INITIAL REPORT

LONG-TERM MONITORING OF OLD WORLD CLIMBING FERN (*LYGODIUM MICROPHYLLUM* (CAV.) R. BR.) IN SOUTHEASTERN FLORIDA

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INTRODUCTION

Old World climbing fern (*Lygodium microphyllum* (Cav.) R. Br.) is an herbaceous perennial fern in the Schizaceae. Unusual for ferns, this species, along with several others in the genus *Lygodium*, is a vine. Old World climbing fern is an invasive exotic in South Florida, and has been classified as a Category I invasive exotic plant species by the Florida Exotic Pest Plant Council (1997). It is one of several invasive exotic species that can spread into South Florida ecosystems without the assistance of relatively major disturbances.

Once established, Old World climbing fern has the potential to disrupt South Florida ecosystems. By the late 1970's, colonies as large as one-quarter mile long and 200 yards wide had been established in southeastern Florida (Nauman and Austin 1978). In 1993, a survey documented that the Old World climbing fern had impacted 1,233 acres at Jonathan Dickinson State Park (Roberts 1996). Old World climbing fern climbs and then blankets vegetation, much like kudzu (*Pueraria montana* var. *lobata*), air-potato (*Dioscorea* spp.), and skunkvine (*Paederia* spp.), causing severe damage to and ultimately mortality of canopy trees (Roberts 1996, Roberts 1997, personal observations of the authors). It also causes fire to spread into the canopy of cypress and pine-dominated ecosystems, and facilitates spot-over fires (Roberts 1996, Roberts1997). It is also of concern due to its potential impact to rare and listed plant species such as tropical curlygrass fern (*Actinostachys pennula*) at A. R. Marshall Loxahatchee National Wildlife Refuge.

Old World climbing fern is a native of Africa, India, Asia (north to Hong Kong and the Ryukyu Islands), Micronesia, Melanesia (Solomon Islands and New Caledonia), and Australia (Serizawa 1975, Edie 1978, Singh and Panigrahi 1984, USDA 1999). It has been introduced into and is now well established in central and southern peninsular Florida. It has been naturalized in southeastern Florida since at least the mid-1960's (Beckner 1968); it apparently became first established in the upper Loxahatchee River area in southern Martin and northern Palm Beach counties (Nauman and Austin 1978). By the late 1970's, Old World climbing fern had been recorded for a number of sites in Martin and Palm Beach counties (Nauman and Austin 1978), but was still absent from other South Florida counties. By the early 1980's, Wunderlin (1982) considered it to be locally abundant in the southern half of central Florida. By the mid-1990's, Old World climbing fern had been recorded from nine counties in South Florida: Broward, Collier, Desoto, Highlands, Lee, Manatee, Martin, Palm Beach, and Polk (Wunderlin et al. 1996). The authors have also observed it in Indian River County (K. Bradley, personal observation), and it is almost certainly present in Dade, Glades, Hendry, and St. Lucie counties. Data collected by the South Florida Water Management District shows an increase in estimated area of Old World climbing fern from 27,686 acres in 1993 to 39,240 acres in 1997 (Pemberton and Ferriter, in press).

In its natural habitat, Old World climbing fern is found in mesic forest, rain forest, and open swampy areas, at altitudes from 0 to more than 1000 m; it appears to be more prevalent in open, and/or disturbed sites (Serizawa 1975, Edie 1978, Singh and Panigrahi

1984). While it was originally reported in South Florida only for wet, disturbed sites (Nauman and Austin 1978), it is now frequent in a number of mesic and wetland ecosystems including relatively undisturbed hammocks, cypress swamps, flatwoods, and bayheads (Nauman 1993, Wunderlin 1998, personal observations of the authors).

Little is known of the ecological requirements of Old World climbing fern in South Florida. The broad natural distribution of Old World climbing fern suggests that it can tolerate a wide range of climatic conditions. Although it has been primarily found in wetlands, it does show some ability to invade mesic soils. In South Florida, Old World climbing fern sporulates all year (Wunderlin 1998). Methods of dispersal are unclear, although spores may be spread accidentally by birds (Nauman and Austin 1978), and both water and wind dispersal seem likely.

Although the exact timing and method(s) of introduction in South Florida are not certain, it is known that Old World climbing fern is occasionally cultivated; the earliest know herbarium specimen was collected in a plant nursery in 1958 in southeastern Palm Beach County (Beckner 1968). It has been suggested that other occurrences of Old World climbing fern in South Florida have been established by direct human translocation (T. Pernas, pers. comm., 1998). Nevertheless, most new populations of Old World climbing fern appear to become established without the assistance of humans. No significant predators or diseases affecting Old World climbing fern are known in Florida, although sensitivity of Old World climbing fern to flooding has been reported (Van Horn and Van Horn 1993).

