Statewide *Lygodium* Treatment Site Evaluation Project

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June 2007
Contract SL-981

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FLORIDA
Natural Areas
INVENTORY

Cover photographs

Top: Example of the cut frond technique used on *Lygodium microphyllum* (Old World Climbing Fern) in Martin County, FL, Chris Lockhart

Bottom: *Lygodium microphyllum* and *Lygodium japonicum* seen growing together in Palm Beach County: the left arrow points to *L. japonicum* (Japanese climbing fern), and the right arrow points to *L. microphyllum*, Chris Lockhart.

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Statewide *Lygodium* Treatment Site Evaluation Project

FINAL REPORT
June 2007

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EXECUTIVE SUMMARY

An effort was initiated in 2004 to better understand effective management practices for the highly invasive exotic climbing ferns, *Lygodium microphyllum* and *L. japonicum*, by field surveys of the current status of *Lygodium* (either species) on 109 control sites statewide. The sites are those where either, or both, of the climbing fern species were treated through funding from the Department of Environmental Protection Bureau of Invasive Plant Management since 1998. Out of this sampling of previous *Lygodium* treatments, and the subsequent analysis of collected data, the intent was to extract information on which control techniques are showing the greatest efficacy under various conditions.

Glyphosate and metsulfuron, or a combination thereof, were shown to be most effective for both *L. microphyllum* and *L. japonicum*. The cut frond technique is very effective particularly for *L. microphyllum*. This technique is also recommended for either species of climbing fern in sensitive areas where herbicides are used, to reduce non-target damage. The key to *Lygodium* management is to interrupt the reproductive cycle. Effective control involves a combination of thorough application, thorough search and treatment of all climbing fern plants in the treatment area, using an effective mix, always using a surfactant, and treat soon after burns while new plants are easy to see and before they become reproductive. Important for the treatment of *L. japonicum* is the addition of a "rainfast," particularly on humid days or when rain is anticipated. Critical for the treatment of *L. microphyllum* is to thoroughly cut all climbing fronds prior to herbicide application. Requiring that contract crews, including those with mowing and fire equipment, follow a "Come clean, leave clean" phytosanitary approach between working at different conservation lands will help to reduce the spread of spores for both climbing fern species.

TABLE OF CONTENTS

LIST OF TABLES i

LIST OF FIGURES i

ACKNOWLEDGEMENTS ii

INTRODUCTION 1

METHODS AND MATERIALS
- **Project Review** 1
- **Field Site Visits** 2

RESULTS
- **Distribution of Review Sites** 3
- **Plant Communities Reviewed** 3
- **Herbicide Efficacy** 3

DISCUSSION
- **Treatment Efficacy** 5
  - **Herbicides** 5
  - **Aerial Herbicide Application** 7
  - **Surfactants and Rainfasts** 7
- **Techniques** 7
  - **Cut Frond Method** 7
  - **Foliar Applications** 8
- **Non-target Damage** 9
- **Native Plant Recruitment** 9
- **Seasonal Differences** 10
- **Prescribed Burns, Treatment Intervals, and Integrated Pest Management** 10
- **Coordination of Evaluation Efforts** 11
- **Geographic Differences in Results** 11
  - **Effects Of Salinity, Soil And Other Factors.** . . 11
- **Phytosanitary Practices** 12

SUMMARY 12
- **General Treatment Recommendations** 13
- **Research Ideas** 14

REFERENCES **14**

APPENDIX A. **A-1**

APPENDIX B. **B-1**

LIST OF TABLES

Table 1. Counties with BIPM-funded *Lygodium* projects, by geographic region. . 5

Table 2. Herbicide response of *Lygodium* 6

LIST OF FIGURES

Figure 1. *Lygodium* Specialist Chris Lockhart evaluates a treatment site. . 2

Figure 2. Locations where BIPM-funded *Lygodium* projects have taken place. . 4

Figure 3. "Gancho" or "go-dum stick" used to pull a handful of trellising *Lygodium* fronds away from trees. 8

Figure 4. The *L. japonicum* rhizome from Palm Beach County after three herbicide treatments. 12

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Many thanks to Drew Leslie, DEP Bureau of Invasive Plant Management, for funding this project and granting FNAI the opportunity to visit many of Florida's wonderful conservation lands during the *Lygodium* site evaluations. Thanks to all the land managers who shared their time, insight and frustrations encountered while managing Florida's exotic pest ferns, and without whose input there would not have been this level of feedback. The contractors who shared their ideas regarding the treatment of *Lygodium* are also acknowledged and thanked. Without the early efforts by former park manager Dick Roberts at Jonathan Dickinson State Park followed by the energetic brainstorming and treatment research on *Lygodium microphyllum* conducted by the University of Florida Center for Aquatic and Invasive Plants and South Florida Water Management District, it is hard to imagine how much worse off we would be with regard to the treatment and management of this species. We also recognize the benefits of joint agency efforts such as the serial reconnaissance flights conducted by the National Park Service and South Florida Water Management District, and who, with the support and collaboration with Florida Natural Areas Inventory, The Nature Conservancy and the Florida Division of Forestry helped to determine the northern extent of *L. microphyllum*. The efforts by means of the Central Florida *Lygodium* Strategy to hold the line on the increased expansion of both *Lygodium* species are to be commended and supported. Much gratitude is also extended to the late Kathy Burks, project co-ordinator, for her support and is sorely missed. Numerous members of the FNAI staff provided valuable time and support, including Brenda Herring, Carolyn Kindell, Amy Jenkins, and Mike Jenkins who reviewed the many project summaries and interns (past and present) who helped to generate maps for the *Lygodium* reports: Jonathan Oravetz, Justin Thornton, Heather Young, and Yesenia Escribano. And finally, many thanks go out to the researchers, agencies, contractors, crews, and individuals who provided feedback and remain vigilant in the fight against the growing menace of these invasive ferns.

INTRODUCTION

An effort was initiated in 2004 to better understand effective management practices for the highly invasive exotic climbing ferns, *Lygodium microphyllum* (old world climbing fern) and *L. japonicum* (Japanese climbing fern), by field surveys of the current status of *Lygodium* (either species) on 109 control sites statewide. The sites are those where either, or both, of the climbing fern species were treated through funding from the Department of Environmental Protection Bureau of Invasive Plant Management (BIPM) since 1998. Out of this sampling of previous *Lygodium* treatments, and the subsequent analysis of collected data, the intent was to extract information on which control techniques are showing the greatest efficacy under various conditions.

Scope of Work

Work under this scope was conducted by the Florida Natural Areas Inventory (FNAI) *Lygodium* specialist. Tasks associated with this scope include coordination with land managers, site visits to all Department of Environmental Protection (DEP) control projects where *Lygodium* fern species were targets, compilation of information from managers on the control of the *Lygodium* fern species, and the evaluation of control methods that were most effective. Factors to consider include: the herbicides used, application rates, seasonality of application, fire management, habitat type, native species response, and non-target damage.

The *Lygodium* specialist served as a liaison with land managers, advising them of options available to them, such as the *Lygodium* Strike Team for the treatment of small infestations less than 10 acres, or referring them to their regional Uplands Working Group for the submittal of a control project proposal. Managers were referred to the BIPM Tallahassee office to schedule re-treatments or to request a project review. Other responsibilities of the *Lygodium* specialist included the coordination of evaluation efforts with The Nature Conservancy's (TNC) initiative to organize focused control efforts on the 14 county Central Florida zone of overlap of the two *Lygodium* species, coordinate efforts with other initiatives that focus on the management of the climbing ferns, and assist in the statewide survey of upland invasive exotics plants.

Site specific project summaries were written and supplied to BIPM and site managers for all managed areas (MA's) visited. These summaries included treatment information, a site description, photos, geo-referenced coordinates of infestations and findings from the *Lygodium* site survey. This report is a compilation of results from this two year study.

METHODS AND MATERIALS

Project review

The initial project review list of 92 projects grew to 109 as information became available on additional projects dated between 1998 and 2005 (Appendix A). Sometimes a *Lygodium* species was listed with other invasive species targets in the project proposal, but after further review it appeared that treatment of the fern(s) had not taken place. If it was verified that treatment had not taken place for that project, then no site visit or further action was taken on that project.

The task assignment for each project was acquired from the BIPM office, which typically included the project description and maps of the project site(s). The task assignment, daily treatment report forms (also known as DPR's), supporting correspondence, as well as related summary reports in BIPM's Annual Report diskettes, were reviewed. The site manager was then contacted, treatment of *Lygodium* was discussed, and arrangements were made for a field visit of the treatment site. Projects varied: some involved one or more locations within a single managed area (MA); others involved fern treatment on several MA's. As a result, some large MA's had multiple projects over time, while other projects reflected treatment of multiple MA's or joint multi-agency regional efforts.

