Urban Forestry & Urban Greening 20 (2016) 1–11

Contents lists available at ScienceDirect

Urban Forestry & Urban Greening

journal homepage: www.elsevier.com/locate/ufug

Conserving rare plants in locally-protected urban forest fragments: A case study from Miami-Dade County, Florida

Joshua M. Diamond[a,b,*], Joel T. Heinen[a]

[a] Florida International University, Department of Earth and Environment, 11200 SW 8th St., AHC-5 #360, Miami, FL 33199, United States
[b] Southeast Environmental Research Center, 11200 SW 8th St., AHC-5 #360, Miami, FL 33199, United States

ARTICLE INFO

Article history:
Received 27 April 2016
Received in revised form 15 July 2016
Accepted 19 July 2016
Available online 30 July 2016

Keywords:
Endemic plants
Micro-reserves
Pine rocklands
Species of special concern
Tropical hardwood hammocks

ABSTRACT

We consider Miami-Dade County's Environmentally Endangered Lands (EEL) network of preserves as a means to conserve rare plant species in urban and suburban forest fragments. In this rapidly urbanizing landscape, upland forests are at particularly high risk of development. We examined the number of rare plant species present in preserves based on the site area, ecosystem type and management practices using the EEL database maintained by the county and a database of plant species inventories collected by the Institute for Regional Conservation. About 99% of the area of the EEL system is located in southern Miami-Dade. Pine rockland forests are primarily in the outer suburbs of the county where fire can be used most effectively for management. Hardwood hammock forests are distributed throughout the county including within the urban core. All 56 EEL forested sites under study contained at least one rare plant species. Small sites often contained high numbers of rare species per unit area, but presumably at lower population sizes. The type of upland forest was not related to the mean richness of rare or state-listed plant species. Public access was not related to the mean richness of rare plants, but was negatively associated with the richness of state-listed plant species.

1. Introduction

South Florida has seen very rapid growth of human populations and economic development over the past century and, by 2010, Miami-Dade County's population was about 2.5 million (United States Census Bureau, 2010). Most development has occurred on the higher elevational limestone Miami rock ridge (Fig. 1) where flooding is least likely. Upland forests became increasingly rare through the 20th century as rock-plowing and other farming techniques drove conversion to agricultural lands (Smith et al., 2011). More recently, drainage and canalization allowed agriculture to advance beyond the rock ridge and continue into the vast former marshes of the eastern Everglades (Carden, 2004).

In 1990, Miami-Dade County began purchasing upland forest sites and other threatened parcels through the Environmentally Endangered Lands (EEL) program (Alonso and Heinen, 2011) after citizens passed a dedicated property tax millage. In addition to this fee-simple conservation program, the county later began the EEL Covenant Program by providing landowners with property tax relief in exchange for preserving forest fragments on private property (Giannini and Heinen, 2014) provided they follow an approved management plan. The two main upland forest types preserved under EEL are pine rocklands and hardwood hammocks.

Worldwide, areas with high plant endemism are characterized by the confluence of geological and climatological conditions that produce unique and relatively stable habitats over time (e.g. Heinen and Shrestha-Acharya, 2011; Liu et al., 2014). Pine rockland forests in South Florida are no exception; they are exclusive to relatively high-elevation limestone outcrops that are fire-prone areas at high risk of development. They are noted for their unique combination of temperate and tropical flora and a large number of rare endemic plants, many of which are either state or federally listed (Avery and Loope, 1980; O'Brien, 1998; Powell and Maschinski, 2012). Despite a high richness of understory plants, pine rocklands are dominated by one canopy tree species, South Florida Slash Pine (*Pinus elliottii* var. *densa*; Simpson, 1920). Today within the county pine rocklands are limited to parts of eastern Everglades National Park and scattered natural areas throughout the urban and suburban matrix of Miami-Dade. Pine rocklands require fire for effective management,

Abbreviations: EEL, Environmentally Endangered Lands; IRC, Institute for Regional Conservation; FNAI, Florida Natural Areas Inventory; FTBG, Fairchild Tropical Botanic Garden.

* Corresponding author at: Florida International University, Department of Earth and Environment, 11200 SW 8th St., AHC-5 #360, Miami, FL 33199, United States.
E-mail address: jdiam009@fiu.edu (J.M. Diamond).

http://dx.doi.org/10.1016/j.ufug.2016.07.008
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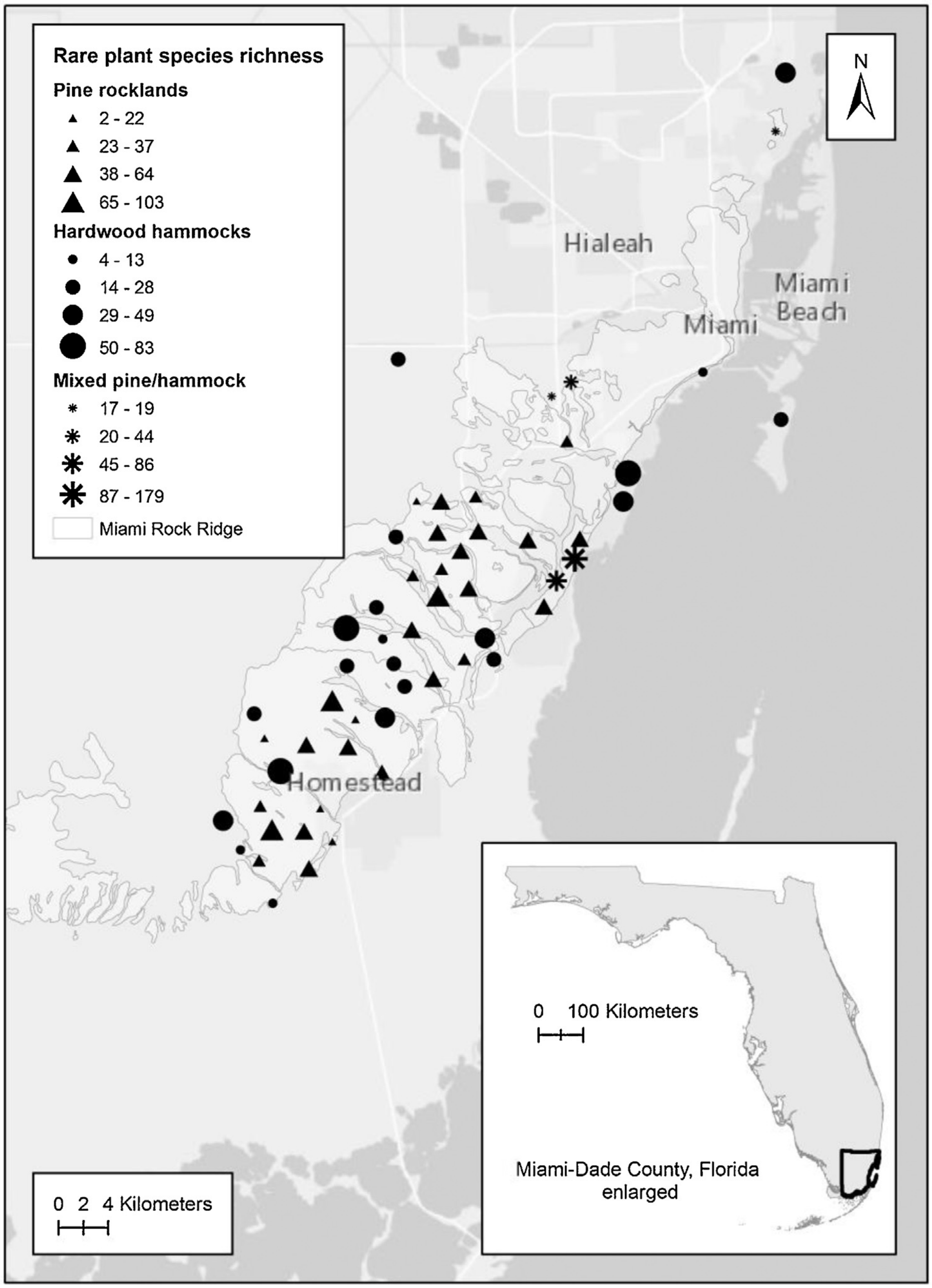