Research on Old World climbing fern has focused on different control measures using herbicides, fire, mechanical removal or trimming, and flooding (Roberts 1996, Roberts 1997, Stocker 1997). Since 1993, The South Florida Water Management District has conducted a biennial aerial survey for Old World climbing fern, which shows an increase in acreage from 1993 to 1997 (Pemberton and Ferriter, in press). Little is known, however, about the spread of Old World climbing fern in areas where it is in the early stages of establishment. We do not know, for instance, how long it takes to form large monotypic stands. Nauman and Austin (1978) postulated that the large stands they noted took more than two decades to form, but no quantitative measurements of Old World climbing fern growth in the field has been conducted. We also do not know how long it takes Old World climbing fern to cause mortality of native plants once it has been established. We also do not know if Old World climbing fern establishment and growth occurs at different rates in different ecosystems and under different conditions. And, finally, we do not know what the relationship is (if any) between Old World climbing fern and other exotic plant species. This study intends to provide some preliminary data on these issues.

METHODS

Study Sites

Three sites in Palm Beach and/or Martin counties were chosen for the establishment of long-term monitoring plots: A. R. Marshall Loxahatchee National Wildlife Refuge

(Loxahatchee), J.W. Corbett Wildlife Management Area (Corbett), and Dupuis Reserve (Dupuis). Each was chosen because it met the following criteria: 1) it was known to contain Old World climbing fern; 2) it contained at least two major habitats which contained Old World climbing fern; 3) it contained sufficient area of relatively undisturbed Old World climbing fern habitat with Old World climbing fern frequency not obviously greater than 10% and cover in the herb layer (< 1 m) not obviously greater than 1%; 4) it did not have an aggressive Old World climbing fern control program; and, 5) the site manager agreed not to conduct exotic species control treatments within the study areas for at least two years.

Habitats

Plots were established in cypress swamps at each site. In addition, plots were established in tree islands at Loxahatchee, in relatively undisturbed flatwoods at Corbett, and in roller-chopped flatwoods at Dupuis.

Three stations for each habitat were chosen at each site for the placement of plots. At each station, one series of randomly placed plots were placed to monitor frequency of Old World climbing fern and other exotic plant species, and one series of randomly-placed nested plots were established to monitor percent cover of Old World climbing fern and all associated exotic and native taxa.

Frequency Plots

At each station, twenty-five 5 m radius plots were established entirely within the habitat to be sampled. Presence or absence of Old World climbing fern and any other exotic plant species was recorded for each plot.

Cover Plots

At each station, one 50 x 50 m canopy plot was established entirely within the habitat to be sampled; three 5 x 5 m shrub plots were nested within each canopy plot; and, three 1 x 1 m herb plots were nested within each shrub plot. The canopy layer was defined as > 3 m in height; the shrub layer was defined as > 1 m and <= 3 m in height; and, the herb layer was defined as <= 1 m in height. Cover of all species present in any layer was estimated using the Daubenmire cover scale (Mueller-Dombois and Ellenburg 1974).

Data Collection

Initial data collection occurred during the fall of 1998. Follow-up data collection will occur in the fall of 2000 and, if funding permits, biannually thereafter.

INITIAL RESULTS: FREQUENCY PLOTS

Frequency Plots: Old World Climbing Fern

Frequency of Old World climbing fern for all plots at all stations at all sites was 41.3% (Table 1). Loxahatchee had the highest frequency of Old World climbing fern (53.3%), followed by Corbett, and Dupuis. Of Old World climbing fern habitats, tree islands had the highest frequency (77.3%), followed by roller-chopped flatwoods, cypress swamps, and undisturbed flatwoods. Within cypress swamps, Corbett had the highest frequency of Old World climbing fern (52.0%), followed by Loxahatchee, and Dupuis.

Frequency Plots: All Exotics[1]

Frequency of all exotics at all plots was 70.7% (Table 2). Loxahatchee had the highest frequency of all exotics (88.7%), followed by Dupuis, and Corbett. Among habitats, roller-chopped flatwoods had the highest frequency of all exotics (100.0%), followed by tree islands, cypress swamps, and undisturbed flatwoods. Within cypress swamps, Loxahatchee had the highest frequency of all exotics (100.0%), followed by Corbett, and Dupuis.

Old World climbing fern was the most frequent of all exotics among all plots (40%), followed by Brazilian-pepper (*Schinus terebinthifolius*), Bahia grass (*Paspalum notatum*), and Asian sword fern (*Nephrolepis multiflora*) (Table 2). In total, 31 species of exotics were recorded among all frequency plots at all sites.