Field Site Visits

Lygodium site visits began with a map review, followed by ground-truthing of a representative sampling for the treatment site(s) funded by BIPM. Because a manager's available field time is often at a premium, they were typically asked to accompany the *Lygodium* specialist to the more difficult access areas first. As needed, with guidance from the manager, the specialist could then survey as much of an area as desired to get a general consensus of treatment efficacy, and sample different plant communities, tracts, burn units, etc (Figure 1). Site visits also provided an opportunity to share feedback on treatment methods that worked best or those that worked poorly.

A copy of the report form used for the *Lygodium* surveys can be found in Appendix B. Both live and dead climbing ferns were characterized, looking at their height, density and habitat. Non-target damage, access, aerial extent, and major disturbances were noted. Methods consistent with those used for the statewide invasive plant surveys were incorporated so that data collected during the *Lygodium* surveys would easily merge with other records in the Florida Invasive Plants Geo-Database (FLInv). Data on other invasive species observed during the *Lygodium* surveys were also collected.

Figure 1. *Lygodium* Specialist Chris Lockhart evaluates a treatment site at Blackwater River State Forest.
Photo by Andrea Van Loan

RESULTS

Distribution of Review Sites

Figure 2 illustrates the distribution of MA's involved in the *Lygodium* site evaluations. The 109 projects reflect treatment of one or both *Lygodium* fern species at 65 MA's within 31 counties, or an average of 1.7 projects per MA. Two MA's, Avon Park Air Force Range and Kissimmee River Floodplain, treated both *L. microphyllum* and *L. japonicum*. These two sites lie within the 14 county region in central Florida where both climbing fern species overlap. There are 31 counties in which BIPM projects have included treatment for *Lygodium* (Table 1). Thirty-six counties in Florida had no projects involving *Lygodium*.

Plant Communities Reviewed

Most of the *L. microphyllum* treatment sites were in hydric habitats, including floodplain forests, hydric hammocks, wet flatwoods, wet prairies, bay heads, bay galls and depressional wetlands, with a couple of sites that were estuarine. *L. japonicum* sites were in mesic or hydric areas that are not inundated for long periods, including floodplain forests, upland hardwood hammocks, seepage wetlands and mesic to wet flatwoods, as well as in access roads and fire breaks. Both *Lygodium* species are found in ruderal areas, occupy the mesic/hydric ecotone and have been observed growing together in Sarasota and Palm Beach Counties.

Herbicide Efficacy

A variety of herbicides have been used over the past several years, but glyphosate (e.g., Roundup/Rodeo) and metsulfuron (e.g., Escort/Patriot), or a combination of the two, tend to be the herbicides of choice to date and appear to be reasonably effective, depending on the rate and method of application. Different mixes of various herbicides were used by different MA's in an effort to increase the mortality rate while considering the effects of non-target damage on native species. Efficacy varied by species, geographic location, and possibly, by soil composition. Table 2 summarizes the overall effectiveness of herbicides used in the *Lygodium* treatment projects. The interval between treatments also affected treatment results. Please note that these results are based on qualitative observations and are not the result of a quantitative study. They are, however, consistent with the results described in Hutchinson et al. (2006), Van Loan (2006), and others.

DISCUSSION

Projects funded by BIPM are required to achieve 95% mortality within 60 days of treatment or the contractor is responsible for one re-treatment of the target species as part of their contracted pay for control of the targeted species in the project area(s). Control is defined as "treatment effective in preventing re-sprout of treated target vegetation." (BIPM). The manager is responsible for following-up on the project areas to determine if the results are satisfactory, but may request a project review from BIPM. The time between follow-up treatments varies at different MA's depending on funding and staff availability. In the projects reviewed, re-treatments most frequently occurred one to three years apart and actual treatment intervals ranged between six months and five years. The *Lygodium* surveys

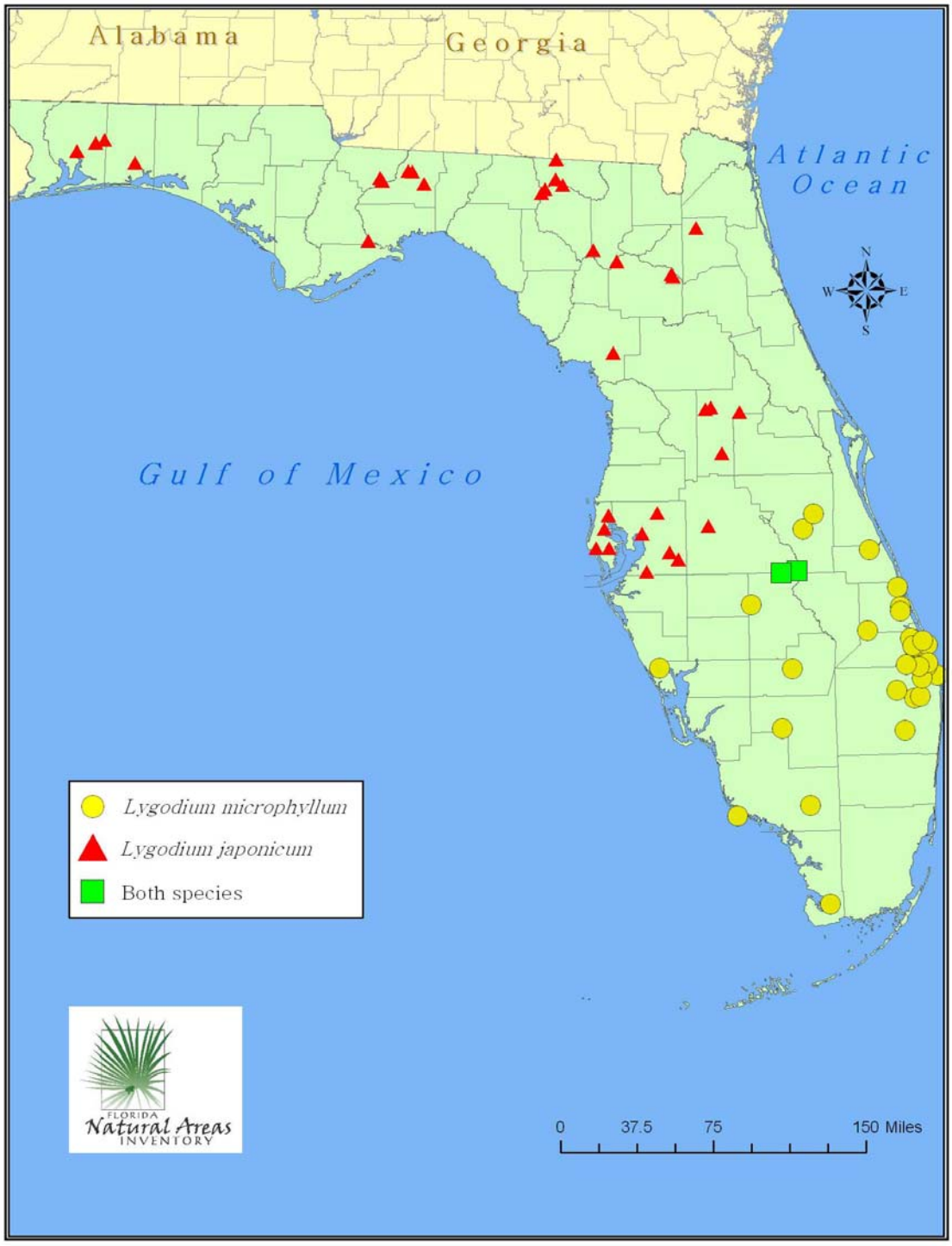

Figure 2. MA's where BIPM-funded *Lygodium* projects have taken place. Yellow depicts projects for *L. microphyllum*, red for *L. japonicum*, and green for projects where both species were treated.

Table 1. Counties with BIPM-funded *Lygodium* projects, by geographic region.

South Florida	Central Florida	North Peninsular Florida	Panhandle
Palm Beach	Highlands	Clay	Leon
Martin	Polk	Levy	Liberty
St. Lucie	Hillsborough	Columbia	Gadsen
Indian River	Pinellas	Suwannee	Walton
Collier	Sarasota	Hamilton	Okaloosa
Glades	Osceola	Madison	Santa Rosa
Hendry	Broward	Lake	
Miami Dade		Alachua	
Monroe		Lake	
Okeechobee		Alachua	

generally took place one or more years after the initial treatment, with zero to several follow-up treatments reported. Based on the information collected, the herbicide mixes that provided the best results are shown in bold in Table 2.

