summary and Conclusions

Concept and Approach

The conservation and management of TES and their habitats are major issues on DOD installations throughout the United States. The development of TES management plans and implementation of management techniques have historically been conducted on a species-by-species basis. However, within DOD, there has been a recent shift toward ecosystem-based management, and emphasis is being placed on managing lands for multiple species rather than single species of interest (Boice 1994; Department of Defense 1994). This approach was also considered appropriate for developing installations Endangered Species Management Plans (ESMP) that involve several species (Science Applications International Corporation 1995).

Boice (1996) reported that DOD was adapting an integrated, ecosystem-based approach to conservation that will allow the military greater flexibility in managing its land. Emphasizing conservation of ecosystems was determined to result in continued high-quality management and care and would provide a more cost-effective means of resource protection. The need for an ecosystem-based approach to TES management on Army lands was discussed in Trame and Tazik (1995). These authors reported that several studies (e.g., Noss, LaRoe and Scott 1991; Franklin 1993) have shown that protection of a species does not automatically translate into conservation of the habitat or ecosystem on which it depends. Furthermore, loss of habitat, which leads to changes in community structure and function, is the major cause of species decline and endangerment (Rohlf 1991). With the implementation of an ecosystem-based approach to TES conservation, species would be conserved by maintaining their habitat, and species-level conservation would be framed in the context of the species' roles within ecosystems (Trame and Tazik 1995).

This investigation represents an attempt to develop a regionalized, community-based approach to TES management. The southeastern United States was selected for development of a prototype plan because the region contains a large number of installations, many of which manage for a diversity of sensitive species. This study was initiated by first locating military installations in the region; DOD personnel and other data sources were then contacted to identify ecosystems and plant communities that supported TES on their installations.

Project investigators then reviewed the available literature and conducted interviews with ecologists and installation personnel to obtain detailed information on plant communities, their associated TES, and potential impacts to these communities.

Knowledge of regional plant communities and their ecological processes, such as fire regime and hydrology, was critical to the development of a prototype plan. Therefore, emphasis was placed on identifying plant communities that support the greatest number of TES in the Southeast, and a detailed literature review was conducted to determine their biotic and abiotic characteristics and function on the landscape. Results of these investigations are provided in six plant community management profiles prepared for the study. Additionally, 18 faunal species profiles (Table 1) were published to provide detailed information on species habitat requirements and management needs in these communities.

Installation of Community-Based Plan

Developing a community-based TES management program at the installation level will require several needed actions to produce an operable plan that is compatible with the military mission. The following step-by-step procedure is recommended to produce the best results.

a. Identify all plant communities present on the installation and delineate their boundaries on appropriate maps. General vegetation maps are available for most installations in the Southeast, at least for larger installations, but community types may be categorized in a variety of ways.

b. Determine if any of the plant communities identified are considered to be rare or otherwise critical in the state or region. State Natural Heritage Survey offices should be contacted for information on the status of plant communities. Refer to Noss, LaRoe, and Scott (1995) for basic information on the status of selected ecosystems. Plant community management reports prepared for this study should be referred to for specific information on longleaf pine woodlands, herbaceous seeps and wet savannas, Florida scrub, bottomland hardwoods and deepwater swamps, and maritime communities.

c. Determine the existing and potential quality of selected plant communities. Use of a quality-ranking system can ensure that priority is given to the highest quality TES habitat. Use of a ranking system will help ensure that only potentially high-quality areas are selected for community restoration and management efforts. See discussion on community quality in Chapter 2 and descriptions in plant community management reports.

d. Identify existing and potential plant and animal TES occurring in selected plant communities on the installation. This will require a thorough inventory of those communities determined to potentially harbor TES populations. These surveys are generally labor intensive and are usually contracted to area universities or consulting firms. Installation managers should ensure that the selected individuals have the proper expertise and permits to conduct the surveys.

e. Determine the life history and habitat requirements of plant and animal TES inhabiting each community of concern. This information is necessary to determine how each species functions and uses the resources available in the community and will subsequently influence management decisions. Season of use, spatial requirements, and competition for resources should be investigated for each species. The faunal species profiles prepared for this study provide detailed information for 18 species. Similar information is available for other species from various federal, state, and private offices. In some cases, little information will be available for a particular species (this is especially the case for many plants and invertebrates), and species experts will need to be contacted to provide existing information.

f. Determine existing and potential impacts on each community resulting from military activities and other land use practices. Examine these activities in the context of their effect on entire communities and their TES components, and conduct an alternatives analysis to ascertain whether existing activities can be modified or conducted in areas that will result in lesser impacts to TES.

g. Prepare and implement an installation ESMP or action plan that addresses TES management at the community level. It is important to note that some species will use several communities (e.g., the pine snake is known to occur in longleaf pine, mixed woodlands, herbaceous seeps, and Florida scrub); thus, natural resources personnel will need to consider the relative values of adjacent communities when developing the management plan. It is also possible that management practices beneficial to certain TES may be detrimental to others. If this occurs, a decision may be required as to which species is considered of higher priority. If sufficient land area is available within a community, patches of habitat can be managed in different ways to benefit species that have dissimilar habitat requirements. Management plans should include measurable goals in order to determine success.

h. Establish a community monitoring program to determine changes in community quality and effects of the management program. Management plans should be adaptive so that changes can be made if selected techniques do not provide the desired results.

Management Recommendations

Specific management actions are discussed in Chapter 4 and described in detail for selected communities in the plant community management plans. Management recommendations that benefit the greatest number of TES populations from a regional perspective are discussed below.

Habitat fragmentation is detrimental to all communities that support TES. Thus, further fragmentation of TES-managed areas (e.g., by roads, firebreaks, land-use conversion) should be avoided. Type I and Type II communities should be connected as much as possible. To minimize effects of fragmentation, managers should consider restoring degraded areas that separate high-quality natural communities. Sensitive wetland areas and riparian corridors should especially be buffered and protected from fragmentation. Fragmentation problems can often be reduced by evaluating the existing network of improved and secondary roads and closing all roads not identified as essential to mission-related activities.

Erosion and sedimentation are serious concerns for TES plants, especially in riparian and wetland communities such as seeps, peatlands, and bottomland hardwoods. Within mission constraints, activities should be avoided that could increase erosion of upland sites and result in sedimentation of lower-lying wetland areas. Provision of adequate buffers can help alleviate this problem. Erosion problems created by road building and forestry practices (e.g., logging roads and skid trails) should be corrected as soon as possible. Recommendations for minimizing soil disturbance during forestry operations are provided in Chapter 4 and by Harper et al. (1997).

Longleaf pine woodlands, forest-dominated peatland communities, and bottomland hardwoods are subjected to various commercial forestry practices on military installations. Large-scale, even-aged timber management, widespread application of pesticides and herbicides, and skidding practices in wetlands and parallel to streambeds are damaging to TES communities. Recommendations provided below apply to all forested areas where TES management is a primary consideration (synthesized from plant community management reports):

a. Minimize clearcutting. In areas where clearcutting is allowed, cuts must be kept as small as possible (usually less than 2 ha).

b. Select uneven-aged systems over even-aged cuts, and maintain longer rotation ages.

c. Avoid disturbance to wetland inclusions in all communities.

d. Do not convert existing or potential TES communities to pine plantations.

e. Minimize mechanical site preparation in Type I and II quality sites, and select nonmechanical methods (e.g., burning) whenever possible.

f. Minimize the number of skid roads used and the number of turns made; use whole-tree skidding to minimize damage to the soil surface (however, it should be noted that whole-tree skidding can cause increased damage to residual trees; John Tingle, Forester, personal communication, EL, ERDC, Vicksburg, MS).

g. Avoid harvest operations in sensitive seep or wet savanna communities.

h. Avoid cutting near ditches, streams, or other bodies of water because of potential erosion and sedimentation problems.

i. Establish a no-cut buffer zone of at least 30 m between roads and watercourses; an adequate buffer (generally 30 m) should always be maintained between upland harvested sites and streamside ecosystems.

j. Close and revegetate logging roads following harvest operations.

k. Maintain snags as part of any forest management program.

l. Avoid pinestraw harvest in Types I and II communities, and ensure that raking does not result in erosion or affect existing TES populations.

Prescribed burning is an important management tool that should be considered for most southeastern plant communities. However, no two communities respond exactly the same to burning programs, and species inhabiting the same community type may not be affected the same way in different geographic regions. Table 4 provides available information on recommended burning regimes for TES inhabiting sensitive communities in the Southeast.

Natural firebreaks, such as wetlands and streams, should be used whenever possible to contain fires, and fire should generally be allowed to spread through ecotones and into the edges of adjacent wetland communities. However, fire is damaging to most BLH communities. If firebreaks or plowlines must be constructed, new plowlines should not be located in ecotonal areas or where TES occur. After burning, plowlines should be rehabilitated using native vegetation, and firebreaks should be filled with native soil and allowed to revegetate.

The timing of prescribed burns will depend on specific management objectives and TES present on the site. Growing-season burns are generally recommended because they most closely approximate natural burning regimes. However, preferred timing will vary geographically and among sites, and installation managers will need to experiment with the timing and intensity of burns and select the program that provides the best results. Adaptive management is essential so that proper adjustments can be made through time. Varying fire frequency among burn units, or among patches within large units, may be necessary to provide optimal habitat for a variety of TES; this will create a mosaic of vegetation conditions and should contribute to species diversity within a community.

In areas where fire has been suppressed for long periods of time, reduction of fuel loads may be needed so that growing-season burns will not damage the existing community. In this case, winter burns are recommended to reduce fuel loads prior to the initiation of growing-season burns. Burning sites on short fire rotations for the first several years is usually required until fuel loads have been reduced. Dormant-season burns are best conducted before October because winter fires are more likely to impact amphibian populations.

