Monitoring the Effects of Repeated Herbicide Application on *Lygodium microphyllum* and Native Vegetation at A.R.M. Loxahatchee NWR

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INTRODUCTION

Old World climbing fern (*Lygodium microphyllum*) is considered one of the worst non-native invasive plants of seasonal hydric habitat in southern Florida. In 2005, this invasive fern covered 49,690 ha in south Florida based on Systematic Reconnaissance Flights (SRF) preformed by the South Florida Water Management District (Amy Ferriter, South Florida Water Management District, Pers. Comm.). Based on models, it is estimated that *L. microphyllum* will overtake the five most invasive plants (*Melaleuca quinquenervia*, *Schinus terebinthifolius*, *Casuarina equisetifolia*, *Colubrina asiatica*, and *Ardisia elliptica*) combined in area coverage in south Florida by 2014 if left unmanaged (Volin et al., 2004). Infestations of *L. microphyllum* often occur in natural areas that are remote and inaccessible to vehicles and personnel due to inundated and mucky soils, making treatment difficult.

As *L. microphyllum* grows, it smothers native vegetation both horizontally and vertically, exhibits indeterminate growth patterns, and forms complete canopy cover that alters habitat for native plants and animals. In addition, this fern changes the fire ecology of a given area, resulting in excessive and possibly non-recoverable damage to normally fire tolerant tree species.

Some of the heaviest infestations of *L. microphyllum* occur in Martin and Palm Beach Counties, the general location of the first documented record for this species in Florida. In 1995, *L. microphyllum* covered ca. 7,284 ha of the Loxahatchee National Wildlife Refuge (LNWR) in Palm Beach County, but increased to ca. 19,433 ha in 2003 based on Systematic Reconnaissance Flights (SRF) performed by the South Florida Water Management District. The current estimate of *L. microphyllum* based on SRF in the refuge is ca. 25,200 ha (Woodmansee et al., 2005).

Volin, J. C., M. S. Lott, J. D. Muss, and D. Owens. 2004. Predicting rapid invasion of the Florida Everglades by Old World climbing fern (*Lygodium microphyllum*). Diversity and Distributions 10: 439-446.

Woodmansee, S.W., K. Bradley, and S. Hodges. 2005. Systematic reconnaissance flights and exotic plant species mapping at selected National Wildlife Refuges in Florida. Final Report. Submitted to U.S. Fish and Wildlife Service, Sanibel, FL.

OBJECTIVES

1) Evaluate the effects of repeated herbicide application (aerial and ground) on tree islands heavily infested with *Lygodium microphyllum*

2) Determine the most effective herbicide to control *Lygodium microphyllum* on tree islands and compare non-target damage

3) Compare which herbicides cause the least non-target damage

Aerial and ground photos of a tree island heavily infested with *Lygodium microphyllum* at A.R.M. Loxahatchee NWR

METHODS

Aerial applications of metsulfuron methyl (Escort XP) and glyphosate (Rodeo) herbicides were applied to 50 tree islands heavily infested with *L. microphyllum* during February 2006 in the Arthur R. Marshall Loxahatchee National Wildlife Refuge, Palm Beach County, Florida. Five tree islands were used as controls. Aerial application of Escort XP included rates of 2 oz / 20 gal / acre (n = 10) and 4 oz / 20 gal / acre (n = 15), and glyphosate at 3.75 pints / 20 gal / acre and 7.5 pints / 20 gal / acre. During years 1 and 2 of the project post-treatment, *L. microphyllum* re-treatment will be conducted by ground herbicide applicator crews. During ground treatments, Escort XP will be applied at rates of 2 and 4 oz / 100 gallons diluent and Rodeo will be applied at 2 and 4 % product. Pre-treatment monitoring was conducted December 2005 - January 2006. Post aerial treatment was conducted December 2006-January 2007, and December 2007. The final evaluation will occur December 2008. In addition to quantitative sampling described below, general photo points will be taken on selected tree island as a visual reference. Ground cover < 1 m tall will be estimated along three line transects the entire width of each tree island. Ground cover will be estimated to the nearest 0.5 cm for each plant species. Cover will be calculated for all species of vegetation along a transect line by dividing the total distance of each species along the line by the length of the transect line. The estimated total ground cover of each island will be combined by taking the mean of the 3 line transects. Cover estimates will allow qualitative analysis of the effects of repeated aerial spraying on *L. microphyllum* and native plants. On each tree island, changes in plant composition and structure will be evaluated pre-treatment and post-treatment for 4 years. Means and standard error will be calculated for cover. Mixed effects general linear models with repeated measures will be used to test for significant differences in cover among treatments. Percent canopy cover will be estimated at the beginning, end, and middle along the transect using a concave densiometer. Percentage canopy cover will be taken at 1 m above the ground. Species within each point will be recorded to document percentage change in canopy coverage. Species lists, both native and exotic plants, will be compiled from each line transect to determine compositional changes over the monitoring period. This information will be used as a site condition assessment to determine the effects on compositional changes to plants from repeated applications of herbicides. Species richness will be calculated to compare pre- and post treatments. On each tree island, native shrubs and trees such as *Myrica cerifera*, *Ilex cassine*, and *Persea palustris* will be marked to examine the effects of aerial herbicide application on native trees. Following aerial application of herbicide, plants will be documented as alive if any green vegetation is present on the plant. Means and standard errors will be calculated for each species. Analysis of variance will be used to test for significant differences between the effects of the treatments on the number of individuals alive and dead.