Treatment Efficacy

Herbicides. Much research has been performed on *L. microphyllum*, including herbicide efficacy, much of which is summarized in the *L. microphyllum* management plan (Hutchinson et al. 2006). The most effective treatment methods have been narrowed to a few select mixes, generally with the use of glyphosate and/or metsulfuron. The development of the cut frond technique, also known as "skirt" or "poodle-cut", has been widely adopted and has proven to be a very effective method when performed thoroughly. This technique is described more fully below.

Less research has been done on *L. japonicum* treatment methods. Research by Van Loan (2006) showed that use of triclopyr is not effective in the treatment of *L. japonicum*. The observations for this report concur with her results. Triclopyr generally caused top kill but regrowth was common, suggesting that the roots and rhizomes remained viable. High rates of triclopyr also resulted in lots of non-target damage. The good results from the use of the glyphosate/triclopyr mix are most likely due to the effects of glyphosate. The manager for one project described that repeated treatments with 3% Garlon 4 at six month intervals was making no progress at all in the *L. japonicum* infestation. During the *Lygodium* site visit, the area treated with triclopyr appeared more robust than usually seen six months after treatment. Van Loan's (2006) results at 12 months after treatment with triclopyr reported greater cover than before treatment, which seems to relate to this case. Use of 3% glyphosate was recommended and recent feedback from the MA reports no re-growth six months after treatment. Rhizome and shoot stimulation by repeated unsuccessful herbicide treatments should be researched further. The glyphosate rates used at most MA's for *L. japonicum* were primarily at rates lower than those shown to be most effective in the research conducted by Van Loan (2006) and Zeller and Leslie (2004). Glyphosate rates currently being used should be reviewed to ensure the best kill possible barring unique circumstances.

Table 2: Herbicide response of *Lygodium japonicum* and *L. microphyllum*, based on the rate, method of application, and significant non-target damage. Metsulfuron rates are based on ounces per 100 gallons. N/A indicates that the projects reviewed did not record this mix as being used. NTD = Non-target damage. Except where noted, results for *L. japonicum* relate to northern Florida. * represents a mix currently being used by managers.

Herbicide	**Rate**	**Method**	***L. japonicum***	***L. microphyllum***
Glyphosate (Roundup, Rodeo, Aquaneat, Aquastar, Razor)	5%	Aerial	N/A	**Good kill, NTD**
	>= 3%	Foliar	**Good kill; at 3%, some re-growth in North FL,** fair results in South FL	**Good kill, especially when "poodle cut", NTD**
	1-2%	Foliar	Browns, comes back	Reduced density
Glypro (Roundup Pro)			(same as Glyphosate)	N/A
Metsulfuron (Escort, Patriot)	1 oz	Aerial	(1 site – foliar; insufficient info)	Fair kill
	2 oz			**Good kill,** particularly in open prairies
Glyphosate/ Metsulfuron	1.5%/ 1 oz	Foliar	Reduced density, re-growth	Reduced density, some re-growth
	2%/ 1oz		Reduced density, some re--growth	**Good kill at 1.5%/ 2oz.**
	1.5%/ 2 oz		***Good kill, very little re-growth**	
	2%/ 2oz	(Aerial)	N/A	**Good kill,** follow with a burn
Glyphosate/ Triclopyr	3%/1%	Foliar	**Good kill, some re-growth**	Good kill, some re-growth at 3%/0.5%
Triclopyr (Garlon 4, Garlon 3, Tahoe)	2-3%;	Foliar	Poor - Top kill, persistent growth	
	20%		Most were dead	Good kill, some re-growth; high NTD
2,4 D (Weedar)	2%	Foliar	Reduced density, some re-growth	Reduced density, some re-growth
Glyphosate/ 2,4 D	2%/ 0.5%	Foliar	Reduced density, some re-growth	NA
Glyphosate/ Arsenal	2%/ 0.5%	Foliar	***Good kill, some re-growth**	NA
Plateau	0.25%	Foliar	Reduced density, some regrowth,NTD	NA
Grazing sheep + Glyphosate	3%	Foliar	Fair; hard to manage	NA

Aerial Herbicide Application**.** Aerial treatments have been very effective at *L. microphyllum* sites with a dense monoculture infestation, and are generally used in areas that are otherwise inaccessible and remote. While the 1 ounce/100 gallon rate of Escort (metsulfuron) had only fair results, three mixes in Table 2 applied aerially have had good results. An essential component of effective aerial treatment includes use of a precision helicopter pilot who can drop herbicide just where it is needed. Non-target damage can be a huge issue with aerial applications. In the Kissimmee River floodplain, 5% glyphosate is used during the late winter months before cypress and red maple trees leaf out. This reduces woody non-target damage and was followed by foliar application for treatment of remaining infestations with ground crews where they were accessible by airboat. The 2 ounce/100 gallon rate of metsulfuron has been successfully employed at Everglades National Park for three years. One benefit of metsulfuron is less non-target damage in general. While it stresses and may kill members of the palm plant family, there is less damage with metsulfuron than with glyphosate on other trees, shrubs and some grasses (Langeland and Link, 2006). High rates of glyphosate can leave an area sterile. If the area has a high spore bank, *L. microphyllum* may be the most competitive plant to emerge after treatment.

An innovative effort at macro bio-control was tested on *L. japonicum* in the Florida panhandle. *L. japonicum* and kudzu (*Pueraria montana* var. *lobata*) were common in an upland mixed forest adjacent to some food plots in a Wildlife Management Area. The intent was to allow sheep to graze on the invasive plants in between mechanical vine cutting and herbicide treatments, however this was difficult to manage. The sheep were effective at grazing near the edge of the forest, but proceeded to clear out about 20 years of understory growth. In addition, the mechanical cutting of vines was poorly done. Some animals got tangled, and there was speculation that *L. japonicum* spores were carried on sheep wool to initiate new *L. japonicum* populations. Plans to expand this method were abandoned.

Surfactants and Rainfasts**.** Herbicides are not the only important part of the mix. In order for the chemical to be effective, it needs to remain on the plant long enough for it to be absorbed and affect plant growth. Use of a surfactant is essential. Without it, treatment is a waste of time and money. Treatments conducted without a surfactant had a poor outcome and re-treatment was required at the expense of the contractor.

Florida is known for its high humidity and rainy days during several months of the year. Again, in order to remain effective, the use of a "rainfast" helps the herbicide stick, or adhere, to the plant. It is an inexpensive addition that can promote treatment efficacy. More research is needed to determine the degree of increased efficacy, particularly for treatment of *L. japonicum*. However a rainfast is recommended as part of the mix during times of high humidity or if there is even a chance of rain. In wetlands, care should be taken to use surfactants suitable for aquatic use.

Techniques

Cut frond method. Implementing a good technique for herbicide application is essential to achieve effective results. *L. microphyllum* is well known for its massive rachis mats and tall trellises that reach into the canopy. The cut frond or "poodle-cut" method has proven to be the most effective way to treat *L. microphyllum*. This method involves cutting all climbing

fronds at about 3-4 feet above ground, and applying a foliar spray to the leafy vegetation that remains. A good kill can be achieved by pulling the frond away from the tree that it is climbing and using a machete to slice through the fronds. Hacking away at the fronds is not productive. Because the rachis is wiry, it often bounces tools away without a cut and disperses spores on the worker. Some crews use a "go-dum stick" or "gancho" (meaning "hook" in Spanish) made from a woody branch (Figure 3). The gancho helps to pull the fronds away from the tree and yields a good handful of stems to cut. Leafy material is necessary for foliar applications to work so it is important to leave at least a small pile of leafy fronds to herbicide. Unlike with woody cut-stem treatments, timing between when a stem is cut and when the herbicide is applied is not critical. Some crews use rainy days to cut the fronds, then spray when the weather is suitable. A gap left between the upper climbing fronds and the lower cut fronds avoids providing an easy ladder for new shoots. It is also essential that cuts be thorough. All fronds must be cut for good results. Stragglers allow live plants to linger in the canopy.

Figure 3. "Gancho" or "go-dum stick" used to pull a handful of trellising *Lygodium* fronds away from trees. Photo by Chris Lockhart

Foliar application. Foliar treatment is the method of choice for low-growing *L. microphyllum* and most *L. japonicum*. While *L. japonicum* also climbs, it rarely gets into the canopy before the winter frost knocks the vegetation back in northern Florida. There is some speculation that when a roughly four to six-foot wide span of *L. japonicum* fronds is sprayed, that the herbicide translocates to any remaining leafy material climbing the tree. This concept bears further investigation.

