Mesic Pine Flatwoods

FNAI Global Rank:	**Undetermined**
FNAI State Rank:	**S4**
Federally Listed Species in S. FL:	**9**
State Listed Species in S. FL:	**40**

Mesic pine flatwoods. *Original photograph by Deborah Jansen.*

The mesic pine flatwoods of South Florida are of critical, regional importance to the biota of South Florida. They provide essential forested habitat for a variety of wildlife species including: wide-ranging, large carnivores such as the Florida panther *(Puma (=Felis) concolor coryi*) and the Florida black bear (*Ursus americanus floridanus*); mid-sized carnivores; fox squirrels (*Sciurus niger* spp.); and deer (*Odocoileus virginianus).* They provide tree canopy for canopy-dependent species including neotropical migrants, tree-cavity dependent species, and tree-nesting species. Mesic pine flatwoods are also important as the principal dry ground in South Florida, furnishing refuge and cover for ground-nesting vertebrates as well as habitat for non-aquatic plant life (such as upland perennials and annuals). During the summer wet season, the mesic pine flatwoods of South Florida function as the upland ark for non-aquatic animals. Mesic flatwoods serve as ground bird nesting areas; adult tree frog climbing areas; black bear foraging, denning, and travelways; and essential red-cockaded woodpecker (*Picoides borealis*) foraging and nesting habitat. At the current rate of habitat conversion, the mesic pine flatwoods, once the most abundant upland habitat in South Florida, is in danger of becoming one of the rarest habitats in South Florida. The impact of this loss on wide-ranging species, listed species, and biodiversity in South Florida could be irreparable.

Synonymy

The mesic pine flatwoods association of southwest Florida has been variously recognized and alluded to in the plant community literature. Pine flatwoods were first identified as “pine barrens” by Bartram (1791) in his narrative of Florida travels. The term “flatwoods” was coined by English speaking settlers to describe the absence of topographic relief (Ober 1954). The term “pine flatwoods” was first used in the scientific literature by Laessle (1942).

Following Davis' (1967) mapping of South Florida vegetation communities, the term became standard for South Florida pine forests.

Long (1974) was the first to recognize mesic pine flatwoods as a separate vegetation type, "dry pineland," and considered it a successional stage between wet flatwoods and hardwood hammock. Klein *et al.* (1970) and Wharton (1977) separately map mesic pine flatwoods in their hydrogeologic cross-sections of the plant communities of the Big Cypress and South Florida successional stages. Duever *et al.* (1979) formally used the term "mesic pine flatwoods" and distinguished mesic pine flatwoods from hydric pine flatwoods by differences in understory, with the mesic flatwoods having a saw palmetto (*Serenoa repens*) understory. Based upon a conceptual successional model, Duever *et al.* (1976) indicate that upland pinelands occur in a hydroperiod of from 0 to 40 days and a fire frequency of 3-to 10-year intervals. Subsequent descriptions by Duever *et al.* (1986) describe flatwoods on the basis of hydrology and understory components, recognizing mesic flatwoods.

The Florida Natural Areas Inventory (FNAI) (1989) recognizes mesic flatwoods as flatland with sand substrate, mesic, subtropical or temperate; with frequent fire, and vegetation characterized by slash pine (*Pinus elliottii*) and/or longleaf pine (*Pinus palustris*) with saw palmetto, gallberry (*Ilex glabra*) and/or wiregrass (*Aristida beyrichiana*)or cutthroat grass (*panicum abscissum*) understory. FNAI lists the following synonyms for mesic pine flatwoods: mesic flatwoods, pine savanna, cabbage palm savanna, and pine barrens. The Florida Land Use Classification and Cover System (FLUCCS) (DOT 1985) does not have a specific categorization for mesic pine flatwoods. As defined by FNAI (1989), mesic pine flatwoods could be mapped as any of the following FLUCCS codes: 411 pine flatwoods, 415 longleaf-upland oak, 419 other pine, or 428 cabbage palm. The U. S. Soil Conservation Service (1986) combines mesic pine flatwoods with hydric and xeric pine flatwoods in a "South Florida flatwoods" category. Abrahamson and Hartnett (1990) define the mesic flatwoods as occasionally inundated flatlands with sand substrates, canopies of slash pine, longleaf pine, and/or cabbage palm (*Sabal palmetto*), and understories of mixed shrubs, grasses and forbs, which vary in accordance with fire frequency, and are a gradation between hydric and xeric flatwoods.

All Florida State and Federal regulatory agencies recognize mesic pine flatwoods as uplands for wetland regulatory purposes.

Distribution

Mesic pine flatwoods were historically found in all the counties of South Florida. The largest remaining areas are in south and eastern Sarasota County, Charlotte County, north and southeastern Lee County, on Pine Island in Lee County, western and northeastern Collier County, central Hendry County, western Glades County, southwest and northeast Highlands County, the Green Swamp and southeastern Polk County, the Horse Creek basin of DeSoto and Hardee counties, northwest and east Osceola County, within the Everglades NP in Miami-Dade County, North Palm Beach County, and in three ridges paralleling the coast in western, mid-and eastern St. Lucie, Indian River and Martin counties, respectively (Figure 1). There may be no natural mesic pine

flatwoods remaining outside of public ownership in Broward and Miami-Dade counties. Small areas of mesic flatwoods are located in Monroe and Okeechobee counties. Figure 1 illustrates the distribution of all pine flatwoods in the South Florida Ecosystem, as of 1989 (Cox *et al.* 1997).

The South Florida slash pine is the dominant tree of the South Florida mesic pine flatwoods canopy, south of Interstate 4. The longleaf pine and South Florida slash pine are in mixed dominance north of Interstate 4 in Polk and Osceola counties, and in some areas of Highlands County at higher elevations. The longleaf pine is found in clusters as far south as Charlotte County on the west coast.

Major public holdings of mesic pine flatwoods occur throughout South Florida, in Everglades NP (Miami-Dade and Monroe counties); Big Cypress National Preserve (Collier County); the Florida Panther NWR (Collier County); Corkscrew Swamp Sanctuary (Collier County); Charlotte Harbor State Buffer Preserve (Charlotte County); Charlotte Harbor Flatwoods (Charlotte County); Babcock-Webb WMA (Charlotte County); CREW (Lee, Collier counties); The Savannas (Martin, St. Lucie counties)**;** Picayune Strand (South Golden Gate Estates in Collier County); Myakka State Forest, Myakka River State Park and Myakka Prairie (Sarasota County); Oscar Shearer SRA (Sarasota County); Pinelands Preserve (Sarasota County); Platt Branch Mitigation Park (Highlands County); Hickey Creek Mitigation Park (Lee County); Caloosahatchee River SRA (Lee County); Koreshan State Park (Lee County); Jonathan Dickinson State Park (Martin and Palm Beach counties); DuPuis Reserve (Martin and Palm Beach counties); J.W. Corbett WMA (Palm Beach County); Loxahatchee Slough Natural Area; and Sebastian Creek Buffer Preserve (Brevard and Indian River counties).

Description

Structure

Mesic pine flatwoods (*sensu* Stout and Marion 1993) typically exhibit an emergent tree layer of pines with limbless lower trunks and ground layers of low vegetation. However, physiognomy varies markedly with fire regime and moisture. Pine densities in mesic pine flatwoods can range from sparse to dense depending on fire history, seed predation, and seedling predation. Canopy coverage of mature mesic pine flatwoods can range from 10 to 80 percent in unlogged stands. Pine trees are usually abundant enough to dominate the apparent landscape view and canopy, but canopy densities can vary, dependent upon the degree of fire exclusion (Wade *et al.* 1980).

Vegetative Composition

The mesic pine flatwoods habitat is dominated by a slash pine or longleaf pine overstory with an upland understory. Mesic pine flatwoods are distinct from hydric and xeric pine flatwoods in the tendency toward midstory dominance by saw palmetto and scrub species such as fetterbush (*Lyonia lucida*), tarflower (*Befaria racemosa*), rusty lyonia (*Lyonia ferruginea*), cabbage palm (*Sabal palmetto*), and wax myrtle (*Myrica cerifera*). Impacted mesic pine flatwoods

