

**Special Technology Development Program
New Project Proposal**

PROJECT NUMBER R08-2002-03

PROJECT TITLE: Japanese Climbing Fern Control Assessment

PROJECT STATUS: New

EXPECTED PROJECT DURATION (total years for project including current fiscal year): 2 years

EXPECTED COMPLETION DATE OF THE PROJECT (fiscal year): FY 2003/2004

SUBJECT (This is a hierarchical table that helps us understand our financial investment. Please indicate percentage of funding for all that apply; total percentage for numbers 1-6 should equal 100):

1. Total Suppression/Prevention Technology	80		2. Survey and Monitoring Technology	%	
a. Total Biological Control	0	%	a. Advancements in Detection Technology		%
i. Microbial %					
ii. Parasitoides %					
iii. Synthetic hormones/pheromones %					
iv. Other %					
i.			b. Landscape Level Assessment Technology		%
			i. Data Visualization		
b. Total Modeling	10	%	c. Remote Sensing		%
i. Pesticide (Insecticide) Application %			i. Aerial %		
ii. Disturbance %			ii. Hyperspectral %		
iii. Growth and Yield %			iii. Satellite %		
iv. Organism %					
v. Population %					
vi. Terrain %					
i.			d. Other		%
c. Genetic, Cultural and Silvicultural Innovations For Controlling Pest Species	30	%	3. Assessment Technology	%	
i. Fire %					
ii. Methyl Bromide Alternatives %	10				
iii. Thinning/Regeneration Techniques and other Silvicultural Guidelines %	20				
iv. Resistance, Screening, and Breeding %					

i.			a. GIS % b. Spatial Analysis % c. Landscape Analysis % d. Decision Support % Risk and Hazard % Expert Systems %		
d. Pesticide Application (Spray) Technology	40	%	4. Social Values	%	
i. Equipment innovations %	20				
ii. Methods and Guidelines %	20				
			5. Technology Transfer Innovations	20	%
e. Other		%	6. Other	%	

STATUS OF SUBJECT SPECIES: non-native invasive

PROJECT OBJECTIVES:

This project will evaluate field control treatments for the invasive, non-native plant, Japanese climbing fern (*Lygodium japonicum*) and assess potential vector and dispersal mechanisms in Florida. The specific objectives are: (1) evaluate treatments for Japanese climbing fern control in pine plantations as well as natural areas, including riverbank and floodplain sites; (2) assess the major systems of dispersal and develop techniques to reduce/prevent spread; and (3) develop outreach programs to increase awareness of the related impacts of Japanese climbing fern and current forest management practices to public and private forest and land owners/managers.

This project seeks to build upon and work in conjunction with current research and control efforts conducted in the state of Florida and elsewhere. To address objective (1) field evaluations (as defined by Miller and Glover 1991) of control treatments will be conducted in replicated experiments. Florida Department of Environmental Protection (and other) field trials will serve as primary sources of treatment efficacy information, whenever possible. This will narrow the focus of rigorous testing to those treatments that already showed promise in the field, aiming at rate and timing refinement in our experiments. The dispersal systems assessment (objective 2) will be addressed utilizing procedures developed by the Center for Aquatic and Invasive Plants at the University of Florida. Spore levels and viability in pine straw bales, on the forest floor, and on equipment used in forest management operations will be evaluated. Additionally, historical species occurrence data combined with known climatic and hydrologic patterns may be evaluated to explain directions and rate of the species spread. The species is believed to spread rapidly mainly by wind-dispersed spores (Miller and Miller 1999). Various physical (e.g. temperature) and chemical (e.g. herbicides) treatments will be evaluated in an attempt to develop practical and economically feasible techniques of killing fern spores present in pine straw and on forest management equipment. Forest landowners/managers will be familiarized with our findings (objective 3) through printed and electronic publications, seminars, workshops and field days.

BRIEF DESCRIPTION OF PROJECT: Describe primary activities for each year. This may be a clearly worded bulleted list or graphic of milestone activities.

2002

- Scouting for suitable sites: 3 to 4 pine plantations and 3 to 4 natural areas.
- Installation of two field experiments: one in pine plantations and one in natural areas.
- Fall application of fire and/or herbicidal treatments.

- Evaluation of field treatment effectiveness (every 30 days).
- Analysis of data.

2003

- Evaluation of field treatment effectiveness (every 30 days).
- Follow up application (spring) of fire and/or herbicidal treatments.
- Collection of fern spores from forest floor, pine straw bales, forest equipment.
- Laboratory experiments with spore levels and viability before and after exposure to physical (e.g. temperature) and chemical (e.g. herbicides) treatments.
- Follow up application in fall of fire and/or herbicides.
- Analysis of data.