L. japonicum typically grows less bushy when compared with *L. microphyllum*. It will, however, fill in the forest understory, climb over existing vegetation, and ascend trees in its path. *L. japonicum* continues to be a problem in pine plantations. If not treated and killed prior to the collection of pine straw, spores will initiate new populations when pine straw is used in the landscape, including MA's. *L. japonicum* sometimes has only a few fronds

sparsely climbing a tree. The stream should be adjusted on the applicator wand to match the width of the *Lygodium* populations and minimize non-target damage on adjacent vegetation when possible. If fronds extend only six to eight feet in height, balling them or cutting fronds as described above will provide better results and yield less non-target damage. Dense, climbing populations should be treated using the "poodle cut" method.

There are concerns that cutting *L. japonicum* fronds will significantly add to the cost of treating an area. However there will be savings in chemical and reduced re-treatment needed. The cost difference will vary based on site conditions and warrants further investigation.

Foliar applications are described as applying the herbicide to the point of run-off. Too lean of a spray will not apply the herbicide according to the desired rate, therefore not producing the desired results. In such cases, more money and time are spent re-treating an area than the perceived savings of stretching the materials to cover a larger area.

All of the shortfalls described above were observed at various locations and did affect the efficacy of treatment.

Spraying from sparsely to densely infested areas. A well-attended meeting of the Florida Exotic Pest Plant Council (FLEPPC) *Lygodium* Task Force meeting was held jointly with TNC and others involved in the Central Florida Lygodium Strategy during Fall 2006. One recommendation made at the meeting was to begin a sweep for *Lygodium* at the outskirts of the population, working from the lightly to densely infested areas. With this approach, there is less exposure of the crew to high concentrations of spores before they walk through adjacent uninfested areas. This approach is contrary to the method typically employed. A thorough inspection of the target area and a little beyond is also essential so that when a sweep is conducted at a later date, there are no missed populations to perpetuate the problem.

Non-target Damage

The amount of non-target damage observed was based partly on the concentration of the herbicide, technique, seasonal frost burn, and the amount of time that had passed since the last treatment was made. High concentrations of glyphosate and triclopyr were the main causes of non-target damage. The application of a broadcast spray also contributed to greater non-target damage, particularly when little attention was paid to spraying just the target plants. Non-target damage is of greatest concern near rare plant species. Use of the cut frond technique and careful herbicide application both help to minimize non-target damage.

Native Plant Recruitment

It appears that native plants from existing seed and spore sources generally were the ones that emerged in treated areas. Native plants filled in spot-treated areas within one to two years provided that the treated area was not heavily infested. Closely targeted yet thorough herbicide techniques yielded better native plant recovery than large scale broadcast foliar sprays. Application with metsulfuron left a more intact plant community and fewer sterile regions than a similar area treated with glyphosate.

Seasonal Differences
The issue of treatment as it relates to the season seems to be more of an issue with *L. japonicum* than *L. microphyllum*. *L. microphyllum* is reproductive most of the year but spores more heavily in the summer and fall months (Ferriter 2001, Lott et al. 2003). Because *L. japonicum* grows mostly in areas that experience winter frost or freeze damage, it is important to treat this species when it is actively growing.

One of the keys to effective *Lygodium* management is to interrupt the reproductive cycle. As such, if field crews can treat while the ferns are growing, but before their prime spore production, there should be less spore dispersal and fewer new plants after treatment. Timing can be difficult because some areas are inaccessible outside the dry season, and some funding cycles often do not allow contracts to be implemented until September or October of the fiscal year, when *L. japonicum* is the most reproductive in northern Florida. Assuming that *L. japonicum* continues to move further south into the sub-tropical region of the state, it can remain evergreen year round (Lott 2003) and will produce mature spores earlier in the year (Lockhart, C, pers. obs.).

During periods of stress, whether drought or cold, less herbicide may be taken up by the fern and reduce herbicide efficacy. Some contractors will apply a slightly stronger mix during periods of less active growth.

Prescribed Burns, Treatment Intervals, and Integrated Pest Management
Prescribed burns are an important tool in managing *Lygodium* and breaking the reproductive cycle of either species. Burns of dead stems clear the understory, provide an open area for native plant recruitment, and make it easier to spot new or re-growing ferns. Dead ferns contain fewer viable spores (Burks, K, pers. comm.). The best strategy seems to be a sequence of: herbicide, burn, and retreat before the fern becomes reproductive. Some spores may drift in the smoke draft, but cutting and treating fronds prior to burning will reduce the risk of canopy damage from flames trellising up live *Lygodium* stems and the risk of spot fires (Roberts 1997; Burks, K; Roberts, R; and Griffiths, F, pers. comm.).

Palm Beach County afforded numerous examples of a systematic re-treatment schedule and integrated pest management. Palm Beach County Environmental Resource Management incorporates cut frond and foliar applications on *L. microphyllum* with prescribed burns in appropriate habitats, and is one of the good models for repeated treatments that cause a reduction not only in density but also of the infested area. The initial treatment of 3% glyphosate plus surfactant is followed by re-treatment at six month intervals where the infestation is accessible. Once the infestation is more manageable, re-treatment becomes an annual event.

The implementation of both aerial and ground treatments as in the Kissimmee River floodplain for difficult access areas has proven more effective than aerial treatments alone. This approach can be used to push the outlying populations back and reduce exposure to adjacent conservation lands.

A good case study for *L. japonicum* is the Suwannee River Water Management District, whose two-stage treatment starting with a 1.5% glyphosate / 2 oz. per acre Escort was followed at 12 and 24 months with 4% glyphosate with excellent results.

Coordination of Evaluation Efforts

The Spring 2006 issue of Wildland Weeds represented information from various agencies, including FNAI, and was devoted to current issues on either species of *Lygodium*. FNAI has supported the Central Florida Lygodium Strategy by participating in the multi-agency effort to coordinate serial reconnaissance flights with ground-truthing efforts to determine the northern extent of the *L. microphyllum* infestation (Serbesoff-King, 2006). When available, information is shared regarding potential treatment areas with TNC for their "Lygo No-Go" zone. Andrea Van Loan (DOF) and Chris Lockhart (FNAI) have been charged with an action item to develop a management plan for *L. japonicum*. University of Florida, Center for Invasive and Aquatic Plants, South Florida Water Management District and TNC completed the second edition of Old World Climbing Fern Management Plan and FNAI provided an Appendix to reflect related information for *L. japonicum*.

Geographic Differences in Results

A private property in Palm Beach County (not a BIPM treatment site) where both *Lygodium* species were discovered in 2005 has provided an interesting case study. Three large patches of trellising *L. microphyllum* were growing in cypress heads, approximately one half to one acre each. In addition, scattered *L. japonicum* plants were found across roughly one-third of an acre near a drainage ditch and along a boundary fenceline. Both were treated using a mix of 1.5 % glyphosate and 2 oz/ 100 gallons Escort, with Timberland 90 as surfactant and Nufilm IR as a rainfast. The site was revisited at roughly six month intervals, and remaining *L. japonicum* plants were sprayed with 4 to 5% Rodeo with surfactant to the point of runoff. Eighteen months after just one treatment, there are only a small handful of small *L. microphyllum* plants emerging from the thick, dead rachis mats. The *L. japonicum*, on the other hand, browned back but remains persistent despite three treatments, and appears to be emerging slightly fuller as time progresses – reminiscent of how shrubs branch out after trimming. The rhizome appeared to be more robust than usually seen in northern Florida (Figure 4), and the overall herbicide response for the southern *L. japonicum* population differed from northern populations.

Effects of Salinity, Soil, and Other Factors

L. microphyllum can be found growing in freshwater wetlands to estuarine areas. The concentration of salt in the water may account for the reduced growth rate of *L. microphyllum* at Cape Sable, Everglades National Park. In Palm Beach and Martin counties, *L. microphyllum* did not breach the Atlantic Intracoastal Waterway. *L. microphyllum* was found growing near white mangroves (*Laguncularia racemosa*) and over giant leather fern (*Acrostichum danaeifolium*) prior to treatment. Heavy salt spray from Hurricanes Frances and Jeanne made it difficult to determine if a large, mostly sterile area at Hobe Sound National Wildlife Refuge was a result of non-target damage or salt exposure.

Figure 4. One *L. japonicum* rhizome from Palm Beach County after three herbicide treatments compared with the typical *L. microphyllum* rhizome mat on the right.
Photos by Chris Lockhart

The effects of soil appear to play a role in the distribution of *L. japonicum*. In addition to the differences described between north and south Florida populations, *L. japonicum* is often found in sink holes, along limestone river banks, and can be very problematic in old borrow pits. This is consistent with Van Loan's findings (2006) that there is a correlation between *L. japonicum* and calcium in the soil. Soil pH may also play a role in growth differences.

