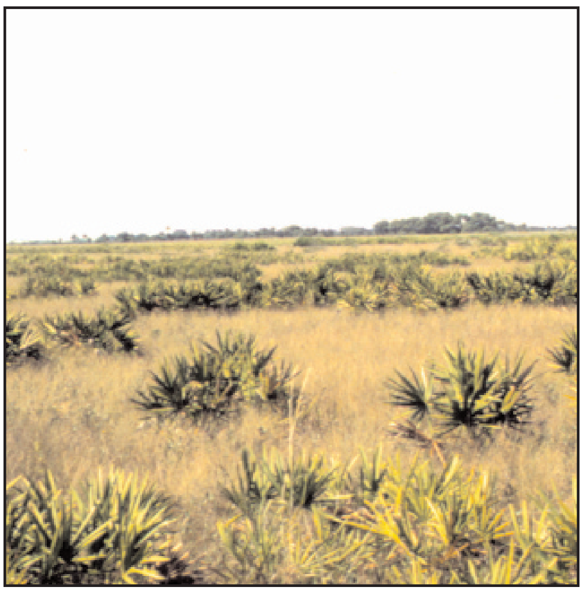
Dry Prairie

FNAI Global Rank:	**G2**
FNAI State Rank:	**S2**
Federally Listed Species in S. FL:	**6**
State Listed Species in S. FL:	**31**

Dry prairie. *Original photograph courtesy of U.S. Fish and Wildlife Service.*



The dry prairie ecosystem consists of a poorly known suite of natural communities endemic to central peninsular Florida. Historically, dry prairie occurred within interior portions of south-central, west-central and central peninsular Florida, mainly on the Okeechobee, Osceola and Desoto plains. Dry prairie is found on nearly level, poorly drained interdrainageway flatlands, on nutrient-poor, sandy to sandy clay Alfisols with a somewhat calcareous clay subsoil and on Spodosols. Dry prairie soils are characteristically saturated during extended wet periods due to the loamy to clayey subsoils, generally low landscape position, and lack of surface drainage features.

Dry prairie is essentially treeless, a pyrogenic landscape with a ground cover diverse in regionally endemic plant taxa and dominated by *Aristida beyrichiana* (wiregrass), scattered, low, stunted *Serenoa repens* (saw palmetto), and low-growing *Quercus minima* (runner oak). The typical dry prairie has a mixture of upland and wetland plants, with the most conspicuous indicator of this mixture being the co-occurrence of *Quercus minima* and *Xyris elliottii*. Five natural community types of dry prairie are tentatively identified [dry (sub-xeric) type, dry-mesic sandy type, mesic type, wet-mesic alfic soil type, and wet-mesic spodic soil type] based upon quantitative vegetation analysis of dry prairies. Each of these community types tends to be correlated with variation in hydrologic regimes (seasonal variation in water table) and edaphic conditions, with ground cover composition similar to that of pine flatwoods and wetland pine savannas in south-central Florida.

In typical, undisturbed, undrained condition, the south-central Florida dry prairie landscape is a mosaic of interdigitating dry prairie and wet prairie, interspersed with ephemeral depression ponds or marshes, mesic hammocks, and slough or swale-like drainages. Dry prairie probably occurred as broad areas with a higher fire return frequency, compared to the mesic pine flatwoods-pine savanna-depression marsh landscape mosaic. Dry prairie can be thought of as the endpoint along a forested to treeless continuum of flatwoods to savanna landscapes, in response to variation in the natural fire regime. In regions devoid of major natural fire barriers, such as in the historical dry prairie landscape, fire is reported as occurring annually or biennially. The treeless condition, a natural feature of dry prairie, is not simply an artifact of human manipulation. Evidence for extensive naturally treeless areas of dry prairie is supported by the mapping of prairie areas in the pre-settlement public land survey and early historical accounts.

Unlike most other grasslands in the southeastern United States, Florida dry prairie harbors numerous endemic vertebrates. Interior dry prairie is considered to be one of four geographic and/or ecological communities in Florida with a concentration of high-ranked vertebrate taxa. Several of the high-ranked avian taxa are near-endemic to the dry prairie region of south-central Florida. Of these, some are not found exclusively in native prairie habitat, but are capable of persisting in anthropogenic altered landscapes (semi-improved pastures, improved non-native pastures, disturbed rangelands, *etc.*). *Ammodramus savannarum floridanus* (Florida grasshopper sparrow) is a federal and state endangered subspecies which is endemic to the prairie region of south-central peninsular Florida. Frequently burned dry prairie is the preferred natural habitat for this non-migratory subspecies, although it is also documented from degraded prairie and other rangeland sites.

Estimates of the historical and current extent of dry prairie vary substantially. Although dry prairie is declining, there are still considerable opportunities for protection. However, there continues to be fragmentation and a reduction in area of high-quality prairie, and an even greater reduction in the number of sites with a continuous fire history and minimal human disturbance. Perhaps the most reliable method to evaluate the original extent of dry prairie is through examination of the pre-settlement land surveys. These land surveys provide documentation on the overall extent and distribution of pre-settlement dry prairie.

Overall management of dry prairie should strive to mimic natural ecological processes (frequent fire, landscape burns, natural hydrology, *etc.)* and provide adequate protection of dry prairie biodiversity. Critical management issues and challenges include prescribed burning, hydrologic alterations, rangeland and livestock grazing, protection of endangered species, control of exotics, and the impact of mechanical treatments. Recent large-scale protection efforts in south-central Florida are encouraging and will hopefully provide protection of remnant dry prairie landscapes.

Synonymy

Examples of true dry prairie are sometimes referred to as palmetto prairie (Huck 1987, Sullivan 1994, Kuchler 1964 [Kuchler Type K079]), palmetto grasslands (Grossman *et al.* 1994), saw-palmetto prairie (Davis 1943), palm savanna (Harper 1927), pineland three-awn range (Sullivan 1994), Florida dry prairie (Grossman *et al.* 1994, Weakley *et al.* 1996), flat prairies (Harper 1921), wiregrass prairies, or South Florida flatwoods with “few, if any trees” (Soil Conservation Service 1989). In a recent vegetation classification scheme for the

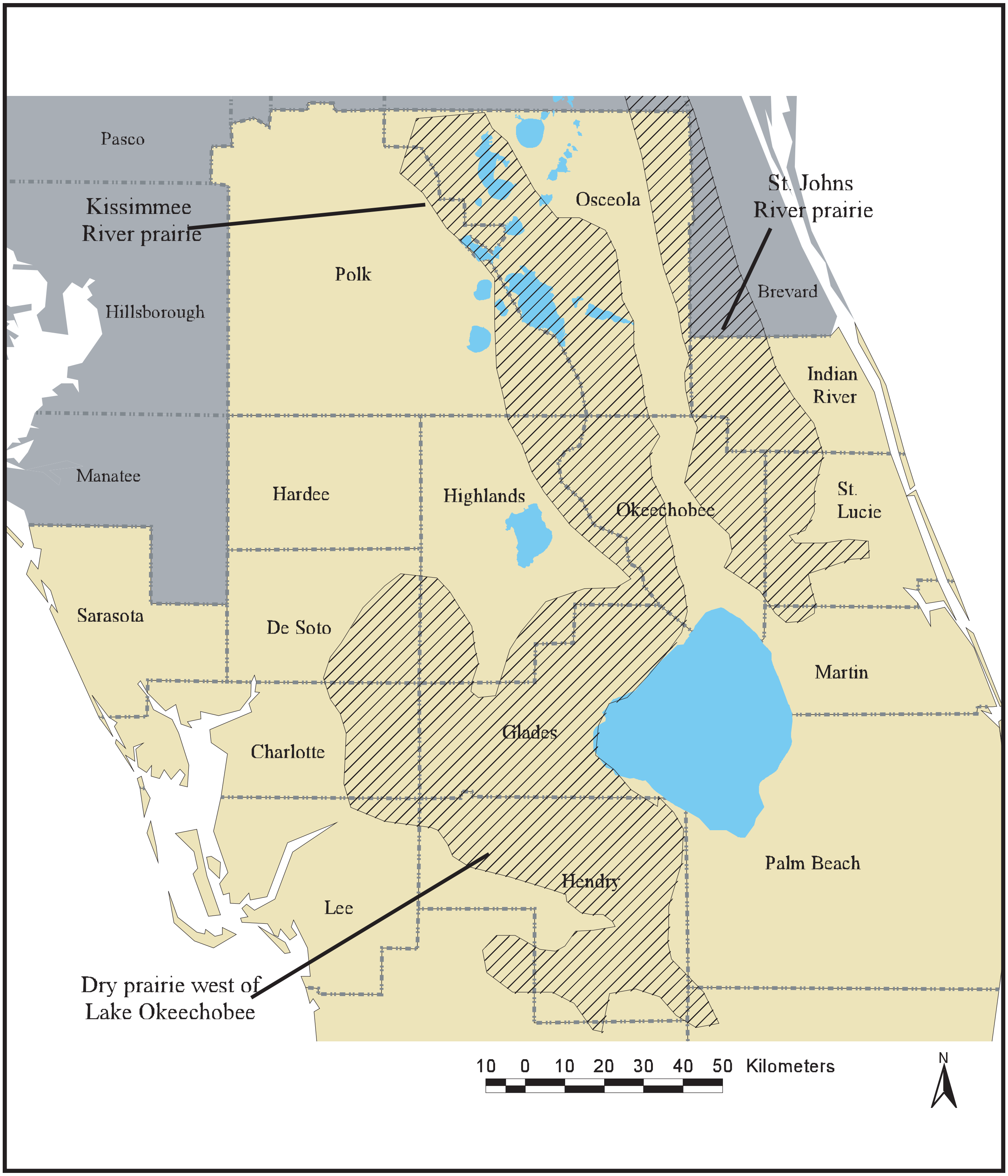


Figure 1. The distribution of dry prairie in South Florida (modified from DeSelm and Murdock 1993).

southeastern United States (Weakley *et al.* 1996), Florida dry prairie is classified as *Serenoa repens/Aristida beyrichiana* upland shrub herbaceous vegetation (saw palmetto/southern wiregrass upland shrub herbaceous vegetation). Clearcut areas of mesic flatwoods are often erroneously referred to as dry prairie, therefore the following names are commonly used interchangeably by resource managers, land stewards, and ranchers for native dry prairies, cut-over flatwoods, treeless mesic flatwoods, and non-forested flatwoods. The FLUCCS code for this account includes: 321 (palmetto prairies), and 310 (herbaceous).

Distribution

General Distribution of Dry Prairie Regions

Historically, the distribution of dry prairie included several disjunct areas of central peninsular Florida (Harshberger 1914, Davis 1943, Harper 1921, 1927, DeSelm and Murdock 1993) (Figure 1). Harshberger (1914) is perhaps the first to provide a map of "prairie vegetation" for south-central and South Florida. He delineates three large areas of prairie: (1) along the Kissimmee River north of Lake Okeechobee, (2) an extensive area west of Lake Okeechobee from south of Fisheating Creek extending northwest to Crewsville and Fort Ogden, and (3) a smaller area north of Charlotte Harbor (in present-day Sarasota and Manatee counties). Davis (1943) also delineates several large areas of "grasslands of prairie type" from parts of nine central Florida counties (DeSelm and Murdock 1993). The Davis (1943) map has been erroneously interpreted as the original distribution of Florida dry prairie, however Davis's map of "grasslands of prairie type," clearly includes other prairie types, many of which are currently referred to as wet prairies and seasonal marshes. Both Davis (1943) and Harper (1921,1927) give some indication of the historical distribution of Florida dry prairie. Harper (1927), depicts two regions of dry prairie. One is centered in Okeechobee County and extends west of the Kissimmee River, and another is centered on Desoto and Glades counties with a southern extension into Hendry and northern Collier counties. Harper (1927) commented that prairies occurred along both sides of the Kissimmee River extending westward with some interruptions nearly to Arcadia and Fort Ogden, forming a region of vast treeless prairie covered with grasses and low bushes. Prairies along the Kissimmee River are somewhat separated from the western prairies by the "Indian Prairie," a palm savanna and marsh region between Lake Istokpoga and Lake Okeechobee (Harper 1927). The Indian Prairie region defined by Harper (1927) in eastern Glades County and southeastern Highlands County had a wetter general landscape dominated by *Cladium jamaicense* (saw grass), and seasonally wet prairies with abundant *Sabal palmetto* (cabbage palm) hammocks and savannas, perhaps with isolated patches of dry prairie on the highest, least wet, soils (Harper 1927). Harper (1927) also notes smaller areas of dry prairie in Manatee and other counties. DeSelm and Murdock (1993) show three general areas of prairie in peninsular Florida-St. Johns River prairie, Kissimmee River prairie, and dry prairies west of Lake Okeechobee; the latter two correspond to areas known for dry prairie.

Kissimmee River Dry Prairie Region

The prairie region centered in Okeechobee County consists of a band of dry prairie, stretching nearly 48 km (30 miles) east to west at some points, adjacent to the Kissimmee River valley from western Osceola County south to Lake Okeechobee, with the greatest extent east of the Kissimmee River in western Okeechobee County. Although the greatest extent of dry prairie in this region lies primarily south of Lake Kissimmee, Davis (1943) maps prairie extending north from the upper Kissimmee River to Lake Tohopekaliga. Harper (1921) commented that the prairies bordering this and other large lakes (see Harper 1921, pg 137 for photo) near the city of Kissimmee are probably different than those further south along the Kissimmee River. However, prior to Harper's (1921) publication he had not been able to access the "Kissimmee River Prairies" on account of their remoteness from railroads. Harshberger (1914) describes extensive prairie north and west of Lake Okeechobee, often extending for 32 to 48 km (20 to 30 miles).

Other Dry Prairie Regions

The dry prairies centered on Desoto and Glades counties occur in the eastern two-thirds of Desoto, northern Charlotte, and Glades counties and were described by Davis (1943) and Harper (1927). This expanse of dry prairie occupied a flat plain that was roughly bounded to the south by the Caloosahatchee River valley, extending northwest nearly to the lower Peace River valley, and east and southeast to south of Fisheating Creek. Harper (1927) notes that before Desoto County was divided into five counties in 1921, it had an area of about 9,713 square km (3,750 sq mi), about 50 percent of which was prairie. During World War I, two aviation fields (Carlstrom and Dorr) were established, perhaps influenced by the suitability of this treeless terrain, at the edge of the prairie a few miles east of Arcadia (Harper 1927). Harshberger (1914) describes the "largest typic prairie" from north of the Caloosahatchee River, along the western shore of Lake Okeechobee, west of Peace Creek, bisected by Fisheating Creek, and centered on Citrus Center. Harshberger (1914) described this area as a prairie grass formation with sod-forming grasses, and some palmetto hammocks. This prairie was described by Harshberger (1914) as grading into sawgrass vegetation where it meets the Everglades at Lake Hicpochee, and merging into pine savanna where it blends into the pine woods. Harshberger (1914) also describes a large semi-circular prairie along the western edge of the Everglades and the Okaloacoochee Slough.

Other dry prairie areas of somewhat lesser extent are mapped by Davis (1943) and mapped, described or photographed in Harper (1927). An outlier region of dry prairie is delineated in Sarasota and southern Manatee counties (Harshberger 1914, Davis 1943, Harper 1927). It occurs in rather close association with the Myakka River valley. Davis (1943) also shows dry prairie in eastern Hendry County and a outlier in northern Collier County. Harper (1927) has a photograph of what is most certainly a dry prairie about five miles north of Immokalee in Collier County.

Other Prairie Regions of Peninsular Florida

Other prairie areas occur in Volusia, Brevard, Palm Beach, and Collier counties, but are not considered in this account since the authors believe these are not a part of the dry prairie landscape, but represent other distinct community types.

A prairie area with north-south orientation, of rather narrow linear strips extending from southeastern Volusia County into western Brevard County through Indian River County and southward into central and western St. Lucie County is mapped by Davis (1943). Harper (1921) mentions prairies scattered through the central portion of Volusia County, and for several miles on either side of the upper St. Johns River. Harper (1921) includes a photograph taken in 1915 of a "nearly treeless prairie in Brevard County about 12.1 km (7.5 miles) west of Melbourne and four miles from the St. Johns River" and notes that "between this point and the St. Johns River there are practically no trees." Harper (1921) describes flat prairies: "going westward from Melbourne one first passes through continuous pine forests for a few miles, and then small prairies begin to appear, gradually becoming larger, and the pines between them smaller and more scattered, until at a distance of about seven miles from the Indian River or four miles from the St. Johns River the trees are all left behind, and the prairie extends beyond the horizon both north and south" (Harper 1921). These areas are not dry prairie, and are best interpreted as shallow seasonal marshes associated with the broad, flat floodplain of the St. Johns River, and are characterized by sand cordgrass (*Spartina bakeri*). Areas mapped as "grasslands of prairie type" by Davis (1943) elsewhere in peninsular Florida *(i.e.* coastal Palm Beach County) are not dry prairies, but probably represent other shallow, seasonally inundated wet prairies or marshes.

The extensive areas of marl prairies (*i.e.* Copeland, Airplane, Windmill, and Buckskin prairies) with their calcareous subsoils, characteristically found in the northern portion of the Big Cypress region, are distinct from the arenaceous, more acidic dry prairies. Marl prairies are discussed in the freshwater marshes and wet prairies account.