At Loxahatchee, Old World climbing fern was the most frequent of all exotics (53.3%), followed by Brazilian-pepper, Asian sword fern, and Guava (*Psidium guajava*) (Table 2). In total, eight species of exotics were recorded among all frequency plots at Loxahatchee. At Corbett, Old World climbing fern was the most frequent of all exotics (36.0%), followed by Brazilian-pepper, and Asian sword fern. In total, five species of exotics were recorded among all frequency plots at Corbett. At Dupuis, Bahia grass was the most frequent of all exotics (38.0%), followed by Old World climbing fern, and Brazilian-pepper. In total, 27 species of exotics were recorded among all frequency plots at Dupuis.

Within tree islands, Old World climbing fern was the only exotic species recorded, with a frequency of 77.3% (Table 2). Within undisturbed flatwoods, Old World climbing fern was the only significant exotic, with a frequency of 20.0%. In total, four species of exotics were recorded among all frequency plots in undisturbed flatwoods. Within roller-chopped flatwoods, Bahia grass was the most frequent of all exotics (76.0%), followed by Old World climbing fern, Brazilian-pepper, torpedo grass (*Panicum repens*), West Indian rush grass (*Sporobolus indicus* var. *pyramidalis*), Indian cupscale (*Sacciolepis indica*), and Colombian waxweed (*Cuphea carthagenensis*). In total, 22 species of exotics were recorded among all frequency plots in roller-chopped flatwoods. Within cypress swamps, Brazilian-pepper was the most frequent of all exotics (47.1%), followed by Old

[1] In this section, only exotics with a frequency of at least 10% are listed in the text.

World climbing fern, and Asian sword fern. In total, 18 species of exotics were recorded among all frequency plots in cypress swamps among the three sites. Within cypress swamps at Loxahatchee, Brazilian-pepper was the most frequent (97.3%), followed by Asian sword fern, Old World climbing fern, and guava. In total, seven species of exotics were recorded among all frequency plots in cypress swamps at Loxahatchee. Within cypress swamps at Corbett, Old World climbing fern was the most frequent (52.0%), followed by Brazilian-pepper, and Asian sword fern. In total, three species of exotics were recorded among all frequency plots in cypress swamps at Corbett. Within cypress swamps at Dupuis, Brazilian-pepper was the most frequent (28.0%), followed by Old World climbing fern, and dotted duckweed (*Spirodela punctata*). In total, 13 species of exotics were recorded among all frequency plots in cypress swamps at Dupuis.

Diversity of exotics excluding Old World climbing fern was highest at Dupuis (26 species), followed by Loxahatchee and Corbett (both 5 species) (Table 3). In total, 31 species of exotics were recorded in all frequency plots among all sites. Roller-chopped flatwoods had the highest diversity of exotics (22), followed by cypress swamps and undisturbed flatwoods; there were no exotics other than Old World climbing fern in tree islands.

INITIAL RESULTS: COVER PLOTS[2]

Cover Plots: Old World Climbing Fern

Average Old World climbing fern cover was highest in shrub plots (1.6%), followed by herb plots and canopy plots (Tables 4-6). Within tree islands, Old World climbing fern cover was highest in shrub plots (7.3%), followed by herb plots, and canopy plots. Within undisturbed flatwoods, Old World climbing fern cover was highest in herb plots (0.6%), followed by shrub plots; no Old World climbing fern was present in canopy plots in undisturbed flatwoods. Within roller-chopped flatwoods, no Old World climbing fern cover was present in any cover plots. Within cypress swamps, canopy plots had the highest Old World climbing fern cover (1.4%), followed by herb plots and shrub plots. Within cypress swamps at Loxahatchee, Old World climbing fern cover was highest canopy plots (2.5%); no Old World climbing fern was recorded in shrub or herb plots in cypress swamps at Loxahatchee. Within cypress swamps at Corbett, Old World climbing fern cover was highest in herb plots (2.2%), followed by shrub plots and canopy plots. Within cypress swamps at Dupuis, Old World climbing fern cover was highest in shrub plots (0.3%), followed by herb plots; no Old World climbing fern was present in canopy plots in cypress swamps at Dupuis.

Herb Plots: Old World Climbing Fern

Average cover of Old World climbing fern for all herb plots at all stations at all sites was 1.5% (Table 4). Loxahatchee had the highest cover of Old World climbing fern (3.1%), followed by Corbett, and Dupuis. Of Old World climbing fern habitats, tree islands had the highest cover (6.2%), followed by cypress swamps, and undisturbed flatwoods; no Old World climbing fern was present in herb plots in roller-chopped flatwoods. Within

[2] Totals may exceed 100% due to overlap.

cypress swamps, Corbett had the highest cover of Old World climbing fern (2.2%); no Old World climbing fern was present in herb plots in cypress swamps at Loxahatchee and Dupuis.