Phytosanitary Practices

Hutchinson's article on the spread of *L. microphyllum* spores by herbicide applicators (2006) points out an important element in *Lygodium* control: good sanitation practices. Equipment used for mowing, disking fire breaks and herbicide control, and workers' clothing are all potential vectors in the spread of *Lygodium* and have been identified by land managers as potential sources of *Lygodium* expansion. Adoption of a "Come clean, leave clean" or phytosanitary rule is in effect at some MA's but managers sometimes have difficulty finding contractors willing to comply. A statewide contract requirement would help to alleviate this issue. Until such a system can be established, land managers can include specifications in their weed control scopes of work. A designated cleaning station with a source of water and/or compressed air would also be needed for use by various types of contractor and staff equipment used for mowing, fire break management and herbicide control that may work in infested areas.

SUMMARY

The *Lygodium* site evaluation project has accomplished its goals (e.g., provide a large enough sample size to glean some information regarding treatment methods). The project has also revealed some gaps in information and the need for further research, particularly with respect to *L. japonicum*. Both species are serious problems and warrant a concerted effort to stay on top of known infestations. In addition, monitoring efforts, such as the serial reconnaissance flights have proven very valuable in locating populations, particularly in remote areas. Other efforts involving satellite imagery and regular field monitoring are all important tools in seeking out new or persistent infestations.

Defining effective treatment methods for *L. microphyllum* has been much more aggressive in southern Florida. The treatments in place appear to be effective when used properly. The limiting factors tend to be staffing and funding, which generally translates to the frequency in which infestations are re-treated.

Recent research for *L. japonicum* shows promise in northern Florida but more research for this species is needed. Because rhizomes appear to grow thicker in southern Florida, the same mix used on both species can provide effective kill for *L. microphyllum*, but have limited effect on *L. japonicum*. Few MA's use rates shown to maintain a high level of mortality 12 months after treatment, yet this is the most commonly reported treatment interval.

Repeated treatments are a critical necessity for both species. Progress can be measured by a reduction in density even if the infested acreage changes little. Progress has also been described as achieving a maintenance level. With the spores in the air over large portions of the state, maintenance will remain a long term necessity.

General recommendations for treatment and research ideas follow.

General Treatment Recommendations

1. Breaking the reproductive cycle is the key to control. Conduct follow-up treatments within six to 12 months after treatment to break it.
2. Use the cut frond technique for *L. microphyllum* and *L. japonicum* where fronds climb tall into the trees (e.g., over six or eight feet). Reducing the height of spore production should reduce the distance that spores will travel.
3. Use the cut frond technique for either species in sensitive areas.
4. Apply herbicides thoroughly.
5. Always use a surfactant. Use a rainfast on days of high humidity or if the forecast indicates that there may be rain. Boosting efficacy is worth the small expense.
6. Inspect the treatment area thoroughly, not just near the dense infestation.
7. Work an area from the less-infested outskirts toward the dense areas.
8. Employ phyto-sanitary practices: have clean vehicles, equipment, and clothing before entering or leaving a new MA. A designated cleaning station would be needed and source of water and/or compressed air for contractors to use. A designated staff or intern could assist with the process to ensure cleaning consistency. Don't be a vector.
9. Keep some herbicide mix handy. Carry a small herbicide bottle and a pair of hand clippers when visiting remote areas to clip and treat small populations or single climbing stragglers that persist.
10. Coordinating herbicide treatments after controlled burns should improve treatment results while maintaining low non-target damage, particularly if plants are treated before they become reproductive.
11. Coordinate aerial and ground treatments whenever possible, even along floodplain and remote areas in an attempt to eradicate outlying populations and reduce the risk of exposure to adjacent conservation lands.

12. Work with neighboring property owners, whether private property, public rights-of-way, etc., to reduce the exposure of infestations along the edges of MA's.
13. Collaborate with TNC's efforts to treat outlier populations of either species on private lands at their farthest extent statewide through the Central Florida *Lygodium* Strategy.

Research Ideas

1. Determine if translocation occurs to upper *L. japonicum* fronds during foliar treatment with glyphosate and/or metsulfuron.
2. Compare the effects of glyphosate and metsulfuron on *L. japonicum* at different rates in areas with clay versus sandy soil, and alkaline versus acidic soils.
3. Run herbicide trials on *L. japonicum* at 2% glyphosate + 2 oz. metsulfuron; compare with 3% and 4% glyphosate and perhaps other mixes, such as 2% glyphosate + 0.5% Arsenal + surfactant + rainfast sticker that can also be used on cogon grass (*Imperata cylindrica*).
4. Examine changes in rhizome growth or atrophy after herbicide application (six months, 12 months) for both *Lygodium* species.
5. Examine the effects of soil pH, calcium and phosphate levels on the growth rate of *L. microphyllum* and *L. japonicum*
6. Use different case scenarios to determine the cost differences between a foliar spray alone versus cut frond/herbicide application, particularly for *L. japonicum*.
7. Compare seasonal spore production of *L. japonicum* between south-central and north Florida.
8. Examine the use of phytochemicals, metabolic pathways, and non-competitive enzymes on either species.
9. Study the integrated pest management use of fire with herbicide treatments (pre- or post-burn or both) for both species.
10. Examine the cost, benefits, and short or long-term impacts of applying pre-emergent chemicals.

REFERENCES

Ferriter, A., editor. 2001. *Lygodium* Management Plan for Florida, a report from the Florida Exotic Pest Plant Council's *Lygodium* Task Force. West Palm Beach, FL: South Florida Water Management District. 59 p.

Ferriter, A. and Pernas, T. 2006. An explosion in slow motion: tracking the spread of *Lygodium microphyllum* in Florida. Wildland Weeds 9:7–9.

Hutchinson, J.T., A. Ferriter, K. Serbesoff-King, K. Langeland, and L. Rodgers. 2006. Old World climbing fern management plan for Florida: A report from the Florida Exotic Pest Plant Council's *Lygodium* Task Force. Second Edition. West Palm Beach, FL: Florida Exotic Pest Plant Council *Lygodium* Task Force. 109 p.

Hutchinson, J.T. 2006. Potential spread of *Lygodium microphyllum* spores by herbicide applicators. Wildland Weeds 9:23-24.

Langeland, K.A., and M.Link. 2006. Evaluation of metsulfuron methyl for selective control of *Lygodium microphyllum* in association with *Panicum hemitomon* and *Cladium jamaicensis*. Florida Scientist 69:149-156.

Lott, M. S.,J. C. Volin, R.W. Pemberton, and D. F. Austin. 2003. The reproductive biology of the invasive ferns *Lygodium microphyllum* and *L. japonicum* (Schizaeaceae): implications for invasive potential. Am. J. Bot. 90:1144–1152.

Roberts, D. 1997. *Lygodium microphyllum* research and mitigation at Jonathan Dickinson State Park. Florida Department of Environmental Protection Resource Management Notes 9:30–32.

Serbesoff-King, K. 2006. Central Florida *Lygodium* Strategy: A Regional Approach. Wildland Weeds 9: 18-21.

Van Loan, A.N. 2006. Aspects of the invasion and management of Japanese climbing fern (*Lygodium japonicum*) in southeastern forests. Master's Thesis. University of Florida, Gainesville, Florida.

Wildland Weeds. 2006. Spring 2006, Vol.9. Florida Exotic Pest Plant Council and the Southweast Exotic Pest Plant Council.

Zeller, M. and D. Leslie. 2004. Japanese climbing fern controls in planted pine. Wildland Weeds 7:6–9.

Appendix A. *Lygodium* Site Evaluation Projects: The projects listed below are a combination of those on the original list plus others added as information became available. (Refer to the "Added" column.) If multiple managed areas were treated under a single Task ID, the Project# will not change. Projects reviewed, where *Lygodium* was not treated or was treated without BIPM funds, are shaded in grey.