Description

Florida dry prairie is a natural landscape that is endemic (Fitzgerald and Tanner 1992, Bridges 1997) to the state, with no similar communities found in adjacent states. It is geographically restricted to the interior of central, south-central and west-central peninsular Florida. Dry prairie is often (but not exclusively) found on the same soil series, topographic positions, and moisture regimes as mesic flatwoods, with dry prairie being the essentially treeless endpoint of a continuum of variation in canopy cover across pine flatwoods landscapes in central Florida.

Physiographic and Topographic Parameters

Extensive areas of dry prairie vegetation once occurred in the Gulf coastal lowlands, Atlantic coastal lowlands, and intermediate coastal lowlands physiographic regions of peninsular Florida, as defined by Schmidt (1997). Within the Gulf coastal lowlands physiographic region, extensive areas of dry prairie occurred on the Desoto Plain (in most of Desoto, southern Hardee, western Highlands, northeastern Charlotte, southern Manatee, and part of Glades counties) and within the Gulf coastal lowlands (in parts of Sarasota and southern Manatee counties). In the Atlantic coastal lowlands, prairie occurred on the Osceola Plain (in parts of Okeechobee, northern Highlands, southeastern Polk, and Osceola counties), and perhaps in the Eastern Valley (in parts of St. Lucie, Indian River, Brevard, and Volusia counties). Prairie also occurred on the intermediate coastal lowlands on the Okeechobee Plain (in northeastern Glades, southeastern Highlands, and southwestern Okeechobee counties) and the Immokalee Rise (in part of Hendry County and northern Collier County [Harper 1927]).

In each of these Florida physiographic regions, dry prairie occurs on nearly level, poorly to somewhat poorly drained, interdrainage flatlands above major river/stream floodplain valleys. Typically, the flatlands characteristic of the Osceola Plain are dotted with numerous small shallow depressions (with ephemeral ponds and marshes), but have very few surface drainage features. Developed on flat plains, the dry prairies at Avon Park AFR are generally below the 19.6 m (65 ft) contour (Bridges 1998b). It is unclear why the dry prairie landscape at Avon Park AFR is lower in elevation than the other landscape associations on the Osceola Plain at this site, but it seems to be correlated with the proximity of major drainages such as Arbuckle Creek, Arbuckle Marsh, and the Kissimmee River (Bridges 1998b). At Myakka State Park, in Sarasota and Manatee counties, dry prairie occurs from 10.7 to 12.2 m (35 to 40 ft) in elevation (Fitzgerald and Tanner 1992). Dry prairies centered on Desoto and Glades counties on the Desoto Plain are above 12.7 m (42 ft) in elevation (Davis 1943, Harper 1927).

Edaphic and Hydrologic Parameters

Dry prairie is best developed on acidic, nutrient-poor, poorly drained, sandy to sandy clay soils in either Spodosol (Abrahamson and Hartnett 1990) or Alfisol soil orders (Bridges 1997), with a tendency to occupy a greater percentage of the area mapped as Alfisols or soils in alfic subgroups (Bridges 1997, 1998b). Alfisols are similar in hydrology to the typical mesic flatwoods soils (Spodosols) of central Florida, but perhaps holding water slightly longer during wet periods due to their loamy to clayey subsoils, generally lower landscape position, and poorly developed surface drainage features. Table 1 summarizes the taxonomic classification for soil series known to occur on dry prairie sites in the Kissimmee River prairie region of central Florida, all of which are in the poorly drained drainage class. The predominant soil association and secondary soil associations most commonly associated with dry prairie in each county are listed in Table 2.

The soils of at least some dry prairies contain few weatherable minerals and have low levels of clay and nutrients in the surface soil layers (Abrahamson and Hartnett 1990, Weakley *et al.* 1996, Grossman *et al.* 1994). Therefore, nutrient storage and availability can be dependent on the amount and type of dead organic matter present (Abrahamson and Hartnett 1990). The hardpan (a spodic or argillic layer), where present, in dry prairies substantially reduces the movement of water below and above its surface, such that the sites may become flooded for short periods during heavy summer rains (Bridges 1997, FNAI and DNR 1990, Weakley *et al.* 1996, Grossman *et al.* 1994). However, the normal water table is below the ground surface during most of the year, typically one meter or so below the surface during the dry winter season. During the dry season, high evapotranspiration draws much water from the upper horizons, and persistent droughty conditions result (Abrahamson and Hartnett 1990). Presumably, the depth and degree of development of these subsurface hardpans (spodic and argillic layers) influence hydrology and plant growth. This gives competitive advantages to certain species, resulting in gradients in plant community composition over slight differences in elevation and hydrology. However, the mechanisms and details of this influence is poorly known, and these complex hydrologic/edaphic relationships may be critical in our understanding of the ecosystem dynamics of the dry prairie landscape.

The term "dry" prairie is somewhat of a misnomer. In undrained dry prairies standing water can drain as overland sheet flow in the summer wet season, or even in the winter (the typical dry season) during El Nino years, for periods of a month or more. Dry prairies are "dry" only when considered relative to the other typically treeless communities of Central Florida-wet prairies (with hydroperiods of two months or longer) and freshwater marshes (Bridges 1997). The average percent cover for plant taxa by hydrologic zones in dry prairie are given in Table 3.

Vegetative Structure and Composition

Plant nomenclature essentially follows Wunderlin *et al.* 1996. There are several generalized vegetation descriptions of Florida dry prairie (Abrahamson and Harnett 1990, Bridges 1997, 1998a, Chafin *et al.* 1997, FNAI and FDNR 1990, Grossman *et al.* 1994, Harper 1921, Harper 1927, Hilsenbeck 1994, Huffman and Judd 1998, Weakley *et al.* 1996). However, there have only been a few quantitative vegetation studies of dry prairie (Bridges 1997, Bridges and Reese 1998, Cole *et al.* 1994a, 1994b, Huck 1987). At first glance, dry prairie may appear to be a relatively homogeneous mixture of *Aristida beyrichiana*, *Serenoa repens*, and a few other species. Contrary to this perception, there is substantial local variation in diversity, composition, and dominance of plant species. In such a flat environment, even small changes in elevation can result in different vegetation associations. Similar slight changes in soil type can also produce marked change in vegetation associations.

Dry prairie is an essentially treeless (Harshberger 1914), pyrogenic community with a ground cover diverse in regionally endemic plant taxa. It is most commonly dominated by wiregrass, sparse, scattered, low stunted saw palmetto, and low-growing runner oak (Bridges 1997). Quantitative sampling of vegetation across hydrologic gradients within dry prairie at Avon Park AFR (Polk and Highlands counties), Kissimmee Prairie State Preserve (Okeechobee County), Ordway-Whittell Kissimmee Prairie Sanctuary (Okeechobee County) and Three Lakes WMA (Osceola County) in 1995 and 1997 confirm that these three species share dominance in most frequently burned dry prairies (Bridges and Reese 1998). Other common shrubs of dry prairie include *Lyonia fruticosa, Lyonia lucida, Ilex* *glabra,* and *Vaccinium myrsinites* (Bridges 1997, Huffman and Judd 1998). In frequently burned sites, shrub cover is reduced, resulting in a diverse herbaceous ground cover (Bridges 1997, Cole *et al.* 1994a). Other characteristic grasses of dry prairie include *Andropogon ternarius* var. *cabanisii, Andropogon virginicus* var. *decipiens, Schizachyrium stoloniferum,* and *Sorghastrum secundum*. Typical dry prairie has a mixture of wetland and upland plants, the most characteristic of these mixtures being the co-occurrence of *Quercus minima* and *Xyris elliottii* (Bridges 1997). As wetter areas are reached, there tends to be an increase in wet-mesic species such as *Ctenium aromaticum* and *Xyris ambigua* (Bridges 1997). Table 4 includes the vascular plant taxa recorded as occurring in dry prairie from selected central Florida counties, and Table 5 includes those plant taxa recorded from dry prairie in at least three counties of the seven counties with dry prairie floristic data.

Field surveys in central Florida (Bridges 1997) show that the floristic composition of dry prairie is similar to that of mesic and wet-mesic pine flatwoods, and a number of authors have noted that dry prairie differs little from pine flatwoods except for the absence of pine trees (Abrahamson and Hartnett 1990). There has been a prevalent misconception that Florida dry prairie consists of mesic pine flatwoods which unnaturally lack a pine canopy, presumably due to unnaturally frequent fire (Steinberg 1980), past clear-cutting, and/or continuous livestock grazing (Abrahamson and Harnett 1990, Weakley *et al.* 1996, Grossman *et al.* 1994, FNAI and FDNR 1990). Rather, the essentially treeless condition, a natural feature of dry prairie, is not simply an artifact of human manipulation. Strong evidence for naturally treeless areas of dry prairie in central Florida is provided by the mapping of extensive prairie areas on the pre-settlement public land surveys (Bridges 1998a, b; Huffman and Judd 1998) and early historical accounts attesting to the treeless conditions (Harper 1921, 1927; Harshberger 1914).

Dry prairie is an exceptionally species-rich natural community type. A total of 240 vascular plant taxa were present in 590 m^2 (10.8 ft^2) plots sampled to characterize dry prairie vegetation (Bridges 1997, Bridges and Reese 1998). The average number of species per plot for these 590 plots sampled at 17 sites is 22 (Bridges 1997, Bridges and Reese 1998). There is considerable variation in number of species per plot, with a low of 9 species per plot, and a high of 41 species per plot. The largest number of plots contained from 16 to 28 species, and relatively few plots were much lower or higher than this average. Peet and Allard (1993) report that only three natural communities in the Western Hemisphere have had plots recorded with over 40 species per square meter. These are Atlantic longleaf pine savannas (North Carolina), Southern longleaf pine savannas (Mississippi), and fall-line longleaf pine seepage savannas (North Carolina). However, it should be noted that their study included only limited plant community sampling in Florida.

Five natural community types of dry prairie [dry (sub-xeric) type, dry-mesic sandy type, mesic type, wet-mesic alfic soil type, and wet-mesic spodic soil type] are tentatively described, based in part upon quantitative vegetation analysis of south-central Florida dry prairies. These community descriptions and their relationships to environmental gradients within the dry prairie landscape are based upon Bridges (1997, 1998a), and may be subject to revision based on continuing data analysis (Bridges and Reese 1998).

Dry (sub-xeric) Community Type of Dry Prairie

Dominant species: *Aristida beyrichiana*, scrub oaks (*Quercus myrtifolia, Q. geminata, Q. chapmanii*), *Serenoa repens, Lyonia fruticosa.*

The dry (sub-xeric) community type of dry prairie occurs in scattered roughly circular to elliptic patches, mostly associated with the escarpments above floodplains. These areas are often incorrectly referred to as "scrub". They do not fit the definition of either scrub or scrubby flatwoods, but they have more characteristics in common with scrubby flatwoods than scrub. They differ from scrubby flatwoods only in the absence of a pine canopy, and can be thought of as a treeless variant of this community within a dry prairie landscape mosaic. The dominant species in the community type include *Quercus geminata, Q. myrtifolia, Q. chapmanii, Lyonia fruticosa, L. lucida, Serenoa repens, Befaria racemosa, Aristida beyrichiana*, and *Vaccinium myrsinites*. Although present in other natural community types (*i.e.* scrub and scrubby flatwoods) differential species that distinguish this community type from other dry prairie community types are the semi-evergreen, sclerophyllous xeric oaks. Other characteristic species of this community type are often restricted to herbaceous sandy openings, and include *Balduina angustifolia, Piloblephis rigida, Palafoxia integrifolia, Rhynchospora intermedia*, and *Polygonella polygama*. These herbaceous openings also support large populations of seasonal wetland species, such as *Drosera brevifolia, Syngonanthus flavidulus, Eleocharis baldwinii, Utricularia subulata*, and *Xyris brevifolia.* The presence of these herbaceous species indicative of seasonally saturated soils serves to easily distinguish the dry community type of dry prairie from scrub, and does not support any wetland herbs. Also, this community type lacks any narrow scrub endemic plant or vertebrate species, particularly such widespread and characteristic scrub species as *Garberia heterophylla, Persea borbonia* var. *humilis,* and *Sceloporus woodi* (Florida scrub lizard). However, like scrub, it can support oak-dependent wildlife species *(i.e. Aphelocoma coerulescens*, Florida scrub-jay). Also, in contrast to scrub, there are few to no white sandy openings within the community type except along cleared roadsides. Openings tend to be quickly vegetated by wiregrass and other grasses in this community type of dry prairie.

This community type occurs as patches on very slight rises within the dry prairie matrix, often only a few feet above the surrounding landscape. These dry patches tend to be more concentrated near the drainage escarpments of the major sloughs and along river escarpments at the edge of the dry prairie landscape.

This community type has very consistent soils, all with a deep strong spodic horizon. Examples are found on Pomello fine sand (Typic Haplohumods), although some are also mapped as Immokalee fine sand (Arenic Haplaquods). The Immokalee soil series has spodic layers ranging from 76 cm (30 in) to at least 137 cm (54 in) deep, whereas the Pomello soil series has spodic layers ranging from 140 cm (55 in) to 155 cm (61 in) deep. The proximity of a major drainage feature to these soils serves to more quickly lower the water table after rainfall events, enhancing drainage and thereby reducing the duration of soil saturation.

The fire frequency of this community is naturally less than in typic dry prairie, but parts may burn as often as every 5 years, while other parts of the same patch may escape fire for 10 to 15 years.

Dry-mesic Sandy Community Type of Dry Prairie

Dominant species: *Serenoa repens, Quercus minima, Aristida beyrichiana, Andropogon ternarius* var. *cabanisii, Lyonia fruticosa, Lyonia lucida.*

This community type has several frequent and/or dominant species which serve to distinguish it from all other dry prairie community types, other than the dry, oak-dominated type. Although this type would be considered as poorly drained, and has strong soil spodic layers which result in high perched wet-season water tables, the soils of this type are rarely saturated to the soil surface for extended periods. The species occurring in dry-mesic sandy prairie reflect these drier hydro-edaphic conditions. Common dominants, in addition to those species present in other dry prairie types, include *Andropogon ternarius* var. *cabanisii,* and a greater abundance of shrubs such as *Hypericum reductum, Lyonia fruticosa* and *Lyonia lucida*. These species, although occurring in other dry prairie communities, are comparatively unimportant in the wetter community types. The dry-mesic sandy community type also has a group of species not encountered within the other dry prairie community types (except the dry type). The most important of these include *Lachnocaulon beyrichianum, Cnidoscolus stimulosus, Chapmannia floridana, Carphephorus corymbosus,* and *Euphorbia polyphylla*. Other characteristic species that usually have higher importance values within this community include *Gaylussacia dumosa, Gratiola hispida, Gymnopogon chapmanianus, Licania michauxii, Liatris tenuifolia* var. *quadriflora, Myrica cerifera, Pityopsis graminifolia, Pterocaulon pycnostachyum, Polygala setacea, Schrankia microphylla* var. *floridana, Scleria pauciflora, Sorghastrum secundum,* and *Xyris caroliniana*.

This community type has very consistent soils, all with a deep strong spodic horizon, with the top of the spodic horizon ranging from 67 (26 in) to 122 cm (48 in) below the surface. Most of these soils are clearly of the Immokalee soil series (Arenic Haplaquods), which can have spodic layers beginning at 76 cm (30 in), and ranging to at least 137 cm (54 in) deep. Some examples with shallower spodic layers would fall at the deep end of the Myakka soil series (Aeric Haplaquods). None of the soils have a clay subsurface horizon, and almost all lack a mucky sand surface layer.

Mesic Community Type of Dry Prairie

Dominant species: *Aristida beyrichiana, Serenoa repens, Quercus minima.*

This community type is closest to the dry-mesic community type, but occurs on slightly lower landscape positions or on soils with shallower spodic layers. Common dominants include only those species which are dominant across the prairie/flatwoods landscape: *Aristida beyrichiana, Serenoa repens,* and *Quercus minima*.

Common species with higher frequency within this community type than in wet-mesic and dry-mesic prairie include a diversity of *Andropogon* species. In particular, common species occurring much more frequently within this community type that serve to distinguish it from wetter sites include *A. brachystachyus, A. virginicus* var. *decipiens, Schizachyrium stoloniferum, Eleocharis baldwinii, Xyris brevifolia, Ilex glabra, Myrica cerifera, Pityopsis graminifolia,* and *Vaccinium myrsinites*. Differential species between this community type and the dry-mesic sandy type include *Amphicarpum muhlenbergianum, Andropogon brachystachyus, Andropogon virginicus* var. *virginicus, Aristida spiciformis, Bigelowia nudata* ssp. *australis, Carphephorus odoratissimus, C. paniculatus, Dichanthelium ensifolium* var. *ensifolium, Erigeron vernus, Eupatorium recurvans, Euthamia tenuifolia, Galactia elliottii,* and *Rhexia nuttallii.*

The mesic community type occupies vast expanses of the dry prairie landscape. This community type tends to occupy the broad, very flat, interdrainage sites, and basically forms a matrix within which other communities occur on drier or wetter microsites or ecotones.

Most of the soils of the mesic community type would be classified as in the Myakka soil series (Aeric Haplaquods) but some have shallower spodic layers and would be classified as in the Smyrna soil series (Aeric Haplaquods).

Wet-mesic (Alfic) Community Type of Dry Prairie

Dominant species: *Aristida beyrichiana, Quercus minima, Xyris elliottii.*

The wet-mesic prairie community type develops on soils with argillic horizons (Alfisols or soils in Alfic subgroups) and is one of the most distinctive community types found in the dry prairie landscape. Wet-mesic alfic prairie has several unifying and distinguishing patterns of species composition. It is dominated by two of the landscape dominants, *Aristida beyrichiana* and *Quercus minima.* The third species in dominance, and also a major indicator species within this community, is *Xyris elliottii* (98 percent frequency, 8 percent relative cover). This species attains a maximum relative cover of less than 2 percent in the other defined community types. *Xyris elliottii* has recently been documented as one of the principal nest materials used by Florida grasshopper sparrows on Avon Park AFR (Bridges and Delany, unpublished data).