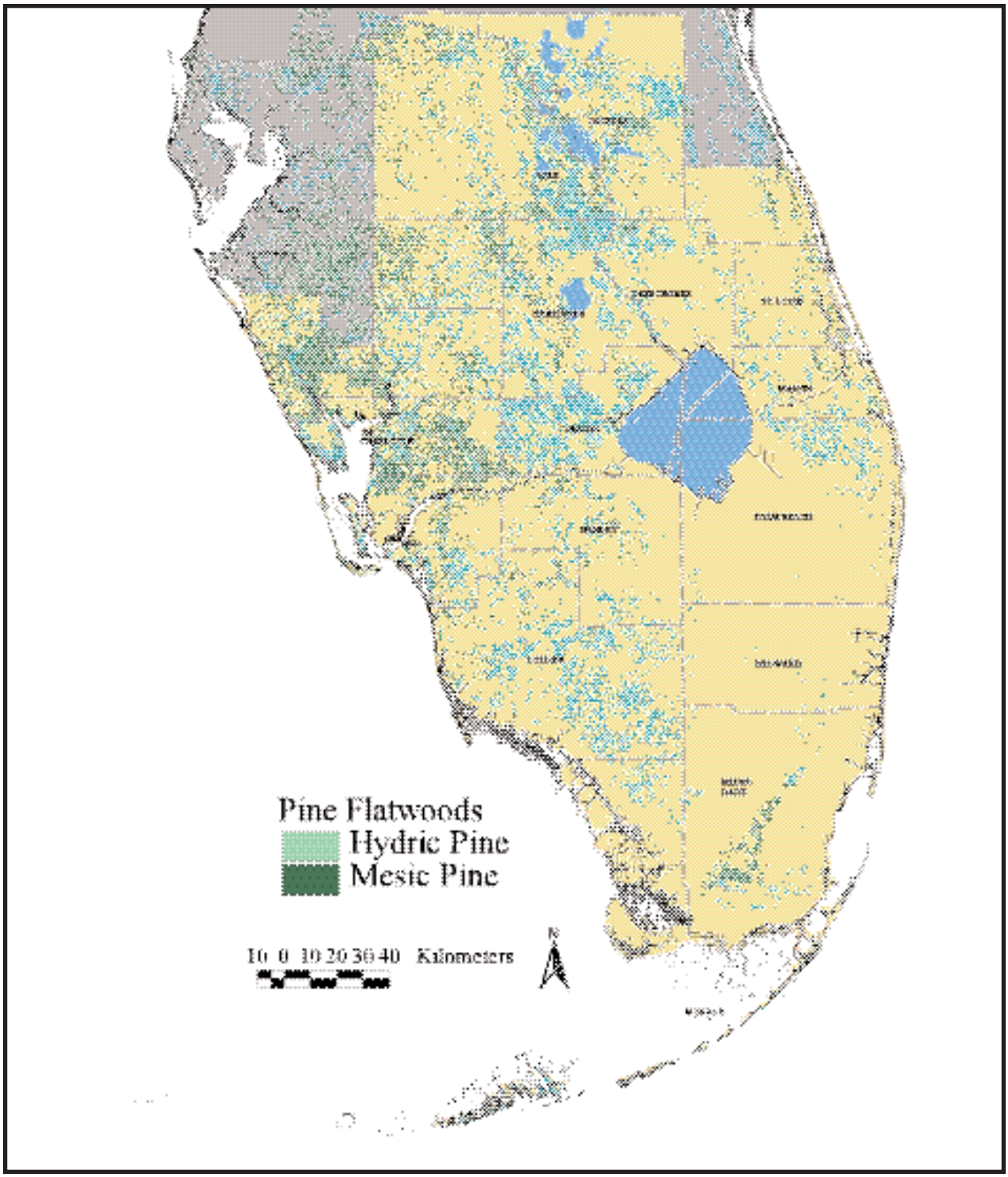

Figure 1. The distribution of hydric and mesic pine flatwoods in South Florida (data from USGS-BRD 1996).

are dominated by the exotic invaders: Brazilian pepper (*Schinus terebinthifolius*), Australian pine (*Casuarina equisetifolia*), downy rosemyrtle (*Rhodomyrtus tomentosus*), ear-leaf acacia (*Acacia auriculiformis*) and melaleuca (*Melaleuca quinquinervia*). Understory includes a wide variety of grasses (*Agrostis*, *Andropogon*, *Aristida*, *Dichanthelium*, *Eragrostis*, and *Panicum* spp., *etc*.), pawpaws (*Asimina* spp.), gopher apple (*Licania michauxii*), legumes (*Cassia*, *Crotalaria*, *Galactia*, *Rhynchosia*, *Tephrosia* spp., *etc*.), milkworts (*Polygala* spp.), blueberries (*Vaccinium* spp.), milkweeds (*Asclepias* spp.), and a wide variety of composites (*Aster, Chrysopsis, Emilia, Eupatorium, Liatris,* and *Solidago* spp., *etc*.).

The taxonomy of the South Florida slash pine has been a matter of significant debate (Small 1913, Little and Dorman 1954, Squillace 1966, Mirov 1967, McMinn and McNab 1971). *Pinus elliottii* var. *densa* is more flood- and drought-tolerant than is var. *elliottii*. Squillace (1966) concluded that the phenotypic plasticity that allows *densa* to accommodate both upland and wetland conditions, fire, and flood is the result of its evolution under the severe environmental factors of South Florida flood and drought that vary from year to year and fluctuate widely over longer time courses.

Mature South Florida slash pine can attain a height of 30 m (110 feet), with a dbh of 40 cm (16 inches) (Duever *et al.* 1976). In an average southwest Florida mesic pine flatwoods, mature trees typically attained 30 to 41 cm (12 to 16 inches) dbh with 23 to 26 m (75 to 85 feet) of height (Beever and Dryden 1998). Growing season is from February to November, with maximum growth rates attained at the spring and autumnal equinoxes (Langdon 1963). The growth rate of South Florida slash pine has been measured in the Corkscrew area of Collier County at an annual diameter at breast height (dbh) increase of 1.15 cm (0.45 inches) per year and an annual height increase of 60 cm (2 feet) per year. The forestry productivity of southwest Florida mesic pine flatwoods for wood products has been recorded at over 27 cords/acre (242 cubic meters/acre) at age 16 (Wade *et al.* 1980). Annual net understory productivity is 140 g/m^2 (1,250 lb/ac) with a litter fall averaging 130 g/m^2/yr (1,160 lb/ac). Decomposition is only 30 percent per year (Duever *et al.* 1976). This results in an annual net accumulation of litter of approximately 90 g/m^2 (800 lb/ac) when fire is excluded. This relatively rapid litter fuel buildup increases the probability of fire ignition and the chance for hot, crowning fires through time.

Longleaf pine and slash pine communities are extremely diverse floristically, and contain several rare and endemic plant taxa, making this one of the most important natural systems in the southeastern United States (Hardin and White 1989). Hardin and White (1989) listed 191 rare plant taxa as occurring in the wiregrass ecosystem; seven of these taxa have been proposed for listing or are currently listed as federally endangered, and 61 are listed as threatened or endangered in three states. The wiregrass ecosystem supports 33 locally endemic plant taxa, all from Florida.

South Florida slash pine and longleaf pine which are growing in normal mesic pine flatwoods conditions and are subjected to fire, typically display: (1) No buttressing of the lower trunk, (2) Fire-darkened or fire-scarred lower trunks, (3) A straight growth form, (4) Little woody debris and needle litter

build-up, and (5) A crowned growth form, with few branches, if any below the top third of the tree.

Long (1974) lists 303 species of plants in the mesic pine forest habitat of South Florida, the third highest plant species diversity of any habitat in South Florida. Presently, 482 plant species (115 monocotyledon, 353 dicotyledon, 3 gymnosperm, and 11 pteridophyte species) have been identified from or are documented as present in the mesic pine flatwoods of southwest Florida. (Beever and Dryden 1998). South Collier County and lower east coast mesic pine flatwoods have more tropical plant species represented in their understory and a different underlying geology, often composed of marl, and oolitic rockland extrusions (Wade *et al.* 1980), when compared to the mesic pine flatwoods of central and western South Florida.

Of the 482 plant species recorded in literature from mesic pine flatwoods of South Florida, 65 species (13 percent) are typically considered to occur in wetland saturated zones. Four hundred and seventeen species (87 percent) are typically considered upland plants. Twenty-five (5 percent) are exotic, introduced species. These 482 plant species comprise 29 percent of the documented terrestrial flora of South Florida (Wunderlin 1986).

Soils

The mesic pine flatwoods of South Florida are all located in the South Florida Basin of the Floridan Plateau (Vaughan 1910, Chen 1965). The soil types in mesic pine flatwoods generally fall into one of two major substrate sediment groups: limestone rock, and sands (marine terraces) (Duever *et al.* 1986, SFWMD 1980). The soils of the mesic pine flatwoods of South Florida are non-hydric soils as defined by the Florida Association of Professional Soil Classifiers (Carlisle 1990).

Sands are the dominant soil type of South Florida, and of the mesic pine flatwoods in particular. Typical mesic pine flatwoods occur on relatively flat, poorly drained terrain. The soils typically consist of 30 to 91 cm (1 to 3 feet) of acidic sands often over an organic hardpan or clay layer. Cabbage palm-dominated mesic flatwoods occur on more neutral sands (pH 6.0-7.5) underlain by marl or shell. This hardpan can substantially reduce the percolation of water below and above its surface (FNAI 1989).

On the east coast of Florida, when exposed limerock substrate is present, these pinelands are identified as Pine Rocklands.

Wildlife Diversity

The mesic pine flatwoods of South Florida are of critical, regional importance to the biota of South Florida. They provide essential forested habitat for a variety of wildlife species including: wide-ranging, large carnivores such as the Florida panther and the Florida black bear; mid-sized carnivores; fox squirrels; and deer. They provide tree canopy for canopy-dependent species including neotropical migrants, tree-cavity dependent species, and tree-nesting species. Mesic pine flatwoods are also important as the principle dry ground in South Florida, furnishing refuge and cover for ground-nesting vertebrates as well as habitat for non-aquatic plant life (such as upland perennials and annuals). During the summer

wet season, the mesic pine flatwoods of South Florida function as the upland ark for non-aquatic animals. Mesic flatwoods serve as ground bird nesting areas; adult tree frog climbing areas; black bear foraging, denning, and travelways; and essential red-cockaded woodpecker foraging and nesting habitat.

The variety and diversity of invertebrate species utilizing the mesic pine flatwoods as foraging, breeding, and nursery habitat has not been well studied. Species that cause economic damage to pine trees, particularly bark beetles, have been the principle focus of entomological literature in pine flatwoods. A total of 7 phyla, at least 12 classes, and at least 40 orders of invertebrates are observed or documented to occur in the mesic pine flatwoods of South Florida. Dominant taxa, in individual numbers and species diversity, include the arthropods, gastropods, nematodes, rotifers, and protozoans. The most conspicuous taxa are the insecta and arachnida. The most common terrestrial crustacean is the isopod pillbug (Beever and Dryden 1998). Representatives of 20 orders of insects are present in the mesic pine flatwoods of South Florida. The abundance and diversity of insect fauna is related to the variable hydrology, host plant diversity, and microhabitat presence (*e.g.*, fungal bracts, dead trees, hosts for parasites, *etc*.) available in the mesic flatwoods ecosystem.