Project #	Project Name	Fiscal Year	Task ID	County	MA Name	Added ?	Comments	Visit Date	Report done	Infest Acres	Agency
1	Triple N Ranch	2003-2004	EC-026	Osceola	Triple N Ranch WMA			March-05	X	15	DRP
2	Three Lakes WMA Lygodium Control	2003-2004	EC-032	Osceola	Three Lakes WMA			March-05	X	8	FWS, SFWMD
3	Carson Tract St Sebastian SBP	2000-2001	MR-003	Brevard	St. Sebastian R Pres SP			March-05	X	120.00	CAMA, DRP
4	Jennings State Forest	2000-2001	NE-008	Clay	Jennings State Forest			August-05	X	150.00	DOF, City
5	Jennings State Forest	2001-2002	NE-011	Clay	Jennings State Forest			August-05	X	33	DRP
6	Jennings State Forest	2004-2005	NE-033	Clay	Jennings State Forest			August-05	X		
7	Alligator Lake	1999-2000	NE-005	Columbia	Alligator Lake	X		September-05	X		
8	O'Leno River State Park	2001-2002	NE-009	Columbia	O'Leno River&River Rise SP			October-05	X	12.8	County
9	Suwannee River State Park And SRWMD Lygodium Project	2001-2002	NE-014	Hamilton	Suwannee River SP & SRWMD			September-06	X	7.5	DRP
10	Multiple site-Twin R.	1999-2000	NE-004	Madison	Holton Creek Conservation Area		Multiple sites	November-06	X		
	Multiple site-Twin R.	1999-2000	NE-005	Hamilton	Lower Alapaha Conservation Area			November-06	X		
11	Twin Rivers State Forest	2001-2002	NE-010	Madison	Twin Rivers State Forest			September-06	X	7.07	USFWS
12	Twin Rivers State Park	2002-2003	NE-015	Madison	Twin Rivers State Forest			September-06	X	15	DOF
13	Northeast Region Joint Lygodium Project	2002-2003	NE-016	Hamilton, Madison, Suwannee	Multiple sites		river banks	April-07	X	50	USFWS
14	Suwanee River WMD Leonhardt & Lake Alto Parcels	2004-2005	NE-019	Alachua	Lake Alto	X		November-06	X	50	USFWS
	Suwanee River WMD Leonhardt & Lake Alto Parcels	2004-2005	NE-019	Hamilton	Leonhardt Tract			-	X	50	USFWS
15	Ichetucknee Springs State Park	1999-2000	NE-006	Suwannee	Ichetucknee Springs SP			September-05	X	16.40	DRP
16	Ichetucknee Springs State Park	2000-2001	RP-016	Suwannee	Ichetucknee Springs SP			September-05	X	50.00	DRP
17	Suwannee River State Park	2000-2001	RP-018	Suwannee	Suwannee River SP			September-06	X	24.00	DRP, Co.

Project #	Project Name	Fiscal Year	Task ID	County	MA Name	Added ?	Comments	Visit Date	Report done	Infest Acres	Agency
18	Big Cypress National Preserve	2003-2004	NP-034	Collier	Big Cypress National Preserve	X	too few to find	-	NA		
	Everglades National Park Aerial Lygodium Control	2003-2004	NP-033	Collier	Big Cypress National Preserve	X		April-06	X	10.00	
19	Everglades National Park Aerial Lygodium Control	2003-2004	NP-033	Miami-Dade	Everglades National Park			March-07	X	800	DOF
20	Elinor Klapp Phipps	1999-2000	PH-004	Leon	Elinor Klapp Phipps			September-06	X	111.00	WMD
21	JR Alford Greenway	2002-2003	PH-019	Leon	JR Alford Greenway			October-06	X	215.2	City
	JR Alford Greenway Kudzu	2002-2003	PH-019	Leon	JR Alford Greenway			October-06	X	22	County
22	Lake Jackson Mounds	2000-2001	PH-011	Leon	Lake Jackson Mounds SP			-	NA	70.00	CAMA
23	Lake Talquin State Lands	2001-2002	PH-014	Gadsden, Leon	Lake Talquin State Forest			October-06	X	35	DOF
23	Lake Talquin State Lands	2001-2002	PH-014	Gadsden, Leon	Joe Budd WMA			October-06	X	35	DOF
23	Lake Talquin State Lands	2001-2002	PH-014	Gadsden, Leon	Lake Talquin State Park			October-06	X	35	DOF
24	Maclay Gardens SP	2001-2002	PH-013	Leon	Maclay Gardens SP	X		November-05	X		DRP
25	Maclay Gardens SP	2002-2003	PH-024	Leon	Maclay Gardens SP	X		November-05	X		DRP
26	Maclay Gardens SP	2003-2004	PH-033	Leon	Maclay Gardens SP	X		November-05	X		DRP
27	Maclay Gardens SP	2004-2005	PH-036	Leon	Maclay Gardens SP	X	partial survey	November-05	X		DRP
28	Miccosukee Greenway	2002-2003	PH-0017	Leon	Miccosukee Greenway			-	NA	317	FWC
29	Rocky Comfort -- Joe Budd - Talquin State Forest	2000-2001	PH-0010	Gadsden, Leon	Joe Budd WMA			Oct, Nov 06	X	76.00	FWC, Co.
30	Florida River Island, WMD Site	2003-2004	PH-0025	Liberty	Florida River Island, WMD			Aug, Oct-05	X	200	Co., SFWMD
31	Blackwater River State Forest	2002-2003	PH-0018	Okaloosa, Santa Rosa	Blackwater River SF			November-05	X	152	County
32	Blackwater River State Forest	2003-2004	PH-0028	Okaloosa, Santa Rosa	Blackwater River SF			November-05	X	83	Co., SFWMD
33	Blackwater River State Forest	2004-2005	PH-033	Okaloosa, Santa Rosa	Blackwater River SF	X		November-05	X		
34	Blackwater River State Park & Heritage Trail Maintenance	2003-2004	PH-0027	Santa Rosa	Blackwater Heritage State Trail	X		October-05	X		
35	Blackwater River State Park & Heritage Trail Maintenance	2003-2004	PH-0027	Santa Rosa	Blackwater River SP			October-05	X	103	CAMA
36	Eglin Air Force Base Parcel 2	2000-2001	PH-0005	Santa Rosa	Eglin AFB			October-05	X	32.00	USAF, DRP

Project #	Project Name	Fiscal Year	Task ID	County	MA Name	Added ?	Comments	Visit Date	Report done	Infest Acres	Agency
37	Eglin AFB	2001-2002	PH-0012	Santa Rosa	Eglin AFB			October-05	X	127	DRP
38	Eglin AFB	2002-2003	PH-0016	Santa Rosa	Eglin AFB			October-05	X	40	City
39	Eglin AFB Santa Rosa Island & Archery Range	2003-2004	PH-0026	Santa Rosa	Eglin AFB			October-05	X	18	CAMA
40	Eglin AFB	2004-2005	PH-031	Santa Rosa	Eglin AFB	X		October-05	X		DOD
41	Alafia River Corridor	1999-2000	SC-005	Hillsborough	Alafia River Corridor			January-05	X	80	County
42	Alafia River Phase II, III and IV Completion	2003-2004	SC-052	Hillsborough	Alafia River Corridor			February-05	X	300	CAMA
43	Alafia River Phase II, III, IV	2002-2003	SC-030	Hillsborough	Alafia River Corridor			March-05	X	300	DOF
44	Alafia River State Park	2003-2004	SC-047	Hillsborough	Alafia River SP			February-05	X	250	County
45	Hillsborough River State Park	2000-2001	RP-019	Hillsborough	Hillsborough R SP			February-05	X	53.27	DRP, FWS
46	Hillsborough River State Park	2001-2002	SC-025	Hillsborough	Hillsborough R SP			February-05	X	111	DRP
47	Hillsborough River State Park Maintenance	2003-2004	SC-051	Hillsborough	Hillsborough R SP			February-05	X	100	FWC, SFWMD
48	Little Manatee River State Park	2003-2004	SC-046	Hillsborough	Little Manatee R SP			January-05	X	93	Co., SFWMD
49	Brooker Creek Preserve	1999-2000	SC-003	Pinellas	Brooker Cr. Preserve	X		April-05	X		
50	Brooker Creek Preserve	2002-2003	SC-028	Pinellas	Brooker Cr. Preserve			April-05	X	95	City
51	Lake Seminole Park	2003-2004	SC-048	Pinellas	Lake Seminole Park			-	NA	97	DRP
52	McKay Greenway	2004-2005	SC-058	Pinellas	McKay Greenway	X		April-05	X		
53	Sawgrass Lake Park	2002-2003	SC-015	Pinellas	Sawgrass Lake Park			April-05	X	82	City
54	Myakka State Forest	2002-2003	SC-018	Sarasota	Myakka State Forest			April-05	X	1457	DRP
55	Hobe Sound NWR	1998-1999	SE-002	Martin	Hobe Sound NWR			March-05	X	20.00	USFWS
56	South Dade Wetlands EEL	2001-2002	SE-026	Miami-Dade	South Dade Wetlands EEL			-	NA	28.00	DRP
57	Corbett WMA And Hungryland WMA Aerial Treatment For Lygodium Microphyllum	2003-2004	SE-068	Palm Beach	Corbett WMA			March-06	X	1000	DRP
58	Corbett-DuPuis Areas	1999-2000	SE-006	Palm Beach	Corbett WMA			March-06	X	300.00	WMD
59	Fox Natural Area	2000-2001	SE-016	Palm Beach	Pond Cypress NA			July-06	X	#####	Co., DRP
60	Juno Dunes Natural Area	2001-2002	SE-029	Palm Beach	Juno Dunes NA			July-05	X	105	CAMA
61	Loxahatchee	1998-1999	SE-003	Palm Beach	Arthur R. Marshall Loxahatchee NWR			March-05	X	309.00	USFWS
62	Loxahatchee	1998-1999	SE-005	Palm Beach	Arthur R. Marshall Loxahatchee NWR			March-05	X	11.50	DRP