Fig. 1. This representation of the EEL pine rockland and hardwood hammock forests indicates the richness of rare plant species at each site. The symbol used indicates ecosystem type, larger symbols indicate greater richness of rare species. Some markers have been geographically dispersed to display nearby sites. Site additions with plant species lists present were displayed as separate markers. Miami is the urban core of this county, and suburban development follows the shape of the Miami rock ridge southwest towards Homestead. Miami rock ridge shape file used with permission of Fairchild Tropical Botanic Garden.

which is politically difficult in densely populated areas (Lloyd and Slater, 2012; Possley et al., 2014).

Tropical hardwood hammocks, like pine rocklands, form on higher and drier land than surrounding freshwater marshes. These tropical dry forests are populated by a wide variety of evergreen and deciduous trees, many of which produce fruits of high importance to migratory birds and frugivorous mammals (Karim and Main, 2009; McCleery et al., 2006). Much of the vegetation is of West Indian origin in contrast to the majority of vegetation along the east coast of the United States. Tropical hardwood hammocks form over thin, well-drained, organic soils (Ross et al., 2003). Pine rocklands and tropical hardwood hammocks are two endpoints of a successional gradient; that is, fire will remove hammock and allow for pine regeneration, while fire suppression will allow hardwood hammock vegetation to dominate (Alexander, 1967).

While efforts to restore South Florida forests have increased, the challenges to management have not abated. Dozens of invasive plant species have established in pine rocklands, compared to just four problematic species noted in the 1970s (Loope et al., 1979). Prescribed burning is difficult as urban sprawl continues into formerly agricultural areas of southwest Miami-Dade County where the majority of EEL preserves are located. Mechanical thinning of hardwoods was investigated as an alternative to fire in urban pine rocklands with mixed results and much higher costs than controlled burns (Maschinski et al., 2005). Researchers have reported that thinning is not a desirable substitute but can be beneficial as a pre-fire treatment or stop-gap measure (Possley et al., 2014). Fragmentation and isolation are concerns in these South Florida forests (Barrios et al., 2011; Karim and Main, 2009). In 2007, Fairchild Tropical Botanic Garden, based in Miami-Dade, began the Connect to Protect Network to provide rare pine rockland plant species to homeowners for landscaping purposes in order to increase connectivity of isolated fragments (Powell and Maschinski, 2012).

Much *in situ* conservation literature is focused on the importance of size and connectivity of protected areas to maintain native diversity and populations of rare species (e.g. Paudel and Heinen 2015; Simberloff and Abele 1976; Wilcox and Murphy, 1985). While large, highly connected reserves may be required for conserving large carnivore populations, smaller reserves totaling the same area may protect more rare plant species (Järvinen, 1982; Shafer 1995; Wilcox and Murphy, 1985). The optimal reserve design to conserve rare organisms will depend greatly on the taxa (McCarthy et al., 2011). In many urban and suburban areas, protected areas are necessarily small and generally disconnected. In rapidly urbanizing landscapes near cities like Los Angeles, California and Valencia, Spain, small preserves have been effective in conserving rare plants (Laguna et al., 2004; Parker, 2012). One larger preserve of equivalent area could be unable to conserve the full variety of plant taxa, depending on habitat conditions. This has previous been described as a value of small urban preserves, which can serve as a compliment to larger conservation areas (Shafer, 1995). Many of the preserves in the EEL system are small, under 20 ha, and fit the definition of Spain's "micro-reserves" described by Laguna et al. (2004).

Here we use data from Miami-Dade County for the locations and sizes of EEL forested preserves and cross-classify them with species locations from a flora database produced by the Institute for Regional Conservation (IRC), a private, non-profit research organization based in South Florida. We address the question of whether, and to what degree, small isolated preserves in a human dominated landscape are important for the conservation of rare, endemic plants.

2. Methods

We correlated preserve area with number of rare species in each EEL preserve. The borders of Miami-Dade EEL preserves are available from Miami- Dade County's self-service GIS portal (http://www.miamidade.gov/technology/gis-maps-and-apps.asp). We conducted spatial analyses in ArcMap GIS version 10.2.2. We used preserve borders to calculate area for each EEL parcel. We designated each preserve with one more ecosystem types based on interpretation of aerial photographs. We omitted wetland preserves from the analysis to focus on upland ecosystems. We classified preserves as being "public access" if they had any public facilities such as bathrooms, trails or playgrounds. Most sites without public access are fenced-in to avoid destructive trespass and trash dumping.

The IRC produced the Floristic Inventory of South Florida, which includes plant inventories for over 400 conservation areas including most EEL preserves and a number of county, state and federal landholdings (Gann and Collaborators, 2015). Plant lists were used for each EEL property unless the IRC flagged the list for updates. On this basis, one preserve was excluded from our analysis. Plants listed as "present, native, and not introduced" were included in this study, excluding obligate wetland and aquatic plants. South Florida plants with any designation of conservation concern by the US Fish and Wildlife Service, the State of Florida, the Florida Natural Areas Inventory (FNAI), or the IRC were considered to be "rare plants" (Table 1, Appendix A, Florida Natural Areas Inventory, 2010; Gann and Collaborators, 2015; U.S. Fish and Wildlife Service, 1999). In order of increasing concern, FNAI and IRC rank rare plants as rare, imperiled, and critically imperiled. Upland plants designated by the State of Florida as threatened or endangered were considered to be "state-listed plants" and generally indicate a greater overall conservation concern than a FNAI or IRC status alone. Subspecies and varieties were analyzed as separate taxa, because of their discontinuous distributions and conservation statuses. The IRC's plant list was used as the standard nomenclatural reference (Gann and Collaborators, 2015).

The data were analyzed with IBM SPSS Statistics version 19.0.0. Linear regression was used to compare the richness of state-listed species to the natural log of preserve area, establishing a species-area relationship. Independent sample T-tests were conducted to compare the numbers of species between preserves with and without public access, and to compare pine rockland and hardwood hammock preserves. Standard deviation was reported as the measure of variability of mean values.

3. Results

The EEL program has acquired 25,067 ha of conservation land through both fee simple purchase and conservation partner agreements throughout its history (Alonso and Heinen, 2011; Giannini and Heinen, 2014). These preserves are located primarily in the southern portion of the county. Miami-Dade County is divided into "Northern" and "Southern" sections by Flagler Street (State Route 973). The heavily urbanized northern portion of the county contains less than one percent of the area within the EEL system. The largest individual EEL parcel surrounds the electrical utility Florida Power & Light (FPL). Collectively referred to as the "South Dade Wetlands," this region has about three quarters of the EEL's land area. It does not support natural forest communities beyond isolated tree islands interspersed in vast wetlands and those were not considered for this analysis.

