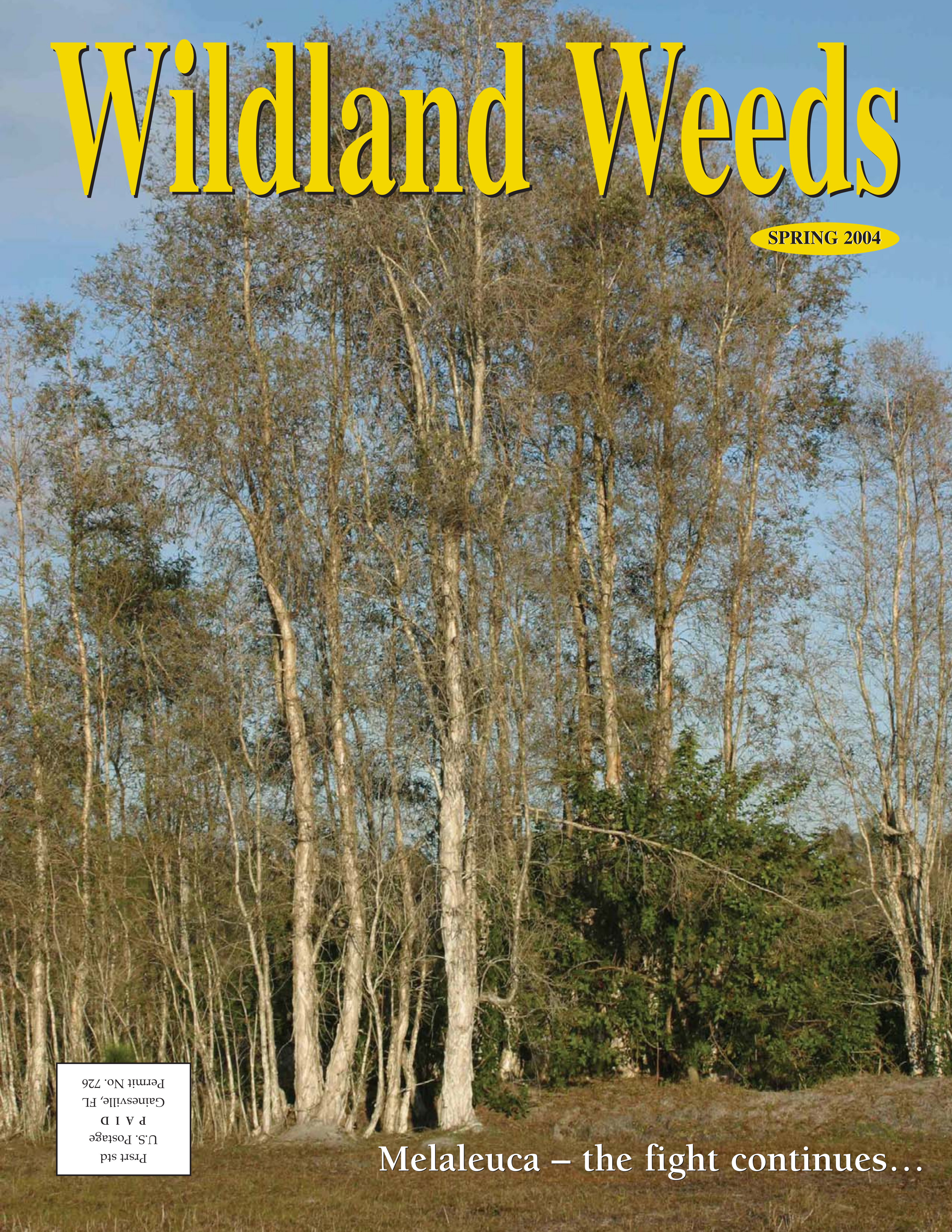
Wildland Weeds

SPRING 2004



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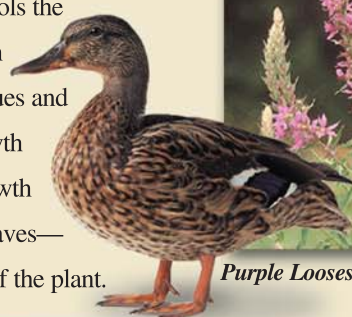

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Wildland Weeds

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Wildland Weeds is published to provide a focus for the issues and concerns regarding exotic pest plant biology, distribution and control. To become a member of FLEPPC or SE-EPPC and receive the Council newsletter and *Wildland Weeds* magazine, contact the respective Treasurer or website.

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On the Cover:

Melaleuca quinquenervia with reduced canopy as a result of feeding damage by the biological control agents *Oxyops vitiosa* and *Boreioglycaspis melaleucae*. *Photo by Paul Pratt.*

editor's note

Dear Readers,

As you will quickly notice, this issue of ***Wildland Weeds*** is almost entirely devoted to the highly invasive Melaleuca (*Melaleuca quinquenervia*). Although the cover of the Summer 2003 issue pictured "The Last Melaleuca," this proclamation referred to mature melaleuca trees in the Big Cypress National Preserve. The notoriously invasive tree still threatens many thousands of acres across south Florida. Our Spring issue includes articles on various methods of managing melaleuca, an update from the TAME Melaleuca project, a note on melaleuca's 'endangered' status in Australia, new information on rooting strategies of the tree, and a fresh look at it's widely-known allergenic properties. New information continues to roll in as the hard work continues.

Below is the new CD offered by the USDA Forest Service, *"Invasive Plants of the Eastern United States – Identification and Control"* featuring complete text and images from four recent books. It's great to see the many excellent tools becoming available in the fight against exotic pest plants. With state and federal agencies, non-profit organizations, professional associations and concerned citizens joining forces, we can, and will, make a difference! — In that light, be sure to join us for the FLEPPC/SE-EPPC Conference in Pensacola Beach, April 28th–30th. It's sure to be a productive meeting!

Karen Brown, Editor

DRAWING ON RECENT PUBLICATIONS by the USDA Forest Service, National Park Service, U.S. Fish and Wildlife Service, USDA APHIS PPQ and the Southeast Exotic Pest Plant Council, this CD-ROM covers the identification characteristics, distribution, and control options for 97 invasive tree, shrub, vine, grass, fern, forb, and aquatic plant species of concern in the eastern United States.

THE CD FEATURES THE COMPLETE TEXT AND IMAGES FROM THE FOLLOWING PUBLICATIONS:

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- **Nonnative Invasive Plants of Southern Forests: A Field Guide for Identification and Control**
- **Biological Control of Invasive Plants in the Eastern United States**
- **Plant Invaders of Mid-Atlantic Natural Areas**
- **Southeast Exotic Pest Plant Council Invasive Plant Manual**

Request free copies of the CD-ROM from Richard Reardon, FHTET, USDA Forest Service, Morgantown, West Virginia, (304) 285-1566, rreardon@fs.fed.us or from **www.invasive.org**

The project was funded by the USDA Forest Service, Forest Health Technology Enterprise Team in Morgantown, WV. Publication No. FHTET-2003-08

***The Areawide Management and Evaluation of Melaleuca (TAME Melaleuca)** is an inter-agency demonstration and implementation program funded by the United States Department of Agriculture's Agricultural Research Service (USDA/ARS). Its goal is to assess and demonstrate ecologically based, integrated melaleuca management strategies for landowners and land managers. This is the second Areawide grant in the country that has been awarded for an invasive plant (the first was TEAM Leafy Spurge; go to www.team.ars.usda.gov for more info).*

by Amy Ferriter

By the late 1980s, melaleuca - deemed the "Tree from Hell" - had reached crisis levels in Florida. Biologists were predicting ecological collapse in the Everglades. Indeed, melaleuca dominated almost a half million acres in South Florida and showed no signs of stopping. Early in 1990, the **Florida Exotic Pest Plant Council** and the **South Florida Water Management District** jointly convened a task force of federal, state and local land managers, scientists and others. Their charge was to develop a comprehensive, interagency plan for managing this notorious Everglades invader. The result was the first edition of the *Melaleuca Management Plan for Florida*.

In the fourteen years since its original publication, this Plan has served as a framework for agencies managing or seeking to protect natural areas infested by melaleuca. It has facilitated interagency cooperation and coordination of control efforts, improved resource utilization efficiency, enhanced public awareness of the problem and inspired legislative support.

The melaleuca management program in Florida is an example of a successful work in progress. Resource managers faced seemingly insurmountable obstacles when the fight began, but interagency cooperation has successfully turned the tide. Achieving this level of success has not been inexpensive. The melaleuca project (including biological, mechanical, chemical and physical control efforts) has cost nearly $35 million thus far. To place this in perspective, however, it was estimated that failing to act against melaleuca would have eventually cost the region $169 million annually in lost revenues. Ecological losses would have been immeasurable.

TAME Melaleuca is building on the success of the EPPC-sponsored *Melaleuca Management Plan for Florida*. Although most of the work will be conducted in Florida, a portion of the project includes assessment and outreach in other areas where melaleuca has escaped cultivation and is spreading into wildlands. An area of special concern is the Commonwealth of Puerto Rico, where melaleuca is just beginning to spread into and dominate valuable wetland areas. A group of TAME Melaleuca collaborators and steering committee members traveled to Puerto Rico in November 2003. The purpose of this trip was to assess melaleuca's invasiveness in Puerto Rico and demonstrate ecologically appropriate control techniques to natural resource managers there.

TAME Melaleuca Team members met with Puerto Rican biologists, foresters and resource managers. The Florida group gave presentations that focused on the problems associated with melaleuca and described the strategy that is outlined in the *Melaleuca Management Plan for Florida*. There is still much debate in Puerto Rico as to the threat melaleuca poses to wetlands. The group asked many questions about the ecological impacts of the species, with some Puerto Rican scientists questioning the need to control this species.

The group also toured Laguna Tortuguero on the northern coast between Vega Baja and Manati municipalities. This is the largest natural body of fresh water in Puerto Rico. The demand for water resources for public supply in the interior of Puerto Rico has led to increased groundwater withdrawals in wetland areas like Laguna Tortuguero.

Melaleuca populations in these wetland areas of Puerto Rico are still relatively contained, although at least one site had what Floridian biologists commonly term "dog hair" melaleuca – sapling-sized trees that grow as thick as

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a dog's hair. Experience in Florida shows that this type of situation will become an impenetrable monoculture of trees in a short time.

