Monitoring Ground Treatments of Old World Climbing Fern *(Lygodium microphyllum)* on the Arthur R. Marshall Loxahatchee NWR

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Introduction

Lygodium microphyllum is a fern native to Australia, Southeast Asia, and tropical Africa that has become established in South Florida since 1950 (Beckner 1968, Nauman and Austin 1978, and Pemberton and Ferriter 1998). It has become established in wet pine flatwoods, Everglades habitats, and in cypress swamps. *L. microphyllum* impacts native vegetation community structure (Brandt and Black 2001) and appears to suppress native plant growth by smothering native vegetation and depriving it of sunlight. Additionally, thick fern mats prevent the germination of native plant seeds, restrict the growth of native plant seedlings, alter water flow, and can affect fire behavior by increasing the chances of crown and spot fires (SFWMD 1997).

The Arthur R. Marshall Loxahatchee National Wildlife Refuge (the Refuge), 59,894 ha of remnant northern Everglades wetland, is comprised of four main habitat types: slough, wet prairie, sawgrass marsh, and tree islands. The thousands of tree islands are one of the features that make the Refuge unique. *L. microphyllum* was first reported on the Refuge in the late 1980s. Currently it is estimated that *L. microphyllum* infests over 10,100 ha, primarily bayhead and strand tree islands in the north-central marsh interior. *L. microphyllum* also has been reported as growing in sawgrass and on fern tussocks, in cypress swamps and domes, and has even been reported as growing freely in wet prairies in the northern portions of the refuge interior (L. Brandt pers. comm.).

With over 10,117 ha being impacted by *L. microphyllum*, the Refuge has the worst infestation of this species in southern Florida. The management of invasive exotic pest plants is one of the highest management priorities for the Refuge. The purpose of this study is to monitor the effectiveness of herbicide treatments on *L. microphyllum* on tree islands, document the regrowth of *L. microphyllum,* and document the response of native species richness and composition in response to the treatments.

Methods

Treatments of *L. microphyllum* were performed by a contractor (Enviroglades, Inc.) assigned by the Florida Department of Environmental Protection (DEP) during August - December 1999. Approximately 140 individual tree islands were treated on 125 ha in the north-central interior of the Refuge (Figure 1.). Most of the tree islands within the delineated treatment area were moderately to severely infested with *L. microphyllum* including the edges of the tree islands, and surrounding sawgrass and fern tussocks. The preferred treatment method was for crews to cut the ascending portion of the fern at waist or knee level followed by the application of a 5% solution of glyphosate plus surfactant in water as a foliar spray to the remaining portion of the *L. microphyllum* rooted in the ground. To prevent additional spread of the spores, the ascending portion of the fern biomass, or fern ladders, were left on site hanging or clinging to native vegetation. The DEP provided funding for re-treatments during November 2000 to January 2001.

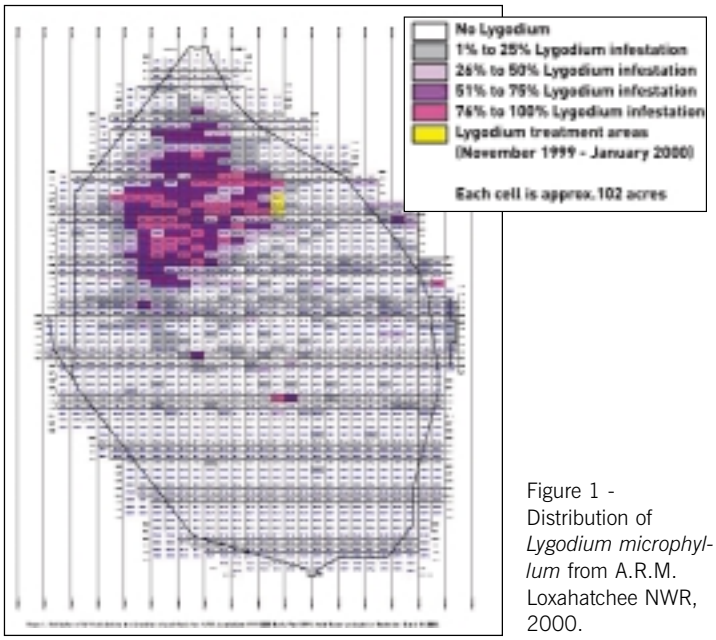

Figure 1 - Distribution of *Lygodium microphyllum* from A.R.M. Loxahatchee NWR, 2000.

Ten of the treated tree islands were randomly selected for study. Random points were picked from a grid map of the 125 ha area, and when located in the field, the nearest treated tree island was selected. Data were collected for percent coverage of live *L. microphyllum* and native vegetation in the ground (0-1 m), mid-story (1-2 m), and overstory layers (>2 m) within a 4 X 5 meter quadrat placed in the center of each island. Coverages were visually estimated to the nearest 5%, and all plant species were identified. Data collected allowed for development of a species list for each layer and the total percent cover of all vegetation within each layer. Quadrat size and quadrat location were used to provide consistency with other studies being conducted on tree islands on the Refuge (Brandt *et al*. in prep.). In addition, photo points were established on each selected island. The northwest corner of the quadrat served as the interior photo point, and an exterior photo point was placed on the east side of each tree island to help document regrowth of *L. microphyllum* and native vegetation over time. Data and photos were collected twice annually for three years post-treatment.

Results and Discussion

During initial sampling in May and August 2000 (6 and 8 months post-treatment), percent coverage of live *L. microphyllum* ranged from <5% to 10%, <5%, and <5% to 10% for the ground, mid-story, and overstory layers respectively. Live *L. microphyllum* was detected in the ground layer in all ten plots, within the mid-story layer in one plot, and in the overstory layer in two plots. Live *L. microphyllum* located in the mid-story and overstory layers was likely missed during original treatments. Only a small portion detected in the ground layer appeared to be new growth from spore. After the fifth visit (3 years post-treatment), *L. microphyllum* percent coverage in the ground layer ranged from 0% to 40%, within the mid-story layer 0% to 10%, and within the overstory layer 0% to 10% respectively. *L. microphyllum* was detected in the ground layer in nine of the ten plots, within the mid-story layer in six plots, and in the overstory layer in three plots, indicating this species was slowly increasing in all vegetative layers. This was expected and is consistent with monitoring post-treatments of other Category 1 invasive pest plants.

Figure 2. Top – Typical *L. microphyllum* infested tree island. Bottom – Tree island 2217D immediately following treatment, November 1999.

Nineteen native species were recorded in the study plots. The native species list was similar to that reported on other refuge tree islands (Brandt and Black 2001, Brandt *et al.* in prep, USFWS 2001). The dominant native species in the ground layer were ferns (swamp, chain, and shield) and herbs and forbs such as marsh beggar's-tick and bog hemp. Native species in the shrub layer included wax myrtle, buttonbush, some ferns, and vines such as wild grape and bamboo vine (*Smilax sp.*). The dominant native overstory trees were red bay, dahoon holly, and wax myrtle. The number of native species in the ground, shrub, and overstory layers ranged from three to eight, three to four, and three to four respectively.

The percent cover of native species in the ground layer within study plots increased during summer visits and decreased during winter visits indicating that some herbs and forbs experienced die-back, or were susceptible to cold temperatures. This was particularly evident during the the second visit (1.5 years post-treatment) during an extended period of cooler temperatures where a lower percent cover of and less native species were documented in the ground layer in 6 of the 10 plots. Flights over the Refuge at this time showed considerable browning of *L. microphyllum* on severly infested tree islands indicating that this species too experienced die-back from extended cold snaps.

After three years, the percent cover of native species had increased in the ground, mid-story, and overstory layers in 8, 5, and 6 of the 10 study plots respectively. The increase in the percent cover of native species after treatment of *L. microphyllum* illustrates that tree islands can recover from severe *L. microphyllum* infestations.

Very minimal non-target damage to native species was observed on treated tree islands during the study. Only when laborers failed to cut the fern trellises, and instead, utilized a single foliar application to *L. microphyllum* extending into the shrub layer, was damage to native wax myrtle and sawgrass observed. This was most evident on the edges of tree islands. There was also some damage to native ferns in the interior of tree islands where foliar applications of glyphosate were performed to *L. microphyllum* rooted in the ground.

Figure 3. Top – Tree island 2217D plot (9 months post-treatment). Note dead fern trellises hanging in foreground. Bottom – Tree island 2217D exterior photo point (20 months post-treatment).

Many of the treated *L. microphyllum* islands remain relatively *Lygodium* free nearly three years after original treatments, indicating that although ground treatments are extremely expensive, they can effectively control this species on a small scale over a short-term period if performed correctly. However, it was noted that a number of the tree islands, which supposedly had been treated, were once again moderately to heavily infested with *L. microphyllum*. This appeared to be a faulty treatment technique by the contractor. It may be that the fern trellises were cut and that the subsequent spray crews failed to treat the portion rooted or that the islands were not treated at all. Also, a faulty herbicide mixture may have been used, or the herbicide may have been washed away in a rain event. A better means of marking the individual islands needs to be developed if future treatments are going to be conducted in this same manner.

The dead fern biomass appears to be degrading slowly, but signficant amounts remain on the ground and in the shrub and overstory layers. Prescribed fire will be tested on several islands as a means to remove dead fern biomass and restore tree island plant community structure.

Figure 4. Improperly treated *L. microphyllum* on tree island 2217A adjacent to plot. This *Lygodium* was brown and appeared to have been treated during initial visits but had recovered fully as of March 2002. This island would be an ideal candidate for immediate re-treatment to prevent reinfestation of other successfully treated islands in close proximity.

Implications For Management and Control

The preferred management strategy for most agencies, including the U.S. Fish and Wildlife Service, is to contain and treat small and/or outlier populations of *L. microphyllum* before they become unmanageable (Ferriter 2001). The most promising method to control *L. microphyllum* to date, implemented on the Refuge and throughout South Florida, remains herbicides, but their application is difficult due to the vertical and horizontal growth of this species. This study has confirmed that ground treatments, when conducted properly and when using the most effective herbicides and surfactants, are an extremely effective method of controlling *L. microphyllum*. Unfortunately, because of the extent of the problem as it relates to the infestation levels, locations, and size of the Refuge, ground treatments may not be the most cost effective or logistically feasible long-term method for controlling *L. microphyllum*.

Original treatment costs totalled $155,000 for a time and materials contract which was completed in approximately 3.5 months. Assuming that each treated tree island averaged 0.30 ha in size, ground treatments cost approximately $3,690.50 per hectare and $1,107.15 per tree island. These costs are comparable to those obtained for initial experimental treatments conducted at Jonathan Dickinson State Park ($3,642.30/ha) in the mid-1990s using the same herbicide and a similar treatment technique (Pemberton and Ferriter 1998). If calculating the total cost for the delineated treatment area (125 ha), which included a significant proportion of uninfested wet prairie, total treatment costs were $1,240.00 per hectare. Using the conservative total treatment cost mentioned above, it is estimated that it would take nearly $12.5 million and approximately 9.6 years to perform initial treatments for *L. microphyllum* on the Refuge. Ground treatment costs for *L. microphyllum* are astronomical when compared to those for melaleuca, where costs range from approximately $24 to $202 per hectare for light to dense infestations respectively. However, aerial treatments for *L. microphyllum*, dependent upon the herbicide used, can cost as little as $30 per hectare (A. Ferriter pers. comm.). Effective aerial treatment methods need to be developed for the Refuge.

The results of this study have direct implications on future expenditures and control operations for the long-term management of *L. microphyllum* on the Refuge. Results show clearly that islands that were correctly treated experienced little *L. microphyllum* regrowth within 3 years. In fact, the native vegetation in all layers on these islands appears to be responding favorably. For cases like the Refuge, re-treatment prior to the third year may be unneccessary and funds could be directed for treatment of more severe infestations. Unfortunately, other islands that appear not to have been treated correctly are experiencing rapid reinfestation. Monitoring both herbicide treatments and contractors is a key component to implementing a successful *L. microphyllum* management strategy. Yearly follow-up treatments are probably logistically feasible and cost effective for smaller infestations on smaller parcels, but in the case of the Refuge where there are thousands of acres of heavy infestations, longer re-treatment intervals will allow resources to be focused on the most heavily infested areas first. Findings also show that it is theoretically possible to achieve maintenance control of this species on the Refuge, or at least, to achieve a level of control where *L. microphyllum* is no longer impacting the ecological function of tree islands.

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