2004

- Final data analyses.
- Preparation of peer-reviewed, refereed publications.
- Preparation of extension type publications.
- 3 to 4 workshops/field days conducted in central and northern Florida disseminating results and findings to forest landowners/managers.

FHP LEAD CONTACT (FHP person submitting proposal):

<u>Name</u>	<u>Affiliation (Office or Dept.)</u>	<u>Phone, E-mail, Fax</u>
John Taylor	IPM Specialist	(404)347-2718 jwtaylor@fs.fed.us

FHP LEAD INVOLVEMENT (add lines as necessary):

<u>Role</u>	<u>Time Commitment</u>
Review and submit project for funding through STDP program	Minimal (2-3 hours?)

PRINCIPAL INVESTIGATOR(S) (add lines as necessary):

<u>Name</u>	<u>Affiliation (Office or Dept.)</u>	<u>Phone, E-mail, Fax</u>
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Dr. Greg MacDonald	University of Florida Department of Agronomy Institute of Food and Agricultural Sciences gemac@gnv.ifas.ufl.edu	(352)392-1811 phone (352) 392-1840 fax

PRINCIPAL INVESTIGATOR(S) INVOLVEMENT (add lines as necessary):

<u>Name</u>	<u>Role</u>	<u>Time Commitment</u>
Dr. Jarek Nowak	Lead Investigator	120 hours/year (maximum)
Dr. Greg MacDonald	Co-Lead Investigator	30-60 hours/year

COOPERATORS (contributing to, but not leading, the project) (add lines as necessary):

<u>Name</u>	<u>Affiliation (Office or Dept.)</u>	<u>Phone, E-mail, Fax</u>
Andrea Van Loan	Florida Division of Forestry	(352)372-3505 x429 phone

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COOPERATOR INVOLVEMENT (add lines as necessary):

<u>Name</u>	<u>Role</u>	<u>Time Commitment</u>
Andrea Van Loan	Field Research/Lab Assessment	210 hours/year (maximum)
Kenneth Langeland	Assist in field/lab implementation	<30 hours/year

JUSTIFICATION (How does the project strengthen FHP program delivery/capability? What is the potential advantage over existing technology?):

This project seeks to refine existing technologies (herbicidal and/or prescribed fire treatments), as well as develop and/or adopt new techniques and protocols that could be used to control Japanese climbing fern infestations and spread. To date control efforts with respect to *Lygodium japonicum* in Florida have been focused on the publicly owned lands, and the existing protocols are only preliminary (Ferriter 2001). Recently, Florida Department of Environmental Protection and Florida Department of Agriculture and Consumer Services of Forestry initiated trials to test infestation control techniques suitable for Non-Industrial Private Forest Landowners in north Florida. However, even those trials do not address the needs and particular issues facing the pine straw industry related to potential spread of the species through pine straw mulch and/or equipment used for management and harvest of the pine needles from the forest floor. Those issues will be addressed through proposed research, and the resulting information popularized among the public and private forest landowners/managers.

Japanese climbing fern is a non-native, invasive, twining vine introduced from Eastern Asia around 1900. The first naturalized population was noticed in Georgia in 1903 (Pemberton and Ferriter 1998). The species is now known to occur from Florida west to Texas, and north into the Carolinas (Miller and Miller 1999). Within Florida, Japanese climbing fern is distributed throughout the panhandle, and south to central Florida. Invasive in a range of habitats and conditions, Japanese climbing fern's threats to biodiversity have been clearly seen in its invasion of, and impacts on the Appalachian River floodplain in the panhandle of the state. Within this area, the plant has been found invading public and private lands alike (Ferriter 2001).

While public land threats have primarily been to biodiversity and site access, the fern has been increasingly impacting private lands for the past 5 years, costing Non-Industrial Private Forest Landowners an untold amount in failed control efforts, often with repeated attempts on a single site. Additionally, the presence and density of infestation of this plant are significantly affecting portions of the pine straw industry in Florida and Georgia. With dense infestations of Japanese climbing fern blanketing the ground between the plantation rows, access to the layers of pine straw collected for packaging and sale as mulch is limited or denied in some sites, leaving the producers with reduced yields in infested stands and in several cases, making it impossible to harvest the straw. The impact of the infestations then becomes threefold in a given site. First, the site biodiversity is reduced due to the dense, tangled and shading nature of the infestations. Second, the pine straw producer faces decreased revenue, or in some situations must pay for a stand lease and cannot harvest at all. Third, in cases where the producers attempt to harvest the straw despite an infestation, the pine straw becomes contaminated with both fronds and spores of the fern, potentially contributing to the spread of this plant. (Japanese climbing fern is a prohibited plant according to the Florida Department of Agriculture and Consumer Services Rule 5B-57. This means that sale, transport or movement of any part of the plant is prohibited.)

URGENCY (Does the project address a crisis situation? Would delay result in irreversible loss?):

This project addresses the situation that has the potential to become very critical. Existing evidence suggests, that we might be approaching the exponential phase of *Lygodium japonicum* expansion. Japanese climbing fern is well established in central and north Florida, as evidenced by increasing number and frequency of reports by resource managers and private landowners. Previous experience with other non-native, invasive plant species such as melaleuca (*Melaleuca quinquenervia*) has shown that after an establishment phase, further expansion is often exponential (Ferriter 2001). Currently Japanese climbing fern infests a wide range of habitats (from pinelands through secondary woods, floodplains to marshes) with infestations smothering whole plant communities including understory and main canopies. Effective control of existing infestations and prevention of further *Lygodium japonicum* spread is critical to maintaining integrity and native character of ecosystems in Florida and other southeastern states.

The potential irreversible losses from delaying development of effective control measures against Japanese climbing fern are paramount. First, composition and integrity of ecosystems in the Southeast are at stake. Once altered, the ecosystems may never be returned to the present state. Second, the species may change fire ecology by altering fire behavior through the fern climbing “trellises” serving as fire ladders. Thus, unchecked spread of Japanese climbing fern may increase fire hazard and increase potential for catastrophic hot crown fires. This in turn may lead to untold amount of financial losses associated with fire suppression efforts and property damage. Third, the fern already causes financial losses to citrus, timber and pine straw industries. In addition, the fern may be unintentionally transferred to gardens and landscaped areas with pine straw mulch, causing additional maintenance costs to homeowners (Ferriter 2001).

NATIONAL FHP TECHNOLOGY DEVELOPMENT PRIORITY (check at least one and describe how proposed work addresses the priorities):

Priority 1: Priority 2: Priority 3: Priority 4:

Priority 2: Develop guidelines for the integration of silvicultural procedures, prescribed burning, and other tools and techniques to reduce the adverse impacts of pest species.

To assess the mechanisms of dispersal of Japanese climbing fern, this study will evaluate spore levels in pinestraw, and on heavy equipment used in forest management. Spore viability will be determined utilizing procedures developed by the Center for Aquatic and Invasive Plants at the University of Florida. This will provide a greater level of understanding regarding the mechanism of dispersal, including regional silvicultural systems, and methods to prevent spread.

Priority 3: Develop techniques to quantify the impact (forest structure and function) of pest species as disturbance agents in forest ecosystems including their interaction with other disturbance agents such as fire, and wind.

The impacts of fire on Japanese climbing fern will be assessed to determine the specific impacts of fire on spore survival and viability, and the potential role of fire in Japanese climbing fern spore dispersal through smoke/fire convective columns. The results will aid in determination of management recommendations to be made to field managers regarding the use of prescribed fire as a land management tool on sites infested with the fern. To date there are no documented studies on the effects of prescribed fire on Japanese climbing fern (Ferriter 2001). Observations from the related non-native species, *Lygodium microphyllum*, in south Florida indicate that, dense vertical growth of Japanese climbing fern may potentially serve as a ladder fuel to carry fire into the canopy of trees resulting in crown fires and long-distance spotting.

Priority 4: Develop or improve detection, analysis, and management of pest species, especially technologies or methods that contribute to our ability to prevent introductions or to detect and eradicate new introductions.

Current management techniques employed to control Japanese climbing fern in private forests/timber stands generally utilize materials, equipment, and techniques which do not provide the maximum level of treatment efficiency or success possible. This is due to a lack of education and awareness in the private sector regarding best management practices for this and other invasive species. This issue will be addressed through two methods: 1) educational materials will be developed and widely distributed through the Florida Division of Forestry Cooperative Forestry Assistance Program, and the University of Florida Cooperative Extension Service on the topics of best management practices for Japanese climbing fern, and 2) coordination with the Florida Forestry Association to incorporate invasive species education into the Master Logger Certification Program. If feasible, a pilot training session will be scheduled within the grant period to provide training and education on the issue of vectoring dispersal of invasive species. The Master Logger Certification Program reaches professional loggers in Florida and Georgia.

TECHNICAL COMMITTEE DEVELOPMENT PRIORITY (check at least one and describe how proposed work addresses the priorities):

Priority 1: ___ Priority 2: ___ Priority 3: ___ Priority 4: ___
Priority 5: ___ Priority 6: ___ Priority 7: ___ Priority 8: X

Priority 8: Development of guidelines and/or techniques for surveying and monitoring of non-target species. These guidelines or techniques should be directly related to actions taken through various Forest Health Protection activities such as prevention, detection, evaluation, suppression, or eradication of native or exotic species.

Non-target species, both trees and understory, will be monitored for survival and damages that might result from application of control treatments. The surveying of the potential damages will be conducted at the same time as the evaluation of treatment effectiveness against Japanese climbing fern. Guidelines for such surveying will be developed based on standard methods employed in weed science (Camper 1986).

SCOPE OF APPLICATION (How widely are results likely to be applied—geographic area, range of pests, length of time?):

Practical field management practices for Japanese climbing fern identified in the project will be made available to public and private land managers throughout the southeastern U.S. via extension and peer-reviewed refereed publications, scientific and technical professional meetings, workshops and training sessions. University of Florida Cooperative Extension Service and Florida Division of Forestry Cooperative Forestry Assistance Program have well established ongoing efforts in Florida and will distribute newly generated information on control and management of Japanese climbing fern into the foreseeable future.

RESEARCH BASIS (strength of research basis, including publication citations):

Publication citations are not available due to the nature of the work completed thus far on herbicidal control of Japanese climbing fern, and the recent, as yet unpublished work on spore germination and other aspects of species biology completed by researchers at Florida Atlantic University. The most comprehensive publication detailing known and unknown aspects of Japanese climbing fern management and biology is the recently published “Lygodium Management Plan for Florida” (Ferriter 2001).

METHODS (project design, hypothesis, statistical approach, and QA/QC procedures):

The project will be composed of three different studies: one each in pine plantations and natural forest areas, and a third spore viability/dispersal study. The field studies will test a hypothesis that prescribed fire alone or in combination with herbicidal treatments can successfully control Japanese climbing fern infestations in pine plantations and/or natural forest areas. The spore viability and dispersal study will

test a hypothesis that pine straw mulch and/or forest equipment contains viable spores that can serve as vectors of the species dispersal.

Each of the two field studies will be arranged in a randomized complete block design. Three to four plantation locations, and three to four natural forest areas will serve as blocks in their respective studies. Each block (location) will be assigned all the herbicidal and prescribed fire treatments in a randomized fashion. Single treatment will be up to 0.5 acre, which is appropriate plot size for the secondary field evaluations (Miller and Glover 1991). Each study will test 3 to 4 herbicidal treatments (each block about 2 acres) with a total field size of 6 to 8 acres. To test role of prescribed fire in Japanese climbing fern control, treatments may be arranged in a split-plot design, with fire treatments assigned to main plots, whenever practical. The refined herbicidal treatments in our studies will be based on the preliminary field results from Northwest Florida Water Management District, Florida Department of Environmental Protection and other trials. Some of the preliminary trial results were published in Lygodium Management Plan for Florida (Ferriter 2001), other trials are currently underway.

Herbicides will be applied utilizing equipment and application techniques typical to the pine straw or other forest products industry with necessary modifications to ensure more thorough plant coverage. An additional benefit of the process will be the assessment of industry-standard herbicide application techniques, and refinement of these techniques for invasive plant treatment. This will enhance the knowledge base of both public and private forest industry personnel pertaining to future management of invasive plant species. Prescribed fire and herbicidal applications will be assessed for the potential integration of Japanese climbing fern control measures with routine and regularly scheduled forest management practices. Spore viability will be determined utilizing procedures developed by the Center for Aquatic and Invasive Plants at the University of Florida. Assessments from these study will be used to make/generate predications regarding spore movement and spread and allow the development of management strategies that integrate spread/infestations from spores.

MEASURES OF SUCCESS:

Standard of Success:

The standard for success will be (1) the development of management strategies for eradication of Japanese climbing fern infestation from pine plantations and/or natural forest areas; (2) the development of treatments to neutralize Japanese climbing fern spores in pine straw and on forest equipment (if this research confirms contamination with viable fern spores); and (3) successful educational efforts for public and private forest owners/managers in the southeastern U.S. about the problems associated with and management of Japanese climbing fern.