Hostess Lourdes Bernier [1] playfully hugs an ornamental Melaleuca tree planted near Laguna Tortuguero. Melaleuca is still used as an ornamental in Puerto Rico and land managers often have trouble convincing the public that it is not a desirable species.

Antonio Pernas (US Department of Interior National Park Service) [2] girdles a tree with a machete, demonstrating the "hack and squirt" method for Puerto Rican land managers. The white spongy bark around the circumference of the tree must be peeled away to expose the cambium for application of a herbicide.

Dan Clark (US Department of Interior National Park Service) [3] applies herbicide to the cambium of the melaleuca tree.

Integrated Pest Management at its finest: Biological control researchers Drs. Ted Center and Paul Pratt [4] try their hand at the hack and squirt method in Laguna Tortuguero.

Record rainfall plagued the early November Puerto Rico trip – mudslides and overflowing rivers hindered driving in some areas of the country. Floridians weed watched as large mats of "bull hyacinth" (*Eichhornia crassipes*) whipped under this bridge near Hatillo on the northern coast. [5] Police closed the bridge shortly after this picture was taken.

Floridians spotted many familiar weeds such as this Brazilian pepper (*Schinus terebinthifolius*) seedling growing amongst the melaleuca. [6]

Kudzu (*Pueraria montana*) is still commonly planted for erosion control in Puerto Rico, which somewhat alarmed the Floridians.

For more information on the TAME Melaleuca project, visit the TAME Melaleuca website at tame.ifas.ufl.edu or contact Amy Ferriter at the SFWMD, aferrite@sfwmd.gov, 561/687-6097.

Following is a preliminary list of Puerto Rico's invasive plant species. It was assembled by an interagency group of biologists and, although it has not been finalized, the list illustrates that land managers in Puerto Rico are beginning to recognize the invasiveness of some species, many of which also are pest plants in Florida.

LISTA PRELIMINAR PLANTAS INVASORAS EN PUERTO RICO

(Preparada por Comité Interagencial)

#	Nombre Científico (*Scientific Name*)	Nombre Común (*Common Name*)	Categoría Problemática (1-5:5 más problemática)	Rapidez de Cobertura (1-5:5 mayor rapidez) (*Rapidity of Coverage*)	Ubicación
1	*Casuarina equisetifolia*	Pino australiano, Australian pine	1		Costas
2	*Eichhornia crassipes*	Jacinto de agua, Water hyacinth	5		Cuerpos de agua
3	*Hydrilla verticillata*	Hydrilla		3	Cuerpos de agua
4	*Melaleuca quinquenervia*	Melaleuca, Paper bark	5		Humedales
5	*Mimosa pellita (pigra)*	Catclaw, Mimosa	5		Áreas alteradas
6	*Pistia stratiotes*	Lechuguilla de agua, Water lettuce	5		Cuerpos de agua
7	*Schinus terebinthifolius*	Pimienta del Brasil, Brazilian pepper	2		Costa norte
8	*Panicum repens*	Torpedo grass	1		Humedales
9	*Typha domingensis*	Eneas, cat-tail	2		Humedales
10	*Albizia procera*	Acacia blanca, Albicia, Tall Albizia	5		Zonas agrícolas; corredores de carreteras
11a	*Leucaena leucoc ephala*	Zarcilla, Acacia pálida, Wild tamarind	1		Zonas agrícolas
11b	*L. leucocephala var. K-8*	Zarcilla, Acacia pálida, Wild tamarind	5		Zonas agrícolas
12	*Sesbania exaltata*	Sesbania	2		Humedales
13	*Sorghum halepense*	Yerba Johnson, Johnson grass	5		Zonas agrícolas
14	*Rottboellia cochinchinensis*	Yerba picante o caminadora			
15	*Albizia lebbeck*	Acacia amarilla; Aroma, Thibet tree	1		Zonas secas
16	*Acacia farnesiana*	Aroma, Rayo, Cashia	3		Zonas agrícolas de ganado del sur
17	*Calotropis procera*	Calotropis, Algodón de seda, Giant milkweed	2		Zonas agrícolas de ganado
18	*Sida acuta*	Escobilla; Escoba blanca, Wire weed	2		Áreas perturbadas
19	*Psidium guajava*	Guayaba silvestre	1		Zonas agrícolas
20	*Prosopis juliflora*	Mesquite, Bayahonda	1		Zonas agrícolas del sur
21	*Mimosa casta*	Graceful mimosa	5		Zonas ganaderas
22	*Azadirachta indica*	Margosa, Neem			Suelos secos
23	*Hyparrhenia rufa*	Yaraguá falsa	2		Suelos secos
24	*Pennisetum ciliare*	Yerba Buffel	3		Zonas agrícolas con suelos calcáreos
25	*Alternanthera philoxeroides*	Yerba Caimán	4		Habitat acuático
26	*Pennisetum purpureum*	Yerba elefante, Elephant grass			
27	*Urochloa maxima (Panicum maximum)*	Yerba de Guinea, Guinea grass	3		Zonas agrícolas
28	*Bothriochloa pertusa*	Yerba huracán, Hurricane grass	3		Áreas perturbadas, pastoreo excesivo
29	*Pennisetum setaceum*	Yerba de fuente; erróneamente llamada "Pampa grass"	2		
30	*Brachiaria arracta*	Yerba Tanner	3		
31	*Paspalum fasciculatum*	Yerba Venezolana	4		
32	*Heteropogon contortus*	Yerba torcida, Twisted grass	5		
33	*Clitoria fairchildiana*	Clitoria	1		
34	*Solanum viarum*	Tropical Soda Apple	5		Área de mogotes
35	*Delonix regia*	Flamboyán			
36	*Sphatodea campanulata*	Tulipán africano	2		Áreas metropolitanas y sur de la Isla
37	*Sterculia apetala*	Anacagüita	3		
38	*Cordia oblicua*	Cordia	2		
39	*Salvinia molesta*	Giant salvinia			
40	*Rottboelia conin*	Rottboelia			
41	*Sida rhombifolia*	Escoba colorada	2		
42	*Maesopsis eminii*	?	2		
43	*Senna siamea*	Casia de Siam			

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Departamento de Recursos Naturales y Ambientales
Departamento de Agricultura
Universidad de Puerto Rico
(Estación Experimental Agrícola)

Una de las fuentes consultadas: Liogier, A.H. y L. P. Martorell. 2000. (2da. ed.) Flora of Puerto Rico and adjacent islands: a systematic sinopsis. Editorial de la Universidad de Puerto Rico. 382 págs.

Status and Impacts of the Melaleuca Biological Control Program

by C. S. Silvers, USDA-ARS Invasive Plant Research Laboratory

The biological control program for ***Melaleuca quinquenervia*** (melaleuca), an invasive tree in South Florida, began in the mid 1980s with the hunt for natural enemies in the tree's native range in Australia. More than a decade later, two insects have successfully run the gauntlet of quarantine-based host specificity testing and emerged as promising biological control agents in the fight to tame melaleuca. Six years after the first biological control agent release, feeding by the two insects is having a dramatic effect on melaleuca throughout southern Florida.

The melaleuca biological control program is spearheaded by the USDA Agricultural Research Service (ARS) Invasive Plant Research Laboratory (IPRL) in Fort Lauderdale, and relies heavily on support from a number of other agencies, including the Army Corps of Engineers, the South Florida Water Management District (SFWMD), the University of Florida, the Florida Department of Environmental Protection (DEP), the Departments of Environmental Resource Management (DERM) in Broward and Miami-Dade Counties, and Australia's Commonwealth Scientific and Industrial Research Organisation (CSIRO). As documented in the Melaleuca Management Plan (Laroche, 1999), the goal of the program was to complement removal efforts of land managers by slowing the spread of remaining infestations, thereby reducing the risk of new invasions and reinvasion of treated areas. To accomplish this, biological control agents were sought that would reduce melaleuca flowering and therefore seed production, and that would inhibit seedling growth and regrowth on cut stumps. This article describes how the two biological control agents already introduced for melaleuca management are meeting and even surpassing program goals.

[from top] Oxyops *weevil adult;* Oxyops *weevil larvae; Branch on right has been damaged by weevils.*

THE BIOLOGICAL CONTROL AGENTS

The first melaleuca biological control agent, the Australian melaleuca snout weevil ***Oxyops vitiosa***, was released in 1997 (Center et al., 2000). Both adult and larval stages of the weevil are foliage feeders, preferring tender new leaves (Purcell and Balciunas, 1994), although the majority of weevil damage is a result of larval feeding. Larvae feed externally, skeletonizing leaves by scraping tender tissue from the surface. Weevil-damaged leaves and branch tips dry out, become brittle, and break off.

The Australian psyllid ("SILL-id"), ***Boreioglycaspis melaleucae***, was the second melaleuca biological control agent introduced into South Florida, in 2002 (Wood and Flores, 2002). Like the weevil, the psyllid feeds on leaves and the immatures (nymphs) do most of the damage (Purcell et al., 1997). But unlike the weevil's chewing mode of feeding, the psyllid uses its piercing-sucking mouthparts to penetrate the leaf surface and feed on sap within the plant's phloem. The psyllid prefers to feed on tender foliage but will feed on older leaves as well, especially when psyllid populations are high and the amount of fresh foliage is limited. Psyllid nymphs secrete honey-dew, which hardens into small crystalline droplets. They also excrete white, waxy filaments that look like cotton when large quantities build up on plant surfaces. These white filaments, called flocculence, make detection of psyllids in the field easy despite their small size. Additional signs of psyllid feeding include leaf discoloration, which changes from yellow to red or brown, leaf desiccation and, ultimately, leaf drop.

[from top] Psyllid adult; Psyllid nymphs; Psyllid flocculence.

AGENT ESTABLISHMENT AND SPREAD

Both the melaleuca weevil and psyllid have readily established at release sites, particularly when releases coincided with a new flush of growth on the trees. The one notable exception is that weevil populations failed to establish in permanently aquatic habitats (Center et al., 2000). This is because the weevil spends part of its life cycle in the soil, falling to the ground to pupate. If the area is flooded for an extended period of time, the pupae drown. In contrast, the life cycle of the psyllid is completed entirely in the tree canopy where it is not affected by flooding.

After initial release and establishment, melaleuca biological control agents have the potential to spread unaided throughout melaleuca infested regions because both weevil and psyllid adults fly. Studies on the weevil estimated an average rate of spread of 0.6 miles per year (Pratt et al., 2003). At that rate, weevil populations were estimated to take 20 years to saturate Florida's melaleuca infestations. To expedite spread, a weevil collection and redistribution program was begun, organized by researchers at the IPRL, funded by DEP and DERM, and powered by labor from Student Conservation Association/AmeriCorps interns and the UF Cooperative Extension Service. The weevil redistribution program has so far collected almost 300,000 weevils and released them at 150 sites throughout southern and central Florida. Weevils are now present in at least half of the state's counties reported to have melaleuca infestations.

Much smaller and lighter than weevils, psyllids are dispersing as far as 6.8 miles per year, with an average rate of spread of 4.3 miles per year (Paul Pratt, unpublished). To expedite the landscape level impacts of psyllid populations, a collection and redistribution program also is underway for this insect. As of the fall of 2003, more than 450,000 psyllids have been released at 26 sites in Florida. The psyllid now appears to be as ubiquitous as the weevil, if not more so.

IMPACTS

In addition to the introduction and establishment of agents, a critical phase of a biological control program is follow up research on post-release activity of the agents. Scientists at the IPRL are currently quantifying impacts of melaleuca biological control agents on the target tree and surrounding vegetation, and determining how to most effectively integrate biological control with conventional control methods as detailed in the Melaleuca Management Plan.

Melaleuca on right was exposed to biocontrol insects while trees on left were protected with insecticide applications. Trees were of similar size when study began.

As part of the approval and permitting process for release, both the melaleuca weevil and psyllid underwent rigorous laboratory studies to insure they would damage only melaleuca and pose no threat to desirable plants or native vegetation (Balciunas et al., 1994; Purcell et al., 1997; Wineriter et al., 2003). Following release and establishment of the two agents in Florida, garden plots and field studies were conducted to confirm that the insects' specificity for melaleuca as a host in the laboratory held true in the field as well. Results from these studies showed that the biological control agents consistently selected melaleuca over other species for egg laying and feeding. When adult melaleuca weevils, for instance, were placed directly onto foliage of native plants (i.e., *Myrica cerifera*, *Eugenia rhombea*, *Calyptranthes pallens*, etc.) 78% of the insects dispersed in search of melaleuca trees within 3 hours and all abandoned the plants within 32 hours. While adult weevils may rest temporarily on native plants, sustained feeding or oviposition (completion of development) on native species has not been observed after three years of field assessments. Consistent with quarantine testing results, minor weevil feeding does occur on the Australian bottlebrush trees *Melaleuca* (=*Callistemon*) *viminalis* and *M. rigidis*.

Psyllid flocculuence and feeding damage on melaleuca flowers.

Undamaged melaleuca flower (left) and weevil-damaged flower.

Because melaleuca exhibits terminal growth, with new vegetative and reproductive buds emerging at branch tips, the biological control agents' feeding preference for new tips was predicted to hinder both growth and flowering of trees. In an ongoing study of biological control agent impacts on melaleuca saplings, trees that were not protected with insecticides and growing under drier, west coast conditions increased in height only 9.8% in 23 months and produced no flowers. Trees growing in wetter, east coast conditions increased in height by 22.6% during the same period and produced an average of 0.3 flowers per tree. In contrast, trees that were protected from the biological control agents with insecticides and growing under drier conditions increased in height more than 100% and produced an average of 4.6 flowers per tree. Finally, trees growing under wet conditions and protected with insecticides were able to increase their height by 127.2% and produce an average of 34 flowers per tree during the study period.

A separate study found that weevil feeding alone can reduce flowering and subsequent seed production by as much as 80% on mature melaleuca trees. Similar studies have shown that insect damaged melaleuca trees are 36 times less likely to reproduce than undamaged trees. For those few damaged trees that did reproduce in the study, the size of the flowers and number of seed capsules were greatly reduced as compared to undamaged trees.

An ongoing study to evaluate the integration of biological control agents with mechanical control shows that insect feeding on melaleuca stump regrowth (coppices) reduces plant biomass by more than 55% as compared to those protected from the insects. Similarly, in a separate study conducted in a cattle pasture, the combination of biological control and occasional mowing reduced the density of coppicing stumps by approximately 80% in less than five years.

Herbivory by the biological control agents also is proving to significantly reduce seedling and sapling survivorship. One study found that feeding by the psyllid alone resulted in as much as 65% seedling mortality after just three generations of the insect (~4 months). Preliminary analysis from a comparison of melaleuca stand density at Holiday Park in Broward County before (1996) and after (2003) insect release indicated that insects caused over 70% defoliation and 83% mortality of young melaleuca seedlings and saplings. This high mortality of juvenile trees directly interferes with natural regeneration of melaleuca stands at the insect release sites.

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Reductions in melaleuca canopy and tree density is followed by an increase in regeneration of various grasses and plants in the genera *Ardisia, Baccharis*, *Blechnum*, *Cephalanthus*, *Cladium, Ctenitis*, *Dryopteris*, *Eugenia, Ficus*, *Ilex*, *Myrica*, *Myrsine*, *Persea*, *Schinus,* and *Woodwardia*.

These research results indicate the melaleuca biological control program is accomplishing its objectives. Significant reductions in flower and seed production, leaf canopy, stand density, and survival and biomass of seedlings, saplings, and stump regrowth add up to a reduction in the invasiveness of melaleuca in much of South Florida.

SIGNIFICANCE FOR MANAGEMENT

But what does it all mean for land managers making treatment decisions? In addition to research results, observations from managers in the field indicate the biological control program is reducing melaleuca's invasive potential. Consequently, in areas most impacted by biological control it may be justified to reduce reliance on conventional tactics, such as herbicide applications, for containment.

Vegetation management crews with the SFWMD report seeing evidence of the biological control agents throughout their melaleuca treatment areas. They find that follow-up treatments are often postponed or in some cases unnecessary. In some areas, the efficacy of aerial herbicide treatments has improved. Francois Laroche of the SFWMD observed that as trees become stressed by insect feeding, they continually push new foliage, which is more susceptible to herbicide activity than mature leaves. Laroche thinks melaleuca's herbicide susceptibility may also be increased by better herbicide penetration as a result of weevil leaf scarring. Both Laroche and Jonathan Taylor with Everglades National Park report less flowering in melaleuca treatment areas. Taylor believes the negative impact of the agents on melaleuca reproduction, particularly in the East Everglades Acquisition Area at the far northeast corner of the park, is allowing him to better focus on removal of mature trees.

BIOLOGICAL CONTROL ON PRIVATE PROPERTY

One of the benefits of the biological control program is that the insects are self-sustaining – they can reproduce and disperse on their own. The insects and their impacts therefore have the potential to spread to all types of lands invaded by melaleuca, providing some level of control even in areas not being actively managed, including private properties.

Recently, the IPRL has received inquiries from homeowners about landscape melaleuca trees in poor health. Some people calling to find out what is damaging their melaleuca trees welcome the insects' assistance in ridding their property of the invasive trees. Others, however, are not so pleased. Insect feeding damage has reduced the amount of shade provided by the trees and made them thoroughly unattractive, so all of melaleuca's arguably redeeming qualities have been lost. In addition, the psyllid flocculence, although innocuous, can be a nuisance. Consequently, many people who previously had no desire to remove melaleuca from their properties are now anxious to get rid of it.

This recent flurry of public attention to melaleuca provides an opportunity to remind the public that melaleuca is listed by both state and federal agencies as a prohibited, noxious weed, that great effort and expenditure have gone into controlling it on public lands, and that any progress made in the fight against melaleuca is threatened as long as it continues unchecked on private lands. Moreover, the surge of interest in melaleuca removal among the private sector, if turned into action, could provide a big boost to areawide melaleuca management efforts on both public and private properties. Unfortunately, melaleuca removal is cost prohibitive for many small landowners and homeowners. Cost-sharing or similar incentive programs could go a long way towards encouraging these citizens to do their part in the fight against melaleuca.

For more information on the melaleuca biological control program and its impacts, contact the scientists at USDA-ARS IPRL, 3205 College Avenue, Ft. Lauderdale, FL 33314; (954) 475-0541; www.weedbiocontrol.org

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LOBATE LAC SCALE AND MELALEUCA

In parts of Broward and Miami-Dade Counties, a third insect, the lobate lac scale *Paratachardina lobata,* is attacking melaleuca. Unlike the melaleuca weevil and psyllid, the lobate lac scale is not part of the biological control program. Rather, lobate lac scale is yet another invasive, exotic pest threatening the ecosystems of Florida. The scale has a very broad host range, attacking well over 100 different woody plants, including native species, horticultural and agricultural cultivars. The scale is inconspicuous, appearing as tiny, brown, bow tie shaped bumps on stems and branches. The damage it causes, however, can be quite noticeable, including defoliation, branch dieback, and death. Even though damage to melaleuca by the scale may not be of concern, the fact that melaleuca is a host to lobate lac scale and can serve as a reservoir for further infestations of more desirable plants increases the importance of continuing to remove this invasive tree from the landscape.

COST COMPARISON OF

Melaleuca Treatment Methods

Introduction

Melaleuca (*Melaleuca quinquenervia*) is an exotic invasive plant species that was introduced to South Florida in the late 19th century. Melaleuca seeds were offered for sale in Florida in 1887 (Serbesoff-King, 2003), and the tree has been distributed throughout South Florida since that time. Around 1937, during the historic rush to drain swamps in the state of Florida, seeds from the native Australian tree were disbursed over the eastern portion of South Florida's Everglades. The tree was believed to be beneficial for drying wetlands for farming and development. In 1941, the United States Army Corps of Engineers planted *M. quinquenervia* on levees south of Lake Okeechobee for erosion control (Bramlage, 2000). Melaleuca was widely planted, and recommended as late as 1970, as "one of Florida's best landscape trees" (Watkins, 1970). Melaleuca grows extremely fast in a variety of conditions. Wetlands, seasonal wetlands, and well-drained uplands offer excellent growing conditions for the tree. Melaleuca is particularly a concern for South Florida because it is highly invasive and has the ability to adapt and flourish in a variety of ecological conditions.

The high production of viable seeds helps this species to establish and disperse and makes control a difficult challenge. Regardless of the method of removal, millions of viable seeds are left behind to re-establish melaleuca populations following any control initiatives. Current methods of control used for melaleuca include integrated strategies of herbicide application, limited mechanical means, and biological controls (Laroche, 1998). Control with herbicides is the most economical and most researched method. The costs and effectiveness of herbicide treatments are well known; however, little information is available on the use and cost of mechanical control options for melaleuca.

The purpose of this project was to determine and compare the cost of various means of mechanical and chemical treatment of melaleuca per amount of standing dry weight biomass treated or removed.

Material and Methods

The project site totaled approximately 400 acres divided into five parcels located in Broward County, Florida. Four parcels were approximately 40 acres each, and the fifth parcel was approximately 240 acres. Each parcel represented the use of a different method of treatment. Parcel No. 3 represented the South Florida Water Management District's (SFWMD) current method of chemical treatment, using ground crews to treat individual trees with the girdle and cut stump application of herbicides, a solution of imazapyr and glyphosate at 25% each. This is the preferred method of treatment for light to moderately infested tracts of land. Parcel 5, the largest parcel, represented aerial spraying, with a combination of 3qts of imazapyr and 3 qts of glyphosate per acre, which is currently the most economical method for controlling large melaleuca monocultures (Laroche, 1998). For Parcels 1, 2 and 4, contractors were selected through a Request for Proposal to treat or remove all exotics while trying to preserve the largest percentage of native vegetation possible within a 90-day period. Future American Corporation was selected for Parcel No. 1, Habitat Restoration Resources for Parcel No. 2, Applied Aquatic Management, Inc. for Parcel No. 3, and Florida Environmental Clearing, Inc. for Parcel No. 4. Helicopter Applicators, Inc. treated Parcel No. 5, which was not included in the estimations of dry weight standing biomass. It was treated by aerial application of herbicides only to illustrate the low cost of this method. All of these parcels were heavily infested, ranging from 90 to 100% coverage of melaleuca with very little incidence of native vegetation.

Tracked Feller Buncher

Future American Corporation proposed to manually cut melaleuca with chainsaws and shearing tools operated by prison inmates. The inmate crews would treat the remaining stumps with herbicide and would move the melaleuca biomass to a staging area where it would be chipped and loaded onto trucks. Lastly, the melaleuca chips would be delivered to prisons for bagging and sold as mulch, or the chips would be delivered to a power plant for bio-fuel.

Habitat Restoration Resources used a tracked Feller Buncher to cut down and windrow trees greater than 1-1/2 inches in diameter. The Feller Buncher cut the trees and also sprayed the stumps with an herbicide solution of 25% imazapyr and 25% glyphosate. Next, a shovel loader moved the tree logs to a staging area, located at the eastern boundary of the parcel, where the debris was chipped with a whole-tree chipper, loaded into trucks and hauled away. Last, a Gyro-Trac forestry mower was used to mow the remaining saplings and a labor crew was mobilized to treat the cut stumps with herbicide.

Applied Aquatic Management, Inc. used laborers with chainsaws and machetes to cut down or girdle melaleuca trees and treat with an herbicide solution of 25% imazapyr and 25% glyphosate. These methods are commonly referred to as "cut/stump" and "frill and girdle." Cut or treated trees were left on site to decay. Florida Environmental Clearing, Inc. used a ClearMore chipper/stumper to knock down melaleuca and grind the trees and stumps into the ground. The melaleuca mulch was mixed into the soil and the ground was left in a level condition upon completion. No herbicide was used with this method. It is proposed that the

ClearMore Tree Chipper/Stumper

melaleuca mulch layer left on the surface will suppress seed germination and the process left no remaining tree stumps for possible regrowth.

Helicopter Applicators, Inc. treated melaleuca by aerially broadcasting herbicide over the treatment area. Parcel No. 5 is approximately 240 acres, however only 188 acres were treated.

To determine total biomass, three experimental plots were measured within each of Parcels 1 thru 4. Within each plot, the diameter of each melaleuca trunk was measured in millimeters at breast height (diameter at breast height, dbh) with a digital micrometer. The circumference for large trees was measured with a metric measuring tape, and was later converted to diameter using the formula Diameter=Circumference/3.14. The measurement was recorded for all trees taller than breast height (approximately 1.5m). Trees shorter than breast height were counted as seedlings. Due to their minimal amount of standing biomass, seedlings have no significance in the analysis of biomass results. Therefore, seedlings were only counted for determining the population density of melaleuca in each parcel. Non-melaleuca species data were not collected. However, the common name of native species present was recorded and the presence of sawgrass (*Cladium jamaicense*) was recorded as sparse, scattered, or dense depending on the observed distribution throughout the plot. The dbh data was used to determine standing dry weight biomass. This was accomplished by using a known combined regression equation, developed by USGS scientists, for estimating standing dry weight biomass of melaleuca (Van, et al., 2000).

$$\mathbf{Log_e(W) = -1.83+2.01* Log_e(DBH)}$$
$$\mathbf{R^2=0.956,\ MSE=0.191}$$

This equation was used to convert the raw dbh data to standing dry weight biomass in metric tons/acre. The average of the plot results was used to determine the estimated biomass for the parcel.

The population density for each plot was calculated by taking the total number of trees counted for each plot (including seedlings) as the number of trees per square feet to determine density per acre in each parcel. Tree dbh measurements were divided into three categories to differentiate between trees sizes: small (dbh less than 10cm), medium (dbh greater than 10cm and less than 20cm), and large (dbh greater than 20cm).

The cost information, from actual completion of work and the proposed contract cost, was used to analyze the cost of each method of removal. A comparison was prepared to show the dollar cost per acre and the dollar cost per metric ton of biomass removed or treated. Acres treated were obtained by GPS measurements of the treated area in each parcel. The possible return from the sale of removed biomass was calculated for each contractor. Although not all contractors proposed to seek revenue from the biomass, this is a good indicator of the value of the melaleuca contained within each parcel. The possible biomass revenue was calculated by multiplying the total biomass contained in each parcel by an estimated market value of $3 per metric ton.

Results and Discussion

Melaleuca biomass, density, and size distribution varied among parcels, as summarized in Table 1.

Future American Corporation proposed a total contract cost of $58,000. The cost per acre for Parcel No. 1 would have been $1,620 based on 35.8 acres. The cost per metric ton of biomass for Parcel No.1 would have been $66 (Table 2). The total possible revenue from the biomass removed would be $2,628.67.

continued on page 14

Table 1. Melaleuca biomass data	Future American Co. (prison labor)*	Habitat Restoration Resources (Feller Buncher)	Applied Aquatic Mgmt. (manual herbicide)	Florida Environmental Clearing (ClearMore chipper)	Helicopter Applicators (aerial herbicide)
Acres	35.8	37.5	38.5	20	180
# Trees/acre	14,273	16,848	9,152	25,159	N/A
Size distribution: Small Medium Large	 93.92% 5.60% 0.49%	 91.93% 7.22% 0.85%	 96.71% 3.18% 0.11%	 96.15% 2.38% 1.25%	N/A
Total Biomass (metric ton)	876	2082	1741	1120	N/A
Metric ton/acre	24.49	55.54	45.24	56.03	N/A

Table 2. Melaleuca control cost by various methods of treatment	Future American Co. (prison labor)*	Habitat Restoration Resources (Feller Buncher)	Applied Aquatic Mgmt. (manual herbicide)	Florida Environmental Clearing (ClearMore chipper)	Helicopter Applicators (aerial herbicide)
Total Cost	$58,000	$99,400	$70,199.53	$75,190	$51411.70
Cost/Acre	$1,620	$2,651	$1,823	$3,760	$286
Cost/metric ton Biomass	$66	$48	$40	$67	N/A
Cost/Plant	$0.18	$0.19	$0.08	$0.22	N/A
Labor/equipment cost/acre	N/A	N/A	$1068	N/A	$60
Herbicide cost/acre	N/A	N/A	$755	N/A	$226
Time to complete	N/A	120 days	21 days	160 days	2 days

Treating Cost *continued*

However, this contractor did not perform the work; cost estimates were determined on the proposed cost for the purpose of this study. It should be noted that unforeseen complications, such as the inability to use prison laborers, could have caused the actual cost to be higher than expected. Habitat Restoration Resources' total contract cost was $99,400. The cost per acre for Parcel No. 2 was $2,651 based on 37.5 acres treated and a cost of $48 per metric ton of biomass. The total possible revenue from the biomass removed was $6,245.44. This contractor was the only one who actually removed the biomass from the site. The work was completed in approximately 120 days. Equipment breakdown and the use of several different types of machines increased the project completion time. Applied Aquatic Management, Inc. completed their contract for a total cost of $70,199.53. The cost per acre for Parcel No. 3 was $1,823 based on 38.5 acres treated and the cost per metric ton was $40. The total possible revenue from the biomass if removed would have been $3,482.66. The work was completed in 21 days with no complications. The actual cost for Florida Environmental Clearing was $75,190. The cost per acre for Parcel No. 4 was $3,760 based on 20 treated acres and a cost per metric ton of biomass of $56. The total possible revenue from the biomass if removed would be $6,720.37. This contractor had major complications and did not complete the whole parcel. Approximately half the parcel was treated (20 acres) over a period of 160 days. This equipment was never tested on melaleuca trees and the contractor needed to do some adjustments to account for the high density of the trees. Helicopter Applicators completed aerial treatment on Parcel No. 5 in two days. Information on this parcel was included to illustrate the low cost per acre of aerial treatment of dense melaleuca monocultures. The total cost for this method was $286.

Cost per acre of the four similarly sized parcels indicates that Future American Corporation would have had the lowest cost per acre of land treated at $1,620/acre. However, as stated earlier, this contractor did not perform the work. Therefore, the possibility exists that this method could be more costly than proposed. Consequently, the commonly used method of frill/girdle and cut/stump used in parcel 3 was the lowest, $1,823 per acre. The prison labor method would have been $200 lower, suggesting that Future American Corporation's method is not significantly less expensive. Many companies could perform similar work within a reasonable price range.

Statistical analysis of the data revealed that the variability between plots within each parcel was not significant. Parcel 1 and 3 yielded significantly lower average dry weight standing biomass than parcel 2 and 4, 25 and 45 metric tons per acre, respectively (Table 1). Parcel 2 and 4 yielded similar average dry weight standing biomass results, 54 and 56 metric tons per acre, respectively. The variation of average dry weight standing biomass between parcels 1 and 3 and parcels 2 and 4 can be explained by further analysis of the distribution of tree sizes. Parcels 2 and 4 had a greater amount of large trees present in the size distribution. The large trees contributed much more substantially to the amount of biomass in these parcels. Parcels 1 and 3 contained the highest percentages of small trees in the distribution, accounting for the lower average dry weight standing biomass. This can also account for the significant increase in time of completion in parcels 2 and 4. However, population density of melaleuca was relatively similar in parcels 2 thru 4. The contractors in these parcels dealt with similar numbers of trees. Tree density in parcel 1 was significantly lower.

Total dollar cost per metric ton of biomass contained within each parcel may represent a fairer comparison than dollar cost per land area since the amount of biomass contained within each parcel varies greatly between parcels of the same area. Greater effort and cost must be expended to treat parcels with higher metric tonnage of biomass. Based on cost per metric ton of biomass, the commonly used method of frill/girdle and cut/stump used in parcel 3 was the least expensive ($40 per metric ton of biomass treated). Florida Environmental Clearing (using the ClearMore chipper) and Future American Corporation (using prison labor) were the most expensive methods of treatment at $67 and $66 per metric ton biomass respectively.

Results from this study indicate that the widely used methods of frill/girdle and cut/stump treatment are more economical than mechanical methods of melaleuca treatment. However this method is not recommended for large areas of dense monoculture of melaleuca. Aerial application of herbicides remains the most economical and the most feasible choice of treatment ($286/acre) for large parcels of heavily infested lands. This method of treatment is not selective to target vegetation, however, and should only be used for monospecific stands of melaleuca.

For more information, contact Francois Laroche, Senior Environmental Scientist, Vegetation Management Department at the SFWMD, (561) 682-6193, flaroche@sfwmd.gov

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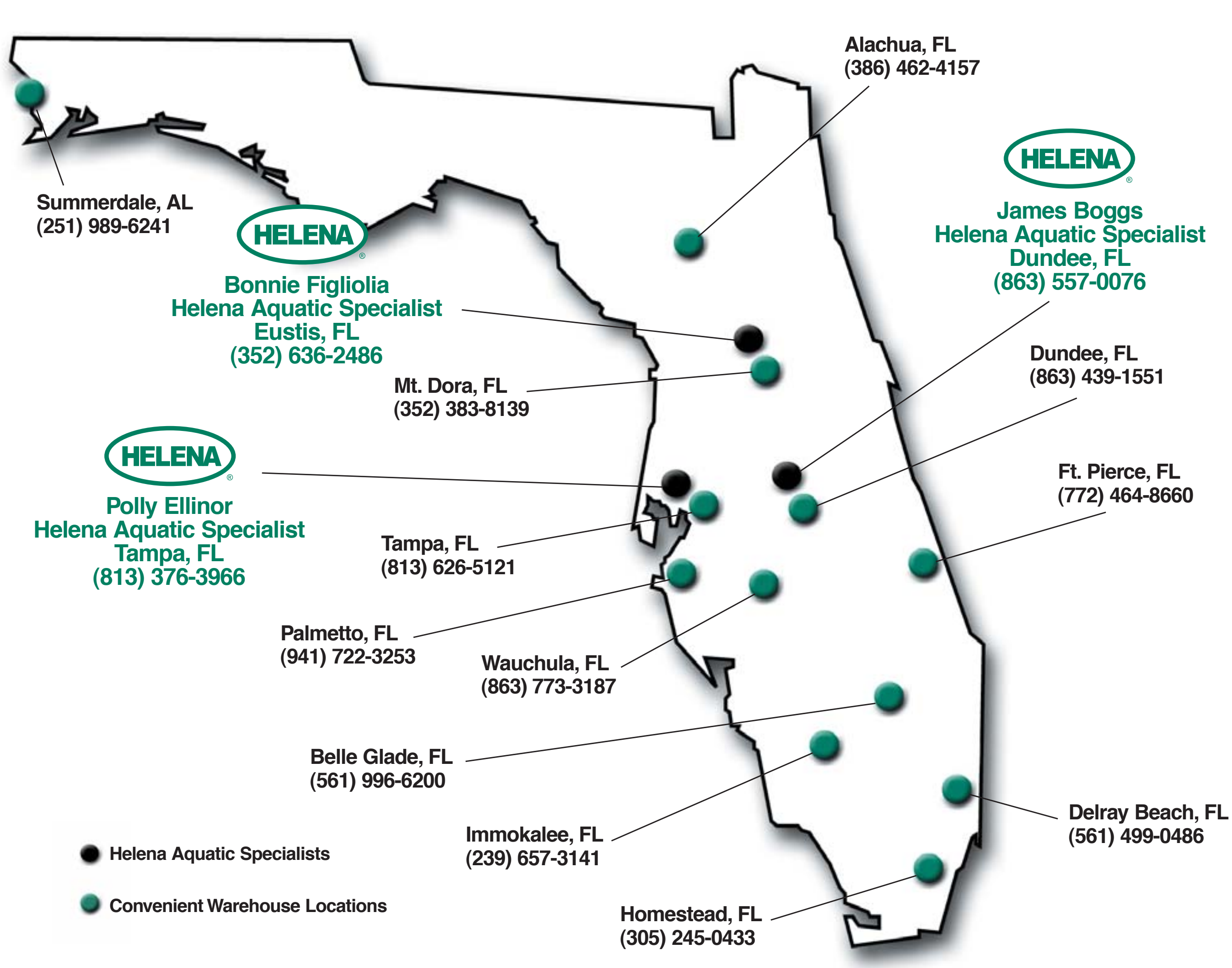

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Melaleuca as an Allergen - Setting the Record Straight

by Michael Meisenburg, UF/IFAS Center for Aquatic & Invasive Plants

Pollen from melaleuca (*Melaleuca quinquenervia*) trees triggers allergic reactions and asthma attacks for people all across South Florida, right? **Wrong**, says an emphatic Richard "Dick" Lockey, Director of the Division of Allergy and Immunology at the University of South Florida's College of Medicine. A paper authored by Lockey appeared in the "Proceedings of Melaleuca Symposium" (Lockey et al., 1980) that disputed the popular misconception, but it received little attention. The article was subsequently re-published in the *Annals of Allergy, Asthma, & Immunology* in 2002 (Stablein et al.), and it was in this second publication where I learned of the article. After reading it, I contacted Dr. Lockey and what he told me will surprise a lot of people in South Florida: Melaleuca pollen does not induce allergic rhinitis (allergies) or asthma in people.

Melaleuca flowers. *Photo by Paul Pratt*

It seems the hoopla started in the 1960's when Julia Morton first wrote about the medical consequences of the despised one (melaleuca, that is). Morton reported subjects who experienced respiratory symptoms after exposure to the tree, and skin irritation after contact with the bark. Unfortunately, her claims were not scientifically studied or reported in medical journals, nor were they correct.

The Lockey et al. study addressed four questions: Is melaleuca an important aeroallergen source? Are people with allergies and asthma skin-sensitive to melaleuca pollen extract (MPE)? Do people with positive skin reactions to MPE also respond with bronchial and nasal reactions? Does the odor from leaves, bark, or flowers induce reactions in people with allergies or asthma?

The findings indicated that melaleuca was not an important source of windborne pollen. Pollen samples taken from under and near melaleuca trees found very low levels of melaleuca pollen, but much higher levels of pollen from other groups of plants (i.e. oaks and grasses) and mold. It is important to remember that melaleuca flowers are pollinated by bees, and as such possess heavy, sticky pollen. Plant species that cause allergic reactions in people are those that utilize wind for pollen dispersal.

Ninety-seven of the 1,017 subjects (9.5%) tested for skin reactions to MPE responded with positive results. This finding is not entirely surprising, as clinical allergists routinely find clients that respond to MPE. The study further indicated that many of the subjects who tested positive to skin tests also reacted when an aqueous MPE solution was placed into nostrils. Positive results suggest an allergy to melaleuca pollen, but if the pollen cannot float in air, a positive reaction is moot. In addition, positive reactions to MPE are complicated by the presence of cross-reactive antigens, which in this case is pollen so similar to melaleuca's that the body reacts to it as if it were melaleuca. Bahiagrass pollen is a proven and abundant aeroallergen in South Florida, and acts as a cross-reactive antigen with melaleuca. Thus, while allergy specialists in South Florida often believe their patients are allergic to melaleuca pollen, what they actually are allergic to may be the windborne bahiagrass pollen. Dick Lockey concedes that melaleuca can cause contact dermatitis in people, albeit rarely. Finally, researchers found that test subjects did not react to melaleuca odors.

For forty years, the melaleuca tree has been blamed for causing allergies and asthma in the citizens of South Florida, and certainly this notion has helped weed managers as the public supported our efforts to rid the state of this species. Although Julia Morton may not have been correct, we have benefitted from her writings. With trepidation (and coaxing from Karen Brown), I decided to spread the word about the Lockey et al. study because, while the tree still gives us ample justification to dislike it, we should know the truth: Melaleuca pollen is not the culprit behind your sneeze.

For more information, contact Michael Meisenburg at ecomike@ufl or (352) 392-6894.

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Invasive Plant Education at Archbold Biological Station

by Jeffrey T. Hutchinson, Archbold Biological Station

Archbold Biological Station is a private non-profit ecological research institution located in Highlands County, Florida. The Station is located at the southern end of the Lake Wales Ridge in central Florida, an area with a high number of endemic plants. Scientists at Archbold conduct extensive research on plant ecology and fire ecology in central Florida ecosystems. As land manager at Archbold Biological Station (ABS), a major portion of my job is treating and controlling invasive vegetation. Over the past 10 years, staff awareness of invasive plants has grown at Archbold in response to the increasing rate of spread of these plants throughout central and south Florida. However, little emphasis was placed on education about these plants. The large number (>2000) of visiting elementary-school students, college interns, and university classes that visit Archbold each year presents an ideal educational opportunity. A $750 grant from the Florida Exotic Pest Plant Council allowed me to develop a multi-faceted invasive plant education program at Archbold that includes a web site, kiosk, field guide, treatment and monitoring manual, PowerPoint presentation, and volunteer workdays to inform individuals and groups about the impacts of invasive plants on Florida's natural communities.

Invasive Plant Web-Site

The primary educational tool initiated with the FLEPPC Education Grant was a web site on the invasive plants of Archbold Biological Station and Highlands County. Published online on July 10, 2003 with the assistance of ABS Webmaster, Fred Lohrer, the site contains over 98 pages plus numerous links. To visit the site, go to www.archbold-station.org/abs/index.htm, click on Land Management (under What We Do), and then click on Invasive Plants at Archbold.

A total of 81 exotic plants, categorized as Category I (n=30), Category II (n=12), or nuisance plants (n=39), are described using text and photos. Nuisance plants are locally problematic introduced plants at ABS or in areas in Highlands County, but are not listed as Category I or II by FLEPPC. Special sections of the web site are devoted to invasive plant control projects at Archbold, treatment of invasive plants, other information (a catch all category), volunteer and internship opportunities, links to other web sites on invasive plants, and a list of some other publications on invasive plants in Florida. Updates to the web site will occur as needed and as additional invasive species are discovered. The website is pictorial rather than text oriented and includes several photos of each species of invasive plant.

Information Kiosk

Approximately 1,400 elementary students from Highlands, Hendry and DeSoto County visit ABS each year to learn about the Lake Wales Ridge Ecosystem. A new kiosk was put in place in November 2003, just in time for the 2003-2004 school year. The kiosk contains general information about invasive plants and their treatment and control, and photos of nine of the worst invasive plants found at the Station. Nancy Deyrup, Archbold's education coordinator, will use the new kiosk as part of her "nature walk" to discuss the impacts of invasive plants on Florida's natural communities. Located near the main entrance of Archbold, the kiosk is available to all visitors.

Field Guide

Laminated booklets entitled *"Invasive Plants of Archbold Biological Station"* were compiled as a guide to land management interns and visitors. Focusing on Category 1 and II plants and certain nuisance plants, the booklets include photos and key characteristics for field identification, and location maps of the 47 most invasive plants found at Archbold.

Treatment and Monitoring Manual

A 75-page manual entitled *"Treatment and Monitoring of Invasive Plants at Archbold Biological Station and the Reserve Based on the Impact, Pest, and Control Status of Each Species"* was compiled for the land manager and maintenance staff to address priority treatment of the most invasive plants at ABS. The manual ranks the twenty-one most invasive species at ABS based on distribution and abundance, gives recommendations for treatment and control, and provides maps showing the current locations of each species. Ongoing, small-scale restoration projects are given priority treatment schedules for each month of the year. Basic information also is presented on the herbicides used, treatment methods, and equipment recommendations.

Ecology Summer Day Camp

Archbold's Ecology Summer Day Camp is held in May and June each year. Five weeklong sessions accommodate approximately 90 students (ages 7-12 years). Each session provides hands-on learning activities including a presentation and field experience unit on the impact of invasive plants on natural communities in Florida. This unit includes a discussion of invasive plant identification using laminated photos on highly invasive species such as air potato, Old World climbing fern, rosary pea, melaleuca, and Brazilian pepper, and an "Air Potato Olympics" during which the campers collected air potatoes and tore down vines from an area on the main grounds of Archbold. The students, divided into 4 groups, competed for prizes awarded to the group that collected the highest total weight of air potatoes, and individual campers that collected the largest, smallest, and strangest looking air potato.

Presentations

Land management PowerPoint presentations that emphasize invasive plants were developed and shown to the Highlands County Audubon Society, University of Florida Environmental Law class, and several visiting high school classes. The presentations depicted all Category I and II plants known from Archbold and their effects on natural communities. On several occasions, shorter presentations were combined with 0.5-1.0 hour exotic plant removal projects on the main grounds. The presentations are available to any group or organization from Highlands County, or counties nearby.

Volunteer Workdays

Invasive plant removal workdays are held monthly at Archbold and are coordinated through The Nature Conservancy's Ridge Ranger Program. Typically 5-10 volunteers work from 8:00 a.m. to 12:00 noon. Most workdays have focused on removal of air potato from the main grounds, but other projects include replanting native vegetation, hand pulling natal grass, removal of flame vine, collection of rosary pea seedpods, and removal of torpedo grass from Archbold's Lake Annie. Several volunteers put in over 40 hours each during 2002.

Conclusions

The first year of the Invasive Plant Education Program was successful in that a framework for future education programs on invasive plants was initiated at Archbold. The environmental education program will reach approximately 1,400 annually in addition to interns, visitors, and visiting college classes, offering a great opportunity for many years to inform these people on the impacts of invasive plants on the natural communities of Archbold and throughout Florida. The web site will be updated as more invasive plants are discovered in Highlands County, while timely topics such as the proposed planting of 8,000 acres of giant reed (*Arundo donax*) in Highlands County are addressed.

Copies of the Field Guide and Treatment and Monitoring Booklet are available on CD, and the PowerPoint presentations may be borrowed. For further information or suggestions for the web site, contact the Land Manager at Archbold Biological Station, 863-465-2571 or landmanager@archbold-station.org, P.O. Box 2057, Lake Placid, FL 33862.

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IPINAMS and EMAPI 7 Conference - A Report

by Thaddeus Hunt, UF/IFAS Center for Aquatic & Invasive Plants

The Conference

When 700 (plus) of the world's scientists, land managers, policy makers, teachers and students congregate in Ft. Lauderdale for the sharing of data, information, and ideas on exotic, invasive plants, you would expect to learn a few new things and to meet a few new people. At the **IPINAMS** (Invasive Plants in Natural and Managed Systems) and **EMAPI** (Ecology and Management of Plant Invasions) joint conference, you also got to witness synergy and the creation of history. Participants from the United States, China, India, New Zealand, Portugal, Italy, South Africa, South Korea, etc., representing a majority of the world's exotic weed specialists, coalesced at the Wyndam Bonaventure Resort on November 3, 2003 and remained until November 7th, completing almost a week of intellectual, practical, and social interactions to help close the race between exotic weed management and exotic weed anarchy.

Dr. Paul Pratt of the Invasive Plant Research Laboratory (USDA/ARS) in Fort Lauderdale shows the effects of biological control agents on melaleuca to attendees of the IPINAMS/EMAPI conference.

The Plan

Nelroy Jackson opened and set the tone for the conference with a reminder for us to extend ourselves to those with whom we are not familiar, to broaden our realms of influence, and to attend sessions where we were not experts and had little background on the topic of discussion. We were reminded of how fortunate it is to have such an international conference and the benefits available through it. The morning sessions served to focus our thoughts each day by discussing broad themes including prevention, early detection, rapid response, management linkages to science, and policy. Many other themes were also resident during the conference including public outreach, planning for the future, the marketplace, and enough others that to continue listing them would violate some rule, which I am sure exists, against long lists, wasted paper, and contextual relevance. They can be condensed, however, to "Ya want it or need it; we got it."

The Setup

At the resort, 10 rooms had been allocated for concurrent sessions, one room allocated to house a large and illuminating poster session, and one very long and high traffic hallway allocated for the purpose of housing buffet tables and coffee dispensers. Away from the resort, buses were allocated for the transportation of guests and bag lunches to various gardens, parks, reserves, labs, and beaches so that they might experience Florida through the conference field trips.

The Action

The typical day started with snacks in the hall followed by three theme speakers in the grand ballroom, after which you had the option of eating a continental breakfast or not eating a continental breakfast. Either way you inevitably found your way to a symposium, workshop, or moderation of oral contributed papers in concurrent status. If you were lucky and from Florida, you did not have to sit under an A/C vent during any of these sessions. These events, by the way, had a variety of topics such as predicting invasions and preventing entry, mapping, vulnerability of communities, effects on soil, and much more. If you wanted it, they had it. This was promptly succeeded by lunch, which gave way to more symposia, oral contributions, workshops, and hooky. At 5 p.m. everyone was set loose to relax and to imbibe the intellectual contributions of the poster session. These contributions came from a diversity of sources with equally varied topics. You might read about distribution in South Korea, take two steps, read about community participation, have an *hors d'ouvres,* then get embroiled in a conversation about nickel hyper accumulators. If, after all this, you found yourself in command of your faculties, you could indulge in roundtable discussions on topics related either directly or philosophically to exotic weeds.

The less typical day put you on a bus to some remote location of South Florida where you would subsequently consume gourmet visions of Florida and a bagged lunch for dessert. Symposium junkies could start the conference a day early at the Information and Data Sharing Workshop.

The Results

If you are a professional teacher, paid for one day of the conference, and attended on your most relevant day, then you were finished with the conference on Monday evening after witnessing weed control professionals shower you with Styrofoam fragments and imagination. You also hopefully brought many wonderful lessons to your students on Tuesday. All other attendees completed each day with new understanding of the strengths and weaknesses of current weed controls, the values of the incoming exotic plant specialists, and the global scale and attention given to these plants, refined goals, as well as new friends and associates. The field trips brought guests who originated from almost anywhere on the planet to experience south Florida weeds, natives, and spot showers. If you were a wannabe graduate student, you left with a new education and your first contact with possible graduate professors.

If you didn't make it to this conference, you should be encouraged to attend the next **EMAPI** in Poland in 2005. If you want it, they will have it. This **EMAPI** and **IPINAMS** conference was an exciting and productive event, illustrating the global attention that exotic plants/weeds have obtained as well as the minds and policies that undertake the responsibility for proper management of these plants for the preservation of all natural resources.

Below Ground Competitive Strategies:

THE ROOT OF THE MELALEUCA PROBLEM IN A SOUTH FLORIDA FLATWOODS

Isabel Lopez-Zamora, Nicholas B. Comerford, Soil and Water Science Department, and Randall Stocker, Center for Aquatic and Invasive Plants, University of Florida/IFAS

Non-native plant species are able to out-compete native Florida plants in many habitats. We are learning about the mechanisms that explain just how that occurs. For instance, many populations of *Sapium sebiferum* (Chinese tallow) in the US allocate much more of their available energy to rapid growth than to defense mechanisms against insects, compared to populations in their native habitats (Rogers and Siemann 2002). Most of what we are learning involves either the physiology of the species, or the above ground morphology. Far fewer studies are looking at root competition - the real battleground beneath the surface where the other half of each plant lives.

How the Other Half Lives

The importance of root competition is nothing new—it was recognized as early as 1960 (Aspinall 1960; Harper 1961; Drew 1966; Baldwin 1972 and Atkinson 1973). Since as much as 50 percent of a plant lies below the soil surface, it might be expected that the same percent of the research on plants would focus on root physiology, morphology, distribution, and function. But we tend to study what is most easily seen, and roots are usually hidden (Waisel *et al.* 1996). Anyone who has tried to dig out the entire root system of even a small shrub can attest to the difficulties involved. Additionally, the very act of exposing plant roots is usually lethal to the plant—we can't easily watch root processes in place!

That hasn't kept researchers from learning how roots interact with other roots and with the soil environment. Most studies have focused on highly managed agricultural ecosystems, including studies in agroforestry (e.g., Livesley *et al.* 2002, Mickovski and Ennos 2002), row crops (e.g., Tuor and Froud-Williams 2002), rice (e.g., Gibson *et al.* 1999), and golf course putting greens (Kendrick and Danneberger 2002). Native plant communities have not been ignored. Seed production and germination success have been related to root competition in native plants (Allison 2002). Success of seedlings of certain tree species has been tied to root competition (Ammer 2002).

But more and more researchers are looking underground to answer questions about why our native plant communities are losing out to non-native species. Successful interspecific root competition (roots of two different species competing for the same limiting resource, such as nitrogen, phosphorous, water, etc.) is suspected as a primary reason why *Sapium sebiferum* (Chinese tallow) is able to outcompete native trees such as *Quercus virginiana, Acer negundo, Celtis laevigata, Salix nigra*, and *Liquidambar styraciflua, Taxodium distichum,* and *Quercus nuttallii* along certain parts of a hydrological gradient in Louisiana (Denslow and Battaglia 2002). Root competition may explain why native plants replanted into a *Pennisetum setaceum* (fountain grass) infestation in Hawaii were able to suppress the *P. setaceum* following certain site treatments (bulldozing, shade, outplanting), but not others (Cabin et al. 2002). We know that openings in the forest canopy are frequent sites for non-native plant invasion in Florida, and researchers have shown reduced root competition in some of these open areas (Cahill and Casper 2003).

Melaleuca quinquenervia is classified as a Category I Species by the Florida Exotic Pest Plant Council (FLEPPC 2001). This definition refers to non-native invasive plants that are altering native plant communities in Florida by displacing native species, changing community structures or ecological functions, or hybridizing with natives.

Anyone who has traveled in south Florida is well aware of the widespread distribution of *Melaleuca quinquenervia*. As impressive as the number of trees present is the number of different types of habitat that this species has been able to invade. What is not as obvious is just why this plant is able to outcompete our native vegetation. Several studies have shown that *M. quinquenervia* produces a tremendous number of flowers and seeds (Meskimen 1962), and that seeds can be transported by both wind and water. So "how does *M. quinquenervia* get around?" is much better understood than "how is it able to occupy space faster than native plant species?"

Once *M. quinquenervia* forms a very dense canopy, it is logical to assume that the shade produced probably limits the types and amounts of native plants that can grow. However, it may be that *M. quinquenervia*'s roots allow it to first dominate a site and exploit soil resources. To study root competition in *M. quinquenervia*, we chose a flatwoods site near Lehigh Acres, Florida, where *M. quinquenervia* grows interspersed with the native grass *Andropogon virginicus* (broomsedge bluestem). The site has poorly drained soil, and is frequently flooded during the rainy season (summer), but also is subject to periodic drought—the water table varied from 3 feet below, to 4 inches above the soil surface during the time of our study. See what was going on underground between germination and canopy closure, we used the part of the site where *M. quinquenervia* had been removed with herbicide five years before our study started, but was re-invading from seeds. Thus we had trees that were from one to five years old.

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Photo 1. A soil trench method was used to measure the root distribution and density of field grown Melaleuca quinquenervia *trees in an age sequence.*

There are two major ways that *M. quinquenervia* can get the nutrients it needs when faced with competition from the native grass: it can simply do a better job of pulling water and nutrients from areas already occupied by the grass (termed "tolerance"), or it can avoid competition and send it's roots into parts of the soil horizon where the grass roots are not found (termed "avoidance").

Bare Root Stock

Examining roots in the soil is not the straightforward process it may seem. First you have to be able to identify which root belongs to which species (tree or grass), then you either have to map out the location of a sample of roots at varying depth, or develop some index of root location within the site. And since root size is an important indicator of where each species is putting its energy, volume measurements have to be taken as well.

We chose to use a soil trench method (photo 1) to find the roots, and an index method to compare the number and volume of the roots we found. We dug a trench approximately 3' wide by 3' deep x 16' long. The youngest *M. quinquenervia* trees were located at one end of the trench, and the oldest at the other. To get a better understanding of the variability within this site, we dug two more trenches (total of three). Roots were examined in three sections of each trench, corresponding to the youngest, middle-aged, and oldest trees along the trench line. Along the face of those specific sections of the trench, the location and diameter of each root found was recorded, and reported as the number of roots per square inch of trench face. Then a small amount of the trench face was removed, and the number of roots was counted and reported as the number of roots per cubic inch of soil volume. Each root was identified as either *M. quinquenervia* or *A. virginicus*.

This approach would give us a reasonable idea of where the roots of each species were located, and what proportion of the total root volume was located at each depth. This is important "historical" information of what has already happened at this site. It did not, however, let us see what happens when *M. quinquenervia* tries to move into an area already occupied by a native grass.

To accomplish that, we planted *A. virginicus* in plastic trays filled with soil collected from the study site (photo 2). Different amounts of phosphorous and nitrogen were added to the trays so we could see the effects of nutrient level on competitive ability. Those trays were then placed in the field where *M. quinquenervia* roots could grow into them.

The Square Root of Melaleuca Is...?

The first surprising result was that *M. quinquenervia* had higher root densities in the upper four inches of the soil trenches than did the native *A. virginicus* (Table 1). In other words, even one-year-old *M. quinquenervia* trees dominate the upper part of the root zone. By age five, *A. virginicus* roots were nearly absent from that upper zone. *A. virginicus* grew much better in the growth trays supplemented with additional nutrients - it may well be that *M. quinquenervia* is much more efficient at exploiting a low nutrient soil than is *A. virginicus*.

Not only were the root densities of *M. quinquenervia* much higher than *A. virginicus*, they were higher than what has been recorded for 20-year-old native southern pines (*Pinus elliottii*

Table 1. **Comparison of root length density values for 1- and 5-year-old Melaleuca trees and native grass *Andropogon virginicus* growing in the study site at Lehigh Acres, FL with those reported for a 20-year-old slash pine stand by Van Rees and Comerford (1986).**	*Melaleuca quinquenervia*	*Andropogon virginicus*	Compared with 20-year-old *Pinus elliottii* var. *densa* (Van Rees and Comerford 1986)
Root density* upper four inches of soil: -at the 1-year-old end of the trench -at the 5-year-old end of the trench	3.9 7.8	.52 .045	4.68
Root density at (mid-level) - ten inches depth: -at the 1-year-old end of the trench -at the 5-year-old end of the trench	1.57 3.12	.026 .026	.845
Root density at (below 16 inches) depth: -at the 1-year-old end of the trench -at the 5-year-old end of the trench	.045 2.16	0 0	2.6

* expressed as: in of root/in^3 of soil volume

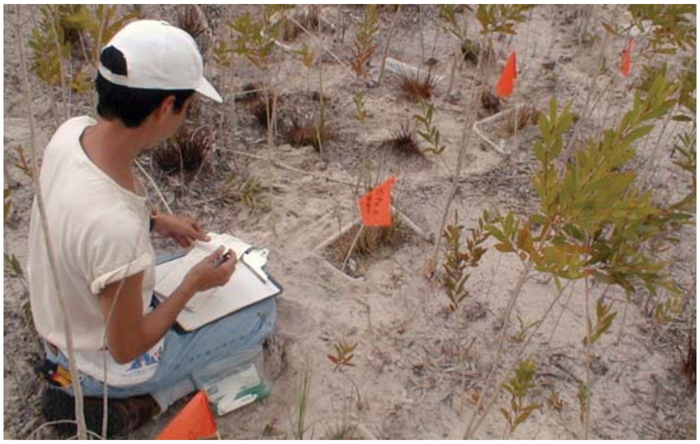

Photo 2. A growth tray study was carried out to address the ability of Melaleuca quinquenervia *to grow roots into soil volumes already occupied by* Andropogon virginicus *root systems.*

var. *densa*) growing on similar soils (Table 1; Van Rees and Comerford 1986).

The roots of *M. quinquenervia* aggressively invaded the *A. virginicus* in the growth trays, regardless of the head start provided to *A. virginicus*. Root densities for *A. virginicus* were substantial, but that did not keep *M. quinquenervia* roots from invading. It is clear that a) *A. virginicus* roots do not inhibit *M. quinquenervia* root development, and b) *M. quinquenervia* is able to tolerate the presence of *A. virginicus* roots — it does not have to avoid native grass roots by growing to an unoccupied portion of the root zone.

Wet Roots vs Dry Roots

Melaleuca rooting also was shaped by the water regime. Melaleuca roots were sampled during both wet and dry conditions. Root densities were lower in dry conditions and higher under wet conditions. The ability of melaleuca to produce high root densities in wet sites helps explain why it is commonly found in these areas. Melaleuca simply tolerates both wet and dry conditions very well.

Rooting Through the Muck

M. quinquenervia roots were present throughout the entire soil profile (Table 1), root density increased with age, and root densities were not negatively affected by the periodically high water table. Root densities for *A. virginicus* were much lower overall, and were zero below 16 inches. *M. quinquenervia*, in other words, not only is able to outcompete *A. virginicus* within the "grass root zone," but it is able to extend roots into sub-surface levels where *A. virginicus* does not grow. *M. quinquenervia* is able to both tolerate *and* avoid competition with *A. virginicus*.

The Root of the Problem - Conclusions

Plant competition is an important factor influencing plant invasion and in predicting the conditions under which a new species can enter a soil compartment (Connell 1983, Fowler 1986, MacArthur and Wilson 1967, Schoener 1983, Strong et al. 1986). The results of this study showed that *M. quinquenervia* is

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an excellent belowground competitor, able to both tolerate and avoid competition from native species. It grows well in wet and dry soils, and can invade soil of high and low fertility. *M. quinquenervia* roots can rapidly invade soil compartments with pre-established, vigorously growing, native *A. virginicus*, and also unoccupied soils. *M. quinquenervia* trees are able to develop greater root densities than those of native vegetation that grow in the same soil conditions. All of these competitive strategies help to explain Melaleuca's enormous success as an invader of flatwoods in south Florida.

For more information on this study, contact Isabel Lopez-Zamora at ilopez@ufl.edu

Acknowledgments

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In response to a "Thanks mates" to Aussie Garry Werren for the invasive Australian tree, *Melaleuca quinquenervia*, Garry responds:

"Thanks mates!"