The myriad of invertebrate species in the mesic pine flatwoods support the vertebrate species. This community is important habitat for a number of common pine flatwoods vertebrate species, including the pine woods tree frog (*Hyla femoralis*), oak toad (*Bufo quercicus*), box turtle (*Terrapene carolina*), eastern diamondback rattlesnake (*Crotalus adamanteus*), black racer (*Coluber constrictor*), brown-headed nuthatch (*Sitta pusilla*), Bachman's sparrow (*Aimophila aestivalis*), pine warbler (*Dendroica pinus*), great horned owl (*Bubo virginianus*), least shrew (*Cryptotis parva*), cotton mouse (*Peromyscus gossypinus*), cotton rat (*Sigmodon hispidus*), and gray fox (*Urocyon cinereoargenteus*) (Layne 1974, Layne *et al.* 1977). Although no mammal is endemic only to the mesic pine flatwoods of South Florida, both Sherman's (*Sciurus niger shermani*) and Big Cypress fox squirrels (*Sciurus niger avicennia*) are closely associated with the open understory provided by fire-maintained mesic pine flatwoods. Three large native mammals that regularly use mesic pine flatwoods are the white-tailed deer (*Odocoileus virginianus*), Florida black bear, and Florida panther (Layne 1974).

To date, field studies and the literature (Beever and Dryden 1998, Cunningham 1961, Duever, *et al.* 1986, Ashton and Ashton 1988, Kale and Maehr 1990, Layne 1978, Myers and Ewel 1990, Soil Conservation Service 1986, Florida Department of Natural Resources 1989, Florida Department Natural Resources 1990) have identified 28 mammal, 116 bird, 29 reptile, and 13 amphibian species from the mesic pine flatwoods of South Florida, including 3 endangered species, 6 threatened species, and 6 species of special concern, and 8 Convention on International Trade in Endangered Species (CITES) species.

Twenty-eight of 32 mammal species known from South Florida are found in the mesic pine flatwoods (Layne 1978, Drew and Schomer 1984). The Big Cypress fox squirrel, Florida weasel *(Mustela frenata peninsulae*), and red fox (*Vulpes vulpes*) have only been observed in Lee and Collier counties (Beever and Dryden 1998). One hundred and sixteen (42 percent) of the 274 bird species known from South Florida (Kale and Maehr 1990) are found in the mesic pine flatwoods (Beever and Dryden 1998). Twenty-nine taxa (54 percent) and 27

species (55 percent) of the 54 taxa (49 species) of reptiles not restricted to coastal waters in South Florida (Duever, *et al.* 1986, Ashton and Ashton 1988), utilize the mesic pine flatwoods as habitat. This includes 20 snakes, 1 turtle, 1 tortoise, and 7 lizards. Reptiles utilize mesic pine flatwoods in both wet and dry seasons, although different species may be present seasonally in different hydrologic conditions (Beever and Dryden 1998).

Thirteen (65 percent) of the 20 amphibian species found in South Florida (Ashton and Ashton 1988) utilize the mesic pine flatwoods habitat for feeding and/or breeding. This includes all of the treefrog and toad species of southwest Florida. The most frequently encountered and abundant amphibians are tree frogs, oak and southern toads, and spadefoot toads (Beever and Dryden 1998).

Wildlife Species of Concern

Federally listed animal species that depend upon or utilize the mesic pine flatwoods in South Florida include: Florida panther, Key deer (*Odocoileus virginianus clavium*), Audubon's crested caracara (*Polyborus plancus audubonii*), Kirtland's warbler (*Dendroica kirtlandii*), bald eagle (*Haliaeetus leucocephalus*), red-cockaded woodpecker (*Picoides borealis*), and eastern indigo snake (*Drymarchon corais couperi*). Biological accounts and recovery tasks for these species are included in "The Species" section of this recovery plan.

The **Florida panther** utilizes mesic pine flatwoods in combination with other forested upland and seasonal wetland habitats. They provide critical foraging, breeding, and wildlife corridor habitat. The documented foraging and breeding territories of the radio-collared Florida panthers, and documented sightings of Florida panther include the large expanses of undisturbed mesic pine flatwoods in the area (D. Maehr, GFC, personal communication, 1991, L. Campbell, GFC, personal communication, 1991). The panther utilizes hydric, mesic, and xeric pine flatwoods, and savanna, hardwood hammocks, and mixed swamp forest. Prey animals, including white-tailed deer (*Odocoileus virginianus*) and feral hog (*Sus scrofa*), utilize the plant diversity of the mesic pine flatwoods for foraging, and the dry cover for the raising of offspring (Layne and McCauley 1976). The prevalence of mesic pine flatwoods on private ranches is thought to be partly responsible for increased deer numbers and deer health, which supports increased Florida panther presence on private lands. Recently burned mesic pine flatwoods provide more prey for panther, and panthers are documented to move toward fires and stay in areas of recent burns (Belden 1986). Panthers require large territories and abundant prey. The mesic pine flatwoods of southwest Florida can provide both these requirements. Additionally, the mesic pine flatwoods and swamp forests associated with natural drainage patterns provide the travel corridors essential to the panther for traveling between the fragmented foraging areas remaining in southwest Florida.

Florida black bear. *Original photograph by Barry Mansell.*

The **Florida black bear** is a forest habitat generalist with seasonal preference for wherever food is most available. Black bears utilize all the natural forested systems of South Florida, with a decided preference for upland/wetland ecotones. Telemetry information, documented sign and sightings of Florida black bear, and periodic road kills all indicate that large, relatively undisturbed mesic pine flatwoods, in combination with other upland forests and the major wetland systems, provide the principal habitat of the black bear in southwest Florida (Brady and Maehr 1985, Maehr 1984, Maehr *et al.* 1988, Land 1994).

Bears are omnivores that feed on readily available food resources. Preferences for berries, insect larvae, the occasional small animal (frogs, mice, *etc*.), eggs, and wild honey can be satisfied in the mesic pine flatwoods environment. Fruits from cabbage palm, saw palmetto, and berry bushes, are consumed on a seasonal basis. Occasionally, young white-tailed deer and wild hog are taken as prey (Williams 1978a).

The southern limit of the **Sherman's fox squirrel** on the west coast of Florida includes the mesic pine flatwoods and riverine hardwood forests of Sarasota, Charlotte and northern Lee counties. Ehrhart (1978) and Kantola (1991) did not include its range to extend into southwest Florida, perhaps because its principal north and central Florida habitat is longleaf pine-turkey oak sand hills, a habitat not found in South Florida to any large extent. In South Florida, the mesic pine flatwoods and mixed flatwood-hardwood riverine forests are important habitats for this fox squirrel subspecies. Sherman's fox squirrels forage on male pine cones in winter and female pine cones during the summer. Acorns from a variety of oaks (live, laurel, and sand live), cabbage palm fruits, bromeliad buds, and insects are also consumed. All of these food sources are available in the mesic pine flatwoods of South Florida. Oak and hardwood hammocks, xeric sandhill ridges, and riverine forests adjacent to mesic pine flatwoods provide additional forage on a rotating seasonal basis. Nesting occurs in mesic pine flatwoods in pines, oak, and cabbage palms.

Big Cypress fox squirrel. *Original photograph by Grant Webber.*

The **Big Cypress fox squirrel** primarily utilizes flatwoods in South Florida. Mesic pine flatwoods understories that are maintained open by fire can provide a good forage for the fox squirrel. The fox squirrel forages on male pine cones in winter, and female pine cones during the summer. Male and female cones from cypress, cabbage palm fruits, bromeliad buds, and acorns are also consumed (Humphrey and Jodice 1991). Mature mangrove forest, oak and hardwood hammocks, and riverine hardwoods adjacent to mesic pine flatwoods provide additional forage on a rotating seasonal basis. Nesting occurs in upland and wetland habitats in pines, oaks, black mangrove, cypress, and cabbage palms; often in bromeliad clumps. The Big Cypress fox squirrel is not observed in pine flatwoods dominated by a thick saw palmetto understory, monocultural dense melaleuca forest, Brazilian pepper forest, Australian pine stands, and man-made habitats that do not possess a superabundance of food. Maintaining large, unfragmented areas of mesic pine flatwood is important to the long-term survival and recovery of this charismatic mammal.

The **Florida weasel** has been recorded in the mesic pine flatwoods of South Florida (Brown 1978c). The species is naturally rare (Brown 1972) and has been, based on records, for the last 100 years. The species also uses hydric and xeric pine flatwoods, cabbage palm and live oak hammocks, and swamps in its range. Surveys for the Florida weasel (Hovis 1993) continue to confirm its rarity.

The **red-cockaded woodpecker** in South Florida utilizes mesic pine flatwoods as nesting and foraging habitat (Beever and Dryden 1992, Duever *et al.* 1986, D. Jansen, NPS personal communication 1991). The territories of red-cockaded woodpeckers in mesic slash pine flatwoods of South Florida are documented to be larger than reported for northern birds (Nesbitt *et al.* 1983, Patterson and Robertson 1981). Of the 123 known red-cockaded woodpecker colonies in southwest Florida, 24 colonies are located in healthy mesic slash

pine flatwoods (Beever and Dryden 1992). Historically, a greater number may have been present in mesic pine flatwoods but loss of habitat to logging and urban and agricultural development severely constrains the availability of mature forests. Subsequent forest regrowth is typically harvested on 20 to 40 year rotations that do not allow the establishment of a mature forest necessary for the creation of start holes and cavities. Fire exclusion, coupled with fast rotation for pulpwood has rendered significant acreages of mesic pine flatwoods unsuitable for use by the red-cockaded woodpecker.

Bald eagles (*Haliaeetus leucocephalus*) utilize the pines of mesic pine flatwoods of South Florida as nest trees, particularly where this community is located adjacent to an estuarine, riverine, or lacustrine foraging area. Large, mature trees capable of supporting the heavy nests are preferred nesting sites. Bald eagles often remain in mesic pine flatwoods year-round. In some areas of South Florida, large groups of eagles soar on thermals during the fall and spring migrations and gather over large pine flatwoods forests inland from the coast (Beever and Dryden 1998). Without large pine trees, eagle nesting would drop precipitously in South Florida.