Any activity that will alter the hydrology of wetlands and ecotonal areas supporting TES should be avoided. These include draining, ditching, filling, damming, and creation of plowlines, roads, and new trails. Efforts should be made to prevent further alteration of natural hydrologic regimes and to restore those regimes that have already been altered. A variety of land treatments and

Table 4
Comparison of Prescribed Burning Recommendations among TES Plant Communities in the Southeastern United States (synthesized from Harper et al. 1997; Gehlhausen and Harper 1998; MacAllister and Harper 1998; Robertson, Harper, and Woolery 1998; and Fischer et al. 1999)

Plant Community	Recommended Burning Interval	Season	Comments
Longleaf pine woodlands	1-3 years	Growing	3- to 5-year cycle preferred when RCW populations present
Herbaceous seeps and wet savannas	1-3 years	Growing	Limited data
Florida scrub	8-20 years	Growing	Highly variable among sites. Restoration sites should consist of burns every 2-4 years during the first 10-15 years.
Peatlands			
Bay forests	–	–	Protect from fire
Atlantic white cedar	–	–	Current information does not show that burning is desirable
Pond pine woodlands	5-8 years	Growing	Burn units on a rotating basis
Basin pocosins (low)	20 years[1]	Growing	Optimal interval not known
Basin pocosins (high)	5-8 years	Growing	Burn on a rotating basis
Streamhead pocosins	3-5 years	Growing[1]	Fire interval will depend on rare species
Cypress domes	2-5 years	Spring	March-June burns recommended
Bottomland hardwoods	Not usually burned intentionally	None	Burns generally damaging to communities
Maritime communities	–	–	Information not available for these communities

[1] Recommendation based on limited data, more research noted.

revegetation strategies can be applied to disturbed watersheds to improve hydrologic and hydraulic conditions. Restoration may include removing berms, filling drainage ditches, and removing road culverts. However, these activities must be conducted with extreme caution to ensure that additional damage is not done. A buffer zone (at least 60 m) should be established between wetland sites and adjacent upland areas, and activities in upland areas should be monitored to ensure that they do not impact the hydrology of the watershed.

When agricultural practices occur on or adjacent to military lands, adequate buffer zones (at least 30 m) should be established between croplands and wetland/riparian sites. The use of fertilizers and other soil amendments should be avoided within or adjacent to high-quality TES sites. In all cases, herbicides, pesticides, and fertilizers should be used with care to ensure that they do not enter wetlands and aquatic areas. Although moderate livestock grazing has shown no damage to upland pine woodland communities in the Southeast, grazing is generally not recommended where TES populations occur. Livestock grazing should be prohibited in BLH and wetland areas managed for TES.

Nonindigenous species pose an alarming threat to natural communities and their associated TES species throughout the Southeast. In fact, invasive species are presently ranked second only to habitat destruction as having the greatest impact to TES in the United States. Managers should identify existing nonnative species present on their installations and implement a monitoring program to rapidly detect invasions of new species. Exotic species invasions and pest or disease outbreaks may require aggressive control methods (biological, mechanical, and/or chemical) to decrease their threat to natural communities.

Managers should examine existing wildlife management programs to determine if practices conducted in the vicinity of TES populations are compatible with management needs of TES species. Management practices that should generally be avoided or modified where TES conservation is a priority include large clearcuts, even-aged management, edge development, food plots, and greentree reservoirs. Management practices that are usually beneficial to game species and TES populations include prescribed burning, snag management, riparian habitat management, wetland creation, prairie restoration, and moist-soil management.

Military training and testing mission requirements are the highest priority land uses on DOD lands. Although training takes precedence over all other concerns, the military mission and TES management can be compatible and should not be thought of as mutually exclusive interests. The protection and maintenance of natural resources on training lands, including TES, is essential for the continued use of these lands to carry out the military mission and to keep DOD in compliance with environmental laws.

Identification and understanding of the spatial requirements of both military activities and TES populations can help reduce potential landuse conflicts between TES and the training mission. Training plans and construction projects that minimize habitat destruction and fragmentation will support more resilient TES populations and reduce local impacts. Intensive foot traffic, occupational exercises, and mechanized training should be minimized on high-quality sites, and activities such as occupation and assembly should occur on improved sites or repeatedly used unimproved sites. In areas used primarily for dismounted infantry training, ecotones and wetlands should be flagged to protect them from off-road vehicle impacts. If possible, heavy equipment use should be confined to improved roads or previously degraded areas. Use of heavy equipment should be avoided in wet areas or during wet conditions. An off-limits or modified-use buffer zone should be created for wetlands and riparian areas.

Concluding Remarks

This prototype plan represents an effort to bring together and summarize under one cover as much information as possible on selected TES communities in the Southeast. More detailed information is provided in accompanying reports on specific plant communities and faunal profiles. These documents should be used collectively to identify and understand the probable characteristics and functions of like communities that may occur on an installation. It is hoped that this information will provide the basis for development of TES community management plans for individual installations throughout the Southeast. It should also serve as a template for TES management programs in other regions.

This document should not be considered to be promoting a "cookbook" approach to TES management within the communities addressed. Rather, installation managers should use the information provided as a cornerstone for building their own plans. Although the same community type will be similar from installation to installation, each site will have certain unique characteristics, and no two areas will support exactly the same complement of species or military training activities. Therefore, management strategies must vary to some extent among installations. Management opportunities will also vary with mission requirements of the installation.

Although this study emphasizes an ecosystem-based approach to TES management, the manager should realize that the habitat requirements of individual species cannot be ignored. In fact, a thorough understanding of the life history requirements of individual species and how different species interact within the community is critical to understanding how the community functions as a system. Therefore, a viable community-based plan should strive to understand the needs of all species present so that the community can be properly managed within the broadest context possible to benefit and sustain an appropriate assemblage of native species.

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Appendix A
Department of Defense Installations in the Southeastern United States

Table A1
Department of Defense Installations in the Southeastern United States (Refer to Figure 1 [main text] for map of installation locations)

Code	Installation	State
	Air Force	
F 6	Alabama Air National Guard Base (ANGB)	AL
F 12	Avon Park Air Force Station (AFS)	FL
F 3	Barksdale Air Force Base (AFB)	LA
F 14	Cape Canaveral (Port)	FL
F 20	Charleston AFB	SC
F 5	Columbus AFB	MS
F 24	Dare County Bombing Range	NC
F 7	Davidsonville Site	MD
F 18	Dobbins AFB	GA
F 21	Dover AFB	DE
F 9	Eglin AFB/Hulbert Field	FL
F 1	Ellington Field ANGB	TX
F 15	Homestead AFB	FL
F 4	Keesler AFB	MS
F 25	Langley AFB	VA
F 2	Little Rock AFB	AR
F 11	MacDill AFB	FL
F 8	Maxwell AFB	AL
F 16	Moody AFB	GA
F 13	Patrick AFB	FL
F 23	Pope AFB	NC
F 17	Robins AFB	GA
F 22	Seymour Johnson AFB	NC
F 19	Shaw AFB	SC
F 10	Tyndall AFB	FL
		(Sheet 1 of 4)

Table A1 (Continued)

Code	Installation	State
	Army	
A 36	Aberdeen Proving Ground	MD
A 25	Alabama Army Ammunition Plant (AAP)	AL
A 11	Anniston Army Depot	AL
A 24	Camp McCain	MS
A 6	Camp Beauregard	LA
A 8	Camp Shelby	MS
A 7	Camp Villerie	LA
A 3	Camp Robinson	AR
A 20	Camp Frank D. Merrill	GA
A 13	Camp Blanding	FL
A 29	Fort Detrick	MD
A 30	Fort Ritchie	MD
A 35	Fort Story	VA
A 28	Fort Lee	VA
A 5	Fort Polk	LA
A 26	Fort A.P. Hill	VA
A 27	Fort Picket	VA
A 2	Fort Chaffee	AR
A 14	Fort Stewart	GA
A 22	Fort Bragg	NC
A 10	Fort McClellan	AL
A 12	Fort Rucker	AL
A 21	Fort Jackson	SC
A 18	Fort McPherson	GA
A 19	Fort Gordon	GA
A 17	Fort Gillem	GA
A 16	Fort Benning	GA
A 15	Hunter Army Airfield	GA
A 31	Lone Star AAP	TX
		(Sheet 2 of 4)

Table A1 (Continued)		
Code	**Installation**	**State**
	Army (continued)	
A 32	Longhorn AAP	TX
A 33	Louisiana AAP	LA
A 23	Mississippi AAP	MS
A 4	Pine Bluff Arsenal	AR
A 1	Red River Army Depot	TX
A 9	Redstone Arsenal	AL
A 34	Sunny Point Military Ocean Terminal	NC
	Marine Corps	
M 4	Marine Corps Air Station (MCAS) New River (Helicopter)	NC
M 1	Albany MC Logistics Base	GA
M 3	Marine Corps Air Station Beaufort	SC
M 5	Marine Corps Base (MCB) Camp Lejeune	NC
M 6	MCAS Cherry Point	NC
M 2	Parris Island MC Recruit Depot	SC
M 7	Quantico MC Combat Development Command	VA
	Navy	
N 25	Annapolis Naval Station (NAVSTA)	VA
N 11	Cecil Field Naval Air Station (NAS)	FL
N 18	Charleston NAVSTA	SC
N 17	Charleston Naval Base	SC
N 20	Cheatham Annex Naval Base	VA
N 21	Dahlgreen Naval Surface Warfare Center	VA
N 4	Gulfport Naval Construction Battalion Center (NCBC)	MS
N 23	Indian Head Naval Ordinance Station	MD
N 12	Jacksonville NAS	FL
N 9	Key West NAS	FL
N 14	Kings Bay Naval Submarine Base	GA
N 13	Mayport NAVSTA	FL
		(Sheet 3 of 4)

Table A1 (Concluded)

Code	Installation	State
Navy (continued)		
N 6	Meridian NAS	MS
N 7	Mobile NAVSTA	AL
N 3	Naval Education and Training	FL
N 2	New Orleans NAS	LA
N 16	Norfolk NAVSTA	VA
N 5	Norfolk Naval Shipyard, Portsmouth	VA
N 19	Northwest Naval ‘Security Group Security (NSGA), Chesapeake	VA
N 22	Oceana NAS	VA
N 10	Orlando Naval Training Center	FL
N 8	Panama City Naval Coastal Systems Center	FL
N 26	Pascagoula NAVSTA	MS
N 24	Patuxent River NAS	MD
N 15	Pensacola NAS	FL
N 1	Whiting Field NAS	FL
		(Sheet 4 of 4)