Gayle Martin evaluating a tree island treated with Escort during December 2007

RESULTS (two years post treatment)

Background: the initial objective of this project was to evaluate three consecutive years of aerial herbicide applications or combinations of these herbicides to control *L. microphyllum.* The initial aerial application provided excellent control of *L. microphyllum.* During the one year post treatment evaluation, it was decided that additional aerial treatment would result in greater non-target damage. Follow-up ground treatments will be conducted instead.

Escort at rates of 2 and 4 ounces reduced pre-treatment percent coverage of *L. microphyllum* from 67.3% and 59.5% to 4.2% and 3.6% percent coverage at two years, respectively (**Figure 1**). Aerial application of Escort at both rates resulted in higher survival rates of dominant canopy trees (swamp bay, dahoon holly, and wax myrtle) than Rodeo (**Figure 2**). Escort at both rates caused greater non-target damage to cinnamon fern, green brier, royal fern, swamp fern, and Virginia chain fern than Rodeo. At two years post treatment, native plant cover was recovering (**Figure 3**), with wild grape (16 - 22 % cover), swamp bay (8.9 - 10.6 % cover) and swamp fern (6.7 - 13.3 % cover) showing the greatest response two years post treatment.

Rodeo at rates of 3 ¾ and 7 ½ pints reduced pre-treatment percent cover *L. microphyllum* from 66.5% and 69.7% to 19.9% and 14.3% percent coverage at two years, respectively (**Figure 1**). Aerial application of Rodeo at both rates resulted in lower survival rates of dominant trees (swamp bay, dahoon holly, and wax myrtle). On tree islands treated with Rodeo (both rates) there was significant damage to the tree canopy (**Figure 2**). Non-target damage to ground cover on tree islands treated with Rodeo was also high but less than tree islands treated with Escort. This may be attributable to the fact that Escort has persistence in the soil while Rodeo has no soil persistence. At two years post-treatment, native plants were recovering (**Figure 3**) at a faster rate than on tree islands treated with Escort. However, the dominant native plant two years post treatment was wild grape (43.6 - 49.1 % cover), with swamp fern ranging from 3.7 - 12.6 % cover.

Control plots increased in percent coverage of *L. microphyllum* from 46.0% pre-treatment to 60.0% at two years. There was also a concomitant decrease in native plant percent coverage from 77.9% at year 0 to 60.3% at year 2. This indicates that *L. microphyllum* increased by 30.4% in percent cover while native plants decreased in percent cover by 22.6 % on untreated tree islands over two years.

Our results at two years indicate that 2 or 4 ounces Escort provided excellent control of *L. microphyllum* and limited damage to canopy trees. Herbicide treatment for long term management of *L. microphyllum* is more effective with aerial application of Escort at 2 or 4 ounces, followed by ground treatments with Rodeo at 2 or 4% product, which would result in less non-target damage to ground cover. However, ground treatments to control *L. microphyllum* at the refuge are not feasible for long term management due to financial and personnel restraints.

Figure 1. Mean percent cover and standard error bars of *Lygodium microphyllum* at pre-treatment, 1 year post-treatment, and 2 years post-treatment for two rates of Escort and Rodeo, and controls.

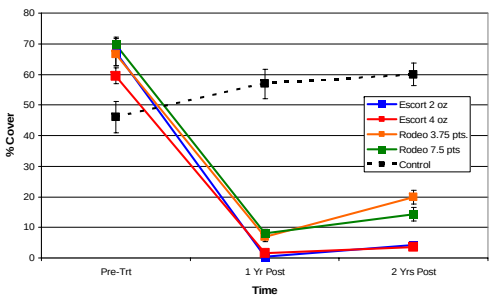
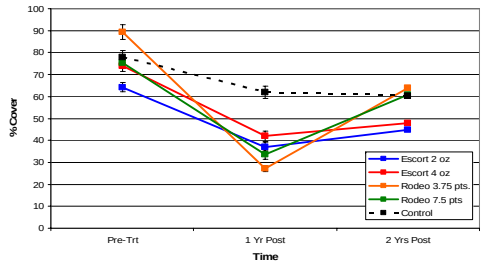


Figure 2. Tree islands treated with 2 oz Escort (left) and 3 ¾ pts. Rodeo (right) two years post treatment. Tree islands treated with Rodeo exhibited greater damage to canopy trees than those treated with Escort.

Figure 3. General trend of native plant cover and standard error bar for ten dominant plants[1] at pre-treatment, one year post-treatment, and two years post-treatment for two rates of Escort and Rodeo, and controls.



[1] Dominant native plants include: cinnamon fern, dahoon holly, wild grape, green brier, myrsine, royal fern, swamp fern, swamp bay, Virginia chain fern and wax myrtle.

PROJECT STATUS

- Pre-treatment survey completed January 2006
- Initial aerial treatments performed on February 2006
- First post-treatment survey completed end of December 2006
- First ground treatment conducted March 2007
- Second post-treatment survey completed December 2007
- Second ground treatment conducted February 2008
- Final post-treatment survey to be conducted December 2008
- Final Report May 2009

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