The low frequency and cover of *Serenoa repens* also seems to differentiate this community from other dry prairie communities. Although present in this type, *S. repens* is not a dominant species. *Serenoa repens* is typically rather widely scattered, and with a low, stunted stature. It often has a rather lengthy decumbent trunk which lies on the ground surface or partially buried in the surface soil. This is in contrast to the generally more robust, somewhat more erect growth form of *Serenoa repens* which is prevalent in most central Florida pine flatwoods. However, relative abundance values for *S. repens* can vary widely between sites due to historical and disturbance events (such as past burn history, roller chopping, *etc.*).

Although they are present in other natural communities (*i.e.*, wet flatwoods, wet prairies, seepage slopes), typical differential species from other dry prairie types include *Polygala rugelii* and *Sabatia brevifolia.* Other indicator species, such as *Aristida spiciformis, Bigelowia nudata* ssp. *australis, Liatris gracilis* and *Syngonanthus flavidulus,* attain a significantly higher importance in this community type when compared to other similar communities.

Soil characteristics within this community type are relatively uniform, and are characterized by having a deep spodic horizon at 75 to 117 cm (30 to 46 in) and also having an argillic (translocated increase in clay) horizon at 100 to 175 cm (39 to 69 in). This underlying sandy clay layer may have a very significant role in the structure of the community due to its influence on the site hydrologic regime. Based on field observations, a relatively deep argillic layer (over 100 cm [39 in]) seems to result in a much longer hydroperiod than a similarly deep spodic layer. Data presented for the soils of Avon Park AFR by Carter (1995) indicate that the argillic horizon of soils such as Oldsmar (Alfic Arenic Haplaquods) and EauGallie (Alfic Haplaquods) have lower permeability than the spodic layers of these soils series or of typical Spodosols. Consequently, although they can be extremely droughty in the dry season, these areas may have water at or above the surface for a month or more in the wet season. This more extreme hydrological fluctuation may be a primary factor responsible for the species composition of this community type. The juxtaposition of *Quercus minima*, a typically dry-mesic indicator species, and *Xyris elliottii*, a wetland indicator species, may be attributable to this soil situation.

Wet-mesic (Spodic) Community Type of Dry Prairie

Dominant species: *Aristida beyrichiana, Quercus minima, Serenoa repens.*

This community type displays considerable differences in species composition and abundance as well as edaphic conditions. Community dominants are essentially those that tend to dominate the typical central peninsular Florida flatwoods landscape (*Aristida beyrichiana, Quercus minima,* and *Serenoa repens*). This community type may be separated based upon distinctive common species rather than dominants.

Indicator species which are much more important in this community type than any of the other community types include *Ctenium aromaticum, Chaptalia tomentosa, Carphephorus carnosus, Xyris ambigua* and *Burmannia capitata*. These species are nearly absent from other dry prairie community types. Several characteristic species achieve a greater importance value in the wet-mesic spodic type as compared to the other dry prairie community types, but may also be present in other natural communities, including *Rhexia mariana, Bigelowia nudata* ssp. *australis, Rhynchospora fascicularis, Xyris elliottii* and *Lachnocaulon anceps*. These species, especially *Xyris elliottii, Bigelowia nudata* ssp. *australis* and *Rhynchospora fascicularis,* also appear as important species within the wet-mesic alfic community type of dry prairie. Of these, *Xyris elliottii* is much more of a dominant within the wet-mesic alfic community type of dry prairie and the others are slightly more abundant in the wet-mesic spodic type.

Soils within this community type tended to be either Spodosols with the spodic horizon appearing at 13 to 30 cm (5 to 12 in) in depth or alternating areas of Spodosols and Alfisols with bright colored Bw horizons appearing at 10 to 20 cm (4 to 8 in) depth. In addition, these areas mostly display a thin to moderate layer of mucky sand at the surface, mostly from 2 to 10 cm (0.79 to 3.9 in) deep. The typical soil composition consists of Smyrna soils (Aeric Haplaquods) on the higher microsites and Malabar soils (Grossarenic Ochraqualfs) in the intervening flats.

Other Communities of the Dry Prairie Landscape

Harshberger (1914), Abrahamson and Hartnett (1990), Bridges (1997), Hilsenbeck (1994) and others have recognized that the dry prairie landscape includes a complex mosaic with gradations to other communities. Harshberger (1914) described the Florida prairies as flat, treeless, sedge and wire-grass prairies unbroken except by a few scattered areas of pine, merging with open pine savannas or open hammock-dotted savannas. Within the dry prairie landscape are many wet prairies and shallow marshes. The typic, undisturbed, undrained dry prairie landscape of south-central Florida consists of a mosaic of interdigitating dry prairie and wet prairie, with interspersed ephemeral depression ponds/marshes, mesic and hydric hammocks, deep sloughs and shallow drainage swales (Bridges 1998a).

Wet wiregrass prairie is common throughout the dry prairie landscape. The boundary between dry prairie and wet prairie is usually not very discrete, but rather reflects a broad ecotone reflecting strongly increasing hydroperiod with only very slight decreases in elevation. There are actually several plant communities or "micro-habitat zones" which are present across this gradient (Bridges 1997). In some sense, this is not unexpected, since in the flatwoods landscape of central Florida, a distinct natural community (wet flatwoods) is found intermediate in hydrology between mesic flatwoods (hydrologically similar to dry prairie) and wet prairie. The ground cover in the transitional zone between dry prairie and wet prairie is very diverse and reflects the micro-topographic diversity within this ecotonal transition. Refer to the freshwater marshes and wet prairies account for a description of the wet prairie community in South Florida.

The surface water drainage features in dry prairie includes both narrow, long mostly linear swale-like drainageways without a defined channel and with short hydroperiods and deeper water, slough-like drainages. These drainages are distinguished from depression marshes and basin marshes by functioning more as a conduit for surface water than as a water storage depression. There is sometimes a gradual gradation from large linear wet prairies to shallow swale-like drainages, but they can be distinguished by the lesser importance of *Hypericum fasciculatum* and *Aristida beyrichiana* in swales.

The swale-like drainages may have been naturally dominated by *Spartina bakeri*, with zones of *Muhlenbergia capillaris* var. *filipes* mixed with *Aristida beyrichiana* at their shallower edges. Isolated small clumps of *Sabal palmetto* occur within the swales, and perhaps higher small areas protected from fire may have supported small hammocks. Swale-like drainages are defined more as a hydrologic feature than by vegetative dominance or physiognomy, and as such, are a mosaic of many plant communities.

Slough-like drainages are distinguished from swale-like drainages by their more permanent water, and consequent deeper marsh vegetation. The deep marsh vegetation of the sloughs is often dominated by *Pontederia cordata*, with substantial amounts of *Panicum hemitomon, Cladium jamaicense, Sagittaria lancifolia, Thalia geniculata,* and *Nuphar lutea* ssp. *advena*. There are scattered clumps of woody plants naturally occurring in sloughs, such as *Salix caroliniana, Fraxinus caroliniana,* and *Nyssa sylvatica* var. *biflora*. In the undrained dry prairie landscape, sloughs serve as the major natural drainage system, due to the lack of definite streams in the flat dry prairie landscape.

Hammocks are localized and represent only a small percent of the total dry prairie landscape but are important biodiversity features, and function as islands of forest in the grassland vegetation. "Prairie hammock" is often used to refer to any clump of live oak and/or cabbage palms surrounded by prairie or marsh communities, and is usually found in close association with wetlands, in fire shadows on the dry prairie landscape. These hammocks vary greatly in size, soil type, degree of protection from fire, and hydrology. Some hammocks have a substantial elevation rise from the surrounding marshes or prairies, sufficient to support some upland vegetation in the center of the hammock, with borders of these hammocks saturated or inundated such as to resemble hydric hammocks. These higher hammocks fall into at least three types, one with marl or limestone subsoils and a subtropical understory, the second on high sandy rises with temperate mesic hardwood hammock species, and the third a low-diversity hammock with few woody species other than *Quercus virginiana* and *Sabal palmetto,* and an understory of *Serenoa repens*. Another hammock type, perhaps better referred to as hydric hammock, has high importance of *Quercus laurifolia*, and is shallowly seasonally inundated. More detailed descriptions of these prairie hammock types can be found in Bridges (1998a). Typically, there are five to six species of *Tillandsia* in most hammocks (*T. balbisiana, T. fasciculata* var. *densispica, T. recurvata, T. setacea, T. usneoides,* and *T. utriculata*), three species of epiphytic ferns (*Phlebodium aureum, Polypodium polypodioides,* and *Vittaria lineata*), and sometimes clumps of the epiphytic butterfly orchid, *Encyclia tampensis*.

The prairie hammocks found within the dry prairie landscape are unusual and sensitive habitats. The present-day low biodiversity of many prairie hammocks could be the result of past damage to the ground cover by cattle and feral hogs, both of which preferentially utilize these sites. Alternatively, some hammocks may have lower diversity by being subject to occasional fire, where during dry periods fires from the surrounding prairies and marshes burn through the ground cover of the hammocks.

Wildlife Diversity

There are many common faunal components of dry prairies. Both breeding and seasonal migrants utilize dry prairies extensively. Breeding birds of the dry prairies include the Florida mottled duck, common nighthawk *(Chordeiles minor*), red-winged blackbird *(Agelaius phoeniceus)*, common yellowthroat *(Geothlypis trichas*), eastern towhee *(Pipilo erythrophthalmus)* and eastern meadowlark *Sturnella magna* (T. Dean, Department of Forestry and Wildlife, University of Massachusetts, personal communication 1998). Seasonal use by northern avian species during the winter season substantially increases the avifauna diversity of dry prairie (T. Dean, Department of Forestry and Wildlife, University of Massachusetts, personal communication 1998). Species that migrate into the central Florida area and overwinter within dry prairie include the savannah sparrow (*Passerculus sandwichensis)*, swamp sparrow *(Melospiza georgiana*), Henslow's sparrow *(Ammodramus henslowii),* as well as the northeastern race of grasshopper sparrow *(Ammodramus savannarum pratensis)* (T. Dean, Department of Forestry and Wildlife, University of Massachusetts, personal communication 1998). Other wintering species include yellow rail *(Coturnicops noveboracensis noveboracensis*), palm warbler *(Dendroics palmarum)*, and a variety of other songbirds. In addition, a variety of avian predators, including northern harrier *(Circus cyaneus)*, American kestrel *(Falco sparverius)*, and *Accipiter* spp. (hawks) migrate into central Florida (T. Dean, Department of Forestry and Wildlife, University of Massachusetts, personal communication 1998). The effect of this influx on the resident avifauna is uncertain, and the importance of Florida dry prairie as wintering grounds for the seasonal residents is poorly known (T. Dean, Department of Forestry and Wildlife, University of Massachusetts, personal communication 1998).

Herpetofauna of the dry prairies include common species such as Florida box turtle *(Terrapene carolina bauri)*, glass lizards *(Ophisaurus* spp.), ground skink *(Scincella lateralis)*, Florida ribbon snake *(Thamnophis sauritus sackenii)*, Florida banded water snake *(Nerodia fasciata)*, black racer (*Coluber constrictor priapus)*, and rough green snake *(Opheodrys aestivus*) (T. Dean, Department of Forestry and Wildlife, University of Massachusetts, personal communication 1998). Amphibians including oak toad *(Bufo quercicus)*, southern cricket frog *(Acris gryllus gryllus*), and pine woods tree frog *(Hyla femoralis*) are also abundant in dry prairies (T. Dean, Department of Forestry and Wildlife, University of Massachusetts, personal communication 1998).

Common mammals include eastern cottontail *(Sylvilagus floridanus*), hispid cotton rat *(Sigmodon hispidus*), oldfield mouse *(Peromyscus polionotus*), spotted skunk *(Spilogale putorius*), and bobcat *(Lynx rufus floridanus*), (T. Dean, Department of Forestry and Wildlife, University of Massachusetts, personal communication 1998).

Wildlife Species of Concern

Federally listed species that depend upon or utilize the dry prairie community in South Florida include: Florida panther (*Puma (=Felis) concolor coryi*), bald eagle (*Haliaeetus leucocephalus*), Florida grasshopper sparrow (*Ammodramus savannarum floridanus*), whooping crane (*Grus americana*), eastern indigo snake (*Drymarchon corais couperi*), and Audubon's crested caracara (*Polyborus plancus audubonii*). Biological accounts and recovery tasks for these species are included "The Species" section of this recovery plan. Unlike

Burrowing owls. *Original photograph by Betty Wargo.*

most other grasslands in the southeastern United States, Florida dry prairie harbors numerous endemic vertebrates (DeSelm and Murdock 1993); Appendix C lists the species of concern in this community. Millsap *et al.* (1990) consider interior dry prairies to be one of four geographic and/or ecological communities in Florida with high concentrations of high-ranked GFC avian taxa, and a few other high-ranked vertebrates. In a relative ranking of major Florida ecological communities, these authors list two taxa of reptiles, five taxa of birds, and three taxa of mammals as high-ranked vertebrate species regularly occurring in dry prairie. They noted the importance of the Kissimmee Prairie and associated habitats to species such as the short-tailed hawk *(Buteo brachyurus fuliginosus*), Florida grasshopper sparrow, Audubon's crested caracara, Florida sandhill crane *(Grus canadensis pratensis*), and Florida burrowing owl *(Speotyto cunicularia floridana*); refer to brief discussions of these species below. Several of the high ranking avian taxa are near-endemic to the dry prairie region of south-central Florida. However, others *(i.e., P. planchus audubonii, G. canadensis pratensis, S. cunicularia floridana*) are not found exclusively in native prairie habitat, and are capable of persisting in anthropogenic altered landscapes (semi-improved pastures, improved non-native pastures, disturbed rangelands, *etc.*) within the dry prairie region of south-central Florida. The anthropogenic landscape of the improved pastures should not be considered as essential for survival of these birds, since they evolved within the natural dry prairie landscape. Their current prevalence in anthropogenic landscapes maybe the result of disproportionate loss of the microhabitat and structural conditions preferred by these species in the dry prairie landscape, perhaps due to less frequent fire. It is possible that populations of these taxa may have been naturally limited, or declined after settlement, and the anthropogenic landscape has provided the conditions for population increase of these species by utilizing areas structurally similar to their pre-settlement habitats. Anecdotal evidence of the preferential use of dry

Sandhill crane. *Original photograph by Betty Wargo.*

prairie by these species is provided by Harper (1927), who noted that burrowing owls and Florida sandhill cranes can be seen more often in the prairies than elsewhere in South Florida.

The **Florida burrowing owl** is considered a species of special concern by the State. It is currently an uncommon or poorly known resident of dry prairies and open agricultural lands and ranges from northern peninsular Florida to the Keys (Millsap *et al.* 1996). Historically most burrowing owls were found in the dry prairie region (Harper 1927, Ridgway 1914, Bent 1938, Enge *et al.* 1997), but seem to have expanded their range between the 1940s and 1970s due to land clearing and improved drainage. However, populations on the Osceola Plain are apparently declining, and presently these owls are found in the greatest concentrations in areas of elevated ground features, usually in disturbed habitats (pastures, canal banks, *etc.*) (Enge *et al.* 1997).

Florida sandhill crane, State listed as threatened, is another avian species that is dependent on the open, treeless habitats of the dry prairie region. Sandhill cranes are year-round residents of the prairies and extensive wetland systems. Florida sandhill cranes are well-known foragers in improved pastures, which simulate the low grassy vegetative cover of frequently burned dry prairie, and also occur frequently in savanna-like open flatwoods.

The **short-tailed hawk** reportedly utilizes dry prairie and scrub habitats for foraging and nests in cypress and some other swamps in south-central Florida (Ogden 1971, Millsap *et al.* 1996, Enge *et al.* 1997).

The **Florida grasshopper sparrow** is a federally and state endangered subspecies which is endemic to the prairie region of south-central peninsular Florida (Vickery and Shriver 1994). Frequently burned dry prairie is the preferred natural habitat (Delaney 1993) for this non-migratory subspecies, although it is also documented from degraded prairie and other rangeland sites (Delaney and Cox 1985).

The **Audubon's crested caracara** is a subspecies of the crested caracara that is listed as a federally and state threatened species, and is endemic to south-central Florida (Morrison 1996). It is largely dependent on the open treeless habitats within the dry prairie landscape. It is also associated with wetlands and rivers within the dry prairie landscape, and uses isolated cabbage palms or palms in hammocks for nesting sites (Morrison 1996). Improved pasture lands that are being actively grazed by livestock are used extensively by this bird (Morrison 1996). Crested caracaras appear to have adapted to cattle ranching in the current Florida landscape; however, conversion of ranchlands to more intensive agricultural uses could potentially pose a threat to this bird (Morrison 1996).

The **whooping crane** (*Grus americana*) is federally listed as an experimental, non-essential population in South Florida. This species was recently extirpated from the State, but was reintroduced in 1993 and 1995 to Three Lakes WMA, as part of the overall recovery strategy for the species. The ultimate goal is to have a self-sustaining population of 25 breeding pair by the year 2020.