Audubon's crested caracara have been observed to utilize open mesic pine flatwoods areas in South Florida in Sarasota, Charlotte, DeSoto, Hardee and Highlands counties during cooler months. Caracaras probably approach the mesic pine flatwoods in a coarse-grained landscape approach. Clusters of mesic cabbage palm seem to be important as a focus for this seasonal foraging by this prairie bird species.

The **Florida sandhill crane** (*Grus canadensis pratensis)* prefers wet prairies, marshy lake margins, low-lying pasture, open marsh, and shallow flooded open areas (Williams 1978b). Sparsely canopied mesic pine flatwoods adjacent to ponds and marshes provide nesting and foraging habitat for sandhill cranes and their young throughout the nesting and fledgling period. In contrast, unburned mesic pine flatwoods are not utilized.

The **southeastern American kestrel** (*Falco sparverius paulus)* is a small falcon that utilizes open habitat for foraging and nests in tree cavities, typically abandoned woodpecker holes in pine trees. The kestrel utilizes tall pine trees, often snags, power and telephone poles and wires, and other tall objects. The kestrel feeds on large insects and, occasionally, on small rodents, reptiles, and birds (Wiley 1978). The mesic pine flatwoods of southwest Florida provide shelter, as well as habitat for reproduction and foraging for the kestrel. The observed foraging areas for these birds often extend to adjacent open habitats, such as pasture, both wet and dry prairies, and mowed roadway edges.

The **eastern indigo snake** utilizes a wide variety of habitats in South Florida, including mesic pine flatwoods, tropical hammocks, and xeric areas (Kochman, 1978). Where available, gopher tortoise (*Gopherus polyphemus*) burrows are utilized as shelter. Eastern indigo snakes occur in mesic pine flatwoods in South Florida throughout the year in the moister areas. The abundant amphibian and reptilian fauna of mesic pine flatwoods are important to the diet of this wide-ranging reptile.

The **gopher tortoise** utilizes dry, well-drained soils with areas of open, herbaceous understory (Auffenberg 1978). In South Florida, gopher tortoise burrows typically are found in xeric and mesic coastal ridges of the Silver Bluff terrace, including coastal scrub, dry tropical hammock, live oak hammock, and pine flatwoods. In most of South Florida, these perennially dry habitats exist as islands surrounded by reticulate hydric habitats. The gopher tortoises that utilize natural mesic pine flatwoods often construct wet season burrows in dry, upland ridge islands. In drained mesic pine flatwoods, gopher tortoises construct dry season burrows in the flatwoods. The gopher tortoise forages in both the upland ridge and the adjacent mesic pine flatwoods when water levels recede and throughout the dry season. The gopher tortoise forages on the grasses, herbs, fruits, and berries provided by the understory of fire-maintained mesic pine flatwoods. Gopher tortoise densities in mesic pine flatwoods are limited by the extent of upland suitable for year-round burrow use and the availability of forage.

The **gopher frog** (*Rana capito*) utilizes gopher tortoise burrows, mouse burrows, stump holes, post holes, and crayfish holes in mesic pine flatwoods. In the breeding season, gopher frogs congregate at night in shallow vegetated ponds to breed (Fogarty 1978b). Mesic pine flatwoods ponds provide such breeding habitat at the appropriate time, adjacent to the xeric scrub habitats where adult gopher frogs are found more frequently.

Plant Species of Concern

Federally listed plant species that are reported to occur in mesic pine flatwoods in South Florida include: beautiful pawpaw (*Deeringothamus pulchellus*), and Carter's mustard (*Warea carteri*). Biological accounts and recovery tasks for these species are included in "The Species" section of this recovery plan. Many rare plant species, including ferns, orchids, midstory trees, and herbaceous monocots and dicots are found in mesic pine flatwoods with natural hydrology and fire regime.

Carter's large-flowered flax (*Linum carteri* var. *smallii*) is an annual plant that occurs throughout South Florida in Miami-Dade, Collier, Monroe, Hendry, Martin, Palm Beach, Broward, and Charlotte counties. This species is shade-intolerant and prefers moist but not inudated soils. This variety can be distinguished from the related *L. c*. var. *carteri* by its smooth stems, taller habit, and its overall larger flower petals. *Linum carteri* var. s*mallii* has demonstrated a tolerance to human disturbance by persisting along roadsides. This species is under threat by development of its habitat. This variety is known from fewer than 10 occurrences. The State of Florida has listed *Linum carteri* var. *smallii* as an endangered species.

Coastal vervain (*Verbena maritima*) is a perennial herb that utilizes mesic pine flatwoods on the east coast of Florida. The South Florida counties where it is known include: Miami-Dade, Palm Beach, Indian River, Collier, St. Lucie, Hendry, and Martin. Other counties include: Brevard, Volusia, Flagler, and Levy. This shade-intolerant plant prefers sandy clearings that are maintained by fire and wind. This species is being threatened by development and exotic plant invasion such as by Australian pine (*Casuarina equisetifolia*). The State of Florida has listed *Verbena maritima* as an endangered species.

Ecology

Hydrology

The flat topography, sandy soils, and the seasonal precipitation cycle are the principal influences of mesic pine flatwoods hydrology. The flat topography, a result of Pleistocene geology, creates minimal gradients, resulting in sufficient time for percolation, soil saturation and slow runoff that occasionally creates very poorly defined first-order streams and typically results in sheetflow patterns if water becomes high. Where hardpan is present, water moves slowly vertically relative to horizontal movement, through horizons above and below the hardpan layer. Mesic pine flatwoods soils then become waterlogged and poorly aerated during the rainy season. This results in the saturated soils typical of unaltered, undrained mesic pine flatwoods. During the dry season, high evapotranspiration draws most of the water out of the upper soil horizons, drying them out. Soil moisture becomes depleted in the upper soil layers, above the hardpan, and a persistent drought condition frequently prevails through the dry season. As a result, during the dry season, groundwater is inaccessible for plants that cannot penetrate hardpan (FNAI 1989).

Water depths in mesic pine flatwoods vary throughout the seasonal hydrologic cycle. Extreme ranges are from just below the surface to 2.4 m (8 feet) below ground surface. Typical ranges are from 0.15 m to 0.30 m (6 inches to 1 foot) below ground surface at the height of the wet season to 1.8 m (6 feet) below ground surface in the late dry season. For most of the year, undrained mesic pine flatwoods have water within 1.2 m (4 feet) below the ground surface (Abrahamson and Hartnett 1990).

Fire

The mesic pine flatwoods is a fire climax, hydroperiod-mediated community (Wade *et al.* 1980). In pre-Columbian times, fires probably occurred in the mesic pine flatwoods every 3 to 10 years. Nearly all plants and animals of the mesic pine flatwoods are adapted to periodic fires (FNAI 1989). While natural fires were numerous, the areal extent of any given fire was probably small [10 ha (25 acres) or less]. Most fires occurred at the end of the dry season. This pattern of patch fires creates a mosaic of plant and habitat diversity, as opposed to a monopyric, even-aged plant community. Frequent, low-intensity surface fires generally characterize the fire regime. Historical evidence suggests that a fire frequency of 1 to 3 years is necessary to maintain this community (Ware, Frost, and Doerr 1993). The chances that a severe, crown-killing fire will occur increase as the fire frequency decreases (Christensen 1988).

South Florida slash pine seedlings have a grass stage that, like longleaf pine, greatly increases resistance to fire damage. Fire stimulates slash pine seedlings to sprout, promoting their growth as pioneers of burned land. Adult South Florida slash pines are also more resistant to fire than are northern slash pines (Wade *et al.* 1980, Ketcham and Bethune 1963). South Florida slash pine possesses longer tap roots and smaller needle size than do the northern slash pine (McNab 1965, McMinn 1970).

Much of the variation in community structure of mesic pine flatwoods is probably associated with fire frequency. The longer the period since the last fire, the more developed the understory shrub layer. If the understory is allowed to grow too long without fire, the accumulated needle bed and the height of flammable understory shrubs increases the probability of catastrophic canopy fires (FNAI 1989). If fires are very frequent, slash pine seedling regeneration will not occur, and the mesic pine flatwoods will tend to be dominated by a herbaceous understory of wetland species with clusters of cabbage palms forming a mesic cabbage palm prairie (Wade *et al.* 1980).

Less fire tolerant plant community components have refugia in the deeper waters found in pineland ponds and adjacent cypress strands. With overdrainage, fire refugia are lost. This typically results in decreases in the midstory and tropical components of South Florida mesic pine flatwoods with subsequent losses in plant species diversity. If overdrainage is coupled with too-frequent fire, and a melaleuca seed source is nearby, the mesic pine flatwoods can become dominated by the melaleuca monocultures typical of south Lee and northern Collier Counties (Wade *et al.* 1980).

Without regular fires, mesic pine flatwoods are expected to succeed into hardwood dominated forests with a closed canopy, eliminating groundcover herbs and shrubs (Alexander 1967, FNAI 1989). After approximately 6 to 10 years of fire absence, perennial plants that are normally set back by fire attain larger size. An increase in ground cover results from the presence of fewer, but larger, individual plants. These individual plants are subsequently shaded out by other plant species that would normally be killed by fire. This results in an increase in cover, but a decrease in plant species diversity. In general, fire exclusion from mesic pine flatwoods results in species loss, decreased forage quantity and quality for herbivorous species, and subsequently for their predators, increased danger from wildfires, and decreased pine regeneration (Wade *et al.* 1980).

Mesic pine flatwoods systems that have had hydroperiod drainage and/or fire exclusion, such as Golden Gate Estates in Collier County, appear to accumulate litter loads quickly, resulting in plant diversity degradation to disturbed and exotic-invaded conditions, declines in tree recruitment, and subsequent wildfires (Beever and Dryden 1998).