The program attempts to preserve different ecosystem types present throughout the county but the area protected varies greatly by ecosystem type. Freshwater wetlands occupy the greatest area within the EEL system including marshlands dominated by sawgrass (*Cladium jamaicense*) as well as cypress swamps dominated by bald cypress (*Taxodium distichum*). Coastal brackish to saltwater EEL preserves line much of Miami-Dade's southern coastline. Most EEL forested preserves follow the geographic pattern of the Miami rock ridge, extending from northeast to southwest Miami-Dade County. Forested preserves east of the ridge are composed primarily of some hardwood hammock and coastal vegetation. Since we concentrate our study on EEL upland forest preserves, wetland preserves were omitted from this analysis.

All 56 EEL eligible forested preserves have at least two rare species, and a mean of 41.8 ($s = 30.0$, Table 1, Fig. 1). Fifty four preserves have at least one state-listed species, with a mean of 21.2 ($s = 14.3$). Species federally designated as endangered, threatened, or candidates for future listing occur at 33 preserves. A total of 310 rare plant species are found in EEL preserves, including 126 that are state-listed and 14 that are federally-listed (Appendix A). The median size of an EEL forest preserve was 10.1 ha ($s = 64.3$). Thirty seven of 56 EEL preserves are less than 20 ha, corresponding to the size of Spanish plant micro-reserves (Laguna et al., 2004). Hardwood hammock EEL preserves were larger on average than pine rockland preserves, but this difference was not significant ($P = 0.16$).

The size of EEL forested sites is not associated with the richness of rare plants. Small sites were previously reported to have high overall plant species richness, sometimes comparable to much larger preserves, although the variance in richness is greater among smaller sites (Possley and Maschinski, 2008). The size of EEL forested sites is positively associated with the richness of state-

Table 1
EEL preserves were categorized as pine rockland, hardwood hammock, or a mixture of the two. 56 upland EEL preserves were included in this analysis.

EEL Preserve Name	Ecosystem Category	Public Access?	Area (hectares)	Number of rare species	Number of state-listed species
AD Doug Barnes Park	Mixed pine rockland & hardwood hammock	Yes	24.3	44	12
Arch Creek Park	Mixed pine rockland & hardwood hammock	Yes	4.0	19	9
Big and Little George Hammock	Hardwood hammock	No	8.5	17	10
Bill Sadowski Park	Mixed pine rockland & hardwood hammock	Yes	9.3	86	41
Black Creek Forest	Hardwood hammock	No	16.2	46	30
Boystown Pineland	Pine rockland	Yes	32.4	19	9
Camp Owaissa Bauer	Pine rockland	Yes	32.8	99	64
Castellow Hammock parcel 28	Hardwood hammock	No	3.6	28	19
Castellow Hammock parcel 31	Hardwood hammock	No	8.1	15	14
Castellow Hammock parcel 33	Hardwood hammock	No	2.8	16	9
Castellow Hammock Park	Hardwood hammock	Yes	22.7	83	53
Chernoff Hammock	Hardwood hammock	No	1.6	8	9
Crandon Park	Hardwood hammock	Yes	362.6	26	9
Deering Estate at Cutler	Mixed pine rockland & hardwood hammock	Yes	179.7	179	73
Eachus Pineland	Pine rockland	No	6.9	29	16
Florida City Pineland	Pine rockland	No	9.7	44	27
Fuchs Hammock Preserve	Hardwood hammock	No	15.8	60	44
Gold Coast Railroad Museum	Pine rockland	Yes	24.3	30	13
Goulds Pineland	Pine rockland	No	24.3	37	21
Greynolds Park	Hardwood hammock	Yes	81.3	32	14
Harden Hammock	Hardwood hammock	No	4.9	17	10
Hattie Bauer Hammock	Hardwood hammock	Yes	5.7	49	32
Holiday Hammock	Hardwood hammock	No	8.9	4	0
Ingram Pineland	Pine rockland	No	4.9	44	27
Larry and Penny Thompson Park	Pine rockland	Yes	65.6	103	39
Loveland Hammock	Hardwood hammock	No	6.1	9	5
Lucille Hammock	Hardwood hammock	No	8.5	41	16
Ludlam Pineland	Pine rockland	No	3.6	59	19
Matheson Hammock Park	Hardwood hammock	Yes	158.2	58	34
Meissner Hammock	Hardwood hammock	No	4.0	26	23
Miami Metrozoo	Pine rockland	Yes	11.3	58	25
Navy Wells Pineland #23	Pine rockland	No	8.5	22	15
Navy Wells Pineland #39	Pine rockland	No	5.7	10	0
Navy Wells Pineland Preserve	Pine rockland	Yes	91.1	83	39
Ned Glenn Pineland Preserve	Pine rockland	No	10.5	60	25
Nixon Smiley Pineland Addition	Pine rockland	Yes	26.7	46	13
Nixon Smiley Pineland Preserve	Pine rockland	Yes	25.5	64	20
Northrop Pineland	Pine rockland	No	5.3	17	11
Palm Drive Pineland	Pine rockland	No	8.1	25	19
Pine Shore Preserve	Pine rockland	No	3.2	53	18
Quail Roost Pineland	Pine rockland	No	29.9	64	25
R. Hardy Matheson Preserve	Hardwood hammock	No	249.3	38	23
Richmond Pine Rocklands/Luis Martinez US Army Reserve Station	Pine rockland	No	53.4	60	28
Rock Pit #34	Pine rockland	No	1.6	2	1
Rock Pit #39	Pine rockland	No	6.1	34	21
Rockdale Pineland	Pine rockland	No	19.0	58	20
Seminole Wayside Park	Pine rockland	Yes	10.9	43	27
Silver Palm Groves	Pine rockland	No	8.1	46	29
Silver Palm Hammock	Hardwood hammock	No	11.7	18	18
Sunny Palms Pineland	Pine rockland	No	16.2	48	24
Tamiami Pineland Complex Addition	Pine rockland	No	10.5	30	20
Tree Island Park	Hardwood hammock	No	48.6	22	5
Trinity Pineland	Pine rockland	No	4.0	37	14
Tropical Park	Mixed pine rockland & hardwood hammock	Yes	88.6	17	11
Vizcaya Museum and Gardens	Hardwood hammock	Yes	4.9	13	12
West Biscayne Pineland	Pine rockland	No	7.7	47	23

listed plant species (Fig. 2) but the relationship, while statistically significant ($P < 0.01$), only explains a small amount of variation ($R^2 = 0.14$).

The type of upland forest ecosystem was not related to the richness of rare plant species ($P = 0.17$). The rare plant richness in pine rocklands ($n = 30$) averaged 4.3 per hectare ($s = 3.9$), while rare plant richness in hardwood hammocks ($n = 21$) averaged 3.0 per hectare ($s = 2.6$). The type of upland forest ecosystem was also not related to the richness of state-listed plants ($p = 0.84$). The state-listed plant richness in hardwood hammocks ($n = 20$) averaged 2.1 per hectare ($s = 1.9$), while state-listed plant richness in pine rocklands averaged 2.0 per hectare ($s = 1.6$).