Appendix B Occurrence of Plant Communities on Military Installations in the Southeastern United States

Table B1
Occurrence of Pine Flatwoods and Sandhills on Military Installations, Southeastern United States (from Harper et al. 1997)

State	Branch	Installation	Community Type	
			Flatwoods	Sandhills
AL	Army	Fort McClellan		X
		Fort Rucker		X
FL	Air Force	Avon Park Air Force Base (AFB)	X	X
		Eglin AFB	X	X
		Hurlburt Field	X	X
		Tyndall AFB	X	
	Army	Camp Blanding	X	X
	Navy	Naval Air Station (NAS) Cecil Field	X	X
		NAS Jacksonville	X	
		McCoy Annex of the Naval Training Center, Orlando	X	
		NAS Pensacola and Outlying Field, Bronson	X	X
		NAS Whiting Field	X	X
GA	Air Force	Moody AFB	X	
	Army	Fort Benning	X	X
		Fort Gordon	X	X
		Fort Stewart	X	X
	Marine Corps	Marine Corps Logistics Base (MCLB), Albany	X	X
LA	Army	Camp Beauregard		X
		Camp Villerie	X	
		Fort Polk	X	X
MS	Army	Camp Shelby	X	X
	Navy	NAS Meridian		X
NC	Army	Camp MacKall & Fort Bragg	X	X
		Military Ocean Terminal (MOT), Sunny Point	X	X
	Marine Corps	Marine Corps Air Station (MCAS), Cherry Point	X	X
		Marine Corps Base (MCB), Camp Lejuene	X	X
SC	Army	Fort Jackson	X	X
	Navy	Naval Weapons Station (NWS), Charleston	X	X

Table B2
Occurrence of Herbaceous Seeps, Wet Savannas, and Small Depression Pond Complexes on Military Installations, Southeastern United States (from Harper, Trame, and Hohmann 1998)

State	Branch	Installation	Community Name in Document
AL	Army	Fort Rucker	Seeps, bogs, wet meadows
FL	Air Force	Avon Park Air Force Base (AFB)	Seepage slope, depression marsh, wet prairie
		Eglin AFB	Depression marsh, wet prairie, seepage slope
		Tyndall AFB	Wet prairie
		Yellow Water Weapons Area, Jacksonville Naval Complex	Drainage ditch
	Army	Camp Blanding	Depression marsh
	Navy	NAS Pensacola and Outlying Field, Bronson	Wet prairie
GA	Air Force	Moody AFB	Flatwoods ponds, hillside seepages, isolated wetland complexes, wet prairie
	Army	Fort Benning	Bogs, seeps
		Fort Stewart	Sandhill seep, pine savanna, cypress savanna, cypress/gum ponds
	Marine Corps	Marine Corps Logistics Base (MCLB), Albany	Limesink ponds, forested limesink depressions
LA	Army	Camp Villerie	Slash pine - cypress - hardwood
		Fort Polk	Hillside bog, wooded seep
		Louisiana Army Ammunition Plant	Wooded seep
MS	Army	Camp Shelby	Wet prairie - savanna
NC	Army	Camp Mackall and Fort Bragg	Little river seepage bank, sandhill seep, vernal pool
		Military Ocean Terminal (MOT), Sunny Point	Small depression pond, pine savanna
	Marine Corps	Marine Corps Base (MCB) Camp Lejuene	Depression meadow, small depression pond, vernal pool, pine savanna, cypress savanna

Table B3
Occurrence of Florida Scrub Communities on Military Installations, State of Florida (from MacAllister and Harper 1998)

State	Branch	Installation
FL	Air Force	Avon Park Air Force Range (AFR)
		Cape Canaveral Air Station
		Eglin Air Force Base (AFB)
		Hurlburt Field
		Tyndall AFB
	Army	Camp Blanding
	Navy	Naval Air Station (NAS) Cecil Field
		NAS Pensacola and Outlying Field, Bronson
		NAS Whiting Field
		NAS Jacksonville

Table B4
Occurrence of Peatland Communities on Military Installations, Southeastern United States (from Robertson, Harper, and Woolery 1998)

State	Branch	Installation	Community Type	Community Name in Document
AL	Army	Fort Rucker	Bay forest	Bay swamp
FL	Air Force	Eglin Air Force Base (AFB)	Bay forest	Baygall
		Eglin AFB	Pocosin	Seepage slope (streamhead pocosin)
		Eglin AFB Hurlburt Field	Cypress dome pocosin	Dome swamp, titi ponds
		Tyndall AFB	Bay forest	Baygall
	Army	Camp Blanding	Bay forest	Bay swamp
	Navy	Naval Air Station (NAS), Pensacola	Bay forest	Bay swamp
		NAS, Pensacola	Pond pine woodland	Pond pine dominated flatwoods (wet flatwoods)
		NAS, Pensacola	Pocosin	Titi swamp
		NAS, Whiting Field	Bay forest	Bayheads
		NAS, Whiting Field	Atlantic white cedar forest	Atlantic white cedar forest
		NAS, Whiting Field	Pocosin	Titi depressions
		Cecil Field, NAS	Cypress dome	Cypress domes
GA	Army	Fort Stewart	Bay forest	Bay forest
		Fort Stewart	Cypress dome	Dome swamp
LA	Army	Camp Villerie	Bay forest	Bayhead swamp
		Fort Polk	Bay forest	Bayhead swamp
MS	Army	Camp Shelby	Bay forest	Bay forest
NC	Air Force	Dare County AFR	Bay forest	Bay forest
		Dare County Bombing Range	Atlantic white cedar forest	Peatland Atlantic white cedar forest
		Dare County Bombing Range	Pond pine woodland	Pond pine woodland
		Dare County Bombing Range	Pocosin	Low pocosin, high pocosin

(Continued)

Table B4 (Concluded)

State	Branch	Installation	Community Type	Community Name in Document
NC (cont)	Army	Camp Mackall and Fort Bragg	Atlantic white cedar forest	Peatland Atlantic white cedar forest, streamhead Atlantic white cedar forest
		Camp Mackall and Fort Bragg	Pocosin	Small depression pocosin, streamhead pocosin
		Sunny Point Military Ocean Terminal (MOT)	Pond pine woodland	Pond pine woodland
	Marine Corps	Marine Corps Air Station (MCAS), Cherry Point	Pond pine woodland	Pond pine wodland
		Marine Corps Base (MCB), Camp Lejeune	Atlantic white cedar forest	Peatland Atlantic white cedar forest
		MCB, Camp Lejeune	Pond pine woodland	Pond pine woodland
		MCB, Camp Lejeune	Pocosin	Low pocosin, high pocosin, small depression pocosin, streamhead pocosin
SC	Army	Fort Jackson	Pocosin	Low pocosin, high pocosin
VA	Army	Fort A. P. Hill	Bay forest	Oligotrophic saturated forest
		Fort A. P. Hill	Pond pine woodland	Oligotrophic saturated woodland
		Fort A. P. Hill	Pocosin	Oligotrophic scrub
		Fort Pickett	Pocosin	Oligotrophic scrub

Table B5
Occurrence of Bottomland Hardwoods and Deepwater Swamps on Military Installations, Southeastern United States (from Fischer et al. 1999)

State	Branch	Installation	Community Name in Document	Zone(s)
AL	Army	Anniston Army Depot and Coosa River Annex	Forested palustrine wetlands	III-V V
		Fort Rucker	Infrequently flooded mesic hardwood forests	V
		Redstone Arsenal	Mixed bottomland oak forest	V
		Fort McClellan, Main Post	Sweetgum-mixed bottomland oak forest	IV-V
		Fort McClellan, Pelham Range	Sweetgum-mixed bottomland oak forest	IV-V
AR	Air Force	Little Rock Air Force Base (AFB)	Bottomland hardwoods	?
FL	Air Force	Avon Park AFB	Floodplain swamp (potentially)	?
		Eglin AFB	Bottomland forest, floodplain forest	?
		Hurlburt Field	Forested wetlands	?
		Tyndall AFB	Floodplain swamp	II
	Army	Camp Blanding	Bottomland hardwood forest, riparian area, swamp, bay, and riparian area, hardwood swamp	IV-V II II-III IV
	Navy	Naval Air Station (NAS), Jacksonville	Wetland bottomland swamp	II-V
		NAS, Cecil Field	Wetland bottomland swamp	II-V
		NAS, Pensacola	Mixed forested wetlands	II
		NAS, Whiting Field	Floodplain swamps	II
GA	Army	Fort Benning	Bottomland hardwood forest	III-IV
		Fort Gibson	Floodplain forest	III-IV
		Fort Stewart	Bald cypress-water tupelo swamp, coastal plain, small-stream swamp forest	II II-III
	Marine Corps	Marine Corps Logistics Base (MCLB)	Blackwater stream, riparian forest	IV
LA	Air Force	Barksdale AFB	Batture forest	III
	Army	Fort Polk	Riparian forest	III-V
		Camp Villerie	Species list only	III-IV

(Continued)

Table B5 (Concluded)

State	Branch	Installation	Community Name in Document	Zones
MS	Army	Camp McCain	Swamp chestnut, oak-cherrybark, oak bottomland forest	V
		Camp Shelby	Mesic-hydric forest	V
NC	Army	Fort Bragg and Camp Mackall	Coastal plain bottomland hardwoods, blackwater coastal plain-levee forest, coastal plain, small-stream swamp	IV III-IV III-V
	Marine Corps	Cherry Point Marine Corps Air Station	Coastal plain, small-stream swamp, blackwater	II
		Camp Lejeune	Coastal plain, small-stream swamp, blackwater cypress-gum swamp	II-IV II
SC	Army	Fort Jackson	Bottomland hardwood forest	Not determined
	Navy	Naval Weapons Station	Forested wetlands	IV-V
VA	Marine Corps	Quantico Marine Corps Base	Deciduous forested wetlands, deciduous scrub/shrub wetlands	II-IV II-IV