Status and Trends

Land Conversion/Development

An analysis of vegetation types most impacted by human land conversion indicates that statewide only 36 percent of the pine flatwoods remain (64 percent loss). Interestingly, this is the same proportionate loss as for pine rocklands. South Florida pine flatwoods are among the least protected habitats by the current distribution of public land managed areas with only 9 percent protected. This is proportionately less than for longleaf pine-xeric oak sandhills (14 percent) and sand pine scrub (35 percent); habitats typically advocated for protection as under-represented on preserve lands (Cox *et al.* 1997).

The mesic pine flatwoods of southwest Florida were not a rare habitat historically, occupying approximately 3,078,361 ha (7,606,525 acres) of South Florida pine flatwoods (Davis 1967). Using a conservative estimate that one-third

of these flatwoods were mesic, historically there would have been approximately 1,026,120 ha (2,535,508 acres) of mesic pine flatwoods. As a group, xeric, mesic, and hydric pine flatwoods were reduced to approximately 50 percent of their historic extent by 1970 (Birnhak and Crowder 1974) as a result of agricultural activities, speculative real estate clearing, and urban development. Wade *et al.* (1980) reported that in 1980, pine flatwoods occupied more area in South Florida than any other kind of plant community except the Everglades marsh. By 1989, GFC mapping of South Florida (Kautz 1993) indicated that pine flatwoods had dropped to fifth in areal extent (acres) behind grasslands, cypress swamp, dry prairies, and freshwater marsh. This study indicated that, for the first time, urban areas occupied more acreage in South Florida than did pine flatwoods. By 1989, there were only 2,648,850 ha (6,545,219 acres) of pine flatwoods in the entire State of Florida (Cox *et al.* 1994).

Flatwoods dominated by longleaf pine are part of the larger longleaf pine-wiregrass ecosystem that was once dominant throughout the southeastern coastal plain of North America. The distribution of this ecosystem has been reduced by approximately 85 percent (or by 99.9 percent if old growth examples are included). At the time of European settlement, longleaf pine communities covered at least 24 to 38 million ha; today these communities cover less than 4 million ha, and most of this is second growth and degraded (Noss 1988).

As of 1996, 1,077,279 ha (2,661,919 acres) of South Florida pine flatwoods existed, with 269,345 ha (665,542 acres) present in public managed areas (Cox *et al.* 1997). Based on the 1989 distribution of pine flatwoods in coastal southwest Florida (Collier, Charlotte, and Lee counties) approximately 40 percent was mesic pine flatwoods (Beever and Dryden 1998). This would calculate to 430,912 ha (1,064,767 acres) of mesic pine flatwoods in South Florida in 1996.

If mesic pine flatwoods are not protected, they will be converted to urban, suburban, and agricultural development within a relatively short time period. Habitat destruction of mesic pine flatwoods and adjacent habitats is the primary threat to the Big Cypress fox squirrel (Brown 1973, 1978). Large-scale commercial and residential development of mesic pine flatwoods west of the Big Cypress National Preserve (BCNP) in the Naples area, conversion of mesic pine flatwoods to citrus north of the BCNP, and expansion of roadways through mesic pine flatwoods pose serious threats to habitat quality and quantity for the Big Cypress fox squirrel (Humphrey and Jodice 1991).

Many existing Developments of Regional Impact and other large projects in mesic pine flatwoods demonstrate the anticipated fate of the last extensive forested refuges in South Florida, and the endangered, threatened, and species of special concern that depend upon the mesic pine flatwoods for breeding, feeding, and wildlife corridors.

Hydrologic Alteration

The most common form of hydrologic alteration of mesic pine flatwoods is ditching to lower the annual water table for agriculture or construction. Deeper regional canals, such as those in Golden Gate Estates (Collier County), can lower the water table on a regional scale for the purposes of land development. This widespread practice substantially eliminates normal mesic flatwoods hydrology from large areas of South Florida including large platted

subdivisions in the City of North Port, Port Charlotte, City of Cape Coral, Lehigh Acres, South Fort Myers, Golden Gate Estates, Sebastian Highlands and the older parts of Port St. Lucie.

Another commonly encountered form of hydrologic alteration is small levees or berms created as a byproduct of ditching, placed as part of road or other linear construction to elevate the path above wetland grade, and intentional barriers designed as part of surface water management systems to retain all waters on a site as part of a development process. These permit-required water management structures dam sheetflow, redirect sheetflow into rapid discharge channels or stormwater retention and detention areas. The berms can simultaneously drown upstream mesic pine flatwoods (creating a deeper water wetland type), while denying sheetflow to downstream areas (creating a drier type of flatwoods). These blocks to sheetflow, coupled with inadequate culverting, are often the cause of significant flooding to both natural areas and human property. These structures significantly fragment regional hydrology and alter landscape flow into coastal estuaries.

Other types of hydrologic alterations to mesic pine flatwoods include water table drawdown by wellfields and surface mine excavation. Due to the permeable substrates that underlie mesic pine flatwoods, changes in surficial aquifer levels can rapidly translate into a drop in the water table. Mines and borrow pits, particularly those that operate pumps to accommodate excavation, can lower local water levels within a mesic pine flatwood. Wellfield pumping can, at significant levels of withdrawal, dry out mesic pine flatwoods, changing plant community structure and susceptibility to exotic invasion.

Substrate Disturbance, Exotic Plant Invasion, and Exotic Animals

Mesic pine flatwoods soils tend to be sandy with shallow, if any, organic layers. Productivity export and incorporation appear to be extremely efficient in natural mesic pine flatwoods, since bare, sandy soil surfaces are the norm in undisturbed mesic pine flatwoods systems, indicating that natural systems do not accumulate significant bed loads of litter. Simple physical disturbance of the surface by vehicles, plows, unimproved roads, excavations, exotic animals, fill, excavation, explosions, and seismic testing can leave an area with a slightly different elevation, altered soil nutrients, and different soil horizons that when revegetated, can be sites of weedy or exotic plant establishment. The first entry of exotic plants into a mesic pine flatwood area can often be along jeep trails, along plowed fire lanes, at the toe of fill roadways, along cleared utility easements, around borrow pits, where wild hogs have rooted, and along rock mine survey grid lines.

If substrate disturbance is coupled with fire exclusion and drainage, it is almost inevitable that Brazilian pepper or melaleuca will become established in the mesic pine flatwood. Mesic pine flatwood systems that have had hydroperiod alterations and/or fire exclusion coupled with substrate disturbance, such as Golden Gate Estates (Collier County), appear to accumulate litter loads quickly, resulting in plant diversity degradation with invasion by opportunistic species such as cabbage palm and grape vine, accelerated exotic plant invasion, declines in pine tree recruitment, and increases in wildfire.

Mesic pine flatwoods that are cleared of native vegetation but are not otherwise altered in hydrology or fire-frequency may return to mesic pine

flatwoods floristics, but typically will include exotic plant species in areas of substrate disturbance. Activities that increase the susceptibility of pine flatwoods to invasion by exotic species include rooting by hogs, fire suppression, clearings for wildlife food plots, fire plow lines, and revegetation (Martin *et al.* 1996).

Of the 482 plant species documented or recorded from the mesic pine flatwoods of South Florida, 25 (5 percent) are exotic, introduced species. Most of the introduced species are not invasive under natural hydrology and fire frequency. The principle invasive species include Brazilian pepper, melaleuca, and downy rosemyrtle.

There is some debate concerning the relative habitat values of exotic plant dominated landscape. While the presence of a few individual plants does not constitute a major community threat, solid monocultures have demonstrably negative effects on plant and animal community diversity. When exotics replace natives, plant and animal species that depend upon those natives are similarly impacted. Thresholds are not yet well understood and both under- and over-estimation of exotic plant invasion effects is common.

Exotic animals identified in South Florida mesic pine flatwoods include: wild hog (*Sus scrofa),* armadillo (*Dasypus novemcinctus),* feral dogs, feral cats, coyote (*Canis latrans),* Cuban tree frog (*Osteopilus septentrionalis),* the brown anole (*Anolis sagrei),* other exotic amphibians and reptiles, and red-imported fire ants. Wild hogs and to a lesser extent, armadillos, can change understory composition through substrate disturbance. This can negatively affect listed groundcover plant species and provide opportunities for exotic plant invasion. Feral hog activity kills plants directly, increases soil erosion, and facilitates weed and exotic species invasion (Martin *et al.* 1996). Cuban tree frogs are predators on native, smaller tree frog species and have been demonstrated to displace native species in urban and agricultural settings. Feral cats and dogs have been demonstrated to significantly impact small mammal, ground-nesting bird, and songbird populations in Florida and throughout the United States. Fire ants have become a problem for small animals including ground-nesting birds and some tree-nesting bird and mammal species as well. The effect of coyote on South Florida ecosystems and food webs is currently unknown. There have been various reports of benefits (predation on feral cats and dogs, wild hogs and armadillos) and problems (predation on gopher tortoises and ground-nesting birds, competition with native medium-sized predators). So far no organized strategies to address exotic predators in mesic pine flatwoods have been developed. The spread of exotic animals into native mesic pine flatwoods has been assisted by fragmentation of the landscape by roadways, canals, agricultural and suburban development. It is clear that the greater the amount of developed edge areas relative to core areas of mesic pine flatwoods, the greater the potential for exotic animal invasion of the habitat.

Extractive Land Use

Logging of the South Florida mesic pine flatwoods began in the 1920's and continued through World War II. Following logging, the understory components recovered quickly, depending on the level of altered hydroperiod. Pine recovery was slow in upland areas of mesic pine flatwoods (Wade *et al.* 1980). Several

factors contributed to this pattern: (1) upland pine areas were easier to deforest utilizing early twentieth-century techniques; (2) slash pine has less fire protection in mesic pine flatwood hydrologic conditions than in hydric conditions; and (3) in the absence of fire, the thick cover of saw palmetto reduces slash pine seedling growth and survival in fires.