In addition to the avian species identified by Millsap *et al.* (1990), Enge *et al.* (1997) address three additional high ranked avian species, Florida mottled duck *(Anas fulvigula fulvigula)*, western kingbird *(Tyrannus verticalis)*, scissor-tailed flycatcher *(Tyrannus forficatus)* and two reptile taxa, South Florida rainbow snake *(Farancia erytrogramma seminola)*, and Florida mole kingsnake *(Lampropeltis calligaster occipitolineata*), that occur within dry prairie, but are not restricted to dry prairie. However the flycatchers are incidental migrants and have not been observed in dry prairie (T. Dean, Department of Forestry and Wildlife, University of Massachusetts, personal communication 1998). DeSelm and Murdock (1993) noted the black-shouldered or white-tailed kite (*Elanus caeruleus majusculus*), a wide-ranging but rare bird in the southeastern United States, as primarily occupying prairies in central Florida. The prairie/pasture system of central Florida is also the landscape chosen to establish an experimental population of the whooping crane. Like the sandhill cranes, the released whooping cranes are largely dependent on open habitats including native prairies, sparsely forested sites, and the wetlands associated with this landscape.

Bison bison bison, the plains bison, once reported as numerous and widespread in northwest and north-central Florida, was apparently extirpated by 1740 (DeSelm and Murdock (1993), and perhaps ranged into the historical dry prairies.

Other faunal species of concern that are not restricted to the dry prairie region, but are commonly encountered, include the southeastern American kestrel (*Falco sparverius paulus*), gopher tortoise *(Gopherus polyphemus)*, gopher frog *(Rana capito)*, eastern indigo snake *(Drymarchon corais couperi)*, and Florida brown snake *(Storeria dekayi victa*).

Species which are high-ranked by GFC that occasionally are found in dry prairie include Sherman's short-tailed shrew *(Blarina carolinensis shermani*), Florida mastiff bat *(Eumops glaucinus floridanus)*, Florida panther, peregrine falcon *(Falco peregrinus tundrius)*, and bald eagle *(Haliaeetus leucocephalus)*

(Enge *et al.* 1997). Peterson (1997) includes one reptile, 13 birds, and five mammals as elements occurring in dry prairie that are currently being tracked by the Florida Natural Areas Inventory.

Many other species associated with other habitat types also occur in dry prairie (T. Dean, Department of Forestry and Wildlife, University of Massachusetts, personal communication 1998). The ecological importance of dry prairie habitat to these species remains unknown.

Plant Species of Concern

No federally listed plants are currently known from dry prairie. One state endangered and six state threatened plants occur in dry prairie, based on the 1998 updated list of Florida regulated plants (Coile 1998). *Calopogon multiflorus* (many-flowered grass pink orchid) is the only state endangered plant that occurs in dry prairie. This member of the Orchidaceae family also grows in dry-mesic pine flatwoods within the dry prairie region of south-central Florida. Three rather widespread and locally abundant species of carnivorous plants are listed as state threatened and occur in the dry prairie landscape-*Pinguicula caerulea* (blue butterwort), *Pinguicula lutea* (yellow butterwort), and *Sarracenia minor* (hooded pitcher plant). Two other orchids of dry prairie are also listed as state threatened-*Spiranthes longilabris* (long-lipped ladies-tresses) and *Pteroglossaspis ecristata* (wild coco). *Lilium catesbaei* (southern red lily), a member of the Liliaceae family, despite being widespread and common in Florida, is also listed as a state threatened plant. Peterson (1997) in the FNAI "County distribution and habitats of rare and endangered species in Florida" lists four plant taxa that FNAI tracks in their statewide data base as occurring in dry prairie [*Gymnopogon chapmanianus* (Chapman's skeletongrass), *Linum carteri* var. *carteri* (Carter's small-flowered flax), *Linum carteri* var. *smallii* (Carter's large-flowered flax), and *Vernonia blodgettii* (Blodgett's ironweed)]. Neither of the *Linum* species nor the *Vernonia* occur in dry prairie, but rather grow in marly prairies or seasonally wet pinelands and cypress savannas, usually where calcareous outcrops are near the surface. Other FNAI listed plants known to occur in dry prairies include *Aristida rhizomophora* (Florida three-awn) and *Pteroglossaspis ecristata* (wild coco), but these are not included on the lists of dry prairie species by Peterson (1997). There is a recent unverified report of *Nolina atopocarpa* (Florida beargrass), a globally rare FNAI listed plant, that is also listed as state threatened, from dry prairie at Kissimmee Prairie State Preserve in Okeechobee County (Chafin *et al.* 1997). None of the above listed plant taxa are restricted to dry prairie, with all of them also occurring in other natural communities in Florida.

Ecology

Fire Ecology

Fire is the most common natural disturbance in upland peninsular Florida ecosystems (Menges *et al.* 1993, Robbins and Meyers 1992), with lightning historically having been the primary ignition source. Peninsular Florida typically has a distinct winter dry season, with the largest burns histoically occurring in late spring and early summer (April through mid-June), at the onset of the May-September lightning season (Abrahamson 1984, Chen and Gerber 1990, Dye 1997). There is no doubt that fires continued to occur throughout the lightning season, but fires later in the season were probably smaller and less intense due to the increasingly wet conditions. Natural fires likely occurred during all seasons to some extent, but the great majority of fires probably occurred during the thunderstorm season. Effects of fire intensity, seasonality, and historical events have been implicated in the dynamics of many Florida plant communities, including dry prairie (*e.g.* Abrahamson 1984, Platt *et al.* 1988, Rebertus *et al.* 1989, Abrahamson and Harnett 1990, Abrahamson 1991).

Frequent lightning strikes just prior to the summer rainy season in dry prairie areas with sufficient fuel, consisting of short shrubs, grasses and herbaceous material, all of which are highly flammable, contributed greatly to natural fire frequency. Deviations in intensity, fire return interval, and seasonality from the natural fire regime are potentially significant anthropogenic factors determining vegetation structure and composition of the dry prairie landscape. Historically, the role of humans before European settlement in shaping the landscape and vegetation with fire is believed by some to have been a significant factor in the maintenance of open pine savannas and prairies. However, the exact fire intensity, fire return interval, and seasonality of fire under which the fire-maintained natural communities and biota evolved in the dry prairie landscape is subject to considerable debate.

In dry prairie communities, dormant season burns tend to favor increased cover of graminoids over forbs, whereas growing season burns tend to favor increased cover of forbs, at least in the year of burning (Orzell and Bridges, personal field observations). Growing season burns also seem to delay flowering of some species, and serve to compress and synchronize flowering peaks of the groundcover species in the year of the burn. Differences between dormant and growing season burns have also been noted by Platt *et al.* (1988) in north Florida, who found that the fire season had little effect on the number of species flowering during the year following the fire. Platt *et al.* (1988) found that fires during the growing season decreased average flowering duration per species and increased synchronization of peak flowering times within species relative to fires between growing seasons. Platt *et al.* (1988) found that fires during the growing season also increased the dominance of fall flowering forbs and delayed peak fall flowering. Field observations by the authors in south-central Florida dry prairies tend to concur with Platt's findings.

The natural fire frequency for dry prairie is unknown but may be every 1 to 4 years, which suggests greater frequency than in any other central Florida community. This statement is based mostly upon historical accounts, journals and surveys (Abrahamson and Hartnett 1990, Frost 1993), although scientific evidence to support or refute this assumption is lacking. A higher fire frequency over a long time period could be the critical factor limiting pine recruitment in this community, but it may not be the sole factor responsible for limiting natural pine establishment. Harper (1921,1927) is perhaps the earliest published source to note that dry prairie was subject to fire practically every year, and like the flatwoods, practically all the plants have large underground parts enabling them to recover following fire. These observations by Harper (1921, 1927) are testimony to the high fire frequency of the dry prairie landscape during early decades of this century.

Dry prairie probably occurred as broad areas with a higher fire return frequency, compared to the mesic pine flatwoods-pine savanna-depression marsh landscape mosaic. Dry prairie can be thought of as the endpoint along a forested to treeless continuum of flatwoods/savanna landscapes, in response to variation in the natural fire regime. In regions devoid of major natural fire barriers, such as in the historical dry prairie landscape, fire is reported as occurring annually or biennially (Harper 1921, 1927). A 1 to 2 year natural fire frequency would be sufficient to prevent pines from becoming established, except occasionally in fire-shadows and other isolated fire-protected sites. Glitzenstein *et al*. (1995) in north Florida, found that with a 2-year fire return interval, the pine population declined steadily, and suggested that pines might disappear with continued burning at that interval. The fire frequency in dry prairie may differ most significantly from pine flatwoods in the position of dry prairie in a natural landscape that was historically essentially devoid of impediments to the spread of fire. Under these conditions, a single ignition could easily burn thousands of hectares before being naturally extinguished. In the present-day condition, barriers such as roads, ditches, and firebreaks artificially limit the size and extent of landscape-scale fires.

Relationships Between Animals and Plants

There is little published information available on the relationships between dry prairie vegetation and faunal components. Most of the available information is on the habitat preferences of the Florida grasshopper sparrow. Shriver (1996) determined that breeding Florida grasshopper sparrows were associated with certain structural vegetation characteristics of the dry prairie habitat, and did not use available habitat randomly. Vickery and Dean (1997) report that sparrows select areas of habitat with specific structural vegetation characteristics during the non-breeding season, again indicating that the Florida grasshopper sparrow does not randomly utilize dry prairie habitat. The strong association of the Florida grasshopper sparrow with certain structural vegetation characteristics within a structurally varied community suggests that habitat management would affect sparrow populations. Delany and Cox (1986) report that Florida grasshopper sparrows are unlikely to adapt to conditions resulting from intensive pasture improvement, though they may be capable of adapting to some level of modification. Determining the microhabitat preferences of the Florida grasshopper sparrow is difficult due to differing land management histories and current land management strategies between known sites for the species. Clearly, aspects of habitat structure at a small scale, and possibly variation in structure, are required to support the Florida grasshopper sparrow (T. Dean, Department of Forestry and Wildlife, University of Massachusetts, personal communication 1998).

Vegetation density is also a factor that affects the quality of Florida grasshopper sparrow habitat. Frequent burning is required to maintain the vegetation density at a level low enough for the sparrows. Excessive shrub heights are also reported to deter grasshopper sparrows from settling (Delany *et al.* 1985, Shriver 1996), and fire is an important agent in maintaining low shrub height and cover.

To date, no information is available on the use of habitat relative to landscape features, other than the presence of trees, which the sparrows strongly avoid during the breeding season (Delany *et al.* 1992). The density of ponds, ditches, cypress domes, and other features may affect sparrows' habitat choices. Plotted radiotelemetry locations of Florida grasshopper sparrows suggest that sparrows may be selecting or avoiding particular features of the landscape, but it is currently unclear what these may be (T. Dean, Department of Forestry and Wildlife, University of Massachusetts, personal communication 1998).

Status and Trends

Estimates of the historical and current extent of dry prairie within central Florida vary substantially. Florida dry prairie is ranked as a G2 (globally imperiled) community type (FNAI and FDNR 1990, Grossman *et al.* 1994, Weakley *et al.* 1996). Based upon DeSelm and Murdock (1993), Noss *et al.* (1995) considered ungrazed dry prairie of Florida as an endangered ecosystem (greater than 98 percent habitat loss and continued threat). Although dry prairie area is declining, there are still considerable opportunities to protect dry prairie in south-central Florida (R. Hilsenbeck, The Nature Conservancy, personal communication 1998). Florida harbors the most extensive areas of native grasslands remaining in the southeastern United States (DeSelm and Murdock 1993). Despite declines in dry prairie, there are areas of native pastures of over several thousand acres each, with native range averaging 85 percent of the area on individual ranches as recently as 1968 to 1970 (Mealor 1972, DeSelm and Murdock 1993). However, in central Florida there continues to be a reduction in area and fragmentation of high-quality dry prairie, and an even greater reduction in the number of sites with a continuous fire history and minimal human disturbance (Bridges 1997, Cole *et al.* 1994a).

Crumpacker *et al.* (1988) estimated that approximately 1,127,346 ha (2,784,545 acres) of palmetto prairie were present in 1967, with 73.25 percent (approximately 826,000 ha or 2,040,220 acres) in a natural condition. Cox *et al.* (1994) map 561,114 ha (1,385,952 acres) of dry prairie in central Florida, as part of an attempt to inventory Florida's vegetation types based on 1985 to 1989 Landsat satellite imagery. Of this area, they indicate that 16.6 percent, or 93,145 ha (230,068 acres), is found in conservation areas, being among the lowest percentages of natural Florida plant communities in conservation areas. Subsequent to this publication, acquisition of Kissimmee Prairie State Preserve in Okeechobee County has increased the area of dry prairie in conservation areas. Although the Landsat estimate alone would indicate a fairly large amount of dry prairie in central Florida, Cox *et al.* (1994) state that "the dry prairie land-cover class often includes areas with widely spaced pine trees ...." Unfortunately, much of what is mapped as dry prairie in central Florida by use of Landsat imagery includes substantial areas of cut-over or "understocked" pine flatwoods, as well as wet prairies, some drained wetlands, and coastal grasslands (Bridges 1997). Dry prairie may have historically been of much more limited extent than mapped by Cox *et al.* (1994) using Landsat data.

For example, dry prairie is mapped as the most common natural community at Avon Park AFR by Cox *et al.* (1994), covering all of the base except for the densest areas of pine cover and the deep-water wetlands. Most authorities would agree that the vast majority of this area would best be classified as open pine flatwoods rather than dry prairie, and the Avon Park AFR vegetation classification, perhaps more accurately, considers most of this area as “flatwoods,” as opposed to the denser pine stands which are mapped as “flatwoods, forested.”

Davis (1967, cited in Cox *et al.* 1997) estimated that 2,048,865 ha (5,060,697 acres) of prairie-type grasslands existed on the historical landscape, but these authors did not distinguish dry prairies from other wetter, palmetto-free prairies in north-central Florida (such as Paynes Prairie). Obtaining consistent estimates of existing areas of dry prairie vegetation is equally difficult. Estimates on the current area of Florida dry prairie are given in studies by the GFC (Kautz 1993, Cox *et al.* 1994, Cox *et al.* 1997) and by Duever *et al.* (1992). Kautz *et al.* (1993), based upon calculations from Davis' 1967 vegetation map of Florida, estimated that 0.83 million ha (2,050,100 acres), or 5.9 percent, of pre-settlement Florida was covered by dry prairie and depression marshes. By 1989, Kautz *et al.* (1993) estimate that 0.56 million ha (1,383,200 acres) of dry prairie remained, but this figure includes areas outside the historic range for dry prairie given in Davis (1967). Cox *et al.* (1997) estimate that 1,385,176 ha (3,421,385 acres) of dry prairie remain in Florida based upon the 1985 to 1989 Landsat imagery, of which 233,069 ha (575,680 acres), 17 percent, is found within managed areas. Duever *et al.* (1992) in a natural area inventory of St. Lucie County estimated that approximately 9,694 ha (23,935 acres) of dry prairie occurred in 1986, whereas 5,438 ha (13,428 acres) remained in 1991, a 43.9 percent loss in a 5-year period based upon GFC Landsat imagery.

Remaining potential dry prairie natural areas have been systematically identified using county black-and-white aerial photography dated 1992 to 1993, as part of a statewide effort to identify significant remaining Florida natural areas for Florida Department of Natural Resources in 1993 to 1994. Shriver (1996) conducted aerial surveys of 138,664 ha (342,500 acres) of these potential dry prairie sites (within 33 potential natural areas) and the adjacent landscape, and identified 64,420 ha (159,117 acres) of this area as high-quality Florida grasshopper sparrow habitat (in native vegetation, with evidence of fire) with an additional 39,933 ha (98,635 acres) of marginal habitat or habitat in need of restoration, and 34,310 ha (84,746 acres) as poor quality or recently converted to agriculture (Shriver 1996). The largest of the dry prairie potential natural areas identified by the senior author, and the highest quality tract verified by the aerial survey (Shriver 1996), later became the Kissimmee Prairie State Preserve.

Losses of dry prairie have been due to several land-use type conversions-conversion of native prairie to improved pasture (Layne *et al.* 1977), conversion to other agricultural uses, such as citrus groves (Davis 1967, Mealor 1972, Callahan *et al.* 1990, DeSelm and Murdock 1993, Layne 1996), conversion to planted pine, and, in the past, conversion to eucalyptus (*Eucalyptus* spp.) plantations. Conversion of dry prairie to citrus groves may represent the single greatest threat to existing prairie remnants. Current pasture and rangeland are the areas with the highest feasibility for citrus conversion, since these sites, with supplemental drainage, can provide the well-drained soils required to grow citrus (Pearlstine *et al.* 1995). In southwest Florida alone, the extent of citrus groves has doubled to 60,000 ha (148,200 acres) since 1980 and is projected to reach 80,000 ha (197,600 acres) by the year 2000 (Pearlstine *et al.* 1995).

Perhaps the most reliable method to evaluate the original pre-settlement extent of dry prairie is through examination of the original Public Land Surveys compiled from 1855 to 1859. These land surveys not only provide documentation on the overall extent and distribution of pre-settlement dry prairie, they also provide anecdotal evidence on the treeless nature of dry prairie. These surveys show that most of the extensive areas of the dry prairie landscape association were mapped as “prairie” in the original surveys, providing evidence that dry prairie is not simply an artifact of anthropogenic origin. In particular, the dry prairie within the Kissimmee Prairie State Preserve was actually somewhat more extensive in the 1850s than in the present day (Bridges 1998a). Most surveyors drew the boundary between prairie and pinelands on the original land survey plats, and this was confirmed by the presence or absence of witness trees for the section corners and section line midpoints. Surveyors were also careful to note when they transited from pine lands to prairie. Based on these facts, we can assume that the extent of prairie delineated by the original land survey is a fairly accurate picture of the landscape of the1850s. Since there had been no widespread logging in central Florida as of that date, we can assume that this represents the best picture available of the extent of prairie in the pre-settlement landscape. Frequent fires would have been required to maintain the historical extent of open prairie, and with reduction of fire frequency and intensity, much of the remaining dry prairie landscape that has not been converted to pasture has been invaded by pines.

As of 1998, there are five protected, managed areas in Florida with significant areas of native dry prairie vegetation. There are approximately 9,200 ha (23,000 acres) of dry prairie at Kissimmee Prairie State Preserve (Chafin *et al.* 1997), making it the largest and most significant remaining dry prairie area currently within protected status. Other protected managed areas of dry prairie are found at Avon Park AFR, Three Lakes WMA, the National Audubon Society’s Ordway-Whittell Kissimmee Prairie Sanctuary, and Myakka River SP. Avon Park AFR has the largest and most significant remaining examples of dry prairie in Highlands and Polk counties (Orzell 1997), with an estimated 2,400 ha (6,000 acres) of dry prairie (Vickery and Perkins 1997). Major areas of dry prairie at Avon Park AFR lie both north and south of Kissimmee Road (in O. Q. Range and north of O. Q. Range), and within Echo and Charlie Ranges. The southern management unit at Three Lakes WMA in Osceola County has approximately 4,000 ha (10,000 acres) of dry prairie (Vickery and Perkins 1997). The National Audubon Society’s Kissimmee Prairie Sanctuary in Okeechobee County has approximately 1,000 ha (2,500 acres) of dry prairie (Vickery and Perkins 1997), most of which is of outstanding natural quality (Orzell, Bridges and Dean, personal field observations). Myakka River SP in Manatee and Sarasota counties has approximately 6,800 ha (17,000 acres) of what was once dry prairie (Fitzgerald *et al.* 1995), over half the park's area (Anonymous 1986) prior to CARL land additions to the park.

Recent large-scale protection efforts by The Nature Conservancy in south-central Florida are encouraging, and will hopefully provide for protection of remnant dry prairie landscapes. A 11,508 ha (28,414 acres) conservation easement on the Bright Hour Ranch in Desoto County would provide for protection of at least 5,418 ha (13,387 acres) of dry prairie of varying natural quality (R. Hilsenbeck, The Nature Conservancy, personal communication 1998). A recent CARL proposal submitted by The Nature Conservancy proposes to create a conservation easement on 59,463 ha (146,932 acres) in Glades County and a small section in Highlands County, of which approximately 22,038 ha (54,456 acres) is livestock-grazed rangeland that includes dry prairie of varying natural quality (R. Hilsenbeck, The Nature Conservancy, personal communication 1998). The future of the dry prairie landscape is currently largely dependent upon the management and protection of native rangelands on cattle ranches in south-central Florida.

Management

Overall management of dry prairie should strive to mimic ecological processes (frequent fire, landscape-scale burns, natural hydrologic conditions, *etc*.) in which the dry prairie ecosystem evolved, preferably through an ecosystem management approach. The overall preservation of native biodiversity should be a primary focus, as studies in grasslands support the diversity-stability hypothesis, and show that ecosystem functioning and sustainability may depend upon ecosystem biodiversity (Tilman and Downing 1994, Tilman *et al.* 1996). Rare and endangered species management within dry prairie should not be the sole predicator of overall management goals and strategies. Management and restoration strategies and approaches should vary depending upon the ecological condition or "naturalness" of any given site, for example: (1) high-quality areas with an intact, diverse native ground cover; (2) areas with intact ground cover, but disrupted ecological function due to alteration of ecological processes (fire suppression); or (3) disturbance-altered former prairie sites (through the effects of drainage, partial clearing, pine or *Eucalyptus* plantations). For example, mechanical treatments should not be used on high-quality sites, however, mechanical treatments might be useful in attempts to restore areas of former prairie. Restoration of degraded dry prairies should first emphasize reintroduction of natural ecological processes (reintroduction of fire on fire-suppressed sites, restoration of hydrologic conditions, *etc.*). Critical management issues and challenges include prescribed burning, hydrologic alterations, rangeland and livestock grazing, control of exotics, and impacts associated with mechanical treatments.

Prescribed Burning

Deviation in fire intensity, fire return interval, and seasonality from the natural fire regime of frequent growing-season burns is perhaps the most significant management factor determining vegetation structure and composition of dry prairie communities (Perry 1997, Dye 1997, Bridges 1997). Loss of ground cover species, changes in pine density and recruitment, invasion of non-constituent oaks, and excessive shrub growth has been documented from dry prairies with long periods (*ca.* 35 years) of fire exclusion (Dye 1997, Perry 1997). When dry prairie is frequently burned, saw palmetto is typically of small stature and sparsely distributed, but it tends to increase in stature and density when fire is absent or infrequent (Cole *et al.* 1994a). Implications of the effects of burning on the native ground cover have been previously discussed in this account. The effects of fire on the faunal component of dry prairie is largely unknown. However, most of the faunal taxa should be well-adapted to the natural fire regime. In particular, those which are endemic to the dry prairie region of south-central Florida have evolved within a high fire frequency ecosystem. In fact, some if not most prairie faunal taxa that are dependent on dry prairie also appear to be dependent on recently burned sites *(i.e.,* Florida grasshopper sparrow, see Walsh *et al.* 1995), or prefer recently burned sites over fire-suppressed dry prairies.

It had been thought that ground-nesting birds might be susceptible to mortality or lower reproductive success due to growing season prescribed burning (T. Dean, Department of Forestry and Wildlife, University of Massachusetts, personal communication 1998). The Florida grasshopper sparrow, Bachman's sparrow and the eastern meadowlark are all ground-nesting birds of dry prairie. All initiate breeding in mid-March through April (Perkins *et al.* 1998), and have relatively short reproductive cycles (30 to 40 days from egg-laying through fledging). It had been hypothesized that natural frequent late spring and early summer lightning fires, now simulated with prescribed burns during the growing season from late March through early June, would destroy some nests and young birds, and that this would result in significant reduction in reproductive success and population levels.

However, all three of these birds regularly re-nest if nests are destroyed (T. Dean, Department of Forestry and Wildlife, University of Massachusetts, personal communication 1998). In addition, multiple successful clutches are possible for all three taxa (T. Dean, Department of Forestry and Wildlife, University of Massachusetts, personal communication 1998). Recent studies have shown that adult Florida grasshopper sparrows and other ground-nesting avian taxa appear to be able to successfully avoid fires, and can occupy recently burned areas within 1 week after fire (Shriver *et al.* 1994, Shriver 1996). Although some nests and young birds could be lost to fire, growing season burning does not preclude successful reproduction in that season for any of these birds. Recent studies have shown that Florida grasshopper sparrows successfully fledge young after June fires (Vickery and Perkins 1997), and increase the length of the breeding season by as much as 8 weeks, extending as late as September, after these fires (Shriver 1996, Vickery *et al.* 1997). However it is still unknown whether reproductive success differs between summer-burned and winter-burned areas (FWS 1997).

There are several factors which suggest that growing season burning may benefit the Florida grasshopper sparrow. Florida grasshopper sparrows preferentially nest in areas less than 1.5 years post-burn (Walsh *et al.* 1995, Shriver 1996). If such habitat patches are available within a mosaic of areas with differing post-burn times, they would most likely be the areas utilized for nesting. Prescribed burning during the nesting season would most likely be conducted on areas of 2 years or more post-burn, therefore the areas least likely to be currently utilized for nesting. Therefore, as long as a sufficient area less than 1.5 years post-burn is present within the population area, nesting season prescribed burning of adjacent areas should destroy relatively few nests. The extension of the breeding season by prescribed burning during the nesting season may have important consequences for a species which appears to have low reproductive success (Shriver 1996). Lengthening the breeding season by provision of newly burned areas effectively doubles the number of nesting opportunities, may increase the number of pairs that attempt additional clutches, and may provide sub-dominant males the opportunity to establish territories and breed for the first time (Shriver 1996). Further research is needed to test these new hypotheses.

The long-term effects of growing season fires on the overall productivity of these ground-nesting sparrows is largely unknown (T. Dean, Department of Forestry and Wildlife, University of Massachusetts, personal communication 1998). However, neither is it known how the traditional winter burning of dry prairie by the cattle ranchers and some current land managers may have affected the long-term population levels of such ground-nesting birds.

Larger prairie birds, including sandhill cranes and caracaras, would possibly have greater potential to be affected by growing-season burns, since they require longer periods to produce young, 30 days incubation in cranes (Walkinshaw 1981) and 30 to 33 days for caracaras (Layne 1996, Morrison 1996). However re-nesting is still common in both species (Nesbitt 1988, Morrison 1996), and loss of nests would not preclude nesting in either bird. In addition, the breeding cycles of both species are in the dry season, before the peak time for natural growing season fires. Since caracaras nest in trees and cranes nest in wetlands, nest losses due to fire may be minimal. However, the indirect effects of fire on overall productivity are unknown. The effects of fire on other prairie occupants are also largely unknown. Armadillo and gopher tortoise burrows and the numerous depressional ponds characteristic of the dry prairie landscape likely provide refuge from fires for herpetofauna and small mammals (T. Dean, Department of Forestry and Wildlife, University of Massachusetts, personal communication 1998).

The uncertainty of the effects of growing season burning on the Florida grasshopper sparrow has caused land managers to shift prescribed burns from optimal late spring and early summer burns (especially April and May). The acceptable burning seasons therefore are pre-avian breeding, dormant season *(i.e.* winter) burns (January to early March), or postponement of prescribed burning until post-avian breeding (July through September). Winter or dormant season burns generally result in less overall reduction of aboveground woody biomass, and reduction in flowering of grasses and other native forbs. Prescribed burning conducted during the post-breeding season (July through September), after the onset of summer convective thunderstorms, has the potential to cause significant shifts in species composition in dry prairie. Heavy rainfall events, which are typically more frequent from mid-June through the summer months, can produce two dramatic effects on vegetation in areas of post-breeding season burns: (1) more patchy burns (resulting in less overall reduction of woody vegetation) and (2) flooding of postburn regrowth, resulting in submersion of regrowth and stress to perennial groundcover grasses. The result is that annual cyperoids, such as *Scleria reticularis* (nut-rush), present in the seed bank are favored over perennial grasses and can locally co-dominate summerburned areas (Orzell and Bridges, personal field observations). Whether this vegetative response is short-term or long-term is unknown, but it needs to be studied.

Hydrologic Alterations

Hydrological restoration of conservation lands has been initiated in recent years, but primarily only in response to clear hydrological problems. Hydrological restoration should become a more important part of management and restoration activities in coming years. Loss of wetland area and reduced wetland quality has been a severe problem nationwide in recent years that has affected many wetland species (Noss *et al.* 1995, Cox *et al.* 1997).

Little data are available on the effects of altering the natural hydroperiod within this ecosystem. Sheet flow was perhaps the most common form of drainage during pre-settlement times. Presently, hydrological alterations have definitely changed the drainage patterns at the smaller prairie sites, but there are still areas with natural sheet flow across dry prairie at Kissimmee Prairie State Preserve. The possibility of additional areas with essentially unaltered sheet flow exists within some of the large rangeland sites. Due to subtle topography, even relatively minor changes in topography and drainage can greatly alter the hydroperiod. Vegetation composition of dry prairie is strongly affected by hydroperiod (Bridges 1997,1998a).

During the last four years, artificial flooding of dry prairie at the Ordway-Whittell Kissimmee Prairie Audubon Sanctuary, due to a dike erected by an adjacent landowner, has reportedly resulted in changes in plant species composition (P. Gray, National Audubon Society, personal communication 1998). Species more commonly associated with wet prairie vegetation (*Eriocaulon decangulare*, *Centella asiatica*, and others) may be replacing dry prairie plants, with individual saw palmetto showing leaf browning, perhaps due to stress from extended periods of inundation (T. Dean, Department of Forestry and Wildlife, University of Massachusetts, personal communication 1998). Recent lack of successful reproduction of Florida grasshopper sparrow at this site has been attributed to the changes in hydrology (Vickery 1996).

The effects of decreased hydroperiod in areas of dry prairie are also poorly known. Along ditch banks in dry prairie, growth of woody vegetation is often quite luxuriant. In these areas, trees often become established, and the height of saw palmetto and other shrubs is greater than in surrounding prairies. It is unclear whether this effect results from increased drainage in the immediate area, or from the obstruction of fires by the adjacent ditches. Woody vegetation along fence lines is also frequently taller and more luxuriant that in surrounding prairie areas, and this likely results from historical fire suppression around fence posts. Comparison of historical and present-day aerial photography confirms recent increases in woody vegetation in proximity to drainage ditches in many dry prairie areas (T. Dean, Department of Forestry and Wildlife, University of Massachusetts, personal communication 1998).

Rangelands and Livestock Grazing

The persistence of dry prairie is closely tied to cattle ranching that has existed in central and South Florida since European settlement, and has continued to the present. The central Florida region was once sparsely populated (in comparison to other regions of Florida) and alternative land use options were scarce, thereby supporting management of native rangeland (DeSelm and Murdock 1993). Livestock have been present in dry prairie, and throughout central and southern peninsular Florida, for several hundred years (Yarlett 1985). Livestock grazing was historically (Harper 1921, Davis 1943) the primary economic benefit from the dry prairie/ flatwoods landscapes of central and south-central Florida (Moore 1974, Sievers 1985, Sullivan 1994). Harper (1927) reported that prior to the division of Desoto County into five counties the U. S. Census of 1900 indicated that Desoto County had 82,183 free-ranging cattle on 9,713 km^2 (3,750 mi^2), about half of which was prairie. In 1920 there were 53,192 cattle in the county (over 95 percent beef cattle) and some 70,459 cattle in 1925 (Harper 1927). Open, unfenced range existed in Florida until 1949 (Yarlett 1985). Between 1940 and 1960, many pastures of bahia grass (*Paspalum notatum*), digit grass (*Digitaria* sp.) and Bermuda grass (*Cynodon dactylon*) were established (Mozley 1985), as a result of land clearing and drainage alterations of native rangeland. By 1985, Florida had 1,215,000 ha (3 million acres) of perennial tame pasture and 405,000 ha (million acres) of annual tame pasture (Mozley 1985), an extensive area of which had formerly been dry prairie and flatwoods. In the early 1970s, production costs caused a shift towards native forage resources, although many ranchers had already recognized the value of native rangeland over improved pasture in the 1960s (Yarlett 1985). In 1984 there was a total cattle and calf inventory of 2.2 million head statewide (Yarlett 1985), with commercial cow-calf operations representing the major livestock production in Florida (Mozley 1985).

One reason Florida attracted such a large cattle industry is a growing season longer than 270 days and ample rainfall, ideal for growing forage and year-round use of native and improved pastures (Mozley 1985, DeSelm and Murdock 1993). Forage production for native rangeland *(i.e.* dry prairie and flatwoods) can range from 1,688 kg/ha (1,500 lbs/acre) on “poor condition ranges” to in excess of 8,438 kg/ha (7,500 lbs/acre) on “excellent condition ranges,” with the average production being from 4,500 to 6,750 kg/ha (4,000 to 6,000 lbs/acre) (Fults 1991, Sievers 1985, Mozley 1985). Hilmon and Hughes (1965) found that native rangelands burned in March or May produced a two-to-fourfold increase in forage, compared to those burned in October or November, with May burns causing *Aristida beyrichiana* to flower. However, native rangeland vegetation is not particularly nutritious for cattle, except immediately following a burn, with nutritional values rapidly declining thereafter (Hilmon and Hughes 1965).

Native central and South Florida rangelands (*i.e.* dry prairies and flatwoods) are typically burned by ranchers annually or biennially during the winter or early spring months to stimulate forage growth, nutrition and palatability during the lean winter months (Abrahamson and Harnett 1990, Frost *et al.* 1986, Sullivan 1994). Ranchers also burn native pastures to maintain openness, reduce shrub cover, reduce fuel accumulations, and improve wildlife habitat (Abrahamson and Harnett 1990, Frost *et al.* 1986). However, frequent winter burning, when coupled with continuous grazing pressure, can lead to a decline in *Schizachyrium stoloniferum* (creeping bluestem, formerly *Andropogon stolonifera*) (White and Terry 1979), *Sorghastrum secundum* (lopsided Indiangrass), *Amphicarpum muhlenbergianum* (goobergrass), *Andropogon virginicus* var. *glaucus* (little chalky bluestem, formerly *Andropogon capillipes*), all of which are major preferred native forage grasses (Sievers 1985) that occur in dry prairie. Under such a management regime, *Aristida beyrichiana* (previously *Aristida stricta*, in part) (Hilmon and Hughes 1965) and saw palmetto are reported to increase (Sievers 1985), as well as other brush cover (Fults 1991). To lessen the impacts of grazing on rangelands with a previous history of frequent burning, some range managers have recommended burning on a 3-year cycle (Sievers 1985, Penfield 1985), which allows more opportunity for recovery in cover of preferentially grazed grasses.

Although the effects of fire and cattle grazing on the central Florida prairie/flatwoods communities have been examined (Hilmon and Hughes 1965, Sievers 1985, Fults 1991, Mozley 1985), there is a lack of knowledge on the effects of livestock grazing on various components of native prairie biodiversity. This is particularly true of most prairies outside of the Tallgrass Prairie region of the central United States. Herbivores preferentially feed on different plant species, consequently affecting dominance and relative abundance of plant species, thereby altering species composition (Howe 1994), with the potential to increase or decrease plant species diversity (Huntly 1991). Prolonged or severe preferential grazing can lead to colonization by ruderal plant taxa (Weaver 1968). In contrast, moderate grazing can result in greater species diversity relative to ungrazed sites, where a few species may dominate a community (Milchunas *et al.* 1988). Grazing activity may change the structure of the community by disrupting soil properties (Abrahamson and Harnett 1990) or by eliminating some life forms (Howe 1994). Furthermore, grazers may interact with other processes operating at different spatial and temporal scales, such as fire, drought, or other species interactions, resulting in scale-dependent effects (Harnett *et al.* 1996). Differences in livestock grazing management (*i.e.* year-round grazing, high intensity-short duration grazing, *etc.*) contribute to differences in vegetation responses (Harnett *et al.* 1996). Finally, historical ungulate assemblages were not confined, adding stochasticity to grassland development that is less evident in ungrazed prairies, small remnants, and fenced pastures (Howe 1994). All of these factors suggest that domestic livestock grazing, managed in different ways can produce significantly different effects on prairie community structure, species composition and prairie biodiversity (Hartnett *et al.* 1996). The effects of domestic livestock grazing on components of dry prairie biodiversity therefore have significant implications for management.

Mechanical Treatments

Mechanical treatments (bedding, root-raking, use of a disc, rollerchopping, web plowing *etc.*), by whatever means, typically produce a wide variety of changes in plant community structure and composition in dry prairie. The use of bedding to reduce or remove competing shrubs and other vegetation, to prepare dry prairie for planting with pine or *Eucalyptus* monocultures (Moore and Swindel 1981) produces distinct microsites in the form of beds, flats, and furrows (Abrahamson and Harnett 1990). The native intact ground cover characteristic of dry prairie is significantly affected by these microsite alterations. Practices such as root-raking and use of a disc displace surface organic and litter layers and mineral soil, and may potentially eliminate native species, allow for the establishment of numerous weedy species, and significantly alter the native species composition and vegetation structure of dry prairie.

The most frequently employed mechanical treatment on dry prairie is the use of rollerchopping to control woody shrub height, in particular excessive growth in saw palmetto (Yarlett 1965). The use of rollerchopping on areas of intact, diverse native groundcover vegetation is not recommended and is strongly discouraged. Double chopping has been reported to almost eliminate wiregrass and saw palmetto (Hilmon *et al*. 1963). Although some herbaceous plant frequencies and species richness can increase following some types of roller-chopping, changes in overall species composition and relative abundance occur, with the increase in species richness (= species diversity) being a result of an increase in undesirable ruderal weedy species. Impacts to vegetation from chopping vary widely and are largely dependent upon the method and type of chopping, and the soil and moisture conditions when the chopping is conducted. Studies conducted by Fitzgerald *et al.* (1995) on “former” fire suppressed dry prairie (12 to 15 years of fire suppression) at Myakka River SP found that application of fire regardless of season was not significant in reducing woody cover. However, repeated chopping and follow-up burning aided attempts to restore dry prairie in shrub-dominated “former” dry prairie (Fitzgerald *et al.* 1995, Tanner 1997) at Myakka River State Park. Therefore, rollerchopping on former fire-suppressed or previously disturbed dry prairie may be a useful restoration tool when used in conjunction with frequent burning (Tanner 1997, Fitzgerald and Tanner 1992). Fitzgerald and Tanner’s (1992) study on former fire-suppressed (35 years of fire suppression), overgrown dry prairie found shrub control treatments (rollerchopping) had an acute effect on bird abundance and species composition, as they had postulated. They noted that the first birds observed in the chopped plots were prairie bird species (eastern meadowlark, *Melospiza georgiana*; loggerhead shrikes, *Lanius ludovicianus*; and grasshopper sparrow) perhaps an early sign of prairie restoration (Fitzgerald and Tanner 1992). Roller chopping is now accepted by many land managers as an effective means to begin restoration of overgrown former prairies and flatwoods (Tanner *et al*. 1988, Moore 1974). This is particularly true where fire has not been sufficient to control woody shrubs, since chopping can be effective in reducing the height and dominance of woody shrubs (Tanner 1997, Fitzgerald *et al.* 1995). However, the destructive nature of this technique, even in disturbed prairie, has the potential to cause unforeseen changes in natural processes. If applied during the spring, summer, or early fall, roller chopping may interfere with nesting activities of many prairie bird species. In addition, Bridges (1997) has postulated that roller-chopping may have been the cause of significant long-term vegetation composition changes at some dry prairie sites.

Exotic Species

The greatest effects of exotic species in the dry prairie landscape are from the large-scale conversion of prairies to pastures. Exotic plant species of central Florida that occur in dry prairie include *Axonopus furcatus* (big carpet grass), *Axonopus fissifolius* (little carpet grass), *Paspalum notatum* (bahia grass), *Panicum repens* (torpedo grass), *Cyperus haspan* (sheathed flatsedge), *Fimbristylis cymosa* (hurricane grass), *Cynodon dactylon* (Bermuda grass) and *Solanum viarum* (tropical soda apple). Bahia grass and Bermuda grass were introduced into Florida in the 1920s to improve native range for cattle (DeSelm and Murdock 1993). Carpet grasses are perhaps the most prevalent exotic grasses in central Florida flatwoods and prairies and are very widespread, even occurring sporadically throughout otherwise fairly pristine prairie communities. Seeds of both of these grasses were aerially dispersed across much of the state to aid in stabilization of barren lands. Consequently, they have an abundant and widespread seed source. These species also establish rapidly on disturbed soils and often dominate plowed fire breaks, field edges, areas rutted by feral hogs, and heavily overgrazed sites. Once established, non-native grasses that are often planted (Bahia grass, carpet grasses, Bermuda grass, and others) appear to be quite difficult to remove without intensive effort. However, these species do not actively encroach into native habitats, unless a disturbance causes removal of the native ground cover producing bare soil conditions. Tropical soda apple is a noxious weed that is unpalatable to livestock and is found in disturbed rangelands (Mullahey and Colvin 1993) and also in degraded examples of dry prairie.

The most significant exotic animal in dry prairie is *Sus scrofa*, the feral hog (Herbster and Elfers 1992). Wild or feral hogs are widely viewed as a serious threat to rare plants in Florida (Pace-Aldana and Scott 1997, Weakley and Malatesta 1997, Menges and Yahr 1997) and native plant communities (Herbster and Elfers 1992, Huffman and Judd 1998, Huffman 1990, Longino and Heuberger 1991). Impacts to the native vegetation caused by feral hog rooting habits has been documented for five natural community types at Myakka River SP, including dry prairie (Huffman 1990). Damage to native plant communities by feral hogs is a serious ecological problem in central Florida. Feral hogs not only disturb and consume native plants, but through indiscriminate rooting create unnaturally disturbed areas that serve as sites for establishment of exotic and adventive plant species, often in areas of otherwise native groundcover. Because of their explosive fecundity and the irreversible damage they can do to native ground cover vegetation, measures need to be employed to attempt to control or eradicate nuisance populations of feral hogs.

Otherwise, among the exotic animals, relatively few threats are present. The exotic shiny cowbird is present in Florida, and is a potential nest parasite for many bird species, including the Florida grasshopper sparrow (Vickery 1996). However, the distribution of this species does not appear to be expanding, and it is not currently a threat to the regional avifauna. The lubber grasshopper is an exotic invertebrate that has become well-established throughout Florida in recent years, and while numbers appear to be low, they are toxic to predators, and are highly resistant to most pesticides.

Table 1. Classification of soil types recorded in dry prairie in the Kissimmee River prairie region (Bridges 1997, Bridges and Reese 1998).*

Soil Series	Soil Order	Soil Subgroup
EauGallie	Spodosols	Alfic Haplaquods
Immokalee	Spodosols	Arenic Haplaquods
Malabar	Alfisols	Grossarenic Ochraqualfs
Myakka	Spodosols	Aeric Haplaquods
Oldsmar	Spodosols	Alfic Arenic Haplaquods
Smyrna	Spodosols	Aeric Haplaquods
Valkaria	Entisols	Spodic Psammaquents* Of

* Of particular note are several soil subgroups which are principally Floridian in range. All soil series of dry prairie are restricted (endemic) to peninsular Florida (due to their hyperthermic temperature regime) (Orzell 1997).

Table 2. Soil associations most commonly associated with dry prairie.*

County	Predominant Soil Association	Secondary Soil Associations
Charlotte	Malabar - Oldsmar - Immokalee	Immokalee - Myakka Oldsmar - Myakka
DeSoto	Farmton - EauGallie - Malabar	Smyrna - Myakka - Immokalee Valkaria - Basinger- Malabar
Glades	Myakka - Immokalee - Smyrna	Pomello - Immokalee
Hardee	Smyrna - Myakka - Ona	
Hendry	Pineda - Oldsmar (s of LaBelle)	
Highlands	Oldsmar - EauGallie - Pomona	Felda - Hicoria - Malabar Myakka - Immokalee - Smyrna
Manatee	EauGallie - Floridana	Myakka - Waveland - Cassia
Okeechobee	Immokalee - Pompano	Myakka - Basinger
Osceola	EauGallie - Smryna - Malabar	Smyrna - Myakka - Immokalee
Polk	Malabar - EauGallie - Valkaria	Smyrna - Myakka - Immokalee
Sarasota	EauGallie - Myakka - Holopaw - Pineda	

* Sources: Charlotte County (Henderson 1984); Desoto County (Cowherd *et al.* 1989); Glades (D. Rutledge, Natural Resources Conservation Service, personal communication 1998); Hardee County (Robbins *et al.* 1984); Hendry County (Belz *et al*. 1990); Highlands County (Carter *et al*. 1989, Carter 1995, Soil Conservation Service 1983); Manatee County (Hyde and Huckle 1983); Okeechobee County (McCullum and Pendleton 1971); Osceola County (Readle 1979); Polk County (Ford *et al.* 1990, Carter 1995, Soil Conservation Service 1983); Sarasota County (Hyde *et al.* 1991).

Not all areas mapped within the soils associations in Table 2 necessarily support dry prairie. In some counties, the dry prairie landscape only occupies a small area within a widespread soil association, whereas in other counties it tends to occupy the major land area of a particular association. In general, the soil associations with Alfisols or soils with argillic (alfic) horizons (associations where either Oldsmar, Malabar, or EauGallie soils are prominent), tend to be more strongly associated with the larger areas of dry prairie. Differences in soil associations between counties in Table 2 is due in part to the ongoing evolution of soil taxonomy, and the differing publication dates of the county soil surveys. In general, a typical soil gradient on the Osceola Plain for dry prairie from dry to wet within the dry prairie landscape is EauGallie - Oldsmar - Malabar - Hicoria - Bradenton - Felda (Bridges 1997).

Table 3. Average percent cover by hydrologic zone in dry prairie, arranged from dry-mesic indicators to wet-mesic indicators (includes only species with an average cover of at least 0.5 % in at least one hydrologic zone) (from Bridges and Reese 1998).

SCIENTIFIC NAME	DRY-MESIC	MESIC	WET-MESIC
Quercus minima	22.0	19.1	10.8
Serenoa repens	9.9	12.6	3.9
Lyonia lucida	2.1	0.1	0.0
Lyonia fruticosa	1.9	1.0	0.0
Vaccinium myrsinites	1.9	0.7	0.1
Gaylussacia dumosa	1.5	0.7	0.0
Eleocharis baldwinii	1.6	1.3	0.2
Hypericum reductum	1.2	0.7	0.1
Liatris tenuifolia var. quadriflora	1.1	0.3	0.0
Andropogon virginicus var. decipiens	1.1	0.4	0.0
Andropogon brachystachyus	1.5	4.5	0.5
Scleria pauciflora	1.1	0.8	0.1
Dichanthelium ensifolium var. unciphyllum	1.2	0.9	0.2
Ilex glabra	1.0	0.6	0.1
Xyris brevifolia	0.9	0.6	0.1
Carphephorus odoratissimus	0.8	0.3	0.0
Galactia regularis	0.7	0.0	0.0
Pityopsis graminifolia	0.8	0.9	0.2
Gymnopogon chapmanianus	0.6	0.1	0.0
Andropogon ternarius var. cabanisii	1.0	1.0	0.4
Paspalum setaceum	0.6	0.4	0.1
Rhynchospora plumosa	0.9	1.3	0.4
Asimina reticulata	0.6	0.3	0.1
Pterocaulon pycnostachyum	0.5	0.2	0.0
Aristida spiciformis	0.5	1.0	0.1
Dichanthelium portoricense	0.6	0.6	0.3
Carphephorus paniculatus	0.5	2.0	0.1
Fimbristylis puberula	0.5	0.5	0.2
Rhynchospora fernaldii	0.3	0.5	0.0
Xyris caroliniana	0.4	0.6	0.2
Sorghastrum secundum	0.8	0.7	0.7
Licania michauxii	0.9	0.2	0.8

Table 3. ***cont.***

SCIENTIFIC NAME	DRY-MESIC	MESIC	WET-MESIC
Polygala rugelii	0.2	0.7	0.2
Drosera brevifolia	0.3	0.6	0.5
Syngonanthus flavidulus	1.1	1.3	1.3
Aristida rhizomophora	0.0	0.9	0.2
Andropogon virginicus var. glaucus	0.2	0.3	0.5
Euthamia tenuifolia	0.1	0.1	0.5
Chaptalia tomentosa	0.0	0.0	0.5
Rhexia nuttallii	0.2	0.7	0.6
Rhexia mariana	0.0	0.1	0.5
Marshallia tenuifolia	0.0	0.0	0.5
Dichanthelium leucothrix	0.0	0.1	0.7
Carphephorus carnosus	0.0	1.8	0.7
Rhexia nashii	0.0	0.1	0.8
Bigelowia nudata ssp. australis	0.0	0.2	0.8
Axonopus furcatus	0.0	0.4	0.8
Dichanthelium strigosum var. glabrescens	0.1	0.5	1.1
Amphicarpum muhlenbergianum	0.1	0.4	1.2
Andropogon virginicus var. virginicus	0.0	0.3	1.1
Lachnocaulon anceps	0.3	0.9	1.4
Erigeron vernus	0.0	1.6	1.3
Xyris ambigua	0.0	0.2	1.3
Helianthus angustifolius	0.0	0.0	1.6
Scleria reticularis	0.3	1.6	2.4
Schizachyrium stoloniferum	0.2	0.8	2.8
Rhynchospora breviseta	0.0	0.0	3.5
Xyris elliottii	0.0	1.0	4.4
Ctenium aromaticum	0.0	0.4	4.8
Aristida beyrichiana	14.3	13.3	26.7

Table 4. Plant species recorded for dry prairie.

Scientific Name	Hardee	Highlands	Okeechobee	Osceola	Polk	Sarasota
Agalinis linifolia				x		
Agalinis obtusifolia		x		x		
Agalinis purpurea				x		x
Agalinis tenuifolia						x
Aletris lutea		x				x
Amphicarpum muhlenbergianum		x	x	x	x	x
Andropogon brachystachyus		x	x	x	x	x
Andropogon glomeratus var. glaucopsis		x	x	x		x
Andropogon glomeratus var. hirsutior			x	x		
Andropogon glomeratus var. pumilus						x
Andropogon gyrans var. gyrans	x		x			x
Andropogon gyrans var. stenophyllus		x				
Andropogon ternarius var. cabanisii		x	x	x	x	x
Andropogon virginicus var. decipiens		x	x	x		
Andropogon virginicus var. glaucus		x	x	x	x	x
Andropogon virginicus var. virginicus	x	x	x	x		x
Aristida beyrichiana	x	x	x	x	x	x
Aristida gyrans	x					
Aristida patula	x					x
Aristida purpurascens var. purpurascens		x				
Aristida purpurascens var. tenuispica		x	x	x		x
Aristida purpurascens var. virgata						x
Aristida rhizomophora			x			
Aristida spiciformis		x	x	x	x	x
Arnoglossum ovatum	x					x
Asclepias connivens						x
Asclepias feayi						x
Asclepias pedicellata		x	x	x		x
Asclepias tuberosa ssp. rolfsii						x
Asimina reticulata		x	x	x	x	x
Aster adnatus	x					x
Aster dumosus		x	x	x	x	x
Aster reticulatus			x	x		x
Aster simmondsii			x			

Table 4. *cont.*

Scientific Name	Hardee	Highlands	Okeechobee	Osceola	Polk	Sarasota
Aster subulatus						x
Aster tortifolius			x			x
Aster walteri	x					
Axonopus compressus	x	x				
Axonopus fissifolius						x
Axonopus furcatus		x	x	x	x	x
Bartonia verna		x				x
Bartonia virginica		x	x			
Befaria racemosa		x	x	x	x	x
Bidens mitis			x			
Bigelowia nudata ssp. australis		x	x	x	x	
Buchnera americana		x	x	x		
Bulbostylis ciliatifolia	x	x				
Burmannia biflora	x					x
Burmannia capitata	x	x			x	
Callicarpa americana			x			x
Calopogon multiflorus	x	x		x		x
Calopogon pallidus		x				x
Carphephorus carnosus		x	x	x	x	
Carphephorus corymbosus		x	x	x	x	x
Carphephorus odoratissimus	x	x	x	x		x
Carphephorus paniculatus	x	x	x	x	x	x
Cassytha filiformis	x					x
Centella asiatica		x	x	x		
Centrosema virginianum	x					x
Chamaecrista fasciculata						x
Chamaecrista nictitans var. aspera	x		x	x		
Chapmannia floridana						
Chaptalia tomentosa	x	x	x	x	x	x
Chrysopsis mariana						x
Cinnamomum camphora						x
Clematis baldwinii						x
Cnidoscolus stimulosus		x	x	x		x
Commelina erecta	x					x

Table 4. ***cont.***

Scientific Name	Hardee	Highlands	Okeechobee	Osceola	Polk	Sarasota
Coreopsis floridana			x			x
Crotalaria rotundifolia			x	x		x
Ctenium aromaticum	x	x	x	x		
Cuthbertia ornata						x
Cyperus croceus	x					x
Cyperus haspan			x			x
Cyperus polystachyos		x	x			
Cyperus retrorsus		x	x			
Dalea carnea var. carnea	x					x
Desmodium tenuifolium						x
Dichanthelium acuminatum						
Dichanthelium dichotomum	x	x			x	
Dichanthelium ensifolium var. ensifolium		x	x			x
Dichanthelium ensifolium var. unciphyllum		x	x	x		x
Dichanthelium erectifolium	x		x			
Dichanthelium leucothrix		x	x	x		
Dichanthelium portoricense		x	x	x		x
Dichanthelium strigosum var. glabrescens	x	x	x	x	x	x
Dichanthelium strigosum var. strigosum		x				
Diodia virginiana			x	x		x
Diospyros virginiana						x
Drosera brevifolia		x	x	x	x	
Drosera capillaris		x	x	x		x
Dyschoriste oblongifolia	x					x
Eleocharis baldwinii		x	x	x	x	x
Eleocharis flavescens	x	x				
Eleocharis geniculata						x
Eleocharis nigrescens						x
Elephantopus elatus			x	x	x	x
Eragrostis atrovirens	x					x
Eragrostis elliottii		x	x	x	x	x
Eragrostis virginica		x	x	x		x
Erigeron vernus	x	x	x	x	x	x
Eriocaulon decangulare		x	x			

Table 4. ***cont.***

Scientific Name	Hardee	Highlands	Okeechobee	Osceola	Polk	Sarasota
Eriocaulon ravenelii				x		
Eryngium aromaticum						
Eryngium yuccifolium	x	x	x	x		x
Erythrina herbacea						x
Eucalyptus rudis						x
Eulophia alta						x
Eupatorium recurvans		x	x	x	x	x
Eupatorium rotundifolium		x	x	x	x	x
Eupatorium serotinum						x
Euphorbia inundata		x				
Eustachys glauca						x
Eustachys petraea						
Euthamia tenuifolia	x	x	x	x	x	x
Fimbristylis caroliniana	x		x			x
Fimbristylis dichotoma						
Fimbristylis puberula	x	x	x	x	x	x
Fimbristylis schoenoides						x
Fuirena scirpoidea		x	x	x		
Galactia elliottii		x	x			x
Galactia regularis	x	x	x			x
Galactia volubilis	x					x
Gaura angustifolia						x
Gaylussacia dumosa		x	x	x		x
Gaylussacia nana	x					x
Gelsemium sempervirens						x
Glandularia tampensis						x
Gratiola hispida		x	x	x		x
Gratiola pilosa	x	x		x		x
Gratiola ramosa			x			
Gymnopogon brevifolius			x			
Gymnopogon chapmanianus		x	x	x	x	x
Habenaria floribunda	x					x
Hedyotis corymbosa						x
Hedyotis procumbens			x			x

Table 4. *cont.*

Scientific Name	Hardee	Highlands	Okeechobee	Osceola	Polk	Sarasota
Hedyotis uniflora	x	x	x			x
Helianthemum corymbosum						x
Helianthus angustifolius	x	x	x			x
Helianthus floridanus	x					x
Helianthus radula				x		
Heliotropium polyphyllum				x		x
Hieracium megacephalon			x			x
Hymenocallis palmeri	x		x			
Hypericum cistifolium		x		x		x
Hypericum crux-andreae						x
Hypericum fasciculatum			x			
Hypericum gentianoides						x
Hypericum myrtifolium		x	x	x	x	x
Hypericum reductum		x	x	x	x	x
Hypericum tetrapetalum		x	x	x		x
Hypoxis juncea	x	x	x	x	x	x
Hyptis alata	x		x	x		
Ilex glabra		x	x	x	x	x
Imperata brasiliensis	x					x
Indigofera hirsuta						
Juncus marginatus var. biflorus	x	x	x			
Juncus scirpoides		x			x	x
Lachnanthes caroliniana	x	x	x	x		x
Lachnocaulon anceps		x	x	x	x	x
Lachnocaulon beyrichianum	x	x				
Lechea torreyi		x	x	x		x
Leptochloa fascicularis						x
Liatris garberi				x		x
Liatris gracilis		x			x	x
Liatris spicata		x	x	x		
Liatris tenuifolia var. quadriflora		x	x	x	x	x
Licania michauxii		x			x	x
Lilium catesbaei	x	x	x	x	x	x
Lindernia grandiflora	x					

Table 4. ***cont.***

Scientific Name	Hardee	Highlands	Okeechobee	Osceola	Polk	Sarasota
Linum medium var. texanum	x		x	x	x	x
Listera australis						x
Lobelia glandulosa		x	x	x		
Lobelia paludosa		x	x	x		x
Ludwigia curtissii				x		
Ludwigia erecta						x
Ludwigia lanceolata						x
Ludwigia linifolia			x	x		
Ludwigia maritima		x	x	x	x	x
Ludwigia suffruticosa	x		x	x		x
Lycopodiella alopecuroides		x				
Lycopodiella cernua						x
Lycopodiella prostrata		x				
Lygodesmia aphylla		x	x	x		x
Lyonia fruticosa	x	x	x	x	x	x
Lyonia lucida	x	x	x	x		x
Marshallia tenuifolia		x	x	x		
Melaleuca quinquenervia						x
Melanthera nivea						x
Melochia spicata						x
Mitreola sessilifolia				x		x
Muhlenbergia capillaris var. filpes						x
Myrica cerifera		x	x	x	x	x
Opuntia humifusa	x					
Osmunda cinnamomea	x					x
Oxypolis filiformis		x	x	x		
Panicum abscissum		x				
Panicum anceps			x			
Panicum hemitomon	x		x			
Panicum longifolium		x	x	x		
Panicum rigidulum						x
Panicum tenerum		x		x		
Panicum verrucosum					x	x
Panicum virgatum						x

Table 4. ***cont.***

Scientific Name	Hardee	Highlands	Okeechobee	Osceola	Polk	Sarasota
Parthenocissus quinquefolia						x
Paspalum floridanum						x
Paspalum laeve		x				x
Paspalum notatum var. saurae						
Paspalum praecox	x	x	x	x		
Paspalum setaceum		x	x	x	x	x
Penstemon multiflorus						x
Phoebanthus grandiflorus		x	x	x	x	
Physostegia purpurea				x		
Piloblephis rigida						x
Pinguicula caerulea						x
Pinguicula lutea		x	x			x
Pinguicula pumila		x	x			x
Pinus elliottii						x
Pinus palustris	x					x
Piptochaetium avenacioides						x
Piriqueta caroliniana				x		x
Pityopsis graminifolia		x	x	x	x	x
Pluchea rosea	x		x	x		
Polygala cruciata				x		x
Polygala grandiflora						x
Polygala incarnata		x		x		x
Polygala lutea		x	x	x	x	x
Polygala nana						x
Polygala ramosa	x	x		x		x
Polygala rugelii		x	x	x	x	x
Polygala setacea		x	x	x	x	x
Pteridium aquilinum var. latiusculum	x		x			x
Pterocaulon pycnostachyum		x	x	x	x	x
Pteroglossaspis ecristata	x	x				x
Quercus geminata	x					
Quercus hemispherica	x					x
Quercus laurifolia					x	
Quercus minima		x	x	x	x	x

Table 4. *cont.*

Scientific Name	Hardee	Highlands	Okeechobee	Osceola	Polk	Sarasota
Quercus pumila	x	x	x	x	x	x
Rhexia cubensis		x	x			
Rhexia mariana		x	x	x	x	x
Rhexia nashii	x	x	x	x		
Rhexia nuttallii		x	x	x	x	x
Rhexia petiolata	x					x
Rhus copallina	x					x
Rhynchospora baldwinii	x	x	x			
Rhynchospora breviseta		x	x	x	x	
Rhynchospora cephalantha			x			
Rhynchospora chapmanii						x
Rhynchospora ciliaris		x	x			x
Rhynchospora fascicularis		x	x	x	x	x
Rhynchospora fascicularis var. distans	x	x				
Rhynchospora fernaldii		x	x	x	x	x
Rhynchospora filifolia		x	x	x		
Rhynchospora inundata			x		x	
Rhynchospora microcarpa						x
Rhynchospora microcephala			x			x
Rhynchospora plumosa		x	x	x	x	x
Rhynchospora pusilla	x	x	x	x		
Rhynchospora rariflora		x	x			
Rubus cuneifolius						
Sabal palmetto	x					x
Sabatia brevifolia		x	x	x	x	x
Sabatia grandiflora	x	x		x		
Saccharum giganteum						x
Sacciolepis indica		x	x	x		
Samolus valerandi subsp. parviflorus						x
Sarracenia minor				x		
Schinus terebinthifolius						x
Schizachyrium stoloniferum		x	x	x	x	x
Schrankia microphylla var. floridana	x					
Scleria georgiana	x	x	x	x		

Table 4. ***cont.***

Scientific Name	Hardee	Highlands	Okeechobee	Osceola	Polk	Sarasota
Scleria hirtella				x		
Scleria pauciflora		x	x	x		x
Scleria reticularis		x	x	x	x	
Scleria triglomerata	x	x				x
Scoparia dulcis			x			
Scutellaria integrifolia	x					x
Serenoa repens		x	x	x	x	x
Setaria geniculata	x	x	x			x
Seymeria pectinata		x		x		
Sisyrinchium angustifolium		x	x	x		
Sisyrinchium atlanticum						x
Smilax auriculata					x	x
Smilax bona-nox	x					x
Solidago fistulosa		x	x	x	x	x
Solidago odora var. chapmanii	x			x		x
Solidago stricta			x		x	x
Solidago tortifolia						x
Sorghastrum nutans						x
Sorghastrum secundum		x	x	x	x	x
Spermacoce assurgens	x					
Spiranthes longilabris	x	x				x
Spiranthes praecox						x
Spiranthes vernalis		x		x		x
Sporobolus indicus						x
Sporobolus junceus			x	x		x
Stenandrium dulce	x					x
Stillingia sylvatica ssp. sylvatica		x	x	x		x
Stillingia sylvatica ssp. tenuis	x			x		x
Stipulicida setacea var. setacea						
Syngonanthus flavidulus	x	x	x	x	x	x
Tephrosia hispidula	x	x	x	x	x	
Tephrosia rugelii						
Tillandsia recurvata	x					x
Tillandsia usneoides						x

Table 4. *cont.*

Scientific Name	Hardee	Highlands	Okeechobee	Osceola	Polk	Sarasota
Urena lobata			x			
Utricularia simulans	x	x	x		x	
Utricularia subulata		x	x	x	x	x
Vaccinium corymbosum	x					x
Vaccinium darrowii						x
Vaccinium myrsinites		x	x	x	x	x
Vaccinium stamineum	x					x
Vernonia blodgettii						x
Viola lanceolata			x			
Viola primulifolia						x
Viola septemloba						x
Vitis aestivalis						x
Vitis rotundifolia var. rotundifolia						x
Vitis shuttleworthii						x
Xyris ambigua		x	x	x	x	x
Xyris brevifolia		x	x	x	x	x
Xyris caroliniana		x	x	x	x	x
Xyris difformis var. floridana	x	x	x	x	x	x
Xyris elliottii		x	x	x	x	x
Xyris flabelliformis		x	x			x
Xyris jupicai						x
Xyris platylepis		x	x			x
Yucca filamentosa						x
Zigadenus densus	x			x		x

*** Sources for county dry prairie floras:**

Hardee County (Cole et al. 1994a) - seems to include only dry and dry-mesic hydrologic zones, and also includes some disturbed areas; Highlands County - Bridges (1997), Bridges and Reese (1998) - quantitative sampling and compiled floristic lists from dry prairie habitats at Avon Park Air Force Range; Okeechobee County - Bridges (1998a), Bridges and Reese (1998) - quantitative sampling and floristic lists from Audubon Kissimmee Prairie Sanctuary and from Kissimmee Prairie State Preserve; Osceola County - Bridges and Reese (1998), Orzell and Bridges (unpublished data) - quantitative sampling and floristic lists from Three Lakes Wildlife Management Area; Polk County - Bridges (1997) - quantitative sampling and compiled floristic lists from dry prairie habitats at Avon Park Air Force Range; Sarasota and Manatee counties - Huffman and Judd (1998) - species noted as occurring in dry prairie, Myakka River State Park (unpublished data) - species listed for "dry prairie and flatwoods" in the park floristic list (note that this may include some species found only in flatwoods not in dry prairie), Bridges (unpublished data) - floristic lists complied in dry prairie at Myakka River State Park.

Table 5. Species recorded from dry prairie in at least three counties (sources are same as Table 4).

Scientific Name	Hardee	Highlands	Okeechobee	Osceola	Polk	Sarasota
Amphicarpum muhlenbergianum		x	x	x	x	x
Andropogon brachystachyus		x	x	x	x	x
Andropogon glomeratus var. glaucopsis		x	x	x		x
Andropogon ternarius var. cabanisii		x	x	x	x	x
Andropogon virginicus var. decipiens		x	x	x		
Andropogon virginicus var. glaucus	x	x	x	x	x	x
Andropogon virginicus var. virginicus	x	x	x	x		x
Aristida beyrichiana	x	x	x	x	x	x
Aristida purpurascens var. tenuispica		x	x	x		x
Aristida spiciformis	x	x	x	x	x	x
Asclepias pedicellata		x	x	x		x
Asimina reticulata	x	x	x	x	x	x
Aster dumosus		x	x	x	x	x
Aster reticulatus			x	x		x
Aster tortifolius	x		x			x
Axonopus furcatus		x	x	x	x	x
Befaria racemosa		x	x	x	x	x
Bigelowia nudata ssp. australis		x	x	x	x	
Buchnera americana	x	x	x	x		
Callicarpa americana	x		x			x
Calopogon multiflorus		x	x	x		x
Carphephorus carnosus		x	x	x	x	
Carphephorus corymbosus	x	x	x	x	x	x
Carphephorus odoratissimus	x	x	x	x		x
Carphephorus paniculatus	x	x	x	x	x	x
Centella asiatica	x	x	x	x		
Chaptalia tomentosa		x	x	x	x	x
Cnidoscolus stimulosus	x	x	x	x		x
Crotalaria rotundifolia	x		x	x		x
Ctenium aromaticum		x	x	x		
Cyperus retrorsus	x	x	x			
Dichanthelium ensifolium var. ensifolium		x	x			x

Table 5. ***cont.***

Scientific Name	Hardee	Highlands	Okeechobee	Osceola	Polk	Sarasota
Dichanthelium ensifolium var. unciphyllum	x	x	x	x		x
Dichanthelium leucothrix		x	x	x		
Dichanthelium portoricense	x	x	x	x		x
Dichanthelium strigosum var. glabrescens		x	x	x	x	x
Diodia virginiana			x	x		x
Drosera brevifolia		x	x	x	x	
Drosera capillaris	x	x	x	x		x
Eleocharis baldwinii	x	x	x	x	x	x
Elephantopus elatus	x		x	x	x	x
Eragrostis elliottii		x	x	x	x	x
Eragrostis virginica	x	x	x	x		x
Erigeron vernus		x	x	x	x	x
Eryngium yuccifolium		x	x	x		x
Eupatorium recurvans		x	x	x	x	x
Eupatorium rotundifolium		x	x	x	x	x
Euthamia tenuifolia	x	x	x	x	x	x
Fimbristylis puberula		x	x	x	x	x
Fuirena scirpoidea		x	x	x		
Galactia elliottii	x	x	x			x
Galactia regularis	x	x	x			x
Gaylussacia dumosa	x	x	x	x		x
Gratiola hispida	x	x	x	x		x
Gratiola pilosa		x		x		x
Gymnopogon chapmanianus	x	x	x	x	x	x
Hedyotis procumbens	x		x			x
Hedyotis uniflora		x	x			x
Helianthus angustifolius	x	x	x			x
Hieracium megacephalon	x		x			x
Hypericum cistifolium		x		x		x
Hypericum myrtifolium		x	x	x	x	x
Hypericum reductum		x	x	x	x	x
Hypericum tetrapetalum	x	x	x	x		x
Hypoxis juncea	x	x	x	x	x	x

Table 5. *cont.*

Scientific Name	Hardee	Highlands	Okeechobee	Osceola	Polk	Sarasota
Ilex glabra	x	x	x	x	x	x
Juncus scirpoides	x	x			x	x
Lachnanthes caroliniana		x	x	x		x
Lachnocaulon anceps	x	x	x	x	x	x
Lechea torreyi		x	x	x		x
Liatris gracilis		x			x	x
Liatris spicata		x	x	x		
Liatris tenuifolia var. quadriflora		x	x	x	x	x
Licania michauxii	x	x			x	x
Lilium catesbaei	x	x	x	x	x	x
Linum medium var. texanum			x	x	x	x
Lobelia glandulosa		x	x	x		
Lobelia paludosa		x	x	x		x
Ludwigia maritima	x	x	x	x	x	x
Ludwigia suffruticosa			x	x		x
Lygodesmia aphylla	x	x	x	x		x
Lyonia fruticosa	x	x	x	x	x	x
Lyonia lucida		x	x	x		x
Marshallia tenuifolia		x	x	x		
Myrica cerifera	x	x	x	x	x	x
Oxypolis filiformis		x	x	x		
Panicum longifolium		x	x	x		
Paspalum praecox		x	x	x		
Paspalum setaceum		x	x	x	x	x
Phoebanthus grandiflorus		x	x	x	x	
Pinguicula lutea		x	x			x
Pinguicula pumila		x	x			x
Pityopsis graminifolia	x	x	x	x	x	x
Polygala incarnata		x		x		x
Polygala lutea		x	x	x	x	x
Polygala ramosa		x		x		x
Polygala rugelii		x	x	x	x	x
Polygala setacea	x	x	x	x	x	x

Table 5. ***cont.***

Scientific Name	Hardee	Highlands	Okeechobee	Osceola	Polk	Sarasota
Pterocaulon pycnostachyum	x	x	x	x	x	x
Pteroglossaspis ecristata	x	x				x
Quercus minima	x	x	x	x	x	x
Quercus pumila		x	x	x	x	x
Rhexia mariana	x	x	x	x	x	x
Rhexia nashii		x	x	x		
Rhexia nuttallii	x	x	x	x	x	x
Rhynchospora breviseta		x	x	x	x	
Rhynchospora ciliaris		x	x			x
Rhynchospora fascicularis	x	x	x	x	x	x
Rhynchospora fernaldii		x	x	x	x	x
Rhynchospora filifolia		x	x	x		
Rhynchospora plumosa	x	x	x	x	x	x
Rhynchospora pusilla		x	x	x		
Sabatia brevifolia	x	x	x	x	x	x
Sacciolepis indica		x	x	x		
Schizachyrium stoloniferum	x	x	x	x	x	x
Scleria georgiana		x	x	x		
Scleria pauciflora		x	x	x		x
Scleria reticularis	x	x	x	x	x	
Serenoa repens	x	x	x	x	x	x
Setaria geniculata		x	x			x
Sisyrinchium angustifolium		x	x	x		
Smilax auriculata	x				x	x
Solidago fistulosa	x	x	x	x	x	x
Solidago stricta			x		x	x
Sorghastrum secundum	x	x	x	x	x	x
Spiranthes vernalis		x		x		x
Sporobolus junceus	x		x	x		x
Stillingia sylvatica ssp. sylvatica	x	x	x	x		x
Syngonanthus flavidulus	x	x	x	x	x	x
Tephrosia hispidula		x	x	x	x	
Utricularia simulans		x	x		x	
Utricularia subulata	x	x	x	x	x	x

Table 5. ***cont.***

Scientific Name	Hardee	Highlands	Okeechobee	Osceola	Polk	Sarasota
Vaccinium myrsinites	x	x	x	x	x	x
Xyris ambigua		x	x	x	x	x
Xyris brevifolia		x	x	x	x	x
Xyris caroliniana	x	x	x	x	x	x
Xyris difformis var. floridana		x	x	x	x	x
Xyris elliottii		x	x	x	x	x
Xyris flabelliformis		x	x			x
Xyris platylepis		x	x			x

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Restoration of Dry Prairie

Restoration Objective: Maintain and enhance the structure, function, and composition of the dry prairie community, protect dry prairie biodiversity to encompass the range of geographic variation, and increase the spatial extent of dry prairie habitat in South Florida.

Restoration Criteria

The restoration objective will be achieved when: (1) dry prairies within the historic range of the community are adequately protected from further habitat loss, degradation, exotic plant invasion, and fire suppression; (2) degraded areas are identified, acquired and restored to suitable dry prairie habitat; (3) appropriate ecosystem management plans (including monitoring and research) have been prepared, funded, and implemented for long-term perpetuation of the dry prairie landscape; (4) dry prairie is appropriately protected and managed to benefit community-dependent species; (5) ecological linkages to adjacent communities are restored; and (6) landscape-level habitat diversity is restored.

Community-level Restoration Actions

1. **Determine the historical and current distribution and status of dry prairie in peninsular Florida.** Published and unpublished data on both the distribution and status of dry prairie is inconsistent and based in part on misinterpretation of Landsat data (see section on Status and Trends in this account). Estimates of the current status of dry prairie vary from virtually none remaining to rather large blocks remaining on privately owned rangeland.

   1.1. **Determine the historical extent and location of dry prairie for all counties in the dry prairie region** as defined by Davis (1943), by utilizing the original land surveys for Florida conducted in the 1850s. These land surveys could be used to produce a historical map of Florida dry prairie and calculate the historical area of dry prairie for each county. See discussion on Status and Trends in this account.

   1.2. **Determine the current distribution and status of dry prairie on both private and public lands in Florida.** This action could be accomplished by using recent aerial photography and Landsat imagery that has been intensively ground-truthed to eliminate errors in interpretation. Digital Orthophoto Quads (DOQ's) could be used to digitize the current distribution of dry prairie as a GIS coverage.

1.3. **Identify, map, and conduct ecological (plant and animal) inventories of the remaining dry prairie to determine locations for the highest-quality dry prairie sites.** Data from a systematic and comprehensive inventory could be used to develop, rank and prioritize the most ecologically significant dry prairie areas and determine the degree of vulnerability of sites. Plant and animal inventories and *de novo* searches for rare species would uncover previously unknown sites and thereby provide updated documentation on the status and distribution of rare species.

2. **Prevent further destruction or degradation of existing dry prairie.**

2.1. **Secure protection of all the remaining intact, high-quality dry prairie sites.** Develop a protection plan for all tracts identified in **1.2** and **1.3.** Continue through land acquisition, landowner agreements, and conservation easements, land trades, or other conservation measures, protection of dry prairie sites. Priority should be placed on preventing the loss of any remaining high-quality dry prairie sites, with emphasis on protection of sites with intact landscapes and an intact, diverse native ground cover. Devise and negotiate interagency agreements (with WMDs, DEP, FWS, *etc.*) to improve mitigation procedures for loss of wetlands in dry prairie landscapes. Sites identified as most threatened with destruction should be targeted and protected to prevent destruction.

2.2. **Prevent further degradation of disturbed, but recoverable examples of dry prairie** by securing protection of such sites. This may best be accomplished by conservation methods other than land acquisition that prevent development, such as conservation easements, particularly on large cattle ranches where land acquisition is cost-prohibitive.

2.3. **Ensure proper protection of existing protected areas.** Drainage and other hydrologic alterations on private land adjacent to existing protected areas continues to be an ongoing and unresolved crisis on at least two protected sites-Three Lakes WMA in Osceola County, and the National Audubon Society's Ordway-Whittell Kissimmee Prairie Sanctuary in Okeechobee County. Federal and State agencies need to work more efficiently and closely together to solve problems that cross the jurisdictional boundaries of an agency.

2.4. **Ensure proper management of existing protected areas.** Staffing and budgetary constraints continue to present the greatest threat to proper management of existing protected areas. Other problems faced by land managers that hinder implementation of proper management strategies include lack of technical guidance information, and insufficient equipment and manpower. In the formulation of management plans, avoid uniformity of management treatments which artificially simplify what probably was once a far more varied set of communities that constituted prairie biodiversity (Howe 1994). Varied treatments and experimental management should be encouraged, since so few quantitative studies exist on management effects on prairie biodiversity (Howe 1994). A rethinking of management priorities is needed if such experiments suggest that prairie biodiversity could be managed out of existence by certain practices (Howe 1994).

2.5. **Develop private landowner protection incentives for dry prairie (Enge *et al.* 1997).** Provide an economic or tax incentive to private landowners to prevent conversion of native pastureland into improved pastureland. Federal, State and county governments should explore new and innovative ways to provide tax breaks or other economic incentives to private landowners that choose ecological stewardship of their lands. Economic opportunities for private landowners to retain native vegetation should be encouraged, including hunting, eco-tourism, low-intensity grazing of native rangeland, harvesting of native grass seed for mining reclamation and other restoration purposes, and harvesting of saw palmetto fruits for medicinal uses. All of these help provide economic incentives to landowners to retain areas in natural dry prairie vegetation.

2.6. **Connect existing dry prairie preserves by acquiring lands for conservation between them**. Land acquisition, landowner agreements, or conservation easements should be used to prevent development of lands between existing conservation areas. Lands acquired as connectors between dry prairie preserves need not be dry prairie. Historically, the dry prairie/flatwoods landscape covered vast areas of south-central Florida, and this pattern should be maintained as much as possible.

2.7. **Conduct vegetation monitoring of dry prairie to determine responses to various management strategies.** Several potential results could come from vegetation monitoring of dry prairie habitat which have implications for the Florida grasshopper sparrow. First, by considering the effects of management on a broader set of ecosystem components (*e.g.* all the plant species present), the possibility of misleading results (in the context of ecosystem management) based on a single species subject to possible non-management related events (*i.e.* predation) is minimized. Secondly, because much more replication is possible in a vegetation study, the chances of uncovering statistically significant differences between treatments is increased. Thirdly, long-term trends in the abundance of conservative versus weedy or opportunistic species can be monitored within vegetation monitoring plots, and can be used as input for management decisions. The long-term population trends of Florida grasshopper sparrows are best addressed by beginning to monitor the health of the ecosystem as a whole, and a better understanding of the microhabitats selected by the species in order to incorporate the perpetuation of these microhabitats into ecosystem management decisions.

2.8. **Encourage and support the efforts of the central and South Florida interagency prescribed fire councils.** Without the ability and flexibility to use prescribed burning, management of dry prairie would be virtually impossible. The role of the prescribed fire councils in safeguarding, promoting and educating the public about the use of prescribed fire is essential to the future of prescribed burning.

3. **Restore existing degraded dry prairies.** Develop techniques for restoring modified or disturbed dry prairie (Enge *et al.* 1997) and criteria for monitoring the success of restoration efforts (Anderson 1997, Zedler 1997).

3.1. **Reintroduce natural fires and/or prescribed controlled burns.** Dry prairies that have been degraded due to fire exclusion can be restored with prescribed burning. Each protected dry prairie site should have a fire management plan. Management plans should specifically include allowing natural, lightning-ignited fires to burn through the dry prairie landscape whenever possible, especially on the larger preserves, such as the Kissimmee Prairie State Preserve and the National Audubon

Society's Ordway-Whittell Kissimmee Prairie Sanctuary. Burn plans for sites should specify fire type, intensity and frequency in order to mimic natural fires and to meet management objectives.

3.2. **Encourage maintenance and recovery of landscape-level ecological processes.** Where possible, management efforts should strive to maintain and enhance ecological processes (natural fire regimes, natural hydrologic perturbations, biological interactions, ecosystem function, *etc.*) characteristic of the natural landscape. In particular, allowing natural lightning fires and other natural disturbances should receive special attention in management plans for areas with intact landscapes. Firebreaks and roads should be placed well away from ecotones. Ecotones that have been degraded by existing roads and fire breaks should be restored.

3.3. **Eliminate or control exotic and off-site species.** The native ground cover of some dry prairies has been altered by past attempts to improve their livestock grazing potential and/or commercial forestry potential. Efforts to eliminate or control exotic plants should be implemented. In addition, total eradication of feral hogs should be a priority on dry prairie preserves.

3.4. **Continue to allow compatible public uses.** Dry prairies acquired for conservation of biotic resources must be protected from inappropriate public use. However, compatible public uses are very valuable in public education about the ecosystem and the need for conservation. Off-road vehicle use and destructive commercial rare plant collecting are not compatible with preservation.

3.5. **Monitor for negative population trends among important dry prairie plant and animal species.** Each dry prairie preserve should have a specific monitoring plan that will alert land managers to extirpation or downward trends in populations of selected dry prairie species, including endemic species, listed species, and keystone species.

3.6. **Monitor and eliminate hydrologic alterations.** Recent hydrologic alterations created by adjacent landowners to control water flows on their properties present a real and current threat on Three Lakes WMA in Osceola County and the National Audubon Society's Ordway-Whittell Kissimmee Prairie Sanctuary in Okeechobee County. Vegetation sampling and monitoring of permanent vegetation plots is needed to determine the effects of hydrologic alteration on dry prairie vegetation.

4. **Create dry prairie analogs where dry prairie has been destroyed by human activities such as mining.** In Polk County, Callahan *et al.* (1990) report on preliminary results that suggest the costs of creating "moderate-quality" examples of "palmetto prairie" on a 60 ha parcel of mined land, although higher in initial cost than creating pastures, may not be as high as formerly reported. Callahan *et al.* (1990) report that while improved pastures can be created on mined land by seeding alone, actual restoration of prairies requires topsoiling, intensive planting of herbaceous species, direct seeding, or a combination of these methods, at a higher initial cost. However, Callahan *et al.* (1990) state that prairies might be nearly maintenance-free, while pastures are accompanied by higher land management expenses. Efforts to revegetate former strip mine lands using native species should continue (Callahan and Cates 1991).

5. **Encourage ecosystem/landscape level research projects in dry prairie.** Identify ecosystem processes (vegetation composition and structure, successional patterns, hydrologic regimes, burn regimes, herbivory, *etc*.) in dry prairie and use research findings to aid in development of management guidelines and strategies (Enge *et al.* 1997). Provide useful information on current research needs to IFAS Southwest Florida Research and Education Centers (SWFREC) Agro-Ecology and Natural Resources Advisory Committee (Enge *et al.* 1997).

5.1. **Determine the rangewide geographic variation in the dry prairie ecosystem.** Conduct rangewide studies incorporating floristic surveys (considering species composition, phytogeographic patterns, relative frequency data, and vegetative physiognomy), faunal surveys and correlated environmental parameters (climate, hydrology, edaphic factors and regional landscape context) to recognize and differentiate regional variation in dry prairie. There is considerable regional diversity in peninsular Florida pine flatwoods and savannas (Orzell and Bridges 1997), and preliminary findings by Bridges and Reese (1998) suggest that there is also regional variation in dry prairie. In order to protect the biodiversity of dry prairie there need to be studies to determine the geographic variation within dry prairie.

5.2. **Fund and conduct research on the effects of livestock grazing on dry prairie.** Since much of the economic incentive to private landowners to retain dry prairie is derived from revenues generated from livestock grazing, it is important to fund studies evaluating the effects of livestock grazing on all components of the dry prairie ecosystem, including the effects on specific plants and animals. Funding to evaluate the effects of livestock grazing on dry prairie vegetation through establishment of permanent plots and grazing exclosures to monitor the long-term effects of livestock grazing should be encouraged. Funding should be secured to continue ongoing projects (*i.e.,* Bridges *et al.* 1998), initially funded by Avon Park Air Force Range, to evaluate the effects of grazing on dry prairie vegetation and the Florida grasshopper sparrow.

5.3. **Encourage research on prescribed burning in dry prairie.** As more dry prairie is purchased and/or protected, management knowledge about the effects of fire frequency, intensity and seasonality will become increasingly important to maintenance of the biodiversity of the dry prairie landscape. Recent trends of land managers to burn at times other than early spring and early summer, in order to avoid impacting any potentially listed birds needs to be studied (see section above in this account). In addition, the long-term effects of differing fire frequencies needs study, since recent trends indicate that many land managers of public properties are burning dry prairie typically on a 3-year rotation, rather than the more natural annual or biennial burn cycle. Knowledge about the natural fire season and research on fire intervals would lead to initiation of improved fire management programs (Dye 1997).

5.4. **Conduct research to determine the applicability and effectiveness of various mechanical treatments for restoration of severely degraded dry prairies.** Former dry prairies that have been degraded due to fire suppression or other disturbances may benefit from controlled burns and some mechanical restoration treatments, such as rollerchopping. Work initiated by Tanner (1997) and Fitzgerald *et al.* (1995) should receive continuing funding to determine long-term effects and trends.

6. **Increase awareness and knowledge of the dry prairie ecosystem.**

6.1. **Provide support for a regional 1-3 day symposium on the Florida dry prairie ecosystem.** The Florida Native Plant Society, Florida Department of Environmental Protection Division of State Land Management, Avon Park Air Force Range Natural Resources Flight, Florida Chapter of The Nature Conservancy, Florida Game and Fresh Water Fish Commission Non-game Wildlife Program, Florida Chapter of the National Audubon Society, FWS South Florida Office, and Southeastern Chapter of the Society for Ecological Restoration should sponsor, participate and support a symposium on Florida dry prairie. Ongoing and past research funded by the Department of Defense on rare dry prairies species and vegetation composition, along with research at Myakka River SP, the National Audubon Society's Ordway-Whittell Kissimmee Prairie Sanctuary, and inventory efforts at the Kissimmee Prairie State Preserve could be highlighted. In addition, land managers of privately owned rangelands and other public lands should be encouraged to attend and make presentations on their management practices and results.

6.2. **Provide technical advisory support to private landowners of dry prairie.** Provide technical information on ecosystem management strategies and practices to private landowners willing and interested in protecting biodiversity of dry prairie.

6.3. **Increase public awareness and understanding of the dry prairie ecosystem.** Public understanding and approval are required for any conservation effort to be successful. Public announcements should highlight land acquisition projects such as Florida's Conservation and Recreational Lands (CARL) program and Preservation-2000. Environmental education programs in South Florida should be encouraged to distribute materials or develop lesson plans on dry prairie habitats, dry prairie species, and the importance of maintaining natural biodiversity. A recent article by Benshoff (1998), "Florida dry prairie, an endangered land," published in Wildlife and Nature, Florida's Outdoor Magazine is an excellent example for educational purposes. Develop a Wildlife Series, like others at GFC, and an education campaign on dry prairie (Enge *et al.* 1997).