Table B6
Occurrence of Maritime Communities on Military Installations, Southeastern United States (from Gehlhausen and Harper 1998)

State	Branch	Installation	Community Type
FL	Air Force	Eglin AFB	Beach dune, maritime hammock
		Tyndall AFB	Beach dune, maritime unconsolidated substrate, coastal grassland, coastal interdune swale, coastal dune lakes, maritime hammock
	Navy	NAS, Pensacola	Sand beaches and dunes
NC	Army	Sunny Point Military Ocean Terminal (MOT)	Coastal fringe evergreen forest, interdune pond
	Marine Corps	MCB, Camp Lejeune	Calcareous coastal fringe forest, maritime evergreen forest, maritime wet grassland, coastal fringe evergreen foresst, upper beach, dune grass
		Marine Corps Air Station (MCAS), Cherry Point	Coastal fringe evergreen forest, maritime evergreen forest
		Marine Corps Outlying Field (MCOLF), Atlantic	Coastal fringe sandhill

Appendix C
Occurrence of TES in Sensitive Plant Communities in the Southeast

Table C1
Occurrence of Animal TES in Sensitive Plant Communities (Refer to plant community management reports and faunal species profiles)

Species	Longleaf Pine	Herbaceous Seeps	Florida Scrub	Peatlands	BLH	Maritime
Mammals						
Gray Bat (*Myotis grisescens*)					X	
Indiana Bat (*Myotis sodalis*)					X	
Southeastern Myotis (*Myotis austroriparius*)					X	
Florida Black Bear (*Ursus americanus floridanus*)	X	X		X	X	
Louisiana Black Bear (*Ursus americanus luteolus*)	X			X	X	
Red Wolf (*Canis rufus*)				X		
Florida Panther (*Felis concolor coryi*)					X	
Florida Long-tailed Weasel (*Mustela frenata peninsulae*)			X			
Sherman's Fox Squirrel (*Sciurus niger shermani*)	X	X			X	
Florida Mouse (*Podomys floridanus*)			X			
Beach Mouse (*Peromyscus polionotus* spp.)						X

(Sheet 1 of 3)

Table C1 (Continued)

Species	Longleaf Pine	Herbaceous Seeps	Florida Scrub	Peatlands	BLH	Maritime
Birds						
Bald Eagle (*Haliaeetus leucocephalus*)	X				X	X
Peregine Falcon (*Falco peregrinus*)						X
Southeastern American Kestrel (*Falco sparverius paulus*)	X	X	X			X
Wood Stork (*Mycteria americana*)				X	X	X
Piping Plover (*Charadrius melodus*)						X
Interior Least Tern (*Sterna antillarum*)					X	X
Snowy Plover (*Charadrius alexandrinus*)						X
Red-cockaded Woodpecker (*Picoides borealis*)	X	X		X		
Loggerhead Shrike (*Lanius ludovicianus*)	X		X			X
Florida Scrub Jay (*Aphelocoma coerulescens*)			X			
Cerulean Warbler (*Dendroica cerulea*)					X	
Bachman's Sparrow (*Aimophila aestivalis*)	X	X				
Henslow's Sparrow (*Ammodramus henslowii*)	X					

(Sheet 2 of 3)

Table C1 (Concluded)

Species	Longleaf Pine	Herbaceous Seeps	Florida Scrub	Peatlands	BLH	Maritime
Reptiles & Amphibians						
Eastern Indigo Snake (*Drymarchon corais couperi*)	X	X	X			
Pine Snake (*Pituophis melanoleucus mugitus*)	X	X	X			
Southern Hognose Snake (*Heterdon simus*)	X				X	
Florida Scrub Lizard (*Sceloporus woodi*)			X			
Gopher Tortoise (*Gopherus polyphemus)*	X		X			
Green Turtle (*Chelonia mydas)*						X
Loggerhead Turtle (*Caretta caretta*)						X
American Alligator (*Alligator mississippiensis*)					X	X
Sand Skink (*Neoceps reynoldsi*)			X			
Blue-tailed Mole Skink (*Eumeces egregius lividus*)			X			
Striped Newt (*Notophthalmus perstriatus*)				X		
Flatwoods Salamander (*Ambystoma cingulatum*)	X	X		X		
Gopher Frog (*Rana capito* spp.)	X	X		X		

(Sheet 3 of 3)

Table C2
Occurrence of Plant TES in Sensitive Plant Communities (Refer to plant community management reports)

Species	Longleaf Pine	Herbaceous Seeps	Florida Scrub	Peatlands	BLH	Maritime
Woody Plants						
Ashe's Magnolia (*Magnolia ashei*)					X	
Bog Spicebush (*Lindera subcoriacea*)				X		
Buckthorn (*Bumelia thornei*)					X	
Chapman's Rhododendron (*Rhododendron chapmanii*)	X					
Georgia Lead Plant (*Amorpha georgiana* var. *georgiana*)	X					
Georgia Plume (*Elliotia racemosa*)	X					
Gulf Coast Lupine (*Lupinus westianus*)			X			
Large-leaved Jointweed (*Polygonella macrophylla*)	X		X			
Maracao Cimarron (*Brysonomia lucida*)	X					
Michaux's Sumac (*Rhus michauxii*)	X					
Nestronia (*Nestronia umbellula*)	X					
Pondspice (*Litsea aestivalis*)		X		X		
White Wicky (*Kalmia cuneata*)	X					
Yellow Anise Tree (*Illicium parviflorum*)	X					

(Sheet 1 of 7)

Table C2 (Continued)

Species	Longleaf Pine	Herbaceous Seeps	Florida Scrub	Peatlands	BLH	Maritime
Forbs						
Alabama Anglepod (Milkweed) (*Matelea alabamensis*)					X	
American Chaffseed (*Schwalbea americana*)	X					
Awned Meadow-beauty (*Rhexia aristosa)*	X	X				
Bog Coneflower (*Rudbeckia scabrifolia*)		X				
Boykin's Lobelia (*Lobelia boykinii*)		X		X		
Carolina Asphodel (*Tofieldia glabra*)				X		
Carolina Goldenrod (*Solidago pulchra*)	X	X				
Carolina Grass of Parnassus (*Parnassia caroliniana*)	X	X				
Chapman's Butterwort (*Pinguicula planifolia*)	X	X		X		
Chapman's Crownbeard (*Verbesina chapmanii*)	X	X				
Coyote-thistle Aster (*Aster eryngifolius*)		X				
Cruise's Golden Aster (*Chrysopsis gossypina cruiseana*)						X
Curtiss Milkweed (*Asclepias curtissii*)			X			
Drummond's Yellow-eyed Grass (*Xyris drummondii*)	X	X				

(Sheet 2 of 7)

Table C2 (Continued)

Species	Longleaf Pine	Herbaceous Seeps	Florida Scrub	Peatlands	BLH	Maritime
Forbs (continued)						
Eulophia (*Pteroglossaspis ecristata*)	X		X			
False Dragon Head (*Physostegia leptophylla*)					X	
Godfrey's Butterwort (*Pinquicula ionantha*)	X	X				
Godfrey's Golden Astor (*Chrysopsis godfreyi*)			X			X
Hairy Wild Indigo (*Baptisia calycosa* var. *villosa*)	X					
Harper's Yellow-eyed Grass (*Xyris Scabrifolia*)	X	X				
Hartwrightia (*Hartwrightia floridana*)		X				
Incised Groovebur (*Agrimonia incisa*)	X					
Macbridia (*Macbridia caroliniana*)					X	
Monkey-face (*Platanthera integrilabia*)	X	X				
Panhandle Lily (*Lilium iridollae*)		X				
Panhandle Meadow-beauty (*Rhexia salicifolia*)		X				
Pickering's Morning Glory (*Stylisma pickeringii* var. *pickeringii*)	X					
Piedmont Cowbane (*Oxypolis ternata*)	X	X				

(Sheet 3 of 7)

Table C2 (Continued)

Species	Longleaf Pine	Herbaceous Seeps	Florida Scrub	Peatlands	BLH	Maritime
Forbs (continued)						
Piedmont Water Milfoil (*Myriophyllum laxum*)		X				
Pigeon Wings (*Clitoria fragrans*)			X			
Pineland Hoary-pea (*Tephrosia mohrii*)	X					
Pine Barrens Boneset (*Eupatorium resinosum*)		X				
Porter's Spurge (*Chamaescyce porteriana* var. *scoparia*)	X					
Purple Balduina (*Balduina atropurpurea*)	X	X				
Quillwort Yellow-eyed Grass (*Xyris Isoetifolia*)	X	X				
Resinous Boneset (*Eupatorium resinosum*)				X		
Rough-leaved Loosestrife (*Lysimachia asperulaefolia*)	X	X		X		
Sandhills Milk-vetch (*Astragalus michauxii*)	X					
Savanna Aster (*Aster chapmanii*)				X		
Seabeach Amaranth (*Amaranthus pumilus*)						X
Smooth Bog-asphodel (*Tofieldia glabra*)	X	X				
Smooth Coneflower (*Echinacea laevigata*)	X					

(Sheet 4 of 7)

Table C2 (Continued)

Species	Longleaf Pine	Herbaceous Seeps	Florida Scrub	Peatlands	BLH	Maritime
Forbs (continued)						
Southern Bog Buttons (*Lachnocaulon beyrichianum*)	X					
Southern Lady's Slipper (*Cypripedium kentuckiense*)					X	
Southern Milkweed (*Asclepias viridula*)	X					
Spring-flowering Goldenrod (*Solidago verna*)		X				
Swamp Pink (*Helonias bullata*)	X					
Texas Trillium (*Trillium texanum*)					X	
Tiny Bog Buttons (*Lachnocaulon digynum*)	X	X				
Toothed Savory (*Calamintha dentata*)	X					
Variable-leaf Crownbeard (*Verbesina heterophylla*)	X					
Venus' Flytrap (*Dionaea muscipula)*	X	X				
Well's Pyxie-moss (*Pyxidanthera barbulata* var. *brevifolia*)	X					
West's Flax (*Linum westii*)	X	X				
West Florida Cowlily (*Nuphar luteum ulvaceum*)		X				
White Fringeless Orchid (*Platanthera integrilabia*)					X	