Mesic pine flatwoods display a resilient recovery from overstory damage due to fire or clearcutting, if the natural hydrology and fire regime are allowed to continue. Recovery is poor when hydrology or ground cover is disturbed. While drainage may result in a shift toward more slash pine density, overdrainage can result in conditions too dry for slash pine establishment and survival in areas of previous slash pine dominance. The result has been an increase in the area of palmetto-dominated prairie from historic conditions prior to logging and drainage (Wade *et al.* 1980).

Overdrainage and pasture conversion has changed the South Florida landscape from pine flatwoods to one dominated by rangeland. Cattle ranching in the South Florida mesic pine flatwoods began immediately with the American settlement of South Florida. Calf raising and associated pasture for stock and dairies continues today, particularly in central South Florida. Drainage for range was a common practice and was encouraged by cooperative extension and farm programs from the 1920s until the 1970s. Following light grazing, the understory components of mesic pine flatwoods recover quickly, depending on the level of altered hydroperiod. Mesic pine flatwoods display a resilient recovery from grazing, if the natural hydrology and fire regime are allowed to continue and exotic, improved pasture grass species are not introduced. Recovery is poor when hydrology or ground cover is disturbed by improved pasture management. Drainage of mesic pine flatwoods has resulted in expansion of improved pasture and decreases in plant diversity, and subsequently wildlife diversity in South Florida. Mesic pine flatwoods converted to improved pasture or subject to high grazing pressure are also very susceptible to exotic invasion by range pests such as the exotic tropical soda apple and cogon grass (FNAI 1989). Management for domestic livestock grazing can result in alteration of soil properties and vegetation structure. In areas that have been grazed for long periods of time, soil becomes compacted, reducing water infiltration and percolation (Myers and Ewel 1990).

Saw palmetto berry gathering for pharmaceuticals has recently become a new extractive use of palmetto understory in mesic pine flatwoods. The effect of hand-harvesting tons of palmetto berries from this system is not currently known. Palmetto berries are important food for many wildlife species, including listed mammal species such as Florida black bear. The saw palmetto is also an important understory component for providing cover for prey species. It is not known if a significant number of berries are being removed, if berry-consuming wildlife is finding sufficient forage, or if berries are germinating sufficiently enough to maintain saw palmetto populations.

Waste Disposal and Nutrient Enrichment Issues

Mesic pine flatwoods are subject to a variety of waste disposal uses in South Florida. Landfills in southwest Florida have been uniformly sited in mesic pine flatwoods (Sarasota, Charlotte, Lee, and Collier counties). This invariably involves complex construction, water management, and containment systems

to prevent leachate discharge to adjacent areas. Such sites can become attractors to species found in mesic pine flatwoods, particularly Florida black bear and bald eagles. This in turn results in nuisance situations, mortality from toxins, unnatural population concentrations, and mortality from exposure to human-dominated landscapes (roadkills, power line collisions, and poaching). Fertilization in pine flatwoods may have drastic effects on these communities because they are naturally low in nutrients, and weedy species are likely to invade following nutrient enrichment (Martin *et al.* 1996). Also, Walker and Peet (1983) reported that an increase in productivity resulting from fertilization should lead to a decline in plant species richness, including a decline in rare plant species richness. It is not known whether fertilization will lead to replacement of rare species by more competitive species able to thrive under fertilized conditions. Fertilization can be carried to the aquatic habitat via runoff (Martin *et al.* 1996).

Most mesic pine flatwoods in South Florida that are accessible by vehicles and not patrolled by public or private on-site managers are subject to extensive dumping of yard debris, construction materials, large objects including vehicles and white goods, chemicals, and basic domestic garbage. This results in direct habitat degradation, exotic plant invasion, and water quality pollution. Dispersed rural and semi-suburban development in mesic pine flatwoods areas of South Florida are typically served by septic tank systems that are designed to leach into drain fields in the permeable sands of the mesic pine flatwoods. During annual wet season high water and other flood events, septic systems become saturated and both surface ground water and surface waters display pollution from fecal coliform bacteria, indicative of waste pollution.

Agricultural lands, including high- intensity cattle operations, display surface water fecal coliform bacteria, indicative of waste pollution from cattle waste. The practice of land spreading sludge from sewage treatment plants and septic systems over rangeland to “enhance” the low nutrient levels of mesic pine flatwood sands introduces nutrients and bacterial contamination into highly permeable and easily leached soils. Agricultural lands adjacent to mesic pine flatwoods also may discharge nitrified runoff to mesic pine flatwoods and other wetlands.

Recreational Damage

The activities of off-road vehicles can significantly alter the substrate of mesic pine flatwoods, altering hydrology and encouraging exotic plant invasion on the disturbed soils. Trash and debris from recreational activity is common on unmanaged areas, including food and beverage packaging, items brought in as targets for shooting, and other discarded items including monofilament, rubber, and plastic products.

Significant debate is ongoing concerning the impacts of some hunting activities on the wildlife and landscape of mesic pine flatwoods, including where off-road vehicles are used for access and for certain types of hunting where dogs are used.

Management

Management issues for mesic pine flatwoods include consideration of size and fragmentation, fire ecology, hydrology, substrate disturbance, exotic plant invasion, exotic animals, extractive land use, recreational uses, and effects of resource mitigation policy.

Management of Size and Habitat Fragmentation

Management to maintain and restore the high level of biodiversity found in mesic pine flatwoods is best achieved on large, intact, contiguous tracts of land composed of mesic pine flatwoods and of other native habitats. The habitat reticulation of xeric, mesic, and hydric pine with seasonal marsh, ponds, cypress and mixed hardwood swamp strands, and various hardwood and palm hammocks, maintained by fire and a dendritic sheetflow hydrology provides a self-sustaining community diversity that provides niches for innumerable species. Mesic pine flatwoods are not maintainable nor sustainable in small, "postage stamp" isolates that may be cut off from sheetflow hydrology, excluded from fire, subject to substrate disturbance, suffering significant edge effect, and vulnerable to exotic plant and animal invasion.

Managing mesic pine flatwoods is an issue of landscape ecology. Most existing public and private lands with intact, healthy mesic pine flatwoods and healthy biodiversity are large multi-square mile parcels. Current land acquisition and land protection proposals include protection of other existing large parcels, connection of existing and proposed parcels, and expansion of existing parcels to attain larger landscape size. This is functionally necessary to achieve the long-term persistence of the mesic pine flatwoods habitat type in South Florida and to achieve multi-species recovery in South Florida. Wide-ranging animals such as the Florida panther, Florida black bear, red-cockaded woodpecker, migratory birds, eastern indigo snake, and fox squirrel need a variety of connected habitats over a wide area to complete life-cycle needs and maintain viable population levels in South Florida.

Fire Management

Burning to increase value to livestock and wildlife is a well-established practice in mesic pine flatwoods. It has been documented to increase range values and wildlife habitat (Komarek 1963, Stoddard 1963, Lewis 1964, Moore 1972, Hughs 1975). Different burn regimes favor different wildlife species. For example, quail are favored by 2-year rotational burns (Moore 1972) and turkey are favored by 3- to 4-year cycles (Stoddard 1963).

Little is known about the frequency and timing that is most beneficial to most of the rare species or some plant communities. There have been few studies conducted to assess whether early or late growing-season burns are most beneficial to the community. However, early growing-season burns have been recommended over late growing-season burns because: (1) lightning fires in South Florida are most common in early summer (June), and the largest number of acres are burned naturally during late spring and early summer; (2) studies suggest that early growing-season burns are more favorable to growth

and survival of longleaf pine seedlings and saplings than late growing-season burns; (3) early growing-season fires are more detrimental to hardwoods, which compete with pines for establishment (Robbins and Myers 1992).

Additionally, smoke and fire management considerations in South Florida are increasingly dictated by human population safety concerns. These concerns have promoted some winter burn schedules.

Natural fire breaks created by moisture or the lowest impact method (such as foam) should be used whenever possible to contain the fire. However it is usually necessary to prevent the spread of fires into adjacent plant communities, off-site, or roadways; therefore control lines should be established using existing trails, roads, or plow lines. In flatwoods, plow or control lines should be cut by disc to avoid disruption of hydrology (sheetflow). However, these lines may be subject to weedy or exotic plant invasion. Spot fires can be created by dropping plastic balls of potassium permanganate and antifreeze from a helicopter. The small intermittent fires created by this method will burn together before becoming too hot. However, this method may not be appropriate for rare species management because it can create uniform, even, landscapes. (Natural fire moves differently.) Fire should be allowed to spread into ecotones and adjacent wetlands.

It is important to maintain natural South Florida hydroperiods and a diverse fire management schedule to achieve the highest plant biodiversity for the system. Landscape scale burning performed on large areas has also achieved good results and areas are not forced to micro-manage burns.

Hydrologic Management

A commonly encountered form of hydrologic alteration to mesic pine flatwoods is small levees or berms placed across the landscape. Removal or installing multiple culverts in these man-made flow blocks can substantially restore mesic pine flatwoods hydrology while reducing flooding effects on human property.

Management of Substrate Disturbance, Exotic Plant Invasion, and Exotic Animals

Mesic pine flatwoods soils tend to be sandy with shallow, if any, organic layers. Physical disturbance of the surface can leave an area with a slightly different elevation, altered soil nutrients, and different soil horizons that when revegetated, can be sites of weedy or exotic plant establishment. If substrate disturbance is coupled with fire exclusion and drainage, it is almost inevitable that Brazilian pepper or melaleuca will become established in the mesic pine flatwood.

Mesic pine flatwoods that are cleared of native vegetation but are not otherwise altered in hydrology or fire-frequency may return to mesic pine flatwoods floristics, but typically will include exotic plant species in areas of substrate disturbance. Activities that increase the susceptibility of pine flatwoods to invasion by exotic species include rooting by hogs, fire suppression, clearings for wildlife food plots, fire plow lines, and revegetation (Martin *et al.* 1996)

Of the 482 plant species documented or recorded from the mesic pine flatwoods of South Florida, 25 (5 percent) are exotic, introduced species. Most

of the introduced species are not invasive under natural hydrology and fire frequency. The principal invasive species: Brazilian pepper, melaleuca, and downy rosemyrtle are able to persist and spread if hydrology is altered and fire is suppressed. Removal or control of invasive and non-invasive exotic plant species is achievable in the mesic pine flatwoods of South Florida by direct mechanical and chemical control, and restoration of hydroperiod and natural fire regimes. Successful projects on public and private lands utilize multiple strategies with long-term persistent management staffing and removal effort. The causes of alteration to the mesic pine flatwoods that encourage exotic plant invasion spread must be eliminated to achieve long-term eradication. If the causes are not addressed, then control is achievable only with repetitive persistent management. If management is suspended, gains can be quickly lost and exotic plants attain dominance.

Exotic animals known to occur in South Florida mesic pine flatwoods include: feral hog, armadillo, feral dogs, feral cats, coyote, Cuban tree frog, the brown anole, and fire ants. Feral hogs and armadillos can be managed by direct trapping and hunting. An alternative, concurrent strategy includes management for the natural predators of these species. So far no organized strategies to address exotic predators in mesic pine flatwoods have been developed. The spread of exotic animals into native mesic pine flatwoods has been assisted by fragmentation of the landscape by roadways, canals, agricultural and suburban development. It is clear that the greater the amount of developed edge areas relative to core areas of mesic pine flatwoods, the greater the potential for exotic animal invasion of the habitat.

Management for Extractive Land Use

Mesic pine flatwoods display a resilient recovery from overstory damage due to fire or clear-cutting, if the natural hydrology and fire regime are allowed to continue. Recovery is poor when hydrology or ground cover is disturbed.

Current best management practices for logging in the mesic flatwoods of South Florida utilize seed tree cutting strategies, rather than clear-cutting, but have relatively rapid 20- to 30-year rotations that eliminate all but a few of the mature old-growth trees, essential to red-cockaded woodpeckers. Removal of snags also reduces biodiversity in mesic pine flatwoods, as 53 different animal species depend upon the cavities found in the dead trees of mesic pine flatwoods.

Overdrainage and pasture conversion has changed the South Florida landscape from pine flatwoods to one dominated by rangeland. Following light grazing, the understory components of mesic pine flatwoods recover quickly, depending on the level of altered hydroperiod. Mesic pine flatwoods display a resilient recovery from grazing, if the natural hydrology and fire regime are allowed to continue and exotic, improved pasture grass species are not introduced. Recovery is poor when hydrology or ground cover is disturbed by improved pasture management.

Mitigation Policies

The mitigation policies of Federal, State and local regulatory agencies can significantly affect the management of mesic pine flatwoods of South Florida.

Those entities may encourage conversion of flatwoods into wetlands as mitigation for impacts to wetlands. Lower quality wetland preservation and enhancement is often preferred to the preservation of high quality upland habitats, including mesic flatwoods. This conversion of mesic flatwoods to wetlands typically fails because the necessary hydrology for the mitigation site is not achieved.

Restoration Science

To date, there has been no successful creation of mesic pine flatwoods from other landscapes. Successful restorations in existing mesic pine flatwoods have involved exotic plant and animal removal and control, restoration of hydrology, restoration of fire management, and removal of trash and debris.

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Restoration of Mesic Pine Flatwoods

Restoration Objective: Maintain the structure, function, and biological composition of hydric pine flatwoods, and increase the spatial extent of protected pinelands in South Florida.

Restoration Criteria

South Florida can contribute to the preservation of regionally significant aquifer recharge and fish and wildlife habitat values by preserving mesic flatwoods. The conservation and recovery of listed plant and animal species, wide-ranging species, neotropical birds, and large complexes of isolated and ephemeral wetlands will be accomplished by the preservation and restoration of this community.

The restoration objective will be achieved when: (1) the mesic pine flatwoods habitat is preserved through land acquisition or private landowner cooperative agreements, consistent with the GFC's "Closing the Gaps in Florida's Wildlife Habitat Conservation System," the Florida Panther Habitat Preservation Plan (South Florida Population), the Game and Fresh Water Fish Commission's Preservation 2000 Act Study (Biodiversity Conservation Analysis), current State/Federal land acquisition proposals (including CARL, SOR, *etc*.), other Federal listed species recovery plans, and regional wildlife habitat protection plans; (2) degraded areas are identified and restored to suitable hydric pine flatwoods habitat; (3) hydrology, fire and exotic plant management is regionally applied to restore and maintain regional plant and animal biodiversity; (4) the geographic extent of mesic pine flatwoods in South Florida is identified; and (5) the integrity of the habitat is maintained by proper South Florida management practices.

Community-level Restoration Actions

1. **Identify the extent of remaining mesic pine flatwoods habitat in South Florida.** Although the existing GIS, aerial photograph, and ground-truthed land cover information is available for this community throughout South Florida, a comprehensive regional analysis has not been conducted.

    1.1. **Detail the geographic extent of mesic pine flatwoods in South Florida.** This task should integrate existing GIS and other databases on land cover, soils, and hydrology, to correctly identify and separate mesic pine flatwoods from other pine flatwood and wetland types in South Florida**.** GIS typically cannot differentiate mesic from hydric flatwoods, resulting in an overestimate of the prevalence of mesic pine flatwoods.

1.2. **Update the GIS database for mesic flatwoods to monitor cumulative impacts.** As areas of mesic pine flatwood are converted to other land uses, changes should be mapped to identify cumulative habitat loss.

1.3. **Identify old-growth mesic flatwoods in South Florida.** Old-growth mesic pine flatwoods have the potential to sustain rare plant and animal communities. These areas provide unique habitats that are not replaceable within short time spans.

2. **Preserve remaining areas of mesic pine flatwoods.** Direct loss of habitat resulting from land conversion, habitat degradation, and fragmentation continues unabated in South Florida. However, many of the best remaining areas of intact mesic pine flatwoods have been identified for land acquisition.

2.1. **Complete purchase of the following CARL projects:** Allapattah Flats (Martin County), Atlantic Ridge Ecosystem (Martin County), Belle Meade (Collier County), Cape Haze/ Charlotte Harbor (Charlotte County), Charlotte Harbor Flatwoods (Charlotte County), Corkscrew Regional Ecosystem Watershed (Lee, Collier counties), Fakahatchee Strand (Collier County), Hall Ranch (Charlotte County), Ocaloacoochee Slough (Hendry, Collier Counties) Pal-Mar (Palm Beach, Martin Counties), Save Our Everglades-South Golden Gates Estates (Collier County), Sebastian Creek (Indian River, Brevard counties), South Savannas (Martin, St. Lucie counties), Lykes Brothers/Palmdale (Glades County).

2.2. **Complete purchase of the following Save Our Rivers projects:** Corkscrew Regional Ecosystem Watershed (Lee County), and Loxahatchee Slough (Palm Beach County).

2.3. **Develop additions to existing Federal and State land acquisition proposals in areas identified as GFC strategic habitat conservation areas and in the 1990 statewide charrette, including the following:** Estero Bay Watershed, South of Corkscrew Road, east of I-75 (Lee County); West and East of Burnt Store Road (Charlotte and Lee counties), North of Cape Coral (Lee County): east of the Babcock-Webb WMA (Charlotte County); Picayune Strand in North Golden Gate Estates (Collier County); North of Belle Meade (Collier County), South and East of Myakka Prairie (Sarasota County); Between Oscar Shearer SP and Pinelands Preserve (Sarasota County); East of the Southwest Florida International Airport (Lee County); North of Immokalee Road (Collier County); the Imperial River drainage (Lee County), areas along Horse Creek (Hardee and DeSoto counties), Brushy Creek (Hardee County), the Peace River (Hardee and DeSoto counties), the Green Swamp (Polk and Osceola counties), northern Palm Beach County and western Martin County.

2.4. **Implement cooperative habitat preservation programs with private landowners.** Much of the mesic pine flatwoods habitat is in private ownership and many private landowners may not choose to participate in fee-simple land acquisition projects (Lykes Brothers/Palmdale -Glades County). Protection through alternate methods may conserve important ecosystems by providing landowners with economic incentives and promoting good stewardship by ensuring that landowners view habitat as an asset, not a liability.

2.5. **Support and implement cooperative regional greenways programs with landowners and other agencies.** Greenways planning has successfully developed cooperative, local conservation plans that will maintain, establish, and manage landscape connections between important resource areas.

2.6. Target agency policy or proposed projects under review by COE, Water Management District, and DEP that degrade or eliminate mesic flatwoods habitat. Mesic flatwoods and other pinelands have declined in areal extent and patch size in South Florida because of characterization as non-jurisdictional and suitable wetland creation areas for on-site and off-site mitigation.

2.6.1. Stress avoidance of impacts of this habitat type as a regional permitting concern. Both consultants and permitting entities need to be educated on the importance of this habitat to regional wildlife.

2.6.2. Require type-for-type on- and off-site wetland mitigation when avoidance and minimization criteria have been exhausted. Both consultants and permitting entities often assess credit mitigation on the basis of the wetland depth, not the landscape importance or biodiversity value. This results in conversion of mesic flatwoods to wetland systems and on-site conversion of mesic flatwoods to ponds or pooled wetlands that often kill pine trees.

2.6.3. Examine federal nationwide and State and Federal general permit and permit exemptions to assess impacts on mesic pine flatwoods habitat. Piecemeal development and speculative land clearing in urbanizing areas under agricultural exemptions appears to exacerbate loss of pinelands in the South Florida Ecosystem.

2.7. Protect natural communities from point source and non-point source pollution.

2.8. Use existing regulatory mechanisms to protect mesic pine flatwoods by identifying their contribution to the function of adjacent wetlands and wetland-dependent species.

2.9. Promote protection of mesic flatwoods by encouraging local government resource planning, including identification of the importance, location, and areal extent in local government comprehensive plans.

3. Manage/enhance mesic pine flatwoods on public lands.

3.1. Develop/identify effective habitat management techniques to maximize the biodiversity of the mesic flatwoods community. South Florida mesic pine flatwoods may benefit from alternate management practices that are sensitive to hydrology, climate, and subtropical vegetation. Standard "southeastern" prescribed fire management, employed in the South Florida Ecosystem, may lower biodiversity of plant and animal species. Diversification of management techniques may increase biodiversity.

3.2. Implement or ensure continuance of habitat management on public lands. State and Federal land managers are faced with funding deficits that prevent or reduce management actions. Perpetual funding sources for staff and equipment should be secured.

3.3. Coordinate land management practices between public land managers. Management of mesic flatwoods on a landscape scale will benefit listed species, particularly wide-ranging species, game species, and neotropical migrants.

3.4. Establish management partnerships with private landowners. Successful fire management and hydrological practices can continue to be supported by or expanded to private lands to achieve a higher level of plant and animal diversity in

the South Florida Ecosystem. For some listed species, including the Florida panther and red-cockaded woodpecker, management partnerships may be critical to the regional South Florida recovery.

3.5. Create, maintain, or restore important habitat linkages. Public landowners should coordinate land acquisition and habitat management activities to ensure the protection of large, contiguous tracts of land that include a mosaic of native habitats, including mesic pine flatwoods. The maintenance of regional refugia for wide-ranging species such as the Florida panther or red-cockaded woodpecker may not be sufficient to protect these species in a developing landscape.

3.6. Identify and disallow incompatible public uses that degrade mesic pine flatwoods. Incompatible public uses that disrupt hydrology, prevent fire management, pollute, encourage exotic plant or animal invasion, overharvest resources, harvest resources too frequently, or destroy habitat beyond the ability for effective management should be identified and eliminated.

3.7. Monitor compatible adjacent land uses to protect mesic pine flatwood ecological function. Secondary and cumulative impacts to public lands can result from adjacent development, including loss of habitat, wildlife-endangering litter, chemical discharges, dumping, enhancement of exotic plant and animal invasion, prevention of fire management, alteration of adjacent hydrology, and noise/light pollution.

3.8. Encourage maintenance and recovery of natural ecotones. Ecotones are important elements of any natural landscape but may be overmanaged or eliminated by "restoration" efforts. Fire breaks and roads should be placed well away from ecotones. Ecotones that been degraded by existing roads and fire breaks should be restored.

3.9. Control exotic plants and animals.

3.10. Prevent collecting of rare plant species such as bromeliads on public lands. Discourage collecting of rare plant species on private lands.

4. Restore mesic pine flatwoods habitat where feasible.

4.1. Identify locations of mesic flatwoods habitat that can be restored.

4.2. Restore the natural seasonal hydroperiod and fire regime of mesic flatwoods communities. The natural South Florida pattern of fire occurrence and seasonal hydrology has contributed to the third highest plant species diversity of any community in South Florida and has resulted in this community being the dominant component of the South Florida upland landscape essential to wide-ranging wildlife.

4.3. Restore sheetflow hydrologic conditions by restoring the regional landscape to natural contour. Much of South Florida has been significantly altered by public and private drainage projects that have resulted in both overdrainage and flooding of natural systems. Where possible, off-site, regional hydrological restorations may be necessary to restore mesic flatwoods function. Areas where restoration should occur include the South Golden Gate Estates and Camp Keais Strand in Collier County, the Estero Bay watershed in Lee County, and the Babcock-Webb WMA in Charlotte County, Loxahatchee Slough in Palm Beach County, and the Charlotte Harbor Flatwoods CARL project in Lee and Charlotte counties.

4.4. Re-establish important habitat linkages by constructing wildlife crossings. A wide variety of development and linear infrastructure projects fragment mesic pine flatwoods. Future design and retrofit/rebuild of these projects should include

undercrossings, overpasses and other features that reduce wildlife mortality and preserve hydrology, and increase connectivity with adjacent habitat.

4.5. Enhance and manage pinelands containing beautiful pawpaw. Prevent habitat damage by off-road vehicle use, over-grazing by cattle and hogs, or over-collection.

4.6. Encourage mitigation banks that restore and enhance mesic pine flatwoods.

5. Identify, acquire and manage mesic flatwoods for the conservation of wide-ranging state and federally listed species. The preservation of pinelands, including mesic pinelands, is critical to the recovery of the Florida panther, Florida black bear, red-cockaded woodpecker, bald eagle, eastern indigo snake, Florida sandhill crane, Big Cypress fox squirrel, Sherman's fox squirrel, and southeastern American kestrels, as well as neotropical migrants.

5.1. Complete purchase of and manage mesic flatwoods in the Belle Meade and South Golden Gate Estates CARL projects for regional protection of Florida panther, Florida black bear, eastern indigo snake, Big Cypress fox squirrel, Florida sandhill crane, and other wildlife.

5.2. Complete purchase of and manage mesic flatwoods in the coastal areas to augment neotropical migratory bird migration and bald eagle foraging and nesting activities, including at the Charlotte Harbor Flatwoods and Cape Haze/Charlotte Harbor Buffer CARL projects, and Pine Island.

5.3. Complete purchase of and manage mesic flatwoods within Priority I and II areas identified in the Florida Panther Habitat Preservation Plan.

5.4. Complete purchase of and manage mesic flatwoods on the east coast for a diverse assemblage of non-game species, including at the Pal-Mar, Atlantic Ridge Ecosystem, Loxahatchee Slough, and Allapattah Ranch CARL projects.

5.5. Determine if old-growth mesic pinelands support red-cockaded woodpecker clusters. Red-cockaded woodpeckers nest and roost in cavities that are typically are excavated in old-age living pines if available. Study the utilization of mesic pine flatwoods by red-cockaded woodpeckers, including development of landscape-scale management recommendations for the recovery of this species in South Florida**.**

5.6. Manage pinelands on public lands in southwest Florida to expand occupation by red-cockaded woodpeckers. The large contiguous public preserves that begin in the Picayune State Forest (Belle Meade and South Golden Gate Estates) and extend east and north the Fakahatchee Strand, Florida Panther NWR and Big Cypress National Preserve should be managed as a larger ecological reserve to improve and augment the existing red-cockaded woodpecker population in southwest Florida.

5.7. Exclude fire from identified areas of mesic flatwoods that include understory thickets of tall thick palmetto to provide resting and denning cover for panthers.

5.8. Prioritize the protection of coastal mesic flatwoods as bald eagle nesting habitat, and neotropical migratory bird habitat. Bald eagles prefer nest and perch sites on the largest and tallest trees available near large, open water bodies and are primarily coastal in South Florida. Neotropical birds require available forage as close to the coast as possible to augment migration across the Gulf of Mexico and Caribbean. Coastal pinelands are targeted for urban and agricultural development. Pine Island in Lee County is an example of an area of pinelands that should be protected.

5.9. Identify important habitat linkages. Important connecting areas include: CREW to the Southwest International Airport mitigation lands (Lee County), Rookery Bay National Estuarine Research Reserve to Belle Meade CARL (Collier County), Corkscrew Sanctuary to Lake Trafford (Lee and Collier counties), Babcock-Webb WMA to Charlotte Harbor Flatwoods and Charlotte Harbor State Buffer Preserves (Charlotte County).

6. Complete purchase of and manage mesic flatwoods in contiguous, connected, unfragmented patches for the conservation of South Florida biodiversity, including nongame species, rare and unique species, and keystone species such as the swallow-tailed kite, Florida weasel, and various owl and raptor species.

6.1. Purchase additional mesic flatwoods for the preservation of the beautiful pawpaw. Very few populations of this plant are protected on public lands. The Charlotte Harbor Flatwoods (Charlotte County) area should be prioritized for ongoing and additional public land purchase.

6.2. Determine if old-growth mesic pine flatwoods support rare plant and animal species, or specific species guilds. Examine the habitat value of mesic pine flatwoods for rare and endemic plants. Old-growth pinelands may support rare and unique species of plants and animals or community guilds.

6.3. Inventory and characterize the importance of mesic flatwoods to avian populations, particularly neotropical migrants, owls and raptors.

6.4. Examine wading bird use of the wetland enclosures of mesic pine flatwoods, including prairies and freshwater "isolated" wetlands.

7. Perform additional research on mesic pine flatwoods.

7.1. Survey mesic flatwoods in southwest Florida for the beautiful pawpaw, and conduct research on appropriate fire regimes for this species. Updated surveys for the beautiful pawpaw have not been conducted. The range of this species should be determined in order to better understand how to manage the population.

7.2. Determine what fire regimes are recommended in mesic flatwoods to stabilize or increase beautiful pawpaw populations on public lands in southwest Florida.

7.3. Perform a hydrologic study of the water recharge potential of mesic pine flatwoods under natural hydrologic conditions.

7.4. Examine the correlation between soil type and mesic pine flatwoods habitats.

7.5. Examine the influence of fire regimes in maintaining optimal plant and animal species diversity.

7.6. Examine invertebrate diversity and life-cycles in the mesic pine flatwoods.

7.7. Monitor mesic pine flatwoods to evaluate biodiversity. Monitor community-level processes, community structure, and community composition, including rare and keystone species, and species guilds.

7.8. Improve reference ecosystem information for community composition, biodiversity, and site-to-site variability.

8. **Increase public awareness concerning mesic pine flatwoods**. Identify mesic flatwoods in text, maps, and on resource presentations to raise public awareness of the different types of pine flatwoods. Stress the important ecosystem function of isolated and ephemeral wetlands included in the mesic flatwoods community. Establish the landscape-scale importance of this community to wide-ranging species and the significance of regional losses of this habitat in South Florida.