Project #	Project Name	Fiscal Year	Task ID	County	MA Name	Added ?	Comments	Visit Date	Report done	Infest Acres	Agency
63	Loxahatchee NWR Retreat 1999 Islands	2000-2001	SE-008	Palm Beach	Arthur R. Marshall Loxahatchee NWR			March-05	X	309.00	FWS, CAMA
64	Loxahatchee NWR Retreat 1999 Islands	2000-2001	SE-010	Palm Beach	Arthur R. Marshall Loxahatchee NWR			March-05	X	400.00	FWS, Co.
65	Loxahatchee Slough Natural Area SW	2001-2002	SE-019	Palm Beach	Loxahatchee Slough NA		partial, too wet	June-05	X	300	CAMA
66	Loxahatchee Slough North East Flatwoods	2003-2004	SE-063	Palm Beach	Loxahatchee Slough NA	X		June'05, Mar'06	X		
67	Loxahatchee Slough North East Portion	2002-2003	SE-039	Palm Beach	Loxahatchee Slough NA			Mar, Apr-06	X	416	County
68	Loxahatchee Slough Northeastern Flatwoods	2003-2004	SE-070	Palm Beach	Loxahatchee Slough NA			Mar, Apr-06	X	793	DOF
69	Loxahatchee Slough Southeast	2002-2003	SE-041	Palm Beach	Loxahatchee Slough NA			Mar, Apr-06	X	454	County
70	Non-melaleuca Projects SFWMD	2001-2002	SE-030	Palm Beach	Fisheating Creek, Kissimmee River		see WC projects	-	NA	1500	DRP
71	North Jupiter Flatwoods Natural Area	2001-2002	SE-024	Palm Beach	North Jupiter Flatwoods NA			June-05	X	118.7	CAMA
72	Palm Beach Co Lox	1998-1999	SE-001	Palm Beach	Loxahatchee River NA			June-05	X	180.00	USFWS
73	Pond Cypress Natural Area (Fox Natural Area)	2001-2002	SE-028	Palm Beach	Pond Cypress NA			July-06	X	438	CAMA
74	Royal Palm Beach Pines Natural Area	1999-2000	SE-0865	Palm Beach	Royal Palm Bch Pines NA			October-06	X	150.00	COUNTY
75	SFWMD Non-Melaleuca Projects -- Alapata Ground; Kiss R Lygo Aerial; Hungryland	2002-2003	SE-043	Palm Beach	Kissimmee River floodplain region		partial	March-06	X	800	DRP
76	Faka Union Canal Rookery Bay TTI	2001-2002	SW-020	Collier	Rookery Bay NERR		Islands-No Lygo treated	-	NA	80.00	County
77	Faka Union Canal Rookery Bay TTI	2002-2003	SW-031	Collier	Rookery Bay NERR			February-07	X	90	DRP
78	Atlantic Ridge State Park	2002-2003	TC-035	Martin	Atlantic Ridge SP		see below*	-	NA	65	DRP
79	Danforth Invasives Project	2000-2001	TC-015	Martin	Danforth Park			October-06	X	27	Co., USFWS
80	JDSP-Loxahatchee River Exotics Removal	2002-2003	RP-026	Martin	Jonathan Dickinson SP		License plate funds-not BIPM	-	NA	265.7	County
81	Jonathan Dickinson SP	2003-2004	TC-048	Martin	Jonathan Dickinson SP			Feb, Apr-06	X	200	DRP, SFWMD
82	Jonathan Dickinson State Park	1999-2000	TC-005	Martin	Jonathan Dickinson SP			July, Sep-05	X	147.00	DRP
83	Jonathan Dickinson State Park Northwest Section	2003-2004	TC-053	Martin	Jonathan Dickinson SP			July, Sep-05	X	858	County

Project #	Project Name	Fiscal Year	Task ID	County	MA Name	Added ?	Comments	Visit Date	Report done	Infest Acres	Agency
84	NW Sections Jonathan Dickinson State Park	2002-2003	TC-036	Martin	Jonathan Dickinson SP			July, Sep-05	X	417	City
85	Jonathan Dickinson SP	2004-2005	TC-059	Martin	Jonathan Dickinson SP	X	partial survey	July, Sep-05	X		DRP
86	Seabranch Preserve SP	2003-2004	TC-049	Martin	Seabranch Preserve SP			December-07	X	142	DRP
87	Hungryland Wildlife And Environmental Area	2003-2004	TC-054	Palm Beach	Jones/Hungryland WEA			January-06	X	130	DRP
88	Hungryland WMA	2002-2003	TC-037	Palm Beach	Jones/Hungryland WEA			January-06	X	7	County
89	Bluefield Natural Area	2003-2004	TC-052	St. Lucie	Bluefield Natural Area			February-06	X	196	DRP
90	Indrio Savannahs Natural Area	2003-2004	TC-056	St. Lucie	Indrio Savannahs NA			August-06	X	5.2	DRP
91	North Fork St	1998-1999	TC-004	St. Lucie	N Fork St Lucie R BPSP			August-05	X	11.15	CAMA
92	North Fork St	1998-1999	TC-004	St. Lucie	Idabelle Island			February-06	X		County
93	North Fork St Lucie River SBP	2003-2004	TC-055	St. Lucie	N Fork St Lucie R BPSP			August-05	X	77	DRP
94	North Fork St Lucie River SBP Parcels 1,2,3	2002-2003	TC-038	St. Lucie	N Fork St Lucie R BPSP			August-05	X	128	County
95	South Fork St. Lucie River	1999-2000	TC-008	Martin	South Fork St. Lucie River			Aug, Sep-06	X		
96	South Fork St. Lucie River	2003-2004	TC-051	Martin	South Fork St. Lucie River			Aug, Sep-06	X		
	Non-melaleuca Projects SFWMD	2001-2002	WC-007	Glades	Fisheating Creek WMA			April-06	X		
97	Fisheating Creek WMA	2003-2004	WC-024	Glades	Fisheating Creek WMA		only TSA on DPR forms	April-06	NA	14954	FWC, SFWMD
98	Fisheating Creek WMA	2003-2004	WC-032	Glades	Fisheating Creek WMA	X		April-06	X		
99	OK Slough Exotic Plant Maintenance	2003-2004	WC-028	Hendry	OK Slough WMA		Plants gone	-	NA	5000	DRP
100	Avon Park AF	1998-1999	WC-001	Highlands	Avon Park AFR			April-05	X	68.10	DRP
101	Avon Park AFR Lygodium Control	2003-2004	WC-029	Highlands	Avon Park AFR			April-05	X	498	County
102	Avon Park Air Force Range	2002-2003	WC-016	Highlands	Avon Park AFR			April-05	X	196	County
103	Avon Parl Air Force Range	2001-2002	WC-006	Highlands	Avon Park AFR			April-05	X	55	CAMA
104	Highlands Hammock State Park	2003-2004	WC-030	Highlands	Highlands Hammock SP			February-05	X	6	DRP
105	LCWA Wolf Branch	2002-2003	WC-015	Lake	Bourlay Historic Nature Pk			July-05	X	115	County
	LCWA Wolf Branch	2002-2003	WC-015	Lake	Crooked R Preserve			July-05	X		
	LCWA Wolf Branch	2002-2003	WC-015	Lake	Sabal Bluff Preserve			July-05	X		
	LCWA Wolf Branch	2002-2003	WC-015	Lake	Wolf Branch Sink Pr.			July-05	X		

Project #	Project Name	Fiscal Year	Task ID	County	MA Name	Added ?	Comments	Visit Date	Report done	Infest Acres	Agency
106	Non-melaleuca Projects SFWMD	2001-2002	WC-008	Okeechobee, Osceola, Polk	Kissimmee River floodplain region	X	aerial	March-05	X		
	SFWMD Non-Melaleuca Projects -- Alapata Ground; Kiss R Lygo Aerial; Hungryland	2004-2005	WC-065	Okeechobee, Osceola, Polk	Kissimmee River floodplain region			March-05	X		
107	Circle B Bar Reserve	2003-2004	WC-027	Polk	Circle B Bar Reserve			-	NA	650	County
108	Goethe State Forest	2001-2002	WR-027	Levy	Goethe State Forest			September-05	X	60.2	WMD
109	Goethe State Forest	2002-2003	WR-039	Levy	Goethe State Forest			September-05	X	26.7	County