(Sheet 5 of 7)

Table C2 (Continued)

Species	Longleaf Pine	Herbaceous Seeps	Florida Scrub	Peatlands	BLH	Maritime
Forbs (concluded)						
White-topped Pitcher Plant (*Sarracenia leucophylla*)	X	X				
Wireweed (*Polygonella basiramia*)			X			
Yellow Coneflower (*Rudbeckia nitida* var. *nitida*)	X					
Grasses, Rushes, & Sedges						
Carolina Goldenrod (*Solidago pulchra*)				X		
Chapman's Sedge (*Carex chapmanii*)						X
Curtis' Sand Grass (*Calamovilfa curtissii*)	X	X		X		
Florida Toothache Grass (*Ctenium floridanum*)	X					
Hirst's Panic Grass (*Panicum hirstii*)		X				
Naked Stemmed Panic Grass (*Panicum nudicaule*)		X				
New Jersey Rush (*Uncus caesariensis*)		X				
Pale Beakrush (*Rhynchospora pallida*)				X		
Piedmont Jointgrass (*Coelorachis tuberculosa*)		X				
Pine Barrens Dropseed (*Sporobolus* sp. 1)	X	X				
Rhynchospora (*Rhynchospora decurrens*)					X	

(Sheet 6 of 7)

Table C2 (Concluded)

Species	Longleaf Pine	Herbaceous Seeps	Florida Scrub	Peatlands	BLH	Maritime
Grasses, Rushes, & Sedges (concluded)						
Scrub Bluestem (*Schizachyrium niveum*)			X			
Southern Three-awned Grass (*Aristida simpliciflora*)	X	X				
Umbrella Sedge (*Cyperus grayoides*)	X					
Nonvascular Plants						
Florida Perforate Cladonia (*Cladonia perforata*)			X			X

(Sheet 7 of 7)

Appendix D
TES Plant Species and their Habitat/Community Requirements

Table D1
TES Plant Species and Their Habitat/Community Requirements (Summarized from plant community management reports)

Common/Scientific Name	Habitat/Community	Status[1]
Woody Plants		
Ashe's Magnolia (*Magnolia ashei*)	Narrow creek bottoms and sandy woods near streams	SOC
Bog Spicebush (*Lindera subcoriacea*)	Baygalls, pocosins, sandy, silty sink hole depressions, and swamps	SOC
Buckthorn (*Bumelia thornei*)	Small hardwood nonalluvial swamp where soil is normally saturated for long periods and woods bordering ponds and creeks where some surface water stands during wet seasons	SOC
Chapman's Rhododendron (*Rhododendron chapmanii*)	Light shade to full sun, good drainage with no chance of flooding, sandy soil, with water table near surface. Species always occurs adjacent to a black titi (*Cliftonia monophylla*) bog; always occupies habitat between pine flatwoods and sand pine scrub	E
Georgia Lead Plant (Indigo Bush) (*Amorpha georgiana* var. *georgiana*)	Occurs primarily in pine/shrub wiregrass terraces along rivers and streams, a type of mesic pine flatwoods; usually occurs at the ecotone between the pine community and the floodplain; collection records also include swamp forest, low flatwoods, low wet pasture, and sandy wiregrass savanna; the species favors clearings, often small ones created by treefall or forest cutting; pocosins, ecotones, wet-mesic savannas/flatwoods	SOC
Georgia Plume (*Elliotia racemosa*)	Oak ridges and sandhills	SOC
Gulf Coast Lupine (*Lupinus westianus*)	Coastal scrubs and dunes, disturbed habitats; a gulf coast dune plant that occupies exposed and active sand dunes facing the Gulf and occasionally disturbed areas where construction has removed the native vegetation	SOC
Large-leaved Jointweed (*Polygonella macrophylla*)	Sandy soils, usually in natural openings in scrubs, occasionally observed in disturbances in sandhills; disturbed areas; in sand pine forests in natural openings in the canopy, or along paths or powerline rights of way	SOC
Maracao Cimarron (*Brysonomia lucida*)	Low hammocks and pinelands, Florida Keys	SOC
Michaux's Sumac (*Rhus michauxii*)	Sandy soils in openings, disturbed areas. Sites are slightly loamy but well drained and occur throughout the sandhills in slight depressions, swales, or along lower slopes; also occurs in the Piedmont	E

(Sheet 1 of 8)

[1] E = Federally endangered; T = Federally threatened; C = Federal candidate for listing; SOC = species of special concern.

Table D1 (Continued)

Common/Scientific Name	Habitat/Community	Status
	Woody Plants (continued)	
Nestronia (*Nestronia umbellula*)	Woods and streambanks, Piedmont to Appalachian Plateau	SOC
Pondspice (*Litsea aestivalis*)	Dome swamps, small depression pocosins, bayheads, edges of sandy sinks, meteor ponds, pocosins, pond and swamp margins, and low wet woodlands. Usually in very acidic, sandy, or peaty soils.	SOC
White Wicky (*Kalmia cuneata*)	Moist ecotones between streamhead pocosins and sandhills; also may occur at the margins or within Carolina bays. Usually found on soils having a long hydroperiod and overlain with a layer of organic material. In well-burned areas where shading is minimal	SOC
Yellow Anise Tree (*Illicium parviflorum*)	Observed in disturbed pine flatwoods, probably an ornamental planting. Occurs naturally in low woods and swamps	SOC
	Forbs	
Alabama Anglepod (Milkweed) (*Matelea alabamensis*)	Bottomland hardwood forests, upland hardwood forests	SOC
American Chaffseed (*Schwalbea americana*)	Usually occurs in sandy, acidic, seasonally moist soils. Sandhills, flatwoods, and ecotones between them and adjacent pocosins or herbaceous seeps/bogs	E
Awned Meadow-beauty (*Rhexia aristosa)*	Wet-mesic flatwoods, margins of ponds or depressions in pinelands, swamps; disturbed areas; Carolina bays, cypress savannas	SOC
Bog Coneflower (*Rudbeckia scabrifolia*)	Hillside bogs	SOC
Boykin's Lobelia (*Lobelia boykinii*)	Cypress savannas, depression meadows, clay-based Carolina bays, pine savannas, dome swamps, bogs, vernal ponds, flatwoods, adjacent ditches, often in shallow water	SOC
Carolina Asphodel (*Tofieldia glabra*)	Streamhead pocosin, savanna and pocosin ecotone	SOC
Carolina Goldenrod (*Solidago pulchra*)	Wet or mesic flatwoods, and ecotones between flatwoods and adjacent pocosins or herbaceous seeps/bogs. Occasionally occurs in savanna ditches, savanna borrow scrape ecotones, powerline rights of way, and roadsides	SOC

(Sheet 2 of 8)

Table D1 (Continued)

Common/Scientific Name	Habitat/Community	Status
	Fobs (continued)	
Carolina Grass of Parnassus (*Parnassia caroliniana*)	Prefers low, permanently moist drainages in open, herb-dominated grasslands (seeps/bogs, flatwoods, savannas, and ecotones between flatwoods or sandhills and adjacent wetlands); also found in disturbed areas	SOC
Chapman's Butterwort (*Pinguicula planifolia*)	In shallow water, margins of peaty ponds, bogs, boggy flatwoods, ditches and drainage canals; Dome swamp, bogs, cypress domes, depressions in flatwoods and savannas, often in shallow standing water in moist peat or peat-sand-muck	SOC
Chapman's Crownbeard (*Verbesina chapmanii*)	Moist pine flatwoods; confined to long hydroperiod, black, sandy-peaty soils, also at the edges of boggy sites; bogs, grassy cypress depressions	SOC
Coyote-thistle Aster (*Aster eryngifolius*)	Bogs, pine savannas and flatwoods, borders of cypress-gum depressions	SOC
Cruise's Golden Aster (*Chrysopsis gossypina cruiseana*)	Found on bare sand in hollows behind foredunes, in blowouts, or in disturbed areas within stable backdune areas with woody vegetation. Not found on recently colonized dunes nor with sea oats on foredune-facing beach	SOC
Curtiss Milkweed (*Asclepias curtissii*)	Endemic to scrub; plants almost never grow close together, so several acres of scrub may only have a few widely scattered plants	SOC
Drummond's Yellow-eyed Grass (*Xyris drummondii*)	Bogs or boggy places where soil moisture is high; it is always in full sun. Pitcher-plant bogs in flatwoods are ideal. Also found in areas with clearcutting. Moist acid sands, sandy peats, or sphagnous peats	SOC
Eulophia (*Pteroglossaspis ecristata*)	Tolerates a wide range of moisture conditions, from very xeric to seasonally inundated or almost permanently saturated soils, but most records are from sites that dry out, at least seasonally. Scrub, sandhills, flatwoods, and various natural and human-disturbed open areas	SOC
False Dragon Head (*Physostegia leptophylla*)	Swamp woodlands, river edges and inlet banks and coastal sloughs; typically found in wet muck or peat, often in shallow water	SOC
Godfrey's Butterwort (*Pinquicula ionantha*)	Bogs, flatwoods depressions, adjacent ditches, or drainage canals	T
Godfrey's Golden Astor (*Chrysopsis godfreyi*)	Sunny openings in or near scrub, also on dunes and backdunes; occurs on both mobile and stable dunes that are dominated by sea oats and Gulf bluestem; can be found in large, pure populations on backdunes	SOC
Hairy Wild Indigo (*Baptisia calycosa var. villosa*)	Dry, sandy pinelands or oak woods; also along roadsides, railroads, powerlines	SOC

(Sheet 3 of 8)

Table D1 (Continued)

Common/Scientific Name	Habitat/Community	Status
	Forbs (continued)	
Harper's Yellow-eyed Grass (*Xyris Scabrifolia*)	Moist-to-wet sandy peats; pocosins, herbaceous seeps/bogs and ecotones between these communities and flatwoods or sandhills.	SOC
Hartwrightia (*Hartwrightia floridana*)	Wet, open areas; found in marshy grassland or among sphagnum in boggy swales	SOC
Incised Groovebur (*Agrimonia incisa*)	Sandy open woodlands, well-drained ravine heads, bluffs and small clearings; sandhills	SOC
Macbridia (*Macbridia caroliniana*)	Bottomland hardwood forests, bottomland woodlands, marshes, bogs, alluvial woods	SOC
Monkey-face (*Platanthera integrilabia*)	Wet, flat, boggy areas at the head of streams or on seepage slopes; usually associated with sphagnum moss (*Sphagnum* spp.) and usually grows in partial shade	SOC
Panhandle Meadow-beauty (*Rhexia salicifolia*)	Sandy shores or exposed shores of sandy limestone sinks, exposed bottoms of limestone-cypress ponds, coastal interdunal swales	SOC
Pickering's Morning Glory (*Stylisma pickeringii* var. *pickeringii*)	Dry to xeric, nutrient-poor, well-drained, coarse sandy soils with little competing vegetation or litter; areas where tree cover is sparse to nonexistent; occurs in xeric sandhills and on exposed bluffs; often found in sparsely vegetated disturbed areas (e.g., roadsides, drop zones, tank training sites)	SOC
Piedmont Cowbane (*Oxypolis ternata*)	Wet flatwoods, pocosins, herbaceous seeps/bogs, ecotones between flatwoods or sandhills and pocosins or herbaceous seeps/bogs; disturbed areas	SOC
Piedmont Water Milfoil (*Myriophyllum laxum*)	Occurs in shallow water of natural ponds, especially sinkhole ponds, also in lakes, impoundments, beaver ponds, blackwater streams, backwaters, sloughs, drainage ditches, and canals	SOC
Pigeon Wings (*Clitoria fragrans*)	Scrub and habitats intermediate between scrub and sandhills (turkeyoak barrens)	T
Pineland Hoary-pea (*Tephrosia mohrii*)	Pinelands	SOC
Pine Barrens Boneset (*Eupatorium resinosum*)	Sphagnous bogs in pinelands and shrub bogs	SOC

(Sheet 4 of 8)

Table D1 (Continued)

Common/Scientific Name	Habitat/Community	Status
	Forbs (continued)	
Porter's Spurge (*Chamaescyce porteriana* var. *scoparia*)	Pine flatwoods	SOC
Purple Balduina (*Balduina atropurpurea*)	Pitcher-plant bogs, wet pine flatwoods, and wet savannas with seasonal standing water	SOC
Quillwort Yellow-eyed Grass (*Xyris isoetifolia*)	Moist sands or sandy peat of savanna bogs, flatwoods pond margins, and lakeshores	SOC
Resinous Boneset (*Eupatorium resinosum*)	Shrub bogs, pocosins, sphagnous bogs in pinelands	SOC
Rough-leaved Loosestrife (*Lysimachia asperulaefolia*)	Ecotones between longleaf pine uplands (flatwoods and sandhills) and pocosins or herbaceous seeps/bogs in moist, sandy, or peaty soils with low vegetation that allows for abundant sunlight in the herb layer; also occurs in disturbed areas	E
Sandhills Milk-vetch (*Astragalus michauxii*)	Sandhills; does not appear to colonize disturbed sites has low tolerance for disturbance in existing sites	SOC
Savanna Aster (*Aster chapmanii*)	Dome swamp, bogs, pine savannas and flatwoods, borders of cypress-gum depressions.	SOC
Seabeach Amaranth (*Amaranthus pumilus*)	Overwash flats and accreting ends of islands and lower foredunes and upper strands of noneroding beaches; occasionally establishes temporary populations in other habitats, such as sound-side beaches, blowouts in foredunes, and sand and shell material placed as beach replenishment on dredge spoil; does not occur on well-vegetated sites; occurs on the upper beach community at Camp Lejeune	T
Smooth Bog-asphodel (*Tofieldia glabra*)	Occurs on moist ecotones between streamhead pocosins or herbaceous seeps/bogs and sandhills; occurs within savannas and wet flatwoods, especially where they border wetlands; can be found in open, disturbed habitats (e.g., roadside ditches, powerline rights of way)	SOC
Smooth Coneflower (*Echinacea laevigata*)	A roadside occurrence adjacent to pine flatwoods; usually associated with basic or circumneutral soils	E
Southern Bog Buttons (*Lachnocaulon beyrichianum*)	Sandy shores and springy places	SOC

(Sheet 5 of 8)

Table D1 (Continued)

Common/Scientific Name	Habitat/Community	Status
	Forbs (continued)	
Southern Lady's Slipper (*Cypripedium kentuckiense*)	Riparian forest	SOC
Southern Milkweed (*Asclepias viridula*)	Moist, acidic pineland savanna; substrate is fine sand that stays moist or wet throughout most of the year	C
Sring-flowering Goldenrod (*Solidago verna*)	Wet flatwoods, ecotones between flatwoods or sandhills and adjacent wetlands; numerous occurrences in disturbed areas	SOC
Swamp Pink (*Helonias bullata*)	Swampy, forested wetlands bordering meandering streams, headwater wetlands, sphagnous, hummocks, dense, Atlantic white cedar swamps, blue ridge swamps, meadows, bogs, and spring seepage areas; habitats are perennially saturated and rarely, if ever, inundated; the water table is at or near the surface and fluctuates only slightly; soils are neutral to acidic; canopy cover varies	T
Texas Trillium (*Trillium texanum*)	Acid hardwood bottoms, a shade plant, in association with bottomland hardwood trees.	SOC
Tiny Bog Buttons (*L. digynum*)	Seasonally or semipermanently saturated substrates (usually with little or no shrub or tree cover), herbaceous bogs and seeps, and wet flatwoods	SOC
Toothed Savory (*Calamintha dentata*)	Sandhills	SOC
Variable-leaf Crownbeard (*Verbesina chapmanii*)	Seasonally wet pine flatwoods; confined to somewhat drier sites or flatwoods	SOC
Venus' Flytrap (*Dionaea muscipula)*	Wet/mesic flatwoods, ecotones between flatwoods or sandhills and adjacent pocosins or herbaceous seeps/bogs, disturbed areas	SOC
Well's Pyxie-moss (*Pyxidanthera barbulata* var. *brevifolia*)	Xeric, thinly wooded sterile sands	SOC
West's Flax (*Linum westii*)	Boggy depressions in pine flatwoods, margins of cypress ponds and depressions, St John's-wort bogs (*Hypericum* spp.), adjacent ditches	SOC
West Florida Cowlily (*Nuphar luteum ulvaceum*)	Fresh waters of rivers and streams, mostly "black" waters	SOC

(Sheet 6 of 8)

Table D1 (Continued)

Common/Scientific Name	Habitat/Community	Status
	Forbs (continued)	
White Fringeless Orchid (*Platanthera integrilabia*)	Boggy deciduous forested ravine woods and streambanks	SOC
White-topped Pitcher Plant (*Sarracenia leucophylla*)	Bogs, wet flatwoods, boggy borders of branch bays and cypress depressions, boggy areas by small streams. Areas that are wet almost year-round	SOC
Wireweed (*Polygonella basiramia*)	Restricted to sand pine-evergreen oak scrub, a species of early scrub vegetation development; grows in areas of bare sand within sand pine and Florida rosemary; ubiquitous in firebreaks, trails and other disturbed areas	E
Yellow Coneflower (*Rudbeckia nitida* var. *nitida*)	This species occurs in moist to acidic clearings in pinelands, either flatwoods or swales in sandhills	SOC
	Grasses, Rushes, & Sedges	
Carolina Goldenrod (*Solidago pulchra*)	Streamhead pocosin, pond pine woodland, moist sandy peat of flatwoods savanna and pocosin borders.	SOC
Chapman's Sedge (*Carex chapmanii*)	Occurs frequently in well-drained hammock wetlands or cleared areas of these, always on sands or sandy loams; typical surrounding forests are beech-magnolia-southern hard maple or red maple, with some oak and pine; at Camp Lejeune, it occurs in calcareous coastal fringe forests.	SOC
Curtis' Sand Grass (*Calamovilfa curtissii*)	Most often found in ecotones between flatwoods and wetter areas that have wiregrass (*A. beytrichiana*) as the most common species; occurs as a band around ponds, in the zone between titi (*Cyrilla racemiflora*) and saw palmetto (*Serenoa serrulata*); in ponds surrounded by sandhills or scrub, it may fill the entire depression; dome swamps, moist sands or sandy peats of slash and long-leaf pine-saw palmetto flatwoods and flatwoods savannas	SOC
Florida Toothache Grass (*Ctenium floridanum*)	Seasonally wet pine savannas, flatwoods, bogs	SOC
Hirst's Panic Grass (*Panicum hirstii*)	At Camp Lejeune, NC, habitats are cypress savannas and depression meadows	SOC
Naked Stemmed Panic Grass (*Paniacum nudicaule*)	Seep bogs, wet savanna; acid organic sands, peaty or silty muck of open stream or river bottoms	SOC
New Jersey Rush (*Uncus caesariensis*)	Open, usually sphagnous, groundwater-saturated habitats	SOC

(Sheet 7 of 8)

Table D1 (Continued)

Common/Scientific Name	Habitat/Community	Status
	Grasses, Rushes, & Sedges (continued)	
Pale Beakrush (*Rhynchospora pallida*)	Small depression pocosin	SOC
Piedmont Jointgrass (*Coelorachis tuberculosa*)	Occurs in a depression marsh at Eglin AFB, FL	SOC
Pine Barrens Dropseed (*Sporobolus* sp. 1)	Wet flatwoods, savannas, small depression pocosins, and pond margins	SOC
Rhynchospora (*Rhynchospora decurrens*)	Swamp forests	SOC
Scrub Bluestem (*Schizachyrium niveum*)	Found only in white sand scrubs, a rarer scrub endemic	SOC
Southern Three-awned Grass (*Aristida simpliciflora*)	Moist pine woods	SOC
Umbrella Sedge (*Cyperus grayoides*)	Full sun sites in sandhills	SOC
	Nonvascular	
Florida Perforate Cladonia (*Cladonia perforata*)	Inhabits sunny, bare sand in scrub vegetation, often near rosemary bushes; at Eglin AFB, occurs in rosemary scrub and at the edge of slash pond forest	E

(Sheet 8 of 8)

Appendix E
TES Animal Species and Their Habitat Requirements

Table E1
ES Animal Species and Their Habitat Requirements (Summarized primarily from faunal species profiles and plant community reports)

Common/Scientific Name	Habitat Requirements	Status[1]
	Mammals	
Gray Bat (*Myotis grisescens*)	Winter: Deep vertical caves with multiple entrances, good air flow, and cold enough for hibernation with temperatures ranging from 6 to 9 °C Summer: In caves where temperature ranges from 14 to 25 °C with maternity roosts the warmest; typical maternity caves contain structural heat traps, such as small chambers, domes, depth of etching, and porosity of rock surface; bats prefer caves within 1 km of a major river or lake; may also roost at artificial sites such as storm sewers and abandoned barns Foraging: Riparian ecosystems within manageable distance of roosting sites and maternity colonies	E
Indiana Bat (*Myotis sodalis*)	Winter: Cool limestone caves and abandoned mineshafts associated with alluvial forests and major river systems; only stable, undisturbed sites are selected Summer: Closed canopy, alluvial forests, and other riparian ecosystems; essential habitat has foraging areas consisting of deciduous forest cover ≥30 percent, suitable roost trees located within 0.4 km of the foraging area, and permanent water available within a 0.5-km radius of the roost; maternity roosts include hollow trees and sites under the loose bark of dead or dying tree species, which vary regionally Foraging: Primarily in closed-canopy alluvial forests, other riparian ecosystems and upland forests	E
Southeastern Myotis (*Myotis austroriparius*)	Winter: Hibernates in cave and noncave sites where temperatures range from 4.4 to 10 °C, but may remain active throughout winter if temperatures are too warm for hibernation Summer: Cave and noncave sites associated with standing water; some maternity caves with permanent bodies of water; maternity colonies reported in chimneys, concrete culverts, buildings, and hollow trees Foraging: Primarily riparian ecosystems near upland forests, forested wetlands, and upland vegetation	SOC
Rafinesque's Big-Eared Bat (*Corynorhinus rafinesquii*)	Winter: In northern range, hibernacula include caves, mines, and artificial habitats such as cisterns and wells; occasionally uses limestone caves Summer: Associated with mature southern forests near permanent water; roost in man-made structures and hollow trees in the Coastal Plain; maternity colonies also occur in abandoned buildings, especially those with partially lighted rooms, and under bridges; males roost solitarily in buildings, hollow trees, and crevices behind loose bark Foraging: Primarily forested floodplains and swamps; preferred feeding sites are mature forests along permanent bodies of water, especially rivers	SOC

(Sheet 1 of 7)

[1] E = Federally endangered; T = Federally threatened; C = Federal candidate for listing; SOC = Species of special concern.

Table E1 (Continued)		
Common/Scientific Name	**Habitat Requirements**	**Status**
	Mammals (continued)	
Florida Black Bear (*Ursus americanus floridanus*)	General: Prefers forested areas with dense understory vegetation, thick swamps, sandhill pine forests, and virgin hardwood hammocks; require access to a variety of habitats that provide an assortment of foods	SOC
Louisiana Black Bear (*Ursus americanus luteolus*)	General: Primarily bottomland hardwood and floodplain forests; upland hardwood, mixed pine/hardwood, and coastal flatwood and marsh habitats also documented Winter: Dens include road culverts, hollow logs, brush piles, or tree cavities (tree cavities are in large, old trees and may have openings from near ground level to as high as 27 m or more)	T
Red Wolf (*Canis rufus*)	General: Any habitat area in the southeastern United States of sufficient size, which provides adequate food, water, and the basic cover requirement of heavy vegetation; range requirements vary from 40 to 80 sq km; most common in moist areas with dense plant growth, including swamps, marshes pine forests, and bottomland hardwood forests. Winter: Dens are built in hollow logs, culverts, and other hidden areas	E
Sherman's Fox Squirrel (*Sciurus niger shermanii*)	General: Hardwood and pine woodlands with den and mast-producing trees.	SOC
	Birds	
Bald Eagle (*Haliaeetus leucocephalus*)	Winter: Primarily associated with riparian and open water areas that provide ample food supply and adequate nocturnal roosting sites. Diurnal perches (e.g., trees, logs, driftwood, ice, powerline poles, fenceposts, and pilings) are important winter habitat components Breeding/Nesting: Riparian ecosystems in open canopied, mature, old growth. Nests are constructed in dominant or codominant pines or cypress, and located in open discontinuous forest stands, along ecotones, or in open fields and pastures, and are rarely farther than 1.5 km from open water Foraging: In proximity to water and nest site	T
Peregrine Falcon (*Falco peregrinus anatum*)	Winter: Generally winters within breeding range, but northern populations may migrate Breeding/Nesting: Primarily found in coastal regions, mountains, plains, tundras, and forested areas; diverse breeding habitat on high, steep cliffs with protected ledges and open undisturbed areas for hunting Foraging: Includes grasslands, meadows, and open areas. Densest populations occur in areas where lakes and streams provide a flight corridor to and from nesting and hunting sites	T
		(Sheet 2 of 7)

Table E1 (Continued)		
Common/Scientific Name	**Habitat Requirements**	**Status**
	Birds (continued)	
Southeastern American Kestrel (*Falco sparverius paulus*)	Winter: Nonmigratory Breeding/Nesting: Prefers open longleaf pine-turkey oak sandhill communities, agricultural/mixed hardwood communities, pine flatwoods, old-growth slash pine, grasslands, pastures, open sites within suburban and sparse residential areas (e.g., golf courses, parks), edges of river bottoms, and along coastal regions Foraging: Most frequently in areas having short grass or sparse ground cover and high perch sites, including pastures, roadside berms, mown hayfields, open orchards, lawns, and parkland areas	SOC
Wood Stork (*Mycteria americana*)	Winter: Same as breeding range; more northern colonies may migrate to South Florida Breeding/Nesting: Consists of medium to large trees located in wetlands over standing water or islands surrounded by open water. Nesting occurs at natural palustrine freshwater and estuarine sites and in artificial wetlands such as impoundments and dredged material islands. Nests are typically located in the upper branches of large trees in freshwater habitats Foraging: Typically in wetland habitats characteristic of the ecoregions in which nesting colonies are located	E
Piping Plover (*Charadrius melodus*)	Winter: Primarily coastal, preferring areas with expansive sand or mudflats for feeding in close proximity to a sandy beach which is used for roosting Breeding/Nesting: Nests are shallow depressions usually lined with small pebbles or shell fragments along the sandy beaches of the Atlantic Coast, the gravelly shorelines of the Great Lakes, and on riverine sandbars and alkali wetlands throughout the Great Plains region. Prefers to nest in sparsely vegetated areas that are slightly raised in elevation. Breeding territories generally include a feeding area Foraging: Dune pond or slough	E
Southeastern Snowy Plover (*Chardrius alexandrinus tenuirostris*)	General: Primarily beaches and dry mud or salt flats along seacoast beaches or alkaline interior lakes Winter: From Bahamas south to Venezuela Breeding/Nesting: Usually lays two or three eggs in the sand within a small depression lined with broken shells and other bits of debris from early April to as late as July Foraging: Edges of the water or on sand flats of tidal creeks	SOC
Loggerhead Shrike (*Lanius ludovicianus migrans*)	General: Inhabit open country (e.g., pastures with fencerows, old orchards, mowed roadsides, cemeteries, golf courses, agricultural fields, riparian areas, and open woodlands) near grassy habitats with isolated trees or large shrubs. Longleaf pine savannas and open, mature stands of loblolly pine-shortleaf pine also provide suitable habitat for the shrike in the Southeast Winter: Migrate southward Breeding/Nesting: Mainly include shrubs and low trees, and settle near isolated trees or large shrubs. Short grassy habitat is also important	SOC
		(Sheet 3 of 7)

Table E1 (Continued)		
Common/Scientific Name	**Habitat Requirements**	**Status**
	Birds (continued)	
Appalachian Bewick's Wren (*Thryomanes bewickii altus*)	General: Dense undergrowth, overgrown fields, thickets, and brush in open or semiopen habitat	SOC
Cerulean Warbler (*Dendroica cerulea*)	Winter: Neotropical migrant; migrates within a narrow elevation zone (500 to 2,000 m) in the humid, evergreen forests of the eastern slope of the Andean foothills Breeding/Nesting: Prefer large and contiguous forested tracts; tree diameter at breast height (DBH) appears to be an important criterion. Territories are most often located in timber stands where a majority of trees are in the larger diameter of classes. Prefer to nest in oaks (*Quercus* spp.), elms (*Ulmus* spp.), and American sycamore (*Platanus occidentalis*)	SOC
Henslow's Sparrow (*Ammodramus henslowii*)	Winter: Coastal plain in longleaf pine forests, where open-canopy pine flatwoods, stretches of pine savanna and prairies, and mixed pine-hardwoods provide suitable wintering habitats. Breeding/Nesting: Breeding habitat in the Northeast consists of open fields and meadows with tall, dense, grassy vegetation; also wet meadows, pine seedling sites, and upland portions of salt marshes, small swales, and timothy (*Phleum* spp.) and clover (*Trifolium* spp.) fields. In the Midwest and Great Plains this species nests in native and restored tallgrass prairie but uses other habitats, such as idle grasslands, pastures and meadows with scattered scrubs, hayfileds with dense cover, and hillside grasslands dominated by broom sedge (*Andropogon virginicus*). Characteristics of typical breeding habitats are plants between 10 and 50 cm in height, deep litter and abundant standing dead vegetation, and the absence of woody vegetation Foraging: Ground foragers in grass that is 10 to 15 cm (4 to 6 in.) tall	SOC
	Reptiles	
American Alligator (*Alligator mississippiensis*)	General: Preferred habitats include shallow lakes, ponds, swamps, bayous, marshes, and rivers; typically found in fresh water but can tolerate brackish water; may also be found in major river drainage basins, drainage canals, ditches, and phosphate-mine settling ponds Winter/Hibernation: Digs deep hole as den Breeding/Nesting: Mature alligators seek open water areas during courtship and breeding season (April to May). Females move into marsh areas to nest from June to July and build a mound-shaped nest of mud, leaves, and rotting organic material	T
		(Sheet 4 of 7)

Table E1 (Continued)		
Common/Scientific Name	**Habitat Requirements**	**Status**
	Reptiles (continued)	
Pine Snake (*Pituophis melanoleucus*)	General: Typically found in areas of sandy soil (facilitates burrowing) dominated by scrub pines and shrubs, flat sandy pine barrens, sandhills, and dry mountain ridges. More midwestern subspecies (*P. m. sayi*) inhabit grasslands with clumps of vegetation and sandy soil. The northern pine snake (*P. m. melanoleucus*) is restricted to the open Pine Barrens of the southern portion of New Jersey. The Florida pine snake (*P. m. mugitus*) is found in xeric sites, occurring primarily in longleaf pine-turkey oak woodlands. Louisiana pine snakes (*P. m. ruthveni*) are restricted to longleaf pine forests and second growth longleaf pine-blackjack oak associations Winter/Hibernation: Hibernacula have been reported in mammal burrows where pine snakes have been occasionally found with the black racer (*Coluber constrictor*). Louisiana pine snakes hibernate almost exclusively in Baird's pocket gopher (*Geomys breviceps*) burrows; black pine snakes (*P. m. lodingi*) use burned or decayed stump holes and root channels Breeding/Nesting: Nest sites include burrows excavated by the female in loose soil, beneath large rocks or logs, or in small mammal burrows	SOC/C[2]
Southern Hognose Snake (*Heterodon simus*)	General: Typically prevails in xeric, upland habitats favoring pine and wiregrass flatwoods, or longleaf pine-turkey oak sandhill habitats. Good quality habitat appears to be pine-dominated or pine-oak woodland having a low, open understory established on sandy soils Winter/Hibernation: Hibernation may occur beneath rocks, stumps, or brush piles, burrows in "hard red clay soil," and beneath sheets of tin on open soil Breeding/Nesting: Appears to require forest openings, with level, well-drained sandy soils and little shrub cover. Nests have been reported at 15 cm below the surface in a gravel deposit, under a rock, and at depths of 10 to 15 cm in sandy fields	SOC
Eastern Indigo Snake (*Drymarchon corais couperi*)	General: Found in a variety of habitats including xeric uplands, pine flatwoods, wet prairies, and mangrove swamps (appears to vary according to latitude). In more northern portions of its range, the indigo snake is typically found in xeric, sandhill habitats Winter/Hibernation: Observed almost exclusively in or near gopher tortoise burrows on sandhills, but also use land crab and armadillo (*Dasypus novemcinctus*) burrows, stump holes, root channels and rodent burrows at the base of large live oaks (*Q. Virginiana*), and limestone solution holes Breeding/Nesting: Nest sites have not been described, although eggs may be laid in inactive gopher tortoise burrows	T
Gulf Salt Marsh Snake (*Nerodia clarki*)	General: Inhabits permanent lakes, ponds, cypress and mangrove swamps, marshes, and sluggish streams; fresh and salt water	SOC
		(Sheet 5 of 7)

[2] Candidate species include the black pine snake (*P. m. lodingi*) and the Louisiana pine snake (*P. m. ruthveni*) subspecies.

Table E1 (Continued)

Common/Scientific Name	Habitat Requirements	Status
Reptiles (continued)		
Northern Diamondback Terrapin (*Malaclemys terrapin terrapin*)	General: Found exclusively in brackish coastal marshes, dwelling in salt-marsh estuaries, tidal flats, and lagoons behind barrier beaches Winter/Hibernation: Occurs within and below the intertidal zone of the salt marsh from November through March Breeding/Nesting: Nests are 12.5- to 15-cm cavities dug at sandy edges of marshes and dunes above the high-tide line	SOC
Gopher Tortoise (*Gopherus polyphemus*)	General: Typically found on well-drained, deep, sandy soils in contiguous areas consisting primarily of longleaf pine, xerophytic oak, woodlands (sandhills) but also of xeric hammock, sandpine and oak scrub, pine flatwoods, coastal grasslands, dry prairie, and a variety of ruderal and successional habitat types. Adequate herbaceous foods and sunny nesting sites must be present. Usually abandons densely canopied areas and may be found in disturbed habitats (roadsides, fence-rows, old fields, and edges of overgrown uplands) Winter/Hibernation: Self-constructed deep burrows approximately 5 m in length which also provide refuge from predators Breeding/Nesting: In southern Georgia, nests were placed in the spoil mound or burrow apron immediately outside the female's burrow; in northern Florida, nests were located in any open sunny area near the female's burrow; nests are not always associated with a burrow	T
Alabama red-bellied Turtle (*Pseudemys alabamensis*)	General: Principal habitat includes the backwater areas of the floodplain of the Mobile River System which is 1 to 2 m in depth with dense beds of aquatic vegetation located between Interstate Highway 10 and U.S. Highway 90 Breeding/Nesting: An 8-ha spoil bank located on one end of an island of a wooded swamp is the only known nesting site	E
Alligator Snapping Turtle (*Macroclemys temmincki*)	General: Most frequently occurs in the deep water of rivers, canals, lakes, oxbows, and sloughs but is also found in swamps and marshes near running water and occasionally in brackish water of the Coastal Plain. The preferred living and foraging habitat is stream bottoms with mud substrate and abundant aquatic vegetation Winter/Hibernation: Hibernacula may include undercut riverbanks and deep holes in bayous and lakes Breeding/Nesting: Usually located near water on high and well-drained sites, such as natural or artificial berms bordering aquatic environments. Nest substrate is either sand or sand mixed with silt and organic alluvium	SOC
Yellow-blotched Map Turtle (*Graptemys flavimaculata*)	General: Typically riverine with a moderate current, large sandbars for nesting, and numerous basking logs; the river must be wide enough to allow sun penetration for several hours Breeding/Nesting: Consists of sand and gravel bars adjacent to a river	T
Barbour's Map Turtle (*Graptemys barbouri*)	General: Streams and rivers with numerous stumps and logjams and an abundance of mollusks Breeding/Nesting: Nests in cavities 3 to 6 in. deep near water's edge on sandbars	SOC

(Sheet 6 of 7)

Table E1 (Concluded)

Common/Scientific Name	Habitat Requirements	Status
	Amphibians	
Gopher frog[3] (*Rana capito* spp.)	General: Primarily longleaf pine-turkey oak sandhill; high-quality habitats include several wetlands within xeric, upland pine-dominated communities. Postlarval gopher frogs are terrestrial and inhabit cool, moist tunnels of burrowing animals such as the gopher tortoise. May also use rodent burrows, crayfish burrows, and stumpholes Winter/Hibernation: Migrate between seasonal habitats, which is correlated with rainfall and rising air temperatures Breeding/Nesting: Circular or near-circular, ephemeral to semipermanent graminoid-dominated wetlands that lack predatory fish and range in size from 0.12 to 33.5 ha. Have also been observed breeding in ditches and borrow pits	SOC
Flatwoods Salamander (*Ambystoma cingulatum*)	General: Occupy fire-maintained, open-canopied longleaf pine and slash pine savannas and flatwoods of the southeastern Coastal Plain. High-quality occurences include several wetlands within a matrix of pine flatwoods and savanna Breeding/Nesting: Sites include pine flatwoods depressions, including cypress- or blackgum-dominated swamps, roadside ditches, and borrow pits Larval: Occurs in acidic (pH 3.6 to 5.6), tannin-stained ephemeral wetlands (swamps or graminoid-dominated depressions) that range in size from 0.02 to 9.5 ha. Postlarval flatwoods salamanders inhabit mesic longleaf pine-wiregrass flatwoods and savannas	T
Hellbender (*Cryptobranchus alleganiensis*)	General: Clear fast-flowing streams and rivers with rocky bottoms Breeding/Nesting: Males prepare saucer-shaped nest cavities beneath large, flat rocks or submerged logs	SOC
		(Sheet 7 of 7)

[3] The Mississippi gopher frog, a distinct population segment of the dusky gopher frog (*R. c. servosa*), was proposed endangered on May 23, 2000.

Appendix F
Products from Regional Guidelines Study

Products from SERDP Research: "Regional Guidelines for Managing Threatened and Endangered Species Habitats"

TECHNICAL REPORTS

Overview Documents

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Jordan, R. A. (1998). "Species profile: **Pine Snake** (*Pituophis melanoleucus* spp.*)* on military installations in the southeastern United States," Technical Report SERDP-98-5, U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

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14. ABSTRACT

The conservation and management of threatened and endangered species (TES) and their habitats are major issues on Department of Defense (DOD) installations throughout the United States. The development of TES management plans and implementation of management practices have traditionally been conducted on a species-by-species basis. However, within DOD there has been a recent shift toward ecosystem-based management, and emphasis is being placed on managing lands for multiple species rather than single species of interest. This study represents an attempt to develop a regionalized, community-based approach to TES management that is compatible with the military mission and ecosystem-based management guidelines. The southeastern United States was selected for development of a prototype plan because the region contains a large number of installations, many of which manage their resources for a variety of sensitive species.

This report represents a synthesis of information provided in detail in Plant Community Management Plans, Faunal Species Profiles, and other documents prepared for the study. These documents should be used collectively to identify and understand the characteristics, quality indicators, functions, land uses, and potential impacts associated with communities that support a diversity of TES in the Southeast. Topics summarized in this report, include characterization of selected plant communities, discussion of TES components, and management

(Continued)

15. SUBJECT TERMS

Community-based management	Plant communities	Threatened and Endangered Species
DOD military installations	Sensitive species	
Ecosystem management	Southern United States	

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considerations (e.g., forestry practices, fire management, land-use conversion, hydrology management, erosion and sedimentation control, wildlife management, and control of nuisance species). It is hoped that this information will provide the basis for preparation of installation TES community management plans in the Southeast, and that it will serve as a template for TES management programs in other regions.