SPECIES: Lygodium japonicum, L. microphyllum

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INTRODUCTORY

AUTHORSHIP AND CITATION:
Munger, Gregory T. 2005. Lygodium spp. In: Fire Effects Information System, [Online]. U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Fire Sciences Laboratory (Producer). Available: http://www.fs.fed.us/database/feis/ [2007, October 24].

FEIS ABBREVIATION:
LYGSPP
LYGJAP
LYGMIC

SYNONYMS:
None

NRCS PLANT CODE [38]:
LYMI
LYJA

COMMON NAMES:
Japanese climbing fern

Old World climbing fern
small-leaf climbing fern

TAXONOMY:
The currently accepted genus name for climbing fern is *Lygodium* Sw. [3,14,28,44,45]. This report summarizes

information on 2 species of climbing fern:

Lygodium japonicum (Thunb.) Sw. [3,12,14,28,44,45] Japanese climbing fern
Lygodium microphyllum (Cav.) R. Br. [14,44,45] Old World climbing fern

When discussing characteristics typical (or likely to be typical) of both species, this report refers to them collectively as climbing fern(s). When referring to individual taxa, the common names listed above are used. Use of the term "climbing fern(s)" does not refer to American climbing fern (*L. palmatum*), which is native to parts of the eastern United States.

LIFE FORM:
Fern or fern ally

FEDERAL LEGAL STATUS:
None

OTHER STATUS:
Old World climbing fern and Japanese climbing fern are both listed as category I invasive species ("...are altering native plant communities by displacing native species, changing community structures or ecological functions, or hybridizing with natives") by Florida Exotic Pest Plant Council [8], and as noxious weeds by the State of Florida [9].

DISTRIBUTION AND OCCURRENCE

SPECIES: Lygodium japonicum, L. microphyllum

GENERAL DISTRIBUTION:
Japanese climbing fern is native from India, east through southeastern Asia and China to Japan and Korea, and south to eastern Australia (Singh and Panigrahi 1984 as cited in [5]). North American establishment was first recorded in the early 1900s in Georgia (Clute 1903 as cited in [26]). Japanese climbing fern is now introduced throughout the southeastern United States from Texas and Arkansas to North Carolina, and also in Puerto Rico (Proctor 1989, Nauman 1993 as cited in [5]). It is considered a "problem weed" from central Florida west across the southern half of the Gulf states [29].

Old World climbing fern is native to tropical and subtropical areas of Africa, southeastern Asia, northern and eastern Australia, and the Pacific islands (reviewed by [5,25]). In North America it is found in southern and central Florida [22,45]. Large parts of the Caribbean, Central and South America, and perhaps coastal areas of southern Louisiana and Texas may also be vulnerable to Old World climbing fern invasion [11,24,26]. Old World climbing fern was first collected from the wild in southern Florida in 1960 [16]. As of 2005, Florida Plant Atlas [43] showed Old World climbing fern distribution in southern Florida from coast to coast and as far north as Hillsborough and Brevard counties. Ecological/climate modeling indicates Old World climbing fern could become established throughout most of southern Florida, with northern distribution extending furthest along the coasts [11].

Ferriter [5] reviewed the history of climbing fern invasion in the southeastern U.S.

The Flora of North America provides distribution maps of climbing ferns.

The following biogeographic classification systems demonstrate where Japanese climbing fern (labeled with the abbreviation J) and Old World climbing fern (O) could potentially be found based on floras and other literature, herbarium samples, and confirmed observations. Precise distribution information is unavailable. In general, predicting distribution of nonnative species in North America is difficult due to gaps in understanding of their biological and ecological characteristics, and because they may still be expanding their range. Therefore, these lists are speculative and may be imprecise.

ECOSYSTEMS [10]:
FRES12 Longleaf-slash pine JO
FRES13 Loblolly-shortleaf pine J
FRES14 Oak-pine J
FRES15 Oak-hickory J
FRES16 Oak-gum-cypress J
FRES39 Prairie J
FRES41 Wet grasslands JO

STATES/PROVINCES: (key to state/province abbreviations)

Japanese climbing fern:

AL	AR	FL	GA	LA
MS	NC	SC	TX	PR

Old World climbing fern:

FL

BLM PHYSIOGRAPHIC REGIONS [2]:
None

KUCHLER [15] PLANT ASSOCIATIONS:
K077 Bluestem-sacahuista prairie J
K078 Southern cordgrass prairie J
K079 Palmetto prairie JO
K080 Marl everglades O
K090 Live oak-sea oats J
K091 Cypress savanna JO
K092 Everglades JO
K100 Oak-hickory forest J
K105 Mangrove O
K111 Oak-hickory-pine J
K112 Southern mixed forest JO
K113 Southern floodplain forest J
K114 Pocosin J
K116 Subtropical pine forest JO

SAF COVER TYPES [4]:
40 Post oak-blackjack oak J
50 Black locust J
52 White oak-black oak-northern red oak J
53 White oak J
57 Yellow-poplar J
59 Yellow-poplar-white oak-northern red oak J
61 River birch-sycamore J
63 Cottonwood J
64 Sassafras-persimmon J

68 Mesquite J
70 Longleaf pine JO
73 Southern redcedar JO
74 Cabbage palmetto JO
75 Shortleaf pine J
76 Shortleaf pine-oak J
78 Virginia pine-oak J
79 Virginia pine J
80 Loblolly pine-shortleaf pine J
81 Loblolly pine J
82 Loblolly pine-hardwood J
83 Longleaf pine-slash pine JO
84 Slash pine JO
85 Slash pine-hardwood JO
87 Sweetgum-yellow-poplar JO
88 Willow oak-water oak-diamondleaf (laurel) oak J
89 Live oak J
91 Swamp chestnut oak-cherrybark oak J
92 Sweetgum-willow oak J
93 Sugarberry-American elm-green ash J
94 Sycamore-sweetgum-American elm J
95 Black willow JO
96 Overcup oak-water hickory J
97 Atlantic white-cedar J
98 Pond pine J
100 Pondcypress JO
101 Baldcypress JO
102 Baldcypress-tupelo JO
103 Water tupelo-swamp tupelo JO
104 Sweetbay-swamp tupelo-redbay JO
105 Tropical hardwoods JO
106 Mangrove O
108 Red maple J
110 Black oak J
111 South Florida slash pine JO

SRM (RANGELAND) COVER TYPES [33]:
711 Bluestem-sacahuista prairie J
723 Sea oats J
726 Cordgrass J
806 Gulf Coast salt marsh JO
807 Gulf Coast fresh marsh JO
809 Mixed hardwood and pine J
810 Longleaf pine-turkey oak hills JO
811 South Florida flatwoods JO
812 North Florida flatwoods J
813 Cutthroat seeps JO
814 Cabbage palm flatwoods JO
815 Upland hardwood hammocks J
816 Cabbage palm hammocks JO
817 Oak hammocks JO
818 Florida salt marsh JO
819 Freshwater marsh and ponds JO
820 Everglades flatwoods JO
821 Pitcher plant bogs J

822 Slough JO

HABITAT TYPES AND PLANT COMMUNITIES:
As of this writing (2005), there are few published accounts of specific North American habitat types and plant communities where climbing ferns are common or likely to be found.

A survey of Big Branch Marsh National Wildlife Refuge in southeastern Louisiana found Japanese climbing fern "well established" in both American beech (*Fagus grandifolia*)-southern magnolia (*Magnolia grandiflora*) woods and "mixed woods" (successional forests dominated by loblolly pine (*Pinus taeda*)) [32].

A review by Pemberton and Ferriter [26] indicates that Old World climbing fern is common in baldcypress (*Taxodium distichum*) stands and also occurs in pine (*Pinus* spp.) flatwoods, wet prairies, sawgrass (*Cladium jamaicense*) marshes, mangrove (*Rhizophora*, *Avicennia*, and/or *Laguncularia* spp.) communities, and Everglades tree islands. Volin and others [39] found that presence of small-spike false nettle (*Boehmeria cylindrica*), royal fern (*Osmunda regalis*), resurrection fern (*Pleopeltis polypodioides* ssp. *polypodioides*), and toothed midsorus fern (*Blechnum serrulatum*) were significant ($p<0.05$) indicators of Old World climbing fern occurrence in Big Cypress National Preserve and Big Cypress Seminole Indian Reservation, southern Florida.

BOTANICAL AND ECOLOGICAL CHARACTERISTICS

SPECIES: Lygodium japonicum, L. microphyllum

GENERAL BOTANICAL CHARACTERISTICS:
This description provides characteristics that may be relevant to fire ecology, and is not meant for identification. Keys for identification are available (e.g. [28,44,45]).

Japanese climbing fern fronds are from 3.3 to 100 feet (1-30.5 m) in length [1,3,28], and Old World climbing fern fronds grow to 90 feet (27 m) long [16]. In Japanese climbing ferns, pinnae (groups of leaflets) are up to 12 inches (30 cm) wide, and are subdivided into 2 or 3 pinnules (leaflets) up to 3 inches (8 cm) long and 6 inches (15 cm) wide [28,29]. Old World climbing fern pinnae are 2 to 5 inches (5-13 cm) long with several pairs of pinnules [16]. Fertile pinnules of Old World climbing fern are fringed with tiny lobes of enrolled leaf tissue along the margin, which cover the reproductive tissues [16]. Japanese climbing fern sporangia are borne on narrow, fingerlike segments of the pinnae [3].

Japanese climbing fern Old World climbing fern

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In addition to their photosynthetic and reproductive functions, adult climbing fern fronds are analogous to the twining shoots of flowering plants, spreading along the ground, over shrubs, or climbing by twining around other structures, such as trees and other vines [3,16,19,28]. Twining growth is indeterminate and occurs at a steady rate [19,20,27]. Annual height increase averaged (± SE) 3.81 ± 0.07 feet (1.16 ± 0.02 m) for Old World climbing fern growing on infested trees in Jonathon Dickinson State Park and Big Cypress Seminole Indian Reservation, southern Florida [39].

Climbing ferns are rhizomatous [3,28]. Rhizomes grow 0.4 to 1.2 inches (1-3 cm) below soil surface [19].

Climbing ferns are evergreen in subtropical environments [5].

RAUNKIAER [30] LIFE FORM:
Phanerophyte
Geophyte

REGENERATION PROCESSES:

Breeding system:

Climbing ferns reproduce sexually by spores. They are capable of intragametophytic selfing. Old World climbing fern can also reproduce via intergametophytic selfing and outcrossing [17,40]. Lott and others [17] suggested that Old World climbing fern's mixed mating system facilitates long distance dispersal, as well as local adaptation in established populations.

Spore production: Volin and others [39] studied Old World climbing fern spore production at 2 sites in southern Florida. Approximately 1% of pinnules were fertile. Fertile pinnules averaged 133 sori, with an average of 215 spores per sorus. Each fertile pinnule could potentially produce 28,600 spores or ~15,000 spores per cm^2 of fertile leaf area [39].

Spore dispersal:

Climbing fern spores are wind-dispersed, potentially over great distances, particularly during storms [5,16,26]. Pemberton (unpublished data, reported in [26]) recorded 724 Old World climbing fern spores/m^3/hour in the air in southeastern Florida.

Spore longevity: Climbing fern spores are thick-walled, providing "long environmental viability" (reviewed by [5]).

Plant establishment/growth:

In a laboratory experiment, climbing fern gametophytes were sexually mature within 5 weeks of germination, followed by sporophyte production through week 12. Rapid development/reproductive rates may be an advantage in many Florida habitats where seasonal environmental conditions such as hydroperiod can vary widely [17].

Asexual regeneration:

Old World climbing fern (and presumably Japanese climbing fern) can apparently regrow aboveground tissues that are damaged by herbicides, mechanical injury, fire [37], or that are killed to the ground by frost (reviewed by [42]), although details describing this biology are lacking.

SITE CHARACTERISTICS:

In the southeastern U.S. Japanese climbing fern can be found in swamps, moist woods, and riparian habitats, and is frequently associated with disturbance [3,28,44,45]. Old World climbing fern occurs in a variety of forested and nonforested sites in southern Florida, including hardwood hammocks, cypress swamps, savannas, woodlands, marshes, and wet prairies [26,44,45]. A review by Ferriter [5] indicated that, in its native range, Old World climbing fern is "found in a variety of habitats including mesic forests, rain forest, and open swampy areas" (Serizawa 1975, Edie 1978, Singh and Panigrahi 1984 as cited in [5]), and Japanese climbing fern is "native to the edges of forests, open forests, and secondary forests" (Serizawa 1975, Edie 1978, Singh and Panigrahi 1984 as cited in [5]).

Climbing ferns do not seem well-adapted to extremely dry habitats or soils with exceptionally long hydroperiods (reviewed by [5]). Nauman and Austin [22] reported that Old World climbing fern is "confined to wet, disturbed sites...found only near canals, rivers, ditches, in disturbed swamps, and other sites which have standing water for a large part of the year." Volin and others [39] reported that Old World climbing fern presence within study sites in Big Cypress National Preserve and Big Cypress Seminole Indian Reservation, southern Florida, was significantly ($p<0.05$) correlated to hydrology, "coinciding with a wet, but not permanently inundated environment."

Aboveground portions of climbing ferns are killed by frost, but roots may be protected [5,26,42]. This is particularly true, at least for Old World climbing fern, when roots are growing in standing water (reviewed by [42]). Japanese climbing fern foliage is killed by freezing temperatures, but browned fronds often remain draped in shrub and tree canopies enabling new growth easier access to the same habitat once favorable temperatures for growth resume [5]. A modeling exercise conducted by Goolsby [11] indicated that, although Old World climbing fern appears intolerant of freezing temperatures, it may be tolerant of near-freezing temperatures if daytime maximums are warm. Pemberton and Ferriter [26] suggested that Old World climbing fern may eventually extend its range into portions of northern and central Florida that are within USDA Plant Hardiness Zone 9b [13]. However, its occurrence may be limited by insufficient heating degree-days. Although damage from cold, but above-freezing temperatures may not be apparent, reduced growth during prolonged periods of cool weather may limit Old World climbing fern competitiveness [11].

SUCCESSIONAL STATUS:

Late-successional, forested habitats may be particularly vulnerable to climbing fern invasion. A review by Pemberton and others [24] indicates that Old World climbing fern can colonize undisturbed habitat. Volin and others [39] reported that Old World climbing fern coverage in Big Cypress National Preserve and Big Cypress Seminole Indian Reservation, southern Florida, was greatest "in a low-light understory environment." Preliminary results from a laboratory experiment by Volin and others [40] suggested that climbing ferns, and particularly Old World climbing fern, are comparatively better adapted to growing under low light conditions than the 2 native vines, muscadine (*Vitis rotundifolia*) and Virginia creeper (*Parthenocissus quinquefolia*). Apparent advantages were attributed to greater photosynthetic rates and greater relative leaf area [40]. Observations suggest that Japanese climbing fern fronds form a dense canopy that can cast substantial shade, potentially suppressing understory plant growth and recruitment [1].

SEASONAL DEVELOPMENT:

As of this writing (2005) there is very little published information describing climbing fern phenology. Japanese climbing fern "flowering and fruiting" occurs from June to September in the Carolinas [28]. While Old World climbing fern spore production occurs year-round, spore production and leaf area both reach a seasonal peak during the wet season (September-November) [39].

FIRE ECOLOGY

SPECIES: Lygodium japonicum, L. microphyllum

FIRE ECOLOGY OR ADAPTATIONS:
There are suggestions that Old World climbing fern is "tolerant of fire" (reviewed by [5]) and that Japanese climbing fern is "promoted" by fire (reviewed by [41]), but no details are provided.

Fire adaptations: Although it is likely that climbing ferns can regenerate following fire (see Plant Response To Fire), as of this writing (2005) there are no published descriptions of climbing fern fire adaptations.

Fire regimes:

Climbing ferns may alter fire regimes by providing ladder fuels, leading to greater incidence of crown fire in communities that are ill-adapted to crown fire (reviewed by [21]).

The following table provides fire return intervals for plant communities and ecosystems where climbing ferns are important. For further information, see the FEIS review of the dominant species listed below. This list may not be inclusive for all plant communities in which climbing ferns occur. If you are interested in plant communities or ecosystems that are not listed below, see the complete FEIS Fire Regime Table.

Climbing fern spp.**	Community or Ecosystem	Dominant Species	Fire Return Interval Range (years)
J	bluestem-Sacahuista prairie	*Andropogon littoralis-Spartina spartinae*	<10 [23]
O	mangrove	*Avicennia nitida-Rhizophora mangle*	35-200 [21]
J	sugarberry-America elm-green ash	*Celtis laevigata-Ulmus americana-Fraxinus pennsylvanica*	<35 to 200
J	Atlantic white-cedar	*Chamaecyparis thyoides*	35 to >200
J	yellow-poplar	*Liriodendron tulipifera*	<35 [41]
JO	Everglades	*Mariscus jamaicensis*	<10
JO	melaleuca	*Melaleuca quinquenervia*	<35 to 200 [21]
J	shortleaf pine	*Pinus echinata*	2-15
J	shortleaf pine-oak	*Pinus echinata-Quercus* spp.	<10
JO	slash pine	*Pinus elliottii*	3-8
JO	slash pine-hardwood	*Pinus elliottii*-variable	<35 [41]
JO	South Florida slash pine	*Pinus elliottii* var. *densa*	1-15 [21,34,41]
JO	longleaf-slash pine	*Pinus palustris-P. elliottii*	1-4 [21,41]
J	pocosin	*Pinus serotina*	3-8
J	pond pine	*Pinus serotina*	3-8
J	loblolly pine	*Pinus taeda*	3-8
J	loblolly-shortleaf pine	*Pinus taeda-P. echinata*	10 to <35
J	Virginia pine	*Pinus virginiana*	10 to <35
J	Virginia pine-oak	*Pinus virginiana-Quercus* spp.	10 to <35
J	sycamore-sweetgum-American elm	*Platanus occidentalis-Liquidambar styraciflua-Ulmus americana*	<35 to 200 [41]
J	eastern cottonwood	*Populus deltoides*	<35 to 200 [23]
J	mesquite	*Prosopis glandulosa*	<35 to <100 [18,23]
J	oak-hickory	*Quercus-Carya* spp.	<35 [41]

J	oak-gum-cypress	*Quercus-Nyssa*-spp.-*Taxodium distichum*	35 to >200 [21]
J	southeastern oak-pine	*Quercus-Pinus* spp.	<10
J	white oak-black oak-northern red oak	*Quercus alba-Q. velutina-Q. rubra*	<35
J	post oak-blackjack oak	*Quercus stellata-Q. marilandica*	<10
J	black oak	*Quercus velutina*	<35
J	live oak	*Quercus virginiana*	10 to<100 [41]
JO	cabbage palmetto-slash pine	*Sabal palmetto-Pinus elliottii*	<10 [21,41]
J	southern cordgrass prairie	*Spartina alterniflora*	1-3 [23]
JO	baldcypress	*Taxodium distichum* var. *distichum*	100 to >300
JO	pondcypress	*Taxodium distichum* var. *nutans*	<35 [21]

*fire return interval varies widely; trends in variation are noted in the species review
** J = Japanese climbing fern, O = Old World climbing fern

POSTFIRE REGENERATION STRATEGY [36]:
Rhizomatous fern, rhizome in soil
Ground residual colonizer (on-site, initial community)
Initial off-site colonizer (off-site, initial community)
Secondary colonizer (on-site or off-site seed sources)

FIRE EFFECTS

SPECIES: Lygodium japonicum, L. microphyllum

IMMEDIATE FIRE EFFECT ON PLANT:
As of this writing (2005) there are no published studies documenting the effects of fire on climbing ferns. Anecdotal accounts suggest that climbing fern fronds will burn (see Fire Management Considerations below), and to the extent that plant tissues are consumed or damaged, may be top-killed. Studies are needed that document and assess the effects of fire on climbing ferns.