Expected Outcomes:

Expected outcomes are: (1) Refine and improve control treatments for Japanese climbing fern, including effectiveness of prescribed fire, which was not studied to date (Ferriter 2001); (2) Support or refute the hypothesis that pine straw and/or forest equipment contain viable Japanese climbing fern spores and serve as vector(s) in the species dispersal; (3) Increase awareness among public and private forest owners/manages in the southeastern U.S. about outcomes (1) and (2) above.

Implementation of Products/methods:

Long-term process (years) of popularizing findings of this project among public and private forest owners/managers through the programmatic efforts of University of Florida Cooperative Extension Service and Florida Division of Forestry Cooperative Forestry Assistance Program.

PRODUCTS AND DUE DATES:

Spring 2004 Workshops/field days (3 to 4) through central Florida and panhandle on Japanese climbing fern infestation and dispersal control methods with appropriate printed materials handed out.

PUBLICATIONS (how results will be reported: journals, reports):

Fall 2004 Extension type article on Japanese climbing fern infestation and dispersal control methods published in a printable form on the appropriate web sites (University of Florida Extension and Florida Division of Forestry sites).

Fall 2004 Submission of peer-reviewed refereed articles for publication in appropriate scientific journal(s).

TECHNOLOGY TRANSFER (Who will the technology be transferred to. How will products or methods be transferred to users, adapted to other uses, or sustained by continuing technology transfer?):

The target audiences for the technology transfer part of this project include: public and private forest owners/managers, county foresters, and county extension personnel. Training workshops/field days will be conducted in coordination between Florida Division of Forestry and University of Florida Cooperative Extension Service. During the workshops/field days information concerning the biology, impact and current management practices for Japanese climbing fern will be provided. In addition, printed and electronic material will be distributed to forest managers and landowners through appropriate agencies and groups including the Florida Division of Forestry and University of Florida Cooperative Extension Service. If appropriate and feasible, information transfer to loggers will occur through the Master Logger Certification Program. Continued technology transfer will occur through appropriate web sites, county extension personnel and county foresters.

PRODUCT LEVERAGING (Is the project part of a development sequence? Does it build on or is it the result of past Research or STDP projects?):

N/A

LONG-TERM BUDGET REQUEST: (estimates by fiscal year and funding, both monetary and in-kind, excluding FHP base funding and salaries) (extend table as necessary):

	Item	Requested FHP STDP Funding	Other-Source Funding	Source
FY 2002/03				
Administration	Salary	2,500	4,000	FL DOF
	Overhead			
	Travel	1,000		
Procurements	Contracting			
	Equipment			
	Supplies	1,500	500-herbicides	Monsanto, BASF, DOW, Dupont
YEAR TOTALS		5,000	5,000	

FY 2003/04				
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Administration	Salary	2,000	4,000	FL DOF
	Overhead			
	Travel	1,000		
Procurements	Contracting			
	Equipment			
	Supplies	1,500	500 - herbicides	Monsanto, BASF, Dow, Dupont
	Publication costs	2,000		
YEAR TOTALS		6,500	5,000	
PROJECT TOTALS		11,500	10,000	

LONG-TERM BUDGET REQUEST EXPLANATION: (add lines as necessary):

BENEFITS (What are the proposed benefits of this project):

1. Refinement of control technologies for the invasive, non-native species Japanese climbing fern in the forest ecosystems of the southeastern U.S.
2. Verification of major dispersal systems responsible for Japanese climbing fern infestations.
3. Technology transfer to forest owners/managers enabling them to control Japanese climbing fern infestations and limit the species spread.

LITERATURE, CITATIONS, ATTACHMENTS, etc.

Ferriter, A. 2001. Lygodium Management Plan for Florida. A Report from the Florida Exotic Pest Plant Council's Lygodium Task Force. First Edition.

Jones, D.L. 1996. Encyclopaedia of Ferns. An Introduction to Ferns, their Structure, Biology, Economic Importance, Cultivation and Propagation. Timber Press, Portland, Oregon. 433p.

Miller, J.H. and G.R. Glover. 1991. Standard Methods for Forest Herbicide Research. Southern Weed Science Society.

Miller, J.H. and K.V. Miller. 1999. Forest Plants of the Southeast and their Wildlife Uses. Southern Weed Science Society.

Pemberton, R.W. and A.P. Ferriter. 1998. Old World climbing fern (*Lygodium microphyllum*), a dangerous invasive weed in Florida. Amer. Fern Journal 88(4): 165-175.