Shrub Plots: Old World Climbing Fern

Average cover of Old World climbing fern for all shrub plots at all stations at all sites was 1.6% (Table 5). Loxahatchee had the highest cover of Old World climbing fern (3.7%), followed by Corbett, and Dupuis. Of Old World climbing fern habitats, tree islands had the highest cover (7.3%), followed by cypress swamps, and undisturbed flatwoods; no Old World climbing fern was present in shrub plots in roller-chopped flatwoods. Within cypress swamps, Corbett had the highest cover of Old World climbing fern (2.0%), followed by Dupuis; no Old World climbing fern was present in shrub plots in Cypress swamps at Loxahatchee.

Canopy Plots: Old World Climbing Fern

Average cover of Old World climbing fern for all canopy plots at all stations at all sites was 1.0% (Table 6). Loxahatchee had the highest cover of Old World climbing fern (2.1%), followed by Corbett; no Old World climbing fern was present in canopy plots at Dupuis. Of Old World climbing fern habitats, tree islands had the highest cover (1.7%), followed by cypress swamps; no Old World climbing fern was present in canopy plots in undisturbed flatwoods, or in roller-chopped flatwoods. Within cypress swamps, Loxahatchee had the highest cover of Old World climbing fern (2.5%), followed by Corbett; no Old World climbing fern was present in canopy plots in cypress swamps at Dupuis.

Cover Plots: All Exotics[3]

Average cover of all exotics was highest in shrub plots (1.6%), followed by herb plots and canopy plots (Tables 7-9). Within tree islands, exotics cover was highest in shrub plots (7.3%), followed by herb plots, and canopy plots. Within undisturbed flatwoods, exotics cover was highest in herb plots (0.6%), followed by shrub plots; no exotics were present in canopy plots in undisturbed flatwoods. Within roller-chopped flatwoods, no exotics cover was present in any cover plots. Within cypress swamps, canopy plots had the highest exotics cover (1.4%), followed by herb plots and shrub plots. Within cypress swamps at Loxahatchee, exotics cover was highest in canopy plots (2.5%); no exotics were recorded in shrub or herb plots in cypress swamps at Loxahatchee. Within cypress swamps at Corbett, exotics cover was highest in herb plots (2.2%), followed by shrub plots and canopy plots. Within cypress swamps at Dupuis, exotics cover was highest in shrub plots (0.3%), followed by herb plots; no exotics were present in canopy plots in cypress swamps at Dupuis.

Herb Plots: All Exotics

Average cover of all exotics for all herb plots at all stations at all sites was 5.3% (Table 7). Dupuis had the highest cover of all exotics (9.2%), followed by Loxahatchee, and Corbett. Of all habitats, roller-chopped flatwoods had the highest cover (17.6%),

[3] In this section, only exotic species with average cover of at least 1% are listed.

followed by tree islands, cypress swamps, and undisturbed flatwoods. Within cypress swamps, Loxahatchee had the highest cover of all exotics (3.5%), followed by Corbett, and Dupuis.

Bahia grass had the highest cover of all exotics (1.9%), followed by Old World climbing fern (Table 7). In total, 20 species of exotics were recorded among all herb cover plots at all sites.

At Loxahatchee, Old World climbing fern had the highest average cover of all exotics (3.1%), followed by Brazilian-pepper (Table 7). In total, five species of exotics were recorded among all herb cover plots at Loxahatchee. At Corbett, Old World climbing fern was the only significant exotic with a cover of 1.4%. In total, five species of exotics were recorded among all herb cover plots at Corbett. At Dupuis, Bahia grass had the highest cover of all exotics (5.6%), followed by Malasian false-pimpernel (*Lindernia crustacea*). In total, 15 species of exotics were recorded among all herb cover plots at Dupuis.

Within tree islands, Old World climbing fern was the only exotic species recorded, with an average cover of 6.2% (Table 7). Within undisturbed flatwoods, no significant exotics were recorded. In total, four species of exotics were recorded among all herb cover plots in undisturbed flatwoods. Within roller-chopped flatwoods, Bahia grass had the highest cover of all exotics (11.2%), followed by Malayan false-pimpernel, hairy indigo (*Indigofera hirsuta*), and low flat sedge (*Cyperus pumilus*). In total, 10 species of exotics were recorded among all herb cover plots in roller-chopped flatwoods. Within cypress swamps, Brazilian-pepper was the only significant species with a cover of 1.0%. In total, eight species of exotics were recorded among all herb cover plots in cypress swamps among the three sites. Within cypress swamps at Loxahatchee, Brazilian-pepper was the only significant exotic with a cover of 3.0%. In total, four species of exotics were recorded among all herb cover plots in cypress swamps at Loxahatchee. Within cypress swamps at Corbett, Old World climbing fern was the only significant exotic with a cover of 2.3%. Only two species of exotics were recorded among all herb cover plots in cypress swamps at Corbett. Within cypress swamps at Dupuis, no significant exotics were recorded. In total, five species of exotics were recorded among all frequency plots in cypress swamps at Dupuis.

Shrub Plots: All Exotics

Average cover of all exotics for all shrub plots at all stations at all sites was 6.5% (Table 8). Loxahatchee had the highest cover of all exotics (17.3%), followed by Dupuis, and Corbett. Of all habitats, cypress swamps had the highest cover (10.5%), followed by tree islands, and undisturbed flatwoods; no exotics were recorded within shrub cover plots within roller-chopped flatwoods. Within cypress swamps, Loxahatchee had the highest cover of all exotics (27.3%), followed by Dupuis, and Corbett.

Brazilian-pepper had the highest average cover of all exotics (4.0%), followed by Old World climbing fern (Table 8). In total, four species of exotics were recorded among all shrub cover plots at all sites.

At Loxahatchee, Brazilian-pepper had the highest average cover of all exotics (10.9%), followed by Old World climbing fern, and Asian sword fern (Table 8). In total, four species of exotics were recorded among all shrub cover plots at Loxahatchee. At Corbett, Old World climbing fern was the only exotic recorded with a cover of 1.1%. At Dupuis, Brazilian-pepper was the only significant exotic recorded with a cover of 1.0%. Only two species of exotics were recorded among all shrub cover plots at Dupuis.

Within tree islands, Old World Climbing fern was the only exotic species recorded, with an average cover of 7.3% (Table 8). Within undisturbed flatwoods, only Old World climbing fern was recorded at an insignificant level (0.3%). Within roller-chopped flatwoods, no exotics were recorded. Within cypress swamps, Brazilian-pepper had the highest cover of all exotics (7.9%), followed by Asian sword fern. In total, four species of exotics were recorded among all shrub cover plots in cypress swamps among the three sites. Within cypress swamps at Loxahatchee, Brazilian-pepper had the highest cover of all exotics (21.7%), followed by Asian sword fern. In total, three species of exotics were recorded among all shrub cover plots in cypress swamps at Loxahatchee. Within cypress swamps at Corbett, Old World climbing fern was the only exotic recorded with a cover of 2.0%. Within cypress swamps at Dupuis, Brazilian-pepper was the only significant exotic with a cover of 2.0%. Only two species of exotics were recorded in cypress swamps at Dupuis.

Canopy Plots: All Exotics

Average cover of all exotics for all canopy plots was 2.4% (Table 9). Loxahatchee had the highest cover of all exotics (5.5%), followed by Dupuis, and Corbett. Of habitats, cypress swamps had the highest cover (4.5%), followed by tree islands (1.7%); no exotics were present in the canopy in undisturbed flatwoods, and roller-chopped flatwoods. Within cypress swamps, Loxahatchee had the highest cover of all exotics (9.3%), followed by Dupuis, and Corbett.

Brazilian-pepper had the highest average cover (1.8%), followed by Old World climbing fern (Table 9). In total, three species of exotics were found in canopy cover plots. At Loxahatchee, Brazilian-pepper had the highest cover (3.4%), followed by Old World climbing fern. At Corbett and Dupuis, no significant exotics were found in the canopy. In total, three species of exotics were recorded among all canopy plots at all sites.

Within tree islands, Old World climbing fern was the only exotic recorded, with an average cover of 1.7% (Table 9). Within undisturbed flatwoods and roller-chopped flatwoods, no exotics were recorded in the canopy. Within cypress swamps, Brazilian-pepper had the highest cover (2.8%), followed by Old World climbing fern.

Cover Plots: Natives[4]

Average native plant cover was highest in canopy plots (98.9%), followed by herb plots and shrub plots (Tables 10-12). Within tree islands, natives cover was highest in shrub plots (123.3%), followed by canopy plots, and herb plots. Within undisturbed flatwoods,

[4] Only native species with a cover of 5% or greater are mentioned in the text.

natives cover was highest in herb plots (137.8%), followed by canopy and shrub plots. Within roller-chopped flatwoods, natives cover was highest in herb plots (36.8%), followed by canopy and shrub plots. Within cypress swamps, canopy plots had the highest natives cover (114.2%), followed by herb plots and shrub plots. Within cypress swamps at Loxahatchee, natives cover was highest in herb plots (113.1%), followed by canopy and shrub plots. Within cypress swamps at Corbett, natives cover was highest in canopy plots (102.2%), followed by herb and shrub plots. Within cypress swamps at Dupuis, natives cover was highest in canopy plots (131.0%), followed by herb and shrub.

Herb Plots: Natives

Average cover of all natives for all herb plots at all stations at all sites was 89.2% (Table 10). Corbett had the highest cover of all natives (119.9%), followed by Loxahatchee, and Dupuis. Of all habitats, undisturbed flatwoods had the highest cover (137.8%), followed by cypress swamps, tree islands, and roller-chopped flatwoods. Within cypress swamps, Loxahatchee had the highest cover of all natives (113.1%), followed by Corbett, and Dupuis.

Swamp fern (*Blechnum serrulatum*) had the highest average cover of all natives (19.3%), followed by water spangles (*Salvinia minima*), gulfdune paspalum (*Paspalum monostachyum*), and saw palmetto (*Serenoa repens*) (Table 10). In total, 175 species of natives were recorded among all herb cover plots at all sites.

At Loxahatchee, water spangles had the highest average cover of all natives (29.9%), followed by swamp fern, cinnamon fern (*Osmunda cinnamomea*), Hottentot fern (*Thelypteris interrupta*), and giant leather fern (*Acrostichum danaeifolium*) (Table 10). In total, 44 species of natives were recorded among all herb cover plots at Loxahatchee. At Corbett, swamp fern had the highest cover of all natives (25.9%), followed by gulfdune paspalum, saw palmetto, sawgrass (*Cladium jamaicense*), and roughhair witch grass (*Dichanthelium strigosum* var. *glabrescens*). In total, 119 species of natives were recorded among all herb cover plots at Corbett. At Dupuis, swamp fern had the highest cover of all natives (7.9%), followed by saw palmetto. In total, 83 species of natives were recorded among all herb cover plots at Dupuis.

Within tree islands, swamp fern had the highest average cover of all natives (43.8%), followed by cinnamon fern, and Hottentot fern (Table 10). In total, 21 species of natives were found among all herb cover plots in tree islands. Within undisturbed flatwoods, gulfdune paspalum had the highest cover of all natives (36.9%), followed by saw palmetto, roughhair witch grass, hemlock witch grass (*Dichanthelium portoricense*), broomsedge bluestem (*Andropogon virginicus* var. *virginicus*), and sawgrass. In total, 93 species of natives were recorded among all herb cover plots in undisturbed flatwoods. Within roller-chopped flatwoods, saw palmetto was the only native with a significant cover (11.3%). In total, 67 species of natives were recorded among all herb cover plots in roller-chopped flatwoods. Within cypress swamps, swamp fern had the highest cover of all natives (23.6%), followed by water spangles, and royal fern. In total, 60 species of natives were recorded among all herb cover plots in cypress swamps among the three sites. Within cypress swamps at Loxahatchee, water spangles had the highest cover

(58.0%), followed by giant leather fern, and royal fern (*Osmunda regalis* var. *spectabilis*). In total, 31 species of natives were recorded among all herb cover plots in cypress swamps at Loxahatchee. Within cypress swamps at Corbett, swamp fern had the highest cover of all natives (50.9%), followed by maidencane (*Panicum hemitomon*), royal fern, Virginia chain fern (*Woodwardia virginicus*), sawgrass, and bald cypress (*Taxodium distichum*). In total, 37 species of natives were recorded among all herb cover plots in cypress swamps at Corbett. Within cypress swamps at Dupuis, swamp fern had the highest cover (15.2%), followed by bald cypress, water sprangles, skyflower (*Hydrolea corymbosa*), and maidencane. In total, 24 species of natives were recorded among all herb cover plots in cypress swamps at Dupuis.

Shrub Plots: Natives

Average cover of all natives for all shrub plots at all stations at all sites was 54.5% (Table 11). Loxahatchee had the highest cover of all natives (92.1%), followed by Corbett, and Dupuis. Of all habitats, tree islands had the highest cover (123.3%), followed by cypress swamps, undisturbed flatwoods, and roller-chopped flatwoods. Within cypress swamps, Corbett had the highest cover of natives (66.3%), followed by Loxahatchee, and Dupuis.

Dahoon holly (*Ilex cassine*) had the highest average cover of all natives (9.3%), followed by swamp fern, and wax-myrtle (*Myrica cerifera*) (Table 11). In total, 71 species of natives were recorded among all shrub cover plots at all sites.

At Loxahatchee, dahoon holly had the highest average cover of all natives (27.8%), followed by wax-myrtle, giant leather fern, and swamp fern (Table 10). In total, 40 species of natives were recorded among all shrub cover plots at Loxahatchee. At Corbett, swamp fern had the highest cover of all natives (11.0%), followed by saw palmetto (*Serenoa repens*). In total, 42 species of natives were recorded among all shrub cover plots at Corbett. At Dupuis, no native had a cover of 5% or greater. In total, 21 species of natives were recorded among all shrub cover plots at Dupuis.

Within tree islands, dahoon holly had the highest average cover of all natives (55.7%), followed by wax-myrtle, swamp fern, and cinnamon fern (Table 11). In total, 19 species of natives were found among all shrub cover plots in tree islands. Within undisturbed flatwoods, saw palmetto was the only native with a significant cover (13.2%). In total, 28 species of natives were recorded among all shrub cover plots in undisturbed flatwoods. Within roller-chopped flatwoods, no significant natives were recorded in shrub cover plots. In total, four species of natives were recorded among all shrub cover plots in roller-chopped flatwoods. Within cypress swamps, swamp fern had the highest cover of all natives (11.1%), followed by giant leather fern, wax-myrtle, and bald cypress. In total, 47 species of natives were recorded among all shrub cover plots in cypress swamps among the three sites. Within cypress swamps at Loxahatchee, giant leather fern had the highest cover (26.9%), followed by wax-myrtle. In total, 28 species of natives were recorded among all shrub cover plots in cypress swamps at Loxahatchee. Within cypress swamps at Corbett, swamp fern had the highest cover (21.4%), followed by maidencane, cabbage palm (*Sabal palmetto*), and wax-myrtle. In total, 22 species of natives were recorded among all shrub cover plots in cypress swamps at Corbett. Within

cypress swamps at Dupuis, swamp fern had the highest cover (8.5%), followed by wax-myrtle, and bald cypress. In total, 18 species of natives were recorded among all shrub cover plots in cypress swamps at Dupuis.

Canopy Plots: Natives

Average cover of all natives for all canopy plots at all stations at all sites was 98.9% (Table 12). Loxahatchee had the highest cover of all natives (112.7%), followed by Dupuis, and Corbett. Of all habitats, tree islands had the highest cover (116.0%), followed by cypress swamps, undisturbed flatwoods, and roller-chopped flatwoods. Within cypress swamps, Dupuis had the highest cover of natives (131.0%), followed by Loxahatchee, and Corbett.

Bald cypress had the highest average cover of all natives (46.1%), followed by dahoon holly, stiff-leaved wild-pine (*Tillandsia fasciculata* var. *densispica*), whitevine (*Sarcostemma clausa*), and slash pine (*Pinus elliottii* var. *densa*) (Table 11). In total, 32 species of natives were recorded among all canopy cover plots at all sites.

At Loxahatchee, dahoon holly had the highest average cover of all natives (42.8%), followed by bald cypress, and wax-myrtle (Table 12). In total, 21 species of natives were recorded among all canopy cover plots at Loxahatchee. At Corbett, bald cypress had the highest cover of all natives (39.0%), followed by slash pine. In total, 19 species of natives were recorded among all canopy cover plots at Corbett. At Dupuis, bald cypress had the highest cover of all natives (42.8%), followed by stiff-leaved wild-pine, and slash-pine. In total, 23 species of natives were recorded among all canopy cover plots at Dupuis.

Within tree islands, dahoon holly had the highest average cover of all natives (85.5%), followed by wax-myrtle (Table 12). In total, 10 species of natives were found among all canopy cover plots in tree islands. Within undisturbed flatwoods, slash pine was the only significant native with a cover of 30.5%. In total, six species of natives were recorded among all canopy cover plots in undisturbed flatwoods. Within roller-chopped flatwoods, slash pine was the only significant native with a cover of 18.7%. In total, five species of natives were recorded among all canopy cover plots in roller-chopped flatwoods. Within cypress swamps, bald cypress had the highest cover of all natives (78.0%), followed by stiff-leaved wild-pine. In total, 32 species of natives were recorded among all canopy cover plots in cypress swamps among the three sites. Within cypress swamps at Loxahatchee, bald cypress had the highest cover (70.5%), followed by stiff-leaved wild-pine, and Spanish-moss (*Tillandsia usneoides*). In total, 20 species of natives were recorded among all canopy cover plots in cypress swamps at Loxahatchee. Within cypress swamps at Corbett, bald cypress was the only significant native with a cover of 78.0%. In total, 19 species of natives were recorded among all canopy cover plots in cypress swamps at Corbett. Within cypress swamps at Dupuis, bald cypress had the highest cover of all natives (85.5%), followed by stiff-leaved wild-pine. In total, 22 species of natives were recorded among all canopy cover plots in cypress swamps at Dupuis.

Relative Cover: Old World Climbing Fern
Average relative cover of Old World climbing fern was highest for shrub plots (1.7%), followed by herb and canopy plots (Table 13).

For herb plots, Loxahatchee had the highest average relative cover of Old World climbing fern (3.3%), followed by Corbett, and Dupuis. Of all habitats, tree islands had the highest relative cover (6.7%), followed by cypress swamps, and undisturbed flatwoods; no Old World climbing fern was recorded in roller-chopped flatwoods. Within cypress swamps, Corbett had the highest relative cover (2.2%), followed by Dupuis; no Old World climbing fern was recorded in cypress swamps at Loxahatchee.

For shrub plots, Loxahatchee had the highest average relative cover of Old World climbing fern (2.8%), followed by Corbett, and Dupuis. Of all habitats, tree islands had the highest relative cover (5.6%), followed by cypress swamps, and undisturbed flatwoods; no Old World climbing fern were recorded within roller-chopped flatwoods. Within cypress swamps, Corbett had the highest relative cover (2.9%), followed by Dupuis; no Old World climbing fern was recorded in cypress swamps at Loxahatchee.

For canopy plots, Loxahatchee had the highest average relative cover of Old World climbing fern (1.8%), followed by Dupuis, and Corbett. Of all habitats, cypress swamp had the highest relative cover (1.8%), followed by tree islands; no Old World climbing fern were recorded within undisturbed flatwoods or roller-chopped flatwoods. Within cypress swamps, Loxahatchee had the highest relative cover (2.1%), followed by Dupuis, and Corbett.

Relative Cover: All Exotics
Average relative cover of all exotics was highest for herb plots (7.7%), followed by shrub and canopy plots (Table 14).

For herb plots, Dupuis had the highest average relative cover of exotics (16.8%), followed by Loxahatchee and Corbett. Of all habitats, roller-chopped flatwoods had the highest relative cover (32.4%), followed by tree islands, cypress swamps, and undisturbed flatwoods. Within cypress swamps, Loxahatchee had the highest relative cover (3.0%), followed by Corbett, and Dupuis.

For shrub plots, Loxahatchee had the highest average relative cover of exotics (17.9%), followed by Dupuis, and Corbett. Of all habitats, cypress swamp had the highest relative cover (12.9%), followed by tree islands, and undisturbed flatwoods; no exotics were recorded within roller-chopped flatwoods. Within cypress swamps, Loxahatchee had the highest relative cover (30.3%), followed by Dupuis, and Corbett.

For canopy plots, Loxahatchee had the highest average relative cover of exotics (4.6%), followed by Dupuis, and Corbett. Of all habitats, cypress swamp had the highest relative cover (3.8%), followed by tree islands; no exotics were recorded within undisturbed flatwoods or roller-chopped flatwoods. Within cypress swamps, Loxahatchee had the highest relative cover (7.8%), followed by Dupuis, and Corbett.

DISCUSSION

Old World climbing fern was recorded at all sites, and in each habitat type sampled. It was found growing in association with other exotic species, but in some instances it was the only exotic present.

Both the frequency and cover of Old World climbing fern was higher than expected, as we had attempted to locate plots in areas with less than 10% frequency and 1% average cover. With a frequency of nearly 50% and an average cover in both the herb and shrub layers greater than 1%, Old World climbing fern is already well established in the study area, even when it is not apparent. However, the cover of Old World climbing fern is low enough to monitor further significant growth. In herb plots, Old World climbing fern cover was greater than 1% only on tree islands (6.2%), and cypress swamps at Corbett (2.3%), while no Old World climbing fern was detected in roller-chopped flatwoods and in cypress swamps at Loxahatchee. Significant affects of frequency changes may be more difficult to quantify, especially on tree islands at Loxahatchee where it already approaches 100%.

The overall frequency and cover of other exotics species is also disheartening. With the exception of the roller-chopped flatwoods, the stations for plots were chosen because they represented relatively intact, undisturbed, natural communities. Even the roller-chopped flatwoods appeared to be relatively free of exotics with the exception of Bahia grass, which was clearly present. When other exotics are added with Old World climbing fern, however, frequency of exotics increased to 70%, with both roller-chopped flatwoods and cypress swamps at Loxahatchee experiencing 100% frequency of exotics. Only the undisturbed flatwoods at Corbett had an exotics frequency lower then 50%. Although more variable, cover of exotics in the herb layer averaged 15%, with roller-chopped flatwoods experiencing an exotics cover of greater than 50%. Even with roller-chopped flatwoods excluded, exotics cover averaged 8% in the herb layer. Lower exotics cover in both the shrub and canopy layers will allow for long-term monitoring of exotics as they spread and grow into these layers.

Finally, the relative cover of both Old World climbing fern and other exotics versus natives was calculated to develop a baseline in order to monitor the interactions between Old World climbing fern and natives, and all exotics and natives. As an increase in exotics (including Old World climbing fern) is expected to cause a decrease in cover of natives, we will be able to monitor the overall affects of Old World climbing fern and other exotics on the native vegetation over time by site, by habitat, and by layer.

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