DISCUSSION AND QUALIFICATION OF FIRE EFFECT:
No additional information is available on this topic.

PLANT RESPONSE TO FIRE:
As of this writing (2005) published studies describing postfire responses of climbing ferns are sparse. Stocker and others [37] noted that Old World climbing fern can "recover" following burning with a propane torch. There is some indication that Old World climbing fern (and presumably Japanese climbing fern) can regrow aboveground tissue damaged by frost, herbicide, or mechanical injury (see Asexual regeneration). Although not well documented, it is likely that climbing ferns may respond similarly to aboveground damage from fire. Research is needed that documents the response of climbing ferns to various fire frequencies and severities.

DISCUSSION AND QUALIFICATION OF PLANT RESPONSE:
No additional information is available on this topic.

FIRE MANAGEMENT CONSIDERATIONS:
As of this writing (2005) there is very little published information about fire management and climbing ferns. Roberts [31] indicated that "fire alone will not control" Old World climbing fern, but no further details were provided. Stocker and others [37] burned Old World climbing fern with a propane torch and indicated that "recovery" was imminent. Citing a personal communication, Ferriter [5] reported that prescribed fire, alone and in combination with 2,4-D herbicide application, was not effective at controlling Japanese climbing fern in northern Florida pine plantations. More detailed research is needed to determine how climbing ferns might respond to broadcast burning or wildfire under varying burn conditions, intervals, seasons, etc.

Climbing fern presence may instigate changes in fire behavior. Old World climbing fern presence in southern Florida forests has been associated with greater incidence of crown fire, due to an increase in ladder fuels. Also, burning mats of Old World climbing fern may be lofted by convection and ignite spot fires downwind from the main fire (reviewed by [21]). There are also suggestions that climbing fern presence in forest canopies may carry fire through wet areas that would otherwise present a boundary to fire spread (reviewed by [16]).

MANAGEMENT CONSIDERATIONS

SPECIES: Lygodium japonicum, L. microphyllum

IMPORTANCE TO LIVESTOCK AND WILDLIFE:
As of this writing (2005) there is no published information describing the importance of climbing ferns to livestock and wildlife.

Palatability/nutritional value: No information is available on this topic.

Cover value: No information is available on this topic.

OTHER USES:
Climbing ferns were originally imported and sold in the United States as ornamentals [24]. In their native ranges, climbing fern spores are used for medicinal purposes and the rachis is used for weaving (reviewed by [5]).

IMPACTS AND CONTROL:
Impacts:
Although there are few studies documenting the impacts of climbing ferns on native plants and ecosystems in the southeastern U.S., their invasion is likely to have deleterious effects. Nauman and Austin [22] reported that climbing ferns are established, persistent, and spreading in Florida, Japanese climbing fern in the north and Old World climbing fern in the south. A review by Ferriter [5] suggested that climbing ferns don't require "human disturbance in order to spread and become established."

Most accounts of impacts associated with climbing fern invasion (e.g. reviews by [1,16,17,22,26,42]) describe interference with native plants due to a prodigious growth habit. Climbing ferns can produce thick mats along the ground, severely reducing native ground cover. A review by Wood [42]) indicated that Old World climbing fern can form mats up to 4 feet (1.2 m) thick. They also climb into forest canopies, shading trees and shrubs that it covers, weakening or killing them, their associated epiphytic orchids and bromeliads, and understory plants.

Japanese climbing fern Old World climbing fern

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Of particular concern may be climbing fern impacts on native vegetation within many of the region's high-quality natural areas. A review by Pemberton and others [24] indicated that, as of 2004, Old World climbing fern was rapidly spreading in southern Florida, including in Everglades National Park. Volin and other [39] expressed concern that efforts to restore Everglades hydrology to approximate a "pre-drainage environment," while perhaps reducing establishment and spread of many important nonnative plant invaders, may "improve the ecological conditions for Old World climbing fern." Lott and others [17] reported that Old World climbing fern "has been observed overtopping tree canopies among tree islands in the Arthur R. Marshall Loxahatchee National Wildlife Refuge" [17]. Volin and others [39] recorded an average of 14 Old World climbing fern infestations (defined as contiguous growth that had climbed above the shrub layer on 1 or more trees) per km^2
along transects in the Big Cypress National Preserve and Big Cypress Seminole Indian Reservation. The most heavily infested transect contained 58 infestations per km^2.

Climbing fern invasion may also impact rare and threatened taxa. Reviews by Ferriter [5] and Langeland [16] indicate that climbing fern invasion in Florida threatens the rare plant ray fern (*Actinostachys pennula*), as well as the endangered Georgia bully (*Sideroxylon thornei*), common dutchmanspipe (*Aristolochia tomentosa*), and branched tearthumb (*Polygonum meisnerianum*).

Control:

Removing dead material following climbing fern control activities may be desirable to reduce fuels and to promote native plant recovery. On-site disposal of dead climbing fern material, such as by burning, can reduce spore dispersal (reviewed by [5]).

Ferriter [5] provides an extensive review of climbing fern management in Florida, available online through Florida Exotic Pest Plant Council.

Prevention:

Frequent monitoring and immediate removal of newly established climbing fern populations may be the best strategy for mitigating their spread, especially since spore production can be prolific and spores may be dispersed over vast distances [5].

Integrated management:

No information is available on this topic.

Physical/mechanical: Repeated pulling and/or cutting can control small climbing fern infestations (reviewed by [29]). Cutting kills fronds above the cut site, but fronds can regrow from below the cut site and after pulling (reviewed by [5]).

Fire: See the Fire Management Considerations section of this summary.

Biological: Pemberton [25] and Pemberton and others [24] reviewed the developmental status (as of 2004) of biological control of climbing ferns in North America. In February 2005, more than 100 individuals of *Austromusotima camptonozale*, an Australian moth and the first biological control agent approved for use against Old World climbing fern in the United States, were released at the Jonathon Dickinson State Park, southeastern Florida. Larvae of *A. camptonozale* feed on Old World climbing fern leaves [7].

Chemical:
Several sources indicate herbicides may be an effective tool for controlling invasive climbing ferns. A review by Langeland [16] suggests the most common climbing fern control method, as of 2004, has been application of glyphosate and metsulfuron herbicides, either individually or in combination. When plants have grown into the canopy, stems may be cut and herbicide applied to the rooted portion of the plant [16]. Roberts [31] indicated foliar spraying of glyphosate can control Old World climbing fern, but few data and no analysis were provided. Descriptive results from several "demonstration trials" in southeastern Florida suggest that glyphosate, triclopyr, and 2,4-D can be used to at least top-kill Old World climbing fern, and that triclopyr ester (vs. triclopyr amine) may be "translocated" within the plant following application [37]. According to Randall [29], managers at Florida Caverns State Park have treated large Japanese climbing fern infestations by pulling the plants down from the trees and spraying their foliage with triclopyr. A review by Ferriter [5], citing unpublished data, indicated that glyphosate was effective for controlling Japanese climbing fern, although some follow-up spot treatments were necessary. Triclopyr treatments, while initially providing greatest observed Japanese climbing fern mortality, were ineffective in the long term due to extensive regrowth.

Other authors have indicated that herbicide use for climbing fern control may be problematic. A review by Stanturf and others [35] suggested that Japanese climbing fern "cannot be controlled by any available herbicide." Old World climbing fern can apparently "regrow after spraying" with herbicides (reviewed by [42]), although further details describing the biology of this phenomenon are lacking. Pemberton and Ferriter [26] suggested that chemical control of Old World climbing fern (and presumably also Japanese climbing fern) will be difficult without damaging associated vegetation.

Cultural: No information is available on this topic.

Lygodium japonicum, L. microphyllum: References

1.
Anon. 1992. Exotic fern a threat to wetlands. Restoration & Management Notes. 10(2): 199. [Abstract]. [20162]

2.
Bernard, Stephen R.; Brown, Kenneth F. 1977. Distribution of mammals, reptiles, and amphibians by BLM physiographic regions and A.W. Kuchler's associations for the eleven western states. Tech. Note 301. Denver, CO: U.S. Department of the Interior, Bureau of Land Management. 169 p. [434]

3.
Clewell, Andre F. 1985. Guide to the vascular plants of the Florida Panhandle. Tallahassee, FL: Florida

State University Press. 605 p. [13124]

4.
Eyre, F. H., ed. 1980. Forest cover types of the United States and Canada. Washington, DC: Society of American Foresters. 148 p. [905]

5.
Ferriter, Amy, ed. 2001. Lygodium management plan for Florida: A report from the Florida Exotic Pest Plant Council's Lygodium Task Force. [Orlando, FL]: Florida Exotic Pest Plant Council. 51 p. [55282]

6.
Flora of North America Association. 2004. Flora of North America: The flora. [Online]. Flora of North America Association (Producer). Available: http://www.fna.org/FNA. [36990]

7.
Flores, Alfredo. 2005. Moth released to curb spread of climbing fern, [Online]. Washington, DC: U.S. Department of Agriculture, Agricultural Research Service (Producer). Available: http://www.ars.usda.gov/is/pr/2005/050214.htm? [2005, October 27]. [54936]

8.
Florida Exotic Pest Plant Council. 2005. List of Florida's invasive species, [Online]. Florida Exotic Pest Plant Council (Producer) Available: http://www.fleppc.org/list/05List.htm [2005, November 1]. [54964]

9.
Garland, Mark A. 2004. Noxious weed list: Plants in chapter 5B-57.007, Florida Administrative Code, [Online]. In: Noxious weed information. Florida Department of Agriculture and Consumer Services, Division of Plant Industry (Producer). Available: http://www.doacs.state.fl.us/pi/enpp/botany/images/noxiousweedtable1.pdf [2005, November 1]. [54963]

10.
Garrison, George A.; Bjugstad, Ardell J.; Duncan, Don A.; Lewis, Mont E.; Smith, Dixie R. 1977. Vegetation and environmental features of forest and range ecosystems. Agric. Handb. 475. Washington, DC: U.S. Department of Agriculture, Forest Service. 68 p. [998]

11.
Goolsby, John A. 2004. Potential distribution of the invasive Old World climbing fern, Lygodium microphyllum in North and South America. Natural Areas Journal. 24(4): 351-353. [54657]

12.
Jones, Stanley D.; Wipff, Joseph K.; Montgomery, Paul M. 1997. Vascular plants of Texas. Austin, TX:

University of Texas Press. 404 p. [28762]

13.
Jordan, Ramon. 2001. USDA plant hardiness zone map, [Online]. Washington, DC: U.S. Department of Agriculture, Agricultural Research Service, National Arboretum (Producer). Web version of: 1990 USDA plant hardiness zone map. Miscellaneous Publication No. 1475. Available: http://www.usna.usda.gov/Hardzone/ushzmap.html [2004, August 30]. [48600]

14.
Kartesz, John T.; Meacham, Christopher A. 1999. Synthesis of the North American flora (Windows Version 1.0), [CD-ROM]. Available: North Carolina Botanical Garden. In cooperation with: The Nature Conservancy, Natural Resources Conservation Service, and U.S. Fish and Wildlife Service [2001, January 16]. [36715]

15.
Kuchler, A. W. 1964. United States [Potential natural vegetation of the conterminous United States]. Special Publication No. 36. New York: American Geographical Society. 1:3,168,000; colored. [3455]

16.
Langeland, Kenneth A. 2004. [Revised edition]. Natural area weeds: Old World climbing fern (Lygodium microphyllum). SS-AGR-21. Gainesville, FL: University of Florida, Institute of Food and Agricultural Sciences. 4 p. Available online: http://edis.ifas.ufl.edu/AG122 [2005, October 27]. [54935]

17.
Lott, Michael S.; Volin, John C.; Pemberton, Robert W.; Austin, Daniel F. 2003. The reproductive biology of the invasive ferns Lygodium microphyllum and L. japonicum (Schizaeaceae): implications for invasive potential. American Journal of Botany. 90(8): 1144-1152. [45270]

18.
McPherson, Guy R. 1995. The role of fire in the desert grasslands. In: McClaran, Mitchel P.; Van Devender, Thomas R., eds. The desert grassland. Tucson, AZ: The University of Arizona Press: 130-151. [26576]

19.
Mueller, Richard J. 1982. Shoot morphology of the climbing fern Lygodium (Schizaeaceae): general organography, leaf initiation, and branching. Botanical Gazette. 143(3): 319-330. [54938]

20.
Mueller, Richard J. 1983. Indeterminate growth and ramification of the climbing leaves of Lygodium japonicum (Schizaeaceae). American Journal of Botany. 70(5): 682-689. [54658]

21.
Myers, Ronald L. 2000. Fire in tropical and subtropical ecosystems. In: Brown, James K.; Smith, Jane Kapler, eds. Wildland fire in ecosystems: Effects of fire on flora. Gen. Tech. Rep. RMRS-GTR-42-vol. 2. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 161-173. [36985]

22.
Nauman, Clifton E.; Austin, Daniel F. 1978. Spread of the exotic fern Lygodium microphyllum in Florida. American Fern Journal. 68(3): 65-66. [54659]

23.
Paysen, Timothy E.; Ansley, R. James; Brown, James K.; [and others]. 2000. Fire in western shrubland, woodland, and grassland ecosystems. In: Brown, James K.; Smith, Jane Kapler, eds. Wildland fire in ecosystems: Effects of fire on flora. Gen. Tech. Rep. RMRS-GTR-42-volume 2. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 121-159. [36978]

24.
Pemberton, R. W.; Goolsby, J.A.; Wright, A. D. 2004. Old World climbing fern. In: Coombs, Eric M.; Clark, Janet K.; Piper, Gary L.; Cofrancesco, Alfred F., Jr., eds. Biological control of invasive plants in the United States. Corvallis, OR: Oregon State University Press: 447-448. [53107]

25.
Pemberton, Robert W. 1998. The potential of biological control to manage Old World climbing fern (Lygodium microphyllum), an invasive weed in Florida. American Fern Journal. 88(4): 176-182. [54939]

26.
Pemberton, Robert W.; Ferriter, Amy. 1998. Old World climbing fern (Lygodium microphyllum), a dangerous invasive weed in Florida. American Fern Journal. 88(4): 165-175. [54937]

27.
Punetha, N. 1987. Apical dominance and apical inhibition in the fronds of Lygodium japonicum (Thunb.) Sw. Phytomorphology. 37(4): 299-301. [54660]

28.
Radford, Albert E.; Ahles, Harry E.; Bell, C. Ritchie. 1968. Manual of the vascular flora of the Carolinas. Chapel Hill, NC: The University of North Carolina Press. 1183 p. [7606]

29.
Randall, John M. 1996. Lygodium japonicum--Japanese climbing fern. In: Randall, John M.; Marinelli,

Janet, eds. Invasive plants: Weeds of the global garden. Handbook #149. Brooklyn, NY: Brooklyn Botanic Garden: 97. [54664]

30.
Raunkiaer, C. 1934. The life forms of plants and statistical plant geography. Oxford: Clarendon Press. 632 p. [2843]

31.
Roberts, Dick. 1997. Old World climbing fern research and mitigation at Jonathan Dickinson State Park. Resource Mangement Notes. Orlando, FL: Florida Department of Environmental Protection, Florida Park Service. 9(2): 30-32. [55564]

32.
Rosen, David J.; Jones, Stanley D.; Rettig, Virginia E. 2003. A floristic survey of Big Branch Marsh National Wildlife Refuge, St. Tammany Parish, Louisiana. SIDA. 20(3): 1189-1216. [7075]

33.
Shiflet, Thomas N., ed. 1994. Rangeland cover types of the United States. Denver, CO: Society for Range Management. 152 p. [23362]

34.
Snyder, James R.; Herndon, Alan; Robertson, William B., Jr. 1990. South Florida rockland. In: Myers, Ronald L.; Ewel, John J., eds. Ecosystems of Florida. Orlando, FL: University of Central Florida Press: 230-274. [17391]

35.
Stanturf, J. A.; Conner, W. H.; Gardiner, E. S.; Schweitzer, C. J.; Ezell, A. W. 2004. Recognizing and overcoming difficult site conditions for afforestation of bottomland hardwoods. Ecological Restoration. 22(3): 183-193. [51278]

36.
Stickney, Peter F. 1989. FEIS postfire regeneration workshop--April 12: Seral origin of species comprising secondary plant succession in Northern Rocky Mountain forests. 10 p. Unpublished draft on file at: U.S. Department of Agriculture, Forest Service, Intermountain Research Station, Fire Sciences Laboratory, Missoula, MT. [20090]

37.
Stocker, Randall K.; Ferriter, Amy; Thayer, Dan; Rock, Michael; Smith, Steve. 1997. Old World climbing fern hitting South Florida below the belt. Wildland Weeds. (Winter): 6-10. [55556]

38.
U.S. Department of Agriculture, Natural Resources Conservation Service. 2005. PLANTS database (2005), [Online]. Available: http://plants.usda.gov/. [34262]

39.
Volin, John C.; Lott, Michael S.; Muss, Jordan D.; Owen, Dianne. 2004. Predicting rapid invasion of the Florida Everglades by Old World climbing fern (Lygodium microphyllum). Diversity and Distributions. 10(5-6): 439-446. [54662]

40.
Volin, John C.; Lott, Michael S.; Muss, Jordan D.; Owen, Dianne; Stewart, Joy. 2003. The physiological ecology of the non-indigenous invasive Lygodium microphyllum in South Florida. In: Abstracts--Invasive plants in natural and managed systems: linking science and management: Proceedings, 7th international conference on the ecology and management of alien plant invasions; 2003 November 3-7; Ft. Lauderdale, FL. [Place of publication unknown]: Weed Science Society of America: 92. [Abstract]. [54656]

41.
Wade, Dale D.; Brock, Brent L.; Brose, Patrick H.; [and others]. 2000. Fire in eastern ecosystems. In: Brown, James K.; Smith, Jane Kapler, eds. Wildland fire in ecosystems: Effects of fire on flora. Gen. Tech. Rep. RMRS-GTR-42-vol. 2. Ogden, UT: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station: 53-96. [36983]

42.
Wood, Marcia. 2000. Global search for climbing fern's foes. Agricultural Research. 48(7): 16-18. [54655]

43.
Wunderlin, R. P.; Hansen, B. F. 2004. Atlas of Florida vascular plants, [Online]. Tampa, FL: University of South Florida, Institute for Systematic Botany (Producer). Available: http://www.plantatlas.usf.edu/ [2005, October 27]. [54934]

44.
Wunderlin, Richard P. 1982. Guide to the vascular plants of central Florida. Tampa, FL: University Presses of Florida, University of South Florida. 472 p. [13125]

45.
Wunderlin, Richard P. 1998. Guide to the vascular plants of Florida. Gainesville, FL: University Press of Florida. 806 p. [28655]

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