Preserves with public access ($n = 20$) average 2.7 rare plants per hectare ($s = 1.5$), compared with 4.3 per hectare ($s = 1.7$) in preserves without public access ($n = 36$). Although the average richness of rare plant species is greater in preserves without public access, this difference is not significant ($P = 0.06$). Public access to EEL preserves was related to the number of state-listed plants. Pre-

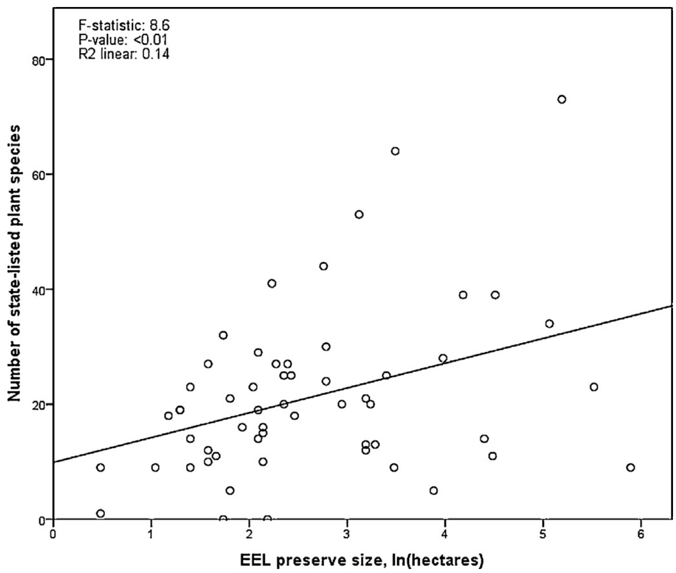

Fig. 2. The size of 56 EEL forested preserves is positively associated with the richness of state-listed plant species. This graph suggests that while larger EEL preserves do contain more state-listed species, many of the smaller sites are helping to achieve the goal of conserving plants. Other factors, such as fire history, soil, and hydrology are presumed to influence the richness of rare taxa.

serves without public access averaged 2.3 state- listed species per hectare (s = 1.7), while preserves with public access averaged 1.4 state-listed species per hectare (s = 1.5). Public access is negatively correlated with the average richness of state-listed plants ($P < 0.05$). Preserves with public access are about three times larger ($P < 0.05$), averaging 63.1 ha (s = 86.4), while preserves without public access average 17.9 ha (s = 41.3). Five of 21 hardwood hammock preserves have public access, compared to nine of 30 pine rockland preserves. All five mixed pine and hammock preserves are publically accessible.

4. Discussion

While small, subnational preserves are not considered among the protected areas recognized globally by the World Conservation Union's Commission on Protected Areas (Heinen, 1995), our results show that these preserves are important for the conservation of rare plant species in a human dominated landscape. Furthermore, in such landscapes, small preserves are the main mechanism for *in situ* conservation and provide some potential for urban populations to enjoy nature locally (Alonso and Heinen, 2011). They are thus both socially and ecologically beneficial. Our results show that plant species of conservation concern are present in all EEL forested preserves for which IRC has produced current species checklists, demonstrating the value of all preserves within the system. Despite small preserve sizes, which in some cases are heavily used and/or embedded within an inhospitable urban matrix, rare plant species have persisted. Many of the rare plants are small herbaceous species that do not necessarily need large land areas to support viable populations, although dispersal options may be limited by the surrounding matrix (Alonso and Heinen, 2011; Parker, 2012).

An active adaptive management approach may be useful to keep such populations viable. In keeping with this ideal, FTBG's Connect to Protect Network attempts to facilitate pine rockland plant dispersal by adding stepping stones between existing sites, including private yards with landowner agreements, to introduce genetic variability into bottlenecked populations (Powell and Maschinski, 2012). Pine rocklands have a greater proportion of wind-dispersed flora than hardwood hammocks (Tomlinson, 1980). Pine rocklands were once well connected such that many herbaceous species could disperse in any direction. Wind dispersal creates a seed deposition pattern where seed abundance decreases exponentially from the source (McClanahan, 1986). Anthropogenic barriers such as large buildings and dense housing likely present a challenge for wind dispersal to and from EEL preserves.

Hardwood hammocks were historically more likely than pine rocklands to be naturally fragmented in South Florida. Patches of hardwood hammock can develop in pine rocklands in areas where fires are rare, but on drier sites, hammocks are probably short-lived, only supporting early-successional hardwood plant species during intervals between fires. On more mesic sites, hammocks persist for up to 200 years (Wade et al., 1980). Hardwood hammocks growing on tree islands inside Everglades National Park often develop a moat around them protecting them from fire. These moats are created as organic acids formed by decomposing biomass dissolve the surrounding limestone bedrock, and fauna further excavate the soil (Lodge, 2010).

The flora of hardwood hammocks consists of plants that produce fleshy fruits, presumably as an adaptation for dispersal by animals. Approximately 70% of Florida's native hardwood hammock trees produce fleshy fruits and are primarily bird dispersed (Tomlinson, 1980). Many characteristic hardwood hammock plants have origins in the Caribbean and were likely introduced to Florida by neotropical migratory birds (Carrington et al., 2015; Tomlinson, 1980). Plant communities with bird-dispersed seeds do not require uninterrupted environments for establishment, as frugivorous birds may fly directly between isolated habitat patches, such as between islands in the Caribbean. Birds in the Everglades which mainly eat fruit are seldom seen outside of hardwood hammock tree islands (Gawlik et al., 2002). Many Florida native trees without fleshy fruits are not characteristic of hardwood hammocks, e.g., the wind-dispersed pineland acacia (*Vachellia farnesiana* var. *pinetorum*) and all three of Florida's mangrove species, which are water-dispersed.

The size of EEL forest sites is positively associated with richness of state-listed plant species (Fig. 2), although small sites are important for the persistence of some species (Possley and Maschinski, 2008). This suggests a value in preserving both large and small sites within the EEL system. The IRC species data are only presence or absence, they are not sufficient to describe the population distribution between sites. The smallest forest parcels presumably have fewer individuals of all species and the rare species contained within are at higher risk of extirpation from disease or disturbance (Parker, 2012). At larger sites, a single disturbance event may not be sufficient to completely eradicate a larger, more widespread population. Larger sites, especially if in close proximity to smaller sites, could serve as source populations for the colonization of plants extirpated from smaller reserves.

We found that public access to EEL preserves is negatively correlated with the number of state-listed plants present; a greater richness of state-listed plants is found in sites without public access. The area of an EEL preserve used in this analysis was based on the entire property, including paved parking lots, which are unlikely to contain rare species. Preserves with public access varied in their extent of paved surface area. Public access sites in our sample are typically managed as county parks. Sites without public access are fenced off to combat challenges like destructive trespass and trash dumping that plague many smaller urban reserves (Alonso and Heinen, 2011; Parker, 2012).

We found that the average richness of rare plant species is not significantly different between pine rocklands and hardwood hammocks ($P = 0.17$). Similarly, the average richness of state-listed plants were not different between the forest types ($P = 0.84$). We were surprised that pine rockland preserves did not have greater richness because of the local and historical emphasis on the conservation of these flora (Lodge, 2010; Simpson, 1920; Snyder et al., 1990). Hardwood hammock forests consist of many plant species with a pan-Caribbean distribution and, as a result, this forest type is not as closely associated with species endemism (Tomlinson, 1980). Pine rocklands, by contrast, are often noted for their high number of endemic species, approximately three times as many endemic species as in hardwood hammocks (Avery and Loope, 1980). Despite greater endemic species richness, pine rocklands may be more vulnerable to exotic invasive vegetation, as this is an early-successional environment. Large, intact hammocks may be less susceptible, as their small canopy gaps are generally unsuitable for pioneer woody species (Diamond and Ross, 2016). Not all of the rare plants are found within EEL reserves, additional endemic upland plants occur in Big Cypress National Preserve, Everglades National Park and Key Deer National Wildlife Refuge on Big Pine Key (Florida Natural Areas Inventory, 2010; Gann and Collaborators, 2015).

Several factors have been suggested to explain finer variation between sites: fire history, hydrology and soil type (Lloyd and Slater, 2012; Possley and Maschinski, 2008). Fire history is a major factor influencing the type and physical structure of vegetation in these urban reserves. Pine rocklands require frequent low-intensity understory burns to clear hardwood vegetation that will shade out many of the rarer herbaceous plants if left unchecked. Fires at a frequency of 5–7 years appear to pose the lowest risk of extirpation for at least one rare pine rockland species (Liu et al., 2005) and high-intensity crown fires are not desirable for pine rocklands. Hardwood hammocks do not benefit from fire. Some rare plants characteristic of hammocks, such as epiphytic bromeliads and ferns, could easily be extirpated from small reserves during fire. Although most EEL preserves are in the more rural sections of Southwest Miami-Dade County, a recent history of fire suppression means that hardwood hammocks have the greatest potential for supporting rare plant species in high-density urban settings. One EEL hammock preserve is less than one kilometer from downtown Miami and supports over 100 plant species (including 13 rare species) on less than five hectares. Although these urban sites have high potential for maintaining hammocks, the land in the urban core is much more valuable and creating new reserves on vacant lots is largely cost-prohibitive.

Hydrology and soils are also major factors than can influence vegetation communities. The vegetation structure of Miami-Dade pine rocklands was less associated with fire history and closely associated with the height of the water table on Long Pine Key and with soil type in urban forest fragments (Lloyd and Slater, 2012). A major division in soil occurs in Miami-Dade County along the rock ridge that determines the distribution of some rare pine rockland plants. Soils shift from acidic quartz sands (Biscayne soil) in the northern portion of the county, to carbonate-rich loams (Redlands soil) in the southern portion (O'Brien, 1998). Soil types have a strong influence on the assemblage of plant species found in pine rockland fragments although they do not significantly influence overall plant species richness (Possley and Maschinski, 2008). As some rare plants are edaphically-limited, soil conditions make some small reserves especially important for conservation (Parker, 2012). For example, *Linum carteri* is a federally-endangered pine rockland flax species endemic to Miami-Dade County. It is only known to be present at four sites, all of which are EEL preserves with Biscayne soils. By contrast, *Euphorbia deltoidea* is a spurge endemic to Miami-Dade County and a candidate for federal protection. It is known from several EEL preserves which have Redlands soils. A single large preserve equal in size to the EEL preserves would not be able to capture the full variety of soil types and unique floristic combinations.

With human populations and urbanization in the region still increasing, it is imperative to protect and study these fractured reserves into the future for the presence and persistence of native biota, especially rare endemics, and to manage actively against invasive exotics. Remote monitoring could make use of large-scale aerial photography to model some general habitat requirements directly (e.g. major vegetation types associated with particular species, Heinen and Cross, 1983) or indirectly through analyses relying on statistical correlation (e.g. associations between soil type, rainfall patterns, slope or aspect with particular habitat requirements, Heinen, 1984). Intensive on-site fieldwork will still be needed periodically to assess the presence and persistence of rare plant species on EEL preserves into the future.

Acknowledgements

We would like to thank G. Gann and the Institute for Regional Conservation for surveying the plant species composition of Miami-Dade Natural Areas, as well as Fairchild Tropical Botanic Garden and Miami-Dade County for additional data. We thank A. Jirout for technical assistance. Two anonymous reviewers provided helpful comments and suggestions on the manuscript. This is contribution number 803 from the Southeast Environmental Research Center at Florida International University from the Southeast Environmental Research Center at Florida International University.

This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Appendix A. List of 313 rare plant species found in upland forests of Miami-Dade County's EEL preserves. Subspecies and varieties were counted as individual taxa because of their discontinuous distributions and conservation statuses. Each species considered has been given at least one status of conservation concern from the IRC, the Florida Natural Areas Inventory, the State of Florida, or the United States Fish and Wildlife Service. Plants without a status designated by the State of Florida were omitted from calculations using "state- listed" plants. Obligate wetland plants and those not found in EEL preserves were not considered. The IRC was used as the standard nomenclatural reference (Gann and collaborators, 2015).

Species name	Family	Number of EEL preserves	IRC South Florida Status	FNAI Status	State of Florida Status	United States Federal Status
Elytraria caroliniensis var. *angustifolia*	Acanthaceae	5	Rare	Imperiled		
Justicia angusta	Acanthaceae	4	Rare			
Stenandrium dulce	Acanthaceae	9	Rare			
Celosia nitida	Amaranthaceae	1	Rare		Endangered	
Eryngium baldwinii	Apiaceae	4	Rare			
Ptilimnium capillaceum	Apiaceae	2	Rare			
Angadenia berteroi	Apocynaceae	36	Apparently secure		Threatened	
Metastelma blodgettii	Apocynaceae	22	Rare		Threatened	
Asclepias lanceolata	Apocynaceae	1	Rare			
Asclepias tuberosa	Apocynaceae	21	Rare			
Asclepias verticillata	Apocynaceae	7	Rare			
Asclepias viridis	Apocynaceae	11	Imperiled			

Ilex krugiana	Aquifoliaceae	23	Rare	Rare	Threatened	
Hydrocotyle verticillata var. *verticillata*	Araliaceae	8	Rare			
Coccothrinax argentata	Arecaceae	26	Secure	Rare	Threatened	
Thrinax radiata	Arecaceae	2	Rare	Imperiled	Endangered	
Sabal etonia	Arecaceae	1	Imperiled			
Asplenium dentatum	Aspleniaceae	6	Imperiled	Imperiled	Endangered	
Asplenium serratum	Aspleniaceae	1	Imperiled	Critically imperiled	Endangered	
Asplenium verecundum	Aspleniaceae	5	Critically imperiled	Critically imperiled	Endangered	
Asplenium x *biscaynianum*	Aspleniaceae	1	Critically imperiled	Critically imperiled		
Chaptalia albicans	Asteraceae	36	Rare		Threatened	
Gamochaeta pensylvanica	Asteraceae	1	Imperiled			
Helenium amarum	Asteraceae	1	Imperiled			
Koanophyllon villosum	Asteraceae	22	Rare	Imperiled	Endangered	
Melanthera parvifolia	Asteraceae	37	Apparently Secure		Threatened	
Sachsia polycephala	Asteraceae	17	Rare	Imperiled	Threatened	
Vernonia blodgettii	Asteraceae	23	Apparently Secure	Rare		
Ageratina jucunda	Asteraceae	1	Rare			
Arnoglossum ovatum	Asteraceae	4	Rare			
Balduina angustifolia	Asteraceae	1	Rare			
Berlandiera subacaulis	Asteraceae	10	Imperiled			
Brickellia mosieri	Asteraceae	13	Imperiled	Critically imperiled	Endangered	Endangered
Eupatorium compositifolium	Asteraceae	3	Critically imperiled			
Eupatorium mohrii	Asteraceae	2	Rare			
Helenium pinnatifidum	Asteraceae	2	Rare			
Iva microcephala	Asteraceae	3	Rare			
Lactuca graminifolia	Asteraceae	5	Rare			
Liatris chapmanii	Asteraceae	4	Rare			
Liatris tenuifolia	Asteraceae	1	Rare			
Liatris tenuifolia var. *quadriflora*	Asteraceae	5	Imperiled			
Melanthera angustifolia	Asteraceae	5	Rare			
Palafoxia integrifolia	Asteraceae	2	Imperiled			
Pseudognaphalium obtusifolium	Asteraceae	1	Rare			
Solidago tortifolia	Asteraceae	1	Imperiled			
Symphyotrichum concolor	Asteraceae	17	Rare			
Symphyotrichum elliottii	Asteraceae	2	Imperiled			
Bourreria cassinifolia	Boraginaceae	7	Critically imperiled	Critically imperiled	Endangered	
Bourreria succulenta	Boraginaceae	3	Rare		Endangered	
Tournefortia gnaphalodes	Boraginaceae	1	Rare	Rare	Endangered	
Tournefortia hirsutissima	Boraginaceae	7	Rare		Endangered	
Myriopus volubilis	Boraginaceae	5	Rare			
Nama jamaicensis	Boraginaceae	13	Rare			
Varronia bullata subsp. *humilis*	Boraginaceae	5	Rare		Endangered	
Byrsonima lucida	Bromeliaceae	33	Imperiled	Rare	Threatened	
Catopsis berteroniana	Bromeliaceae	3	Imperiled	Imperiled	Endangered	
Guzmania monostachia	Bromeliaceae	2	Imperiled	Imperiled	Endangered	
Tillandsia balbisiana	Bromeliaceae	16	Secure		Threatened	
Tillandsia fasciculata var. *densispica*	Bromeliaceae	21	Secure		Endangered	
Tillandsia flexuosa	Bromeliaceae	7	Rare	Rare	Threatened	
Tillandsia utriculata	Bromeliaceae	16	Secure		Endangered	
Tillandsia variabilis	Bromeliaceae	12	Rare		Threatened	
Lobelia paludosa	Campanulaceae	2	Imperiled			
Trema lamarckiana	Cannabaceae	8	Rare	Imperiled	Endangered	
Crossopetalum ilicifolium	Celastraceae	38	Rare	Rare	Threatened	
Crossopetalum rhacoma	Celastraceae	7	Rare	Rare	Threatened	
Hippocratea volubilis	Celastraceae	3	Rare			
Lechea divaricata	Cistaceae	1	Imperiled	Imperiled	Endangered	
Helianthemum corymbosum	Cistaceae	1	Rare			
Lechea sessiliflora	Cistaceae	3	Imperiled			
Lechea torreyi	Cistaceae	4	Rare			
Polanisia tenuifolia	Cleomaceae	4	Rare			
Ipomoea microdactyla	Convolvulaceae	23	Rare	Imperiled	Endangered	
Ipomoea tenuissima	Convolvulaceae	22	Rare	Imperiled	Endangered	
Jacquemontia curtisii	Convolvulaceae	29	Rare	Imperiled	Threatened	
Jacquemontia pentanthos	Convolvulaceae	1	Rare	Imperiled	Endangered	
Jacquemontia reclinata	Convolvulaceae	2	Critically imperiled	Critically imperiled	Endangered	Endangered
Cuscuta pentagona	Convolvulaceae	2	Rare			
Ipomoea cordatotriloba	Convolvulaceae	3	Rare			
Ipomoea hederifolia	Convolvulaceae	18	Rare			
Stylisma villosa	Convolvulaceae	3	Imperiled			
Cayaponia americana	Cucurbitaceae	1	Critically imperiled			
Abildgaardia ovata	Cyperaceae	23	Rare			
Bulbostylis ciliatifolia	Cyperaceae	16	Rare			
Bulbostylis stenophylla	Cyperaceae	1	Imperiled			
Cyperus elegans	Cyperaceae	1	Imperiled			
Cyperus filiculmis	Cyperaceae	8	Imperiled			
Cyperus flavescens	Cyperaceae	6	Rare			
Cyperus floridanus	Cyperaceae	1	Imperiled	Critically imperiled	Endangered	
Cyperus tetragonus	Cyperaceae	4	Rare			
Eleocharis baldwinii	Cyperaceae	2	Rare			
Fimbristylis caroliniana	Cyperaceae	4	Imperiled			

Fimbristylis dichotoma	Cyperaceae	2	Rare			
Rhynchospora globularis	Cyperaceae	6	Imperiled			
Rhynchospora grayi	Cyperaceae	18	Rare			
Rhynchospora intermedia	Cyperaceae	1	Imperiled			
Rhynchospora plumosa	Cyperaceae	5	Rare			
Schoenus nigricans	Cyperaceae	3	Rare			
Scleria ciliata var. *curtissii*	Cyperaceae	2	Imperiled			
Scleria lithosperma	Cyperaceae	5	Rare		Endangered	
Scleria triglomerata	Cyperaceae	3	Rare			
Ctenitis sloanei	Dryopteridaceae	7	Imperiled	Imperiled	Endangered	
Ctenitis submarginalis	Dryopteridaceae	1	Critically imperiled		Endangered	
Tectaria fimbriata	Dryopteridaceae	13	Imperiled	Imperiled	Endangered	
Tectaria heracleifolia	Dryopteridaceae	6	Rare		Threatened	
Euphorbia deltoidea	Euphorbiaceae	11	Imperiled	Critically Imperiled	Endangered	Endangered
Euphorbia deltoidea var. *adhaerens*	Euphorbiaceae	6	Critically imperiled	Critically Imperiled	Endangered	Endangered
Euphorbia deltoidea var. *pinetorum*	Euphorbiaceae	7	Rare	Critically Imperiled	Endangered	Candidate
Euphorbia garberi	Euphorbiaceae	1	Rare	Critically Imperiled	Endangered	Threatened
Euphorbia pergamena	Euphorbiaceae	13	Rare		Threatened	
Euphorbia pinetorum	Euphorbiaceae	25	Rare	Imperiled	Endangered	
Euphorbia porteriana	Euphorbiaceae	6	Rare	Imperiled	Endangered	
Acalypha ostryifolia	Euphorbiaceae	10	Rare			
Argythamnia blodgettii	Euphorbiaceae	9	Rare	Imperiled	Endangered	
Astraea lobata	Euphorbiaceae	4	Critically imperiled			
Euphorbia conferta	Euphorbiaceae	17	Rare			
Euphorbia thymifolia	Euphorbiaceae	3	Imperiled			
Tragia saxicola	Euphorbiaceae	30	Rare	Imperiled	Threatened	
Tragia urens	Euphorbiaceae	14	Rare			
Aeschynomene americana	Fabaceae	10	Rare			
Aeschynomene viscidula	Fabaceae	13	Rare			
Amorpha herbacea var. *crenulata*	Fabaceae	3	Critically imperiled	Critically imperiled	Endangered	Endangered
Caesalpinia major	Fabaceae	2	Critically imperiled	Critically imperiled	Endangered	
Dalbergia brownei	Fabaceae	1	Rare		Endangered	
Dalea carthagenensis var. *floridana*	Fabaceae	4	Critically imperiled	Critically imperiled	Endangered	Candidate
Galactia smallii	Fabaceae	9	Imperiled	Critically imperiled	Endangered	Endangered
Mimosa quadrivalvis var. *angustata*	Fabaceae	5	Rare			
Pithecellobium keyense	Fabaceae	8	Secure		Threatened	
Rhynchosia parvifolia	Fabaceae	11	Rare		Threatened	
Senna mexicana var. *chapmanii*	Fabaceae	17	Rare		Threatened	
Tephrosia florida	Fabaceae	13	Rare			
Chamaecrista deeringiana	Fabaceae	29	Rare			
Dalea carnea	Fabaceae	19	Rare			
Desmodium floridanum	Fabaceae	2	Critically imperiled			
Desmodium lineatum	Fabaceae	9	Critically imperiled			
Desmodium marilandicum	Fabaceae	15	Imperiled			
Galactia floridana	Fabaceae	10	Imperiled			
Galactia pinetorum	Fabaceae	18	Imperiled	Imperiled		
Indigofera miniata var. *florida*	Fabaceae	8	Rare			
Rhynchosia cinerea	Fabaceae	8	Rare			
Rhynchosia michauxii	Fabaceae	2	Imperiled			
Rhynchosia reniformis	Fabaceae	24	Rare			
Senna ligustrina	Fabaceae	17	Rare			
Sophora tomentosa var. *truncata*	Fabaceae	4	Rare			
Tephrosia rugelii	Fabaceae	1	Imperiled			
Vachellia farnesiana	Fabaceae	8	Rare			
Vachellia farnesiana var. *pinetorum*	Fabaceae	4	Rare			
Zornia bracteata	Fabaceae	4	Critically imperiled			
Quercus minima	Fagaceae	9	Rare			
Quercus pumila	Fagaceae	31	Rare			
Voyria parasitica	Gentianaceae	10	Rare	Imperiled	Endangered	
Sabatia grandiflora	Gentianaceae	2	Rare			
Didymoglossum krausii	Hymenophyllaceae	7	Critically imperiled	Critically imperiled	Endangered	
Didymoglossum punctatum var. *floridanum*	Hymenophyllaceae	8	Critically imperiled	Critically imperiled	Endangered	Endangered
Hypoxis sessilis	Hypoxidaceae	7	Imperiled			
Hypoxis wrightii	Hypoxidaceae	3	Rare			
Sisyrinchium nashii	Iridaceae	11	Rare			
Ocimum campechianum	Lamiaceae	1	Imperiled		Endangered	
Scutellaria havanensis	Lamiaceae	17	Rare	Imperiled	Endangered	
Physostegia purpurea	Lamiaceae	3	Imperiled			
Piloblephis rigida	Lamiaceae	6	Rare			
Salvia occidentalis	Lamiaceae	9	Rare			
Salvia serotina	Lamiaceae	1	Imperiled			
Persea borbonia	Lauraceae	11	Rare			
Linum arenicola	Linaceae	3	Imperiled	Imperiled	Endangered	Candidate
Linum carteri	Linaceae	4	Critically imperiled	Critically imperiled	Endangered	Endangered
Linum carteri var. *smallii*	Linaceae	2	Imperiled	Imperiled	Endangered	
Linum medium var. *texanum*	Linaceae	1	Rare			
Sphenomeris clavata	Lindsaeeaceae	6	Imperiled	Imperiled	Endangered	
Mitreola sessilifolia	Loganiaceae	3	Rare			
Spigelia anthelmia	Loganiaceae	18	Rare			
Lomariopsis kunzeana	Lomariopsidaceae	3	Critically imperiled	Critically imperiled	Endangered	

Ammannia latifolia	Lythraceae	4	Rare			
Abutilon permolle	Malvaceae	1	Rare			
Corchorus hirtus	Malvaceae	1	Imperiled			
Corchorus siliquosus	Malvaceae	13	Rare			
Sida ulmifolia	Malvaceae	1	Imperiled			
Tetrazygia bicolor	Melastomataceae	8	Rare		Threatened	
Calyptranthes pallens	Myrtaceae	16	Rare		Threatened	
Calyptranthes zuzygium	Myrtaceae	1	Imperiled	Imperiled	Endangered	
Eugenia confusa	Myrtaceae	3	Imperiled	Rare	Endangered	
Mosiera longipes	Myrtaceae	23	Apparently Secure	Imperiled	Threatened	
Myrcianthes fragrans	Myrtaceae	7	Apparently secure		Threatened	
Aletris bracteata	Nartheciaceae	3	Imperiled	Imperiled	Endangered	
Aletris lutea	Nartheciaceae	3	Rare			
Nephrolepis biserrata	Nephrolepidaceae	10	Rare		Threatened	
Nephrolepis x *averyi*	Nephrolepidaceae	1	Imperiled			
Boerhavia erecta	Nyctaginaceae	2	Rare			
Ludwigia erecta	Onagraceae	1	Imperiled			
Ludwigia maritima	Onagraceae	2	Rare			
Basiphyllaea corallicola	Orchidaceae	2	Critically imperiled	Critically imperiled	Endangered	
Bletia purpurea	Orchidaceae	10	Rare		Threatened	
Epidendrum floridense	Orchidaceae	1	Imperiled		Endangered	
Epidendrum nocturnum	Orchidaceae	4	Imperiled	Imperiled	Endangered	
Epidendrum rigidum	Orchidaceae	4	Imperiled		Endangered	
Galeandra bicarinata	Orchidaceae	2	Critically imperiled	Critically imperiled	Endangered	
Polystachya concreta	Orchidaceae	8	Rare		Endangered	
Prosthechea boothiana var. *erythronioides*	Orchidaceae	1	Imperiled	Critically imperiled	Endangered	
Prosthechea cochleata	Orchidaceae	3	Imperiled	Imperiled	Endangered	
Pteroglossaspis ecristata	Orchidaceae	6	Imperiled	Imperiled	Threatened	
Spiranthes torta	Orchidaceae	3	Critically imperiled	Critically imperiled	Endangered	
Triphora gentianoides	Orchidaceae	5	Imperiled			
Cyclopogon cranichoides	Orchidaceae	6	Imperiled			
Eulophia alta	Orchidaceae	4	Rare			
Habenaria quinqueseta	Orchidaceae	7	Rare			
Agalinis maritima	Orobanchaceae	1	Rare			
Passiflora pallens	Passifloraceae	5	Imperiled	Imperiled	Endangered	
Passiflora sexflora	Passifloraceae	4	Critically imperiled	Imperiled	Endangered	
Phyllanthus abnormis	Phyllanthaceae	3	Rare			
Petiveria alliacea	Phytolaccaceae	4	Imperiled			
Alvaradoa amorphoides	Picramniaceae	9	Imperiled	Critically imperiled	Endangered	
Picramnia pentandra	Picramniaceae	4	Critically imperiled	Critically imperiled	Endangered	
Peperomia obtusifolia	Piperaceae	7	Imperiled	Imperiled	Endangered	
Linaria canadensis	Plantaginaceae	1	Rare			
Mecardonia procumbens	Plantaginaceae	14	Rare			
Penstemon multiflorus	Plantaginaceae	4	Imperiled			
Andropogon gyrans	Poaceae	8	Imperiled			
Andropogon tracyi	Poaceae	8	Imperiled			
Andropogon virginicus	Poaceae	3	Rare			
Andropogon virginicus var. *decipiens*	Poaceae	10	Imperiled			
Aristida condensata	Poaceae	5	Imperiled			
Aristida patula	Poaceae	1	Rare			
Bouteloua hirsuta	Poaceae	4	Imperiled			
Cenchrus gracillimus	Poaceae	24	Rare			
Chrysopogon pauciflorus	Poaceae	4	Imperiled			
Dichanthelium ensifolium var. *unciphyllum*	Poaceae	10	Rare			
Dichanthelium laxiflorum	Poaceae	1	Imperiled			
Dichanthelium ovale	Poaceae	24	Rare			
Digitaria filiformis var. *filiformis*	Poaceae	5	Rare			
Digitaria filiformis var. *dolichophylla*	Poaceae	15	Rare		Threatened	
Digitaria horizontalis	Poaceae	2	Imperiled			
Digitaria insularis	Poaceae	2	Imperiled			
Distichlis spicata	Poaceae	5	Rare			
Elionurus tripsacoides	Poaceae	4	Imperiled			
Eragrostis spectabilis	Poaceae	1	Imperiled			
Eriochloa michauxii	Poaceae	1	Imperiled			
Gymnopogon ambiguus	Poaceae	2	Critically imperiled			
Imperata brasiliensis	Poaceae	19	Rare			
Leersia hexandra	Poaceae	2	Rare			
Leptochloa fusca subsp. *fascicularis*	Poaceae	2	Rare			
Panicum dichotomiflorum var. *dichotomiflorum*	Poaceae	3	Rare			
Paspalum distichum	Poaceae	1	Rare			
Paspalum floridanum	Poaceae	1	Imperiled			
Setaria macrosperma	Poaceae	5	Rare			
Sporobolus clandestinus	Poaceae	2	Critically imperiled			
Sporobolus pyramidatus	Poaceae	3	Imperiled			
Tridens flavus	Poaceae	1	Critically imperiled			
Tripsacum dactyloides	Poaceae	6	Rare			
Tripsacum floridanum	Poaceae	21	Rare	Imperiled	Threatened	
Polygala smallii	Polygalaceae	5	Imperiled	Critically imperiled	Endangered	Endangered
Polygala balduinii	Polygalaceae	2	Rare			
Polygala boykinii	Polygalaceae	4	Rare			

Polygala incarnata	Polygalaceae	7	Rare			
Polygonella gracilis	Polygonaceae	1	Critically imperiled			
Microgramma heterophylla	Polypodiaceae	1	Imperiled	Imperiled	Endangered	
Samolus valerandi subsp. *parviflorus*	Primulaceae	1	Rare			
Adiantum melanoleucum	Pteridaceae	2	Critically imperiled	Critically imperiled	Endangered	
Adiantum tenerum	Pteridaceae	14	Rare	Rare	Endangered	
Pityrogramma trifoliata	Pteridaceae	5	Rare			
Pteris bahamensis	Pteridaceae	31	Rare	Rare	Threatened	
Drypetes diversifolia	Putranjivaceae	1	Rare	Imperiled	Endangered	
Drypetes lateriflora	Putranjivaceae	8	Rare		Threatened	
Clematis baldwinii	Ranunculaceae	15	Rare			
Colubrina cubensis var. *floridana*	Rhamnaceae	5	Imperiled	Critically imperiled	Endangered	
Gouania lupuloides	Rhamnaceae	5	Rare			
Prunus myrtifolia	Rosaceae	18	Rare	Imperiled	Threatened	
Erithalis fruticosa	Rubiaceae	3	Rare		Threatened	
Ernodea cokeri	Rubiaceae	8	Critically imperiled	Critically imperiled	Endangered	
Psychotria ligustrifolia	Rubiaceae	1	Imperiled	Critically imperiled	Endangered	
Spermacoce neoterminalis	Rubiaceae	27	Apparently Secure		Threatened	
Diodia teres	Rubiaceae	9	Rare			
Galium tinctorium	Rubiaceae	6	Rare			
Houstonia procumbens	Rubiaceae	5	Rare			
Spermacoce keyensis	Rubiaceae	4	Imperiled			
Spermacoce prostrata	Rubiaceae	17	Rare			
Spermacoce tetraquetra	Rubiaceae	20	Rare			
Stenaria nigricans var. *floridana*	Rubiaceae	23	Rare			
Zanthoxylum coriaceum	Rutaceae	1	Critically imperiled	Critically imperiled	Endangered	
Zanthoxylum clava-herculis	Rutaceae	4	Rare			
Cardiospermum halicacabum var. *microcarpum*	Sapindaceae	13	Rare			
Dodonaea viscosa var. *angustifolia*	Sapindaceae	6	Rare			
Dodonaea viscosa var. *viscosa*	Sapindaceae	2	Imperiled			
Sapindus saponaria	Sapindaceae	2	Rare			
Sideroxylon reclinatum subsp. *austrofloridense*	Sapotaceae	2	Imperiled			Candidate
Saururus cernuus	Saururaceae	1	Rare			
Anemia wrightii	Schizaeaceae	1	Critically imperiled	Critically imperiled	Endangered	
Schoepfia chrysophylloides	Schoepfiaceae	13	Rare			
Selaginella eatonii	Selaginellaceae	3	Imperiled	Imperiled	Endangered	
Smilax havanensis	Smilacaceae	32	Secure		Threatened	
Solanum donianum	Solanaceae	5	Rare		Threatened	
Capsicum annuum var. *glabriusculum*	Solanaceae	4	Rare			
Physalis angustifolia	Solanaceae	3	Imperiled			
Physalis pubescens	Solanaceae	2	Rare			
Solanum bahamense	Solanaceae	4	Rare			
Thelypteris augescens	Thelypteridaceae	12	Rare		Threatened	
Thelypteris patens	Thelypteridaceae	2	Critically imperiled		Endangered	
Thelypteris reptans	Thelypteridaceae	14	Imperiled	Critically imperiled	Endangered	
Thelypteris sclerophylla	Thelypteridaceae	2	Critically imperiled	Critically imperiled	Endangered	
Thelypteris serrata	Thelypteridaceae	2	Imperiled	Critically imperiled	Endangered	
Thelypteris ovata	Thelypteridaceae	11	Rare			
Pilea herniarioides	Urticaceae	5	Imperiled			
Glandularia maritima	Verbenaceae	3	Imperiled	Rare	Endangered	
Lantana canescens	Verbenaceae	4	Critically imperiled	Critically imperiled	Endangered	
Lantana depressa	Verbenaceae	35	Rare	Rare	Endangered	
Phyla stoechadifolia	Verbenaceae	5	Rare		Endangered	
Priva lappulacea	Verbenaceae	11	Rare			
Verbena scabra	Verbenaceae	3	Rare			
Viola sororia	Violaceae	1	Imperiled			
Vitis aestivalis	Vitaceae	3	Rare			

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