Indeed!!! Well, I can return that compliment for you - pond apple, *Annona glabra*. This plant now is a weed of national significance here in Australia, achieves the highest score when assessed by the regional weed risk assessment system I developed a couple of years ago, and is expanding widely within the wet tropics region of north Queensland. There also are spot infestations along the Cape York Peninsula coast. Here it actually threatens paperbark [*Melaleuca quinquenervia*] dominated freshwater wetlands (!!!) that are regarded as endangered regional ecosystems. So thanks for *that* mate! QPWS (Queensland Parks and Wildlife Service) actually have used fire to suppress pond apple and promote paperbark reestablishment. It is weird just how things get turned on their head when us humans disregard those geographic barriers that make the world such a rich and fascinating place."

From Garry Werren, Research Officer for the Australian Centre for Tropical Freshwater Research and Assoc. Lecturer in the School of Tropical Biology at the Cairns Campus of James Cook University in Queensland, Australia, garry.werren@jcu.edu.au

Editor's Note: *Annona glabra* is a native plant in south Florida that once occurred in abundance around Lake Okeechobee.

Internodes

Mark Your Calendar

- 55th Annual Meeting of the American Institute of Biological Sciences (AIBS), **March 16-18, 2004**, Westin Grand Hotel, Washington, DC. *Invasive Species: the Search for Solutions.* http://www.aibs.org/annual-meeting-2004/index.html
- 65th Annual Meeting of the Association of Southeastern Biologists (ASB), **April 14-17, 2004,** Memphis, TN. http://www.people.memphis.edu/~biology/asb/
- 19th Annual FLEPPC and 6th Annual SE-EPPC Joint Symposium, **April 28-30, 2004**, Clarion Conference Center, Pensacola Beach, Florida. www.fleppc.org or www.se-eppc.org
- 2004 Aquatic Weed Short Course, **May 4-7, 2004**, UF/IFAS Fort Lauderdale Research and Education Center. Fort Lauderdale Marriott North. http://conference.ifas.ufl.edu/aw/
- 2004 Annual Conference of the Florida Native Plant Society, *"Protecting Florida's Future with Native Landscapes,"* **May 13-16, 2004,** Royal Plaza Hotel Lake Buena Vista, Florida. Go to http://www.fnps.org/ for complete details.
- Second Latin-American Short Course on Biological Control of Weeds, **June 7-10, 2004**, Barcelo Hotel, Montelimar, Nicaragua. Organized by the University of Florida in cooperation with the Universidad Nacional Agraria of Nicaragua. Conference will be in Spanish. Dr. Julio Medal, Course Coordinator, medal@ifas.ufl.edu or http://biocontrol.ifas.ufl.edu/materials/nicaragua.htm
- Aquatic Plant Management Society 44th Annual Conference, **July 11-14, 2004**, Tampa Hyatt Regency, Tampa, FL. www.apms.org
- 13th International Conference on Aquatic Invasive Species, **September 19-23, 2004,** Ennis, County Clare, Ireland. Elizabeth Muckle Jeffs, profedge@renc.igs.net -or- http://www.aquatic-invasive-species-conference.org/
- 12th Annual NAWMA (North American Weed Management Association) Conference and Trade Show, **September 20-23, 2004**, Rushmore Plaza Holiday Inn, Rapid City, SD, http://www.nawma.org/
- 3rd International Conference on Biological Invasions NEOBIOTA – *From Ecology to Control*. **September 30 – October 1, 2004,** University of Bern, Switzerland. Invasive alien species of all taxa (plants, animals, fungi) will be discussed, with a focus on ecology of neobiota, environmental, socio-economic and human health impacts, risk assessment, pathways and prevention, and control. Geographic focus is on Central Europe. www.neobiota.unibe.ch
- 31st Natural Areas Association Conference: *Emerging Issues: Possibilities and Perils*, **October 13-16, 2004**, Holiday Inn Mart Plaza, Chicago, IL. Symposia and plenary sessions will focus on emerging problems and creative strategies to preserve biological resources for the future. Co-hosted by the Natural Areas Association, Illinois Nature Preserves Commission, and Illinois Department of Natural Resources with participation of the University of Illinois and other state and private educational institutions, federal resource agencies, the Illinois Chapter of The Nature Conservancy, several conservation, forest preserve and park districts, Chicago's world class museums, botanical and zoological institutions and the Chicago Wilderness coalition. The **NA-EPPC** meeting will be held here, as well. http://www.naturalarea.org/

Publications

- "Melaleuca in Florida: a literature review on the taxonomy, distribution, biology, ecology, economic importance and control measures" by Kristina Serbesoff-King in the *Journal of Aquatic Plant Management 41:98-112 (2003)*.
- An air potato poster has been developed and is nearly ready for distribution. Go to http://kgioeli.ifas.ufl.edu/airpotato.htm to preview this poster or be put on the poster distribution waiting list. Posters available on a first come, first served basis.
- **Invasive Plant Species Of The World - A reference guide to environmental weeds**, by E. Weber (2003), 548 pp. A comprehensive reference to more than 400 non-agricultural invasive plant species, with nativity and global distributions. Includes growth form, synonomy, commercial uses, habitats invaded, ecology, control methods, and primary references. CABI Publishing, ISBN 0851996957. http://www.oup.com/us
- **Plant Invasions - Ecological Threats And Management Solutions**, edited by L. Child, J.H. Brock, G. Brundu, K. Prach, P. Pysek, P.M. Wade and M.Williamson (2003), 457 pp. 30 papers from the 6th EMAPi (Ecology and Management of Alien Plant Invasions) conference at Loughborough University, UK (September, 2001). Backhuys Publishers, ISBN 90-5782-135-4. Euro 108.00. backhuys@backhuys.com -or- http://www.backhuys.com
- **Aquatic And Riparian Weeds Of The West**, by J.M. DiTomaso and E.A. Healy (2003), 442 pp. The "first comprehensive identification manual for aquatic and riparian weeds west of the Rocky Mountains." Full descriptions and excellent photographs of seeds, seedlings and mature plants, root structure, flowers and fruits of 89 species, plus another 96 plants compared as similar species. Includes synonyms, habitat, distribution, propagation and phenology. Includes "identification tables" and keys. California Weed Science Society, ISBN 1-879906-59-7. $40.00 http://www.cwss.org/aquatic_book.htm
- **Andersen's Guide to Practical Methods of Progagating Weeds & Other Plants** by D.G. Buhler and M.L. Hoffman (1999), 248 pp. Provides basic methods for propagule germination and establishment of specific weeds for over 900 species. Weed Science Society of America, ISBN 1-891276-10-7. $50.00 www.wssa.net

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notes from the disturbed edge - chapter 11

She was lying on her back, just staring up into the clouds that drifted by, anchored to the earth and thinking about what might lay above and beyond. Several nights ago she had been lying on her side, on the floor, attempting to attain some yoga-induced zen-like state that felt instead like self-inflicted fruitless torture, when her attention had been mercifully distracted by a stack of titles on the bottom shelf of her bookcase - remnants from a past foray into religions of the world. Her research on that front had proceeded about as far as her experiments in yoga, but that was OK. The way she saw things, each experience had been educational, and she had come to realize that we do not always learn only what we initially pursue. The night she rediscovered those books, she had learned that her leg simply did not bend that way, and she had learned that she would rather lay on the floor and attempt to grasp man's varied interpretations of the greater powers than grasp her ankle from behind her head. She had stayed up late that night reading, and had come to the conclusion that she would likely have to muddle this one out alone. The clouds were silent and unbiased, and she thought perhaps they drew her focus a bit nearer the horse's mouth.

She was considering the concept that they were, perhaps, on a mission from God, to put right that which mankind has put asunder. She'd come to realize that many earthlings considered it literally their God-given right to take plants from one part of the globe and introduce them to other environments, and she had encountered plenty of folks who based much of their opinion regarding the topic of invasive exotic plant issues on one word they'd read in the Bible: Dominion. "And God said, let us make man ... and let them have dominion over all the earth, and over every creeping thing that creepeth upon the earth." She couldn't help but wonder if Dominion wasn't exactly what The Creator might have intended.

Dominion: her dictionary defined it as "sovereign authority; domination; the right of absolute possession and use; exercising the right and power to command, decide, rule and judge." That sounded pretty watertight, but still she had her doubts. To hang her hat upon one word in a book written over the course of thousands of years by a variety of people and translated umpteen times was not her style. The concept that the Supreme Being would make everything in the world and put each thing in its place and say "that is good," and then make one more thing (us) to which was given "the right of absolute possession and use" made little sense to her humble mortal mind. Plus, she just couldn't believe that The Ultimate Power would actually use the phrase "every creeping thing that creepeth." There had to be some issues related to translation, or at least interpretation, here.

She felt it possible that someone along the line had perhaps meant to use the term "Stewardship" instead of "Dominion." Her dictionary defined Steward as "a person entrusted with management of affairs not his own." That term just seemed a better fit.

She recognized, of course, that all this deep thinking and independent research was fine - as long as she kept it mostly to herself. Theological mental musings were fair game for long rides with him in a pickup truck, but she'd found that, for the most part, nobody really wanted to hear anyone else's interpretation of what they had already decided to be true, and past experiments in casual conversation related to anything nearing religion had often ended in uncomfortable silence. She could never really lay all this out in front of the various flavors of God's lovers or fearers unless she volunteered to supply the tar, the feathers or the firewood herself. And so, for now, she would lay on her back and watch the clouds. Because, after all, there is a time to every purpose under Heaven, or Nirvana or Valhalla.

- J.A.

An Excerpt from *"The Adventures of Hack Garlon and His Buxom Sidekick Squirt"*

Internodes *continued*

Continuing Education

- The **Lygodium Control Independent Study Training Course** is designed for use by agricultural pesticide applicators interested in earning continuing education units (CEU's) toward their restricted-use pesticide license renewal. The course also is appropriate for individuals licensed or certified under the Bureau of Entomology and Pest Control. Go to: http://kgioeli.ifas.ufl.edu/lygodium.htm
- The **North American Weed Management Association (NAWMA),** whose mission is to provide education, regulatory direction, professional improvement, and environmental awareness to preserve and protect our natural resources from the degrading impacts of exotic, invasive noxious weeds, offers certification as a **Certified Manager of Invasive Plants (CMIP)**, a voluntary, examination-based program with continuing education requirements. An exam will be offered at the NAWMA Annual Conference & Trade Show in September 2004. For information, go to www.nawma.org or call 970/887-1228.

Web Sites

- Read the monthly **No Ivy League** newsletter at http://www.noivyleague.com/ featuring *De Vine Times* and the *Ivy Clippings*.

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