Appendix B. Lygodium Survey Evaluation Forms

FLORIDA NATURAL AREAS INVENTORY
LYGODIUM SPECIES PRE-VISIT CHECKLIST AND SITE INFORMATION

Management Area _____ County _____

Site Name _____ Task ID# _____

1. Lygo density @ initial trt _____
2. Estimated initial acreage infested by L. microphyllum _____ ; infested by L. japonicum _____
3. Date of initial trt: _____ ; Time lapse: _____ ; Acres worked for initial trt _____
4. a. Number of follow-up trts _____ ; b. Frequency of follow-up treatments _____

Application Method	Date	Herbicide used	Rate	Surfactant	Rate	Acres
	Recommended per SOW					

5. Mechanical methods used? ___ Describe_____ 5B. Contractor _____
6. Biological control methods introduced? ____ Describe _____ 6B. Satisfied? Y N
7. Most recent follow-up treatment? _____ Time lapse: _____

   By (circle): staff contractor
8. Contact Site Manager _____
9. Previous contacts made (circle): Y N If yes, by whom? _____
10. Convenient date(s) and hours: _____
11. Is a specific staff designated for invasive plant / Lygodium removal efforts? Y N
12. Staff available on day of site visit? (circle): Y N If yes, by whom? _____
13. Key needed to access treatment area? (circle): Y N
14. Permission slip required? (circle): Y N Comments_____
15. ATV needed? _____ ; Condition of access roads: Paved? ___ Need 4WD? ___
16. Directions:
17. Recommendations on place to stay:

Casual Field Questions:

18. Any differences noticed when treated in different seasons?
19. Any vines pulled down? Y N If yes, (circle) when Dead or Green?

    Rachis mats removed? Y N Spray only? Y N
21. Was removed material left in place or transported off-site? Y N

    If transported, was material bagged or otherwise contained? Y N

22. Observed any new infestations (check)? __ new area; ___ near equipment storage; ___ along trt access roads

23. Vehicle and staff sanitation practices in place, if any? e.g., ___ change external clothing before moving to uninfested area; ___ hose down tires before moving into uninfested area; ___ Other

    Other _____

FLORIDA NATURAL AREAS INVENTORY

LYGODIUM SPECIES SITE EVALUATION FORM

[Set GPS "Datum" to WGS84. Set lat/long form to "decimal degrees."]

Date: _____ **Observer(s)**: _____
Cons. Land (Managed Area):_____ **County**_____
Contact Person(s): _____ **Task ID#**: _____

1. Unit/Area being surveyed: _____ **2. Multiple Data sheets**? (Circle) Y N _____
How many?

3. Which species present? (check all that apply) __ *L. japonicum* __ *L. microphyllum*
If both are present, use separate evaluation sheet for each sp., and **circle species evaluated on this sheet**.
Note: For this form, **Lyja** is the preferred abbreviation for L. japonicum; **Lymi** – for L. microphyllum

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4. Occurrence I.D. (referring to waypoint(s) or polygon)**:** _____
Series GPS (for polygon, as needed):

ID#	LAT -N	LONG -W	Notes

ID#	LAT -N	LONG -W	Notes

5. Natural Community Type Infested:

Check one community type below if it is fairly contiguous, and complete the table below for that area. Check more than one ONLY IF IT IS A MOSAIC. If the site has multiple community types, complete separate table for each community type, and record multiple sheets (above) (more tables on the last page, if needed).

NATURAL COMMUNITY (check one, unless mosaic)**	**NON-TARGET DAMAGE*1 (check all that apply)**	**SIGNS OF OTHER PAST DISTURBANCES (check all that apply)**	**FIRE STATUS (check/fill-in applicable info)**	**SIGNS OF RECOVERY (check all that apply)**
__ Basin Wetlands __ Coastal Uplands __ Floodplain Wetlnds __ Highly Disturbed __ Lake __ Marine, Estuarine __ Mesic Flatlands __ Mesic Uplands	Dead plants in: __Groundcover __Shrubs __Trees __Epiphytes __ None observed	__ Hog rooting __ Tilling __ Trash dumping __ Logging __ Clearing __ Other (describe) _____	__ Needed __ Not needed Time since last burn _____ __ Not applicable	Native: __ Seed bank releases __ Recruits of dominant comm. species present Species observed (list):
__ Rocklands __ Seepage Wetlands __ Streams, Rivers __ Wet Flatlands __ Xeric Flatlands ~ ~ ~ __ Mosaic	**LEVEL OF DAMAGE*2** __ a. Small / possible __ b. Small / definite __ c. Noticeable / Scattered __ d. Significant	**STANDING H_20 IN TRT AREA?** __ Present __ None observed	Other observations:	**HABITAT QUALITY (Note disturbances, especially of soil)** __ Excellent __ Good __ Fair __ Poor

*1. Damage not likely caused by storms, fire, or other natural events
*2. a. = rare, questionable dead spots; b. = few, small brown patches; c. several large dead spots; d. many dead zones / dead trees common in treatment areas / numerous melted epiphytes, etc.

** BW = marsh, swamp, bog, depression, dome; CU = dune, strand, rock barren, mound, maritime hammock; FW = bottomland, marsh, swamp, slough, swale, strand; HD = ROWs, old fields, pastures, pine plantations; LK = lake; ME = marine, estuarine; MF = mesic/scrubby flatwoods, dry prairie, prairie hammock; MU = bluffs/slope hammock, glade, mixed pine/hardwood, high pine; RL = pine, hammock, sinkhole rocklands; SW = baygall, seepage slope; SR = Streams, rivers; WF = wet flatwoods, marl/wet prairie, hydric hammock; XU = sandhiill, scrub, xeric hammock.

6. Lygodium info (Lyja = L. japonicum; Limi = L. microphyllum)

Live **LYGODIUM SPECIES (check one)**	**DENSITY (check one)**	**ORIGINAL STRATA (use # ranking below (0/1)**)**	**CURRENT STRATA (use # ranking below (0/1)**)**	**OTHER INVASIVES PRESENT (check all that apply)**
__ Lyja __ Lymi	__ Single/small clump __ Scattered plants __ Scattered dense patches __ Dominant cover __ Dense monoculture ****Strata ranking:** **0 = none present;** 1 = present	__ < 1 m tall __ 1 to 2 m tall __ 2 to 4 m tall __ > 4 m tall ---- (check if applicable) __ walls up trees-few __ walls up trees-many __ canopy tops-few __ canopy tops-many	__ < 1 m tall __ 1 to 2 m tall __ 2 to 4 m tall __ > 4 m tall ---- (check if applicable) __ walls up trees-few __ walls up trees-many __ canopy tops-few __ canopy tops-many	__ Air potato __ Australian pine __ Brazilian pepper __ Camphor __ China berry __ Cogon grass __ Elephant __ Guava __ Honeysuckle __ Kudzu __ Melaleuca __ Mimosa __ Rosary pea __ Skunk vine __ Shoebutton ardisia __ Tallow __ TSA __ Wisteria __ Other
DEAD FRONDS (check items below, as applicable)				
	DENSITY	**STRATA**	**RACHIS**	**%DEAD of INFESTATIO**
__ Absent __ Present (If present, complete box to the right)	__ Single/small clump __ Scattered plants __ Scattered dense patches __ Dominant cover __ Dense monoculture	__ walls up trees-few __ walls up trees-many __ canopy tops-few __ canopy tops-many	__ Poodle cut __ Intact __ Pulled down __ Rachis mat: __ thin __ thick/dense	__ <= 30% __ 31-74% __ >= 75%
COMMENTS:				

7. Points for other invasives (with estimated acres infested by each)

Point #	Lat	Long	Species	Density (as above)	Acres

8. Percent of unit/area/section surveyed: <30% 31-74% >75%

9. Is treatment area close to (check all that apply)?: __ Water/pond, etc. __MA property line
__ Non-MA infestation __ Archaeological site **__ Rare plants (list below)**

Comments:

OUTSIDE TREATMENT AREA

11. New infestations:
__ along equipment trails
__ near equipment storage area

12. What are the sanitation practices?
__ clean on-site
__ clean off site

13. Location of storage/ work area _____

14. Additional notes or sketch to review later for estimating infestation reduction, etc.: