

T.A.M.E. Melaleuca: a Regional Approach for Suppressing One of Florida's Worst Weeds

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ABSTRACT

The adventive Australian tree *Melaleuca quinquenervia* (Cav.) S.T. Blake is an invasive pest plant in the greater Everglades region of Florida. Public agencies and organizations responsible for natural areas management have developed effective chemical and mechanical strategies for treating infestations, but these methods can be costly and labor intensive. Meanwhile, many infestations on privately held lands remain unmanaged. The melaleuca biological control program, developed to complement conventional removal tactics, reduces reproduction and growth of the tree and functions on unmanaged lands. But the full impacts of the biological control program will only be realized when private landowners and public land managers become familiar with its benefits. An areawide pest management project for melaleuca was initiated in 2001 with funding from the U.S. Department of Agriculture's Agricultural Research Service (USDA-ARS) to promote regional implementation of biological control as the basis for integrated management. Modeled after other successful areawide projects, principal components of the project include high stakeholder participation, treatment demonstration sites and assessments, melaleuca distribution surveys, socio-economic assessments of melaleuca impacts, and transfer of technology and information to professional land managers and private land owners. Herein, we discuss reasons for developing the melaleuca areawide project, describe the project components and their expected outcomes.

Key words: *Melaleuca quinquenervia*, Integrated Pest Management, areawide pest management, *Oxyops vitiosa*, *Boreioglycaspis melaleucae*.

INTRODUCTION

Melaleuca quinquenervia (Cav.) S.T. Blake (hereafter referred to as melaleuca) is a long-lived evergreen perennial tree that can reach heights of 20 meters or more (Hofstetter 1991). In its native habitats in eastern Australia, New Caledonia, southern New Guinea and adjacent parts of Indonesia, melaleuca forms open canopy forests in low lying coastal and riparian areas exposed to seasonal or permanent flooding (Boland et al. 1987). Melaleuca was introduced as an ornamental into southern Florida from Australia during the late 1800s (Dray 2003). Climatic and hydrological conditions in south Florida, being similar to those in melaleuca's native

range, allowed this newly introduced tree to flourish. Its fast growth and robust nature enticed Floridians to explore additional uses as an ornamental tree, timber source, soil stabilizer, and a means to dry up wetlands for agriculture and development (Morton 1966). Consequently, melaleuca was planted widely on both east and west coasts of the state, as well as along inland waterways and lakes (Hofstetter 1991).

Melaleuca quickly naturalized in south Florida to become one of the most invasive plant species in the state. Small infestations soon developed into dense, monocultural forests, displacing native vegetation, degrading wildlife habitat, elevating soil levels, affecting water flow patterns, and altering fire regimes (Di Stefano and Fisher 1983, Balciunas and Center 1991, O'Hare and Dalrymple 1997). At its recorded peak, conservative estimates put melaleuca acreage at more than 200,000 hectares of wetland, riparian and, to a lesser degree, agricultural systems in the southern third of the state (Cost and Craver 1981, Bodle et al. 1994; Figure 1), much of which comprises the greater Florida Everglades ecosystem.

Melaleuca's spread has had significant economic repercussions beyond the ecological impacts of invasion. Loss estimates in the hundreds of millions of dollars due to melaleuca infestations reflect reduced tourism, recreation, and wetland function, loss of property and infrastructure due to fire, and increased fire control costs (Balciunas and Center 1991, Diamond et al. 1991, Flowers 1991). These esti-

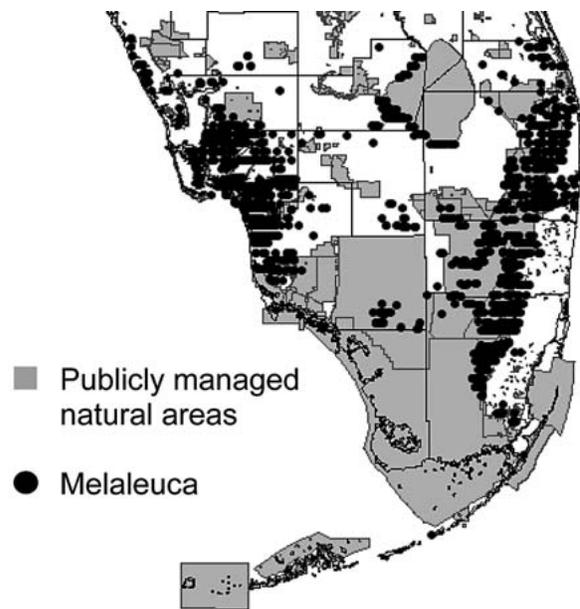


Figure 1. Melaleuca distribution in southern Florida, 1993.

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mates do not include management costs for removal and maintenance of melaleuca infestations. Between 1988 and 1998, an estimated \$25 million was spent on melaleuca removal by public resource management agencies in south Florida (Laroche 1999).

Several aspects of melaleuca biology contribute to its invasiveness and competitive superiority over other vegetation. Melaleuca is a precocious and prolific seed producer. Flowering may occur within two years after germination and as frequently as five times per year (Meskimen 1962). Each compound inflorescence gives rise to a cluster of serotinous woody seed capsules, and each capsule contains 200-300 small seeds. The canopy of a mature melaleuca tree typically contains more than 5 million viable seeds (Rayachhetry et al. 1998) held in these persistent capsules. There is a continuous, low-level seed rain (Van et al. 2002), but most seeds remain on the tree until an interruption of phloem function, often caused by some external stress, triggers dehiscence of the capsules (Meskimen 1962). The resulting *en masse* seed release is typically followed by recruitment of numerous seedlings, with up to 10 million individuals per hectare.

A prolific and early rooter, melaleuca can form dense, shallow or deep root systems to tolerate fluctuating water regimes and competing vegetation (Lopez-Zamora et al. 2004). Melaleuca also easily forms adventitious buds above ground which allows plasticity in response to changing growing conditions and rapid recovery from physical damage or extreme temperatures (Hofstetter 1991, Serbesoff-King 2003).

Melaleuca is well adapted to fire (Meskimen 1962, Hofstetter 1991). Leaf litter is slow to decompose, creating a heavy ground fuel load (Flowers 1991). Inner layers of its thick, spongy bark protect the cambium while the papery outer layers serve as a ladder to shuttle flames to the canopy. The high levels of volatile oils in the foliage fuel intense crown fires that other vegetation cannot withstand. Epicormic buds on surviving trees quickly sprout and flowers may appear within weeks of a fire. Fire induces seed release and creates nutrient-rich ashen soil and a newly opened canopy, ideal conditions for melaleuca seed germination and seedling growth. This process facilitates rapid conversion of native landscapes such as sawgrass-dominated prairies into melaleuca forests (Laroche and Ferriter 1992).

MELALEUCA MANAGEMENT

High reproductive potential, rapid growth, adaptation to fire, and tolerance of a wide range of soil types and hydrological conditions allow melaleuca to invade virtually all types of upland and freshwater wetland habitats in south Florida (Serbesoff-King 2003). Melaleuca can therefore be a noxious weed problem for any individual, agency, or organization with land holdings in the region. Inasmuch as the invasion is little restricted by habitat characteristics, land use, or property lines, management approaches need to be equally boundless.

When the invasive threat of melaleuca was first recognized, individual agencies faced the problem independently with varying approaches and varying degrees of success. A regionally organized approach was needed through which treatment tactics could be developed, evaluated and widely implemented. In 1990, representatives from resource man-

agement agencies, environmental organizations, research institutes and private entities formed a task force to develop a comprehensive plan for combating the invasion. They compiled into one document all known information on melaleuca, its impacts, and viable control tactics that had been learned to date. They also outlined what would be needed to develop a permanent solution, including additional research, organizational and legislative support. The consortium published its findings and recommendations as the Melaleuca Management Plan (Thayer 1990). Two subsequent updated editions have since been produced (Laroche 1999).

Melaleuca's large size, prolific seed production, rapid growth and vegetative regrowth mean that effective management must include multiple treatments to both cut down or kill existing stands and to prevent reseeding and regeneration from treated plants. The Melaleuca Management Plan emphasized an integrated approach that uses all available control tactics. The recommended tactics focused on a "quarantine strategy" (Woodall 1981): killing outlying trees first to preempt further spread and then working back into denser areas towards the infestation foci.

Progress has been made over the years in refining management techniques for melaleuca, particularly using frill and girdle (hack and squirt), cut stump, aerial herbicide applications, and mechanical removal. Effective, integrated management programs based on these options (Laroche 1998, Langeland 1999, Langeland and Meisenburg 2005, Serbesoff-King 2003) have been developed. Implementation of these programs, based largely on herbicidal techniques, on publicly managed lands has significantly reduced melaleuca infestations in many of these areas (Figure 2) to the point where maintenance con-

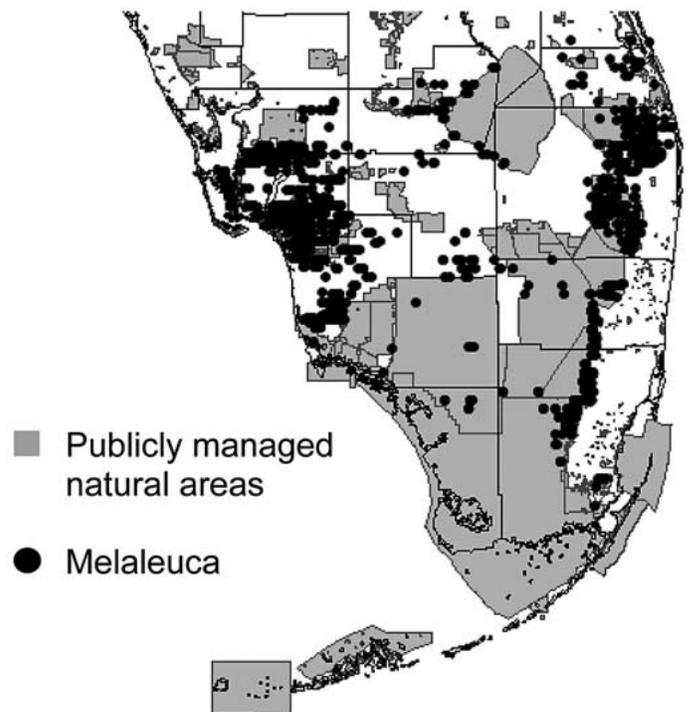


Figure 2. Melaleuca distribution in southern Florida, 2001, showing reduction in occurrence on public lands as compared to 1993.

control is now practiced; that is, the principle infestation has been eliminated and treatment now consists of applying management techniques in a continuous basis to keep the melaleuca population at its lowest feasible level (Laroche 1998). However, containment of infestations in remote and sensitive areas, where conventional tactics may be difficult or environmentally risky to implement, conceptually remains a challenge although actual infestations in these areas have been effectively eliminated. In addition, infestations on privately held properties often remain unmanaged due to limited funding or lack of motivation on the part of the landowners. These melaleuca populations continue to expand and serve as sources for infestation of pristine and restored landscapes.

In addition to the more conventional herbicide-based approaches, biological control was recognized early as an important long-term management tool for melaleuca because of its potential to both contain the spread of melaleuca in areas where it was not being managed, and to ease the burden of land managers by stressing melaleuca and reducing the need for follow-up treatments (Habeck 1981, Balciunas 1990, Thayer and Bodle 1990, Balciunas and Center 1991). The original Melaleuca Management Plan identified development of a biological control program as an essential component of effective suppression along with herbicidal and mechanical options. Each later edition of the Plan listed continued funding for biological control research and development as a top priority.

The search for potential melaleuca biological control agents began in the mid-1980s by the U.S. Department of Agriculture Agricultural Research Service (USDA-ARS) (Balciunas 1990, Balciunas and Center 1991). The project is based at the Australian Biological Control Laboratory in Brisbane, Queensland and the Invasive Plant Research Laboratory in Fort Lauderdale, Florida. The South Florida Water Management District and the Florida Department of Environmental Protection also provide significant financial support for the biological control program, with additional funding from other federal, state, and local resource management agencies. The program has led to the successful introduction of two agents thus far. The melaleuca snout beetle *Oxyops vitiosa* Pascoe was introduced in 1997 (Center et al. 2000) and the psyllid *Boreioglycaspis melaleuciae* Moore was introduced in 2002 (Pratt et al. 2004c, Center et al. 2007). Both agents were released and are well established throughout melaleuca-infested regions of south Florida (Figure 3). Both are leaf feeders and primarily attack newly expanding foliage, although the psyllid will colonize mature leaves as well. Sustained herbivory by these insects results in defoliation, reduced flowering and seed production, stunted growth, delayed maturity, stand thinning, and seedling mortality (Pratt et al. 2003, Pratt et al. 2004b, Pratt et al. 2004c, Silvers 2004, Pratt et al. 2005, Franks et al. 2006, Morath et al. 2006).

With the introduction of the weevil and the psyllid, all components of a fully integrated melaleuca management approach as recommended by the Melaleuca Management Plan are in place. However, most potential end-users are not yet familiar with the insects or their impacts, so integration of the biocontrol agents with mechanically and chemically based approaches has not been realized on an areawide basis. Additional outreach tools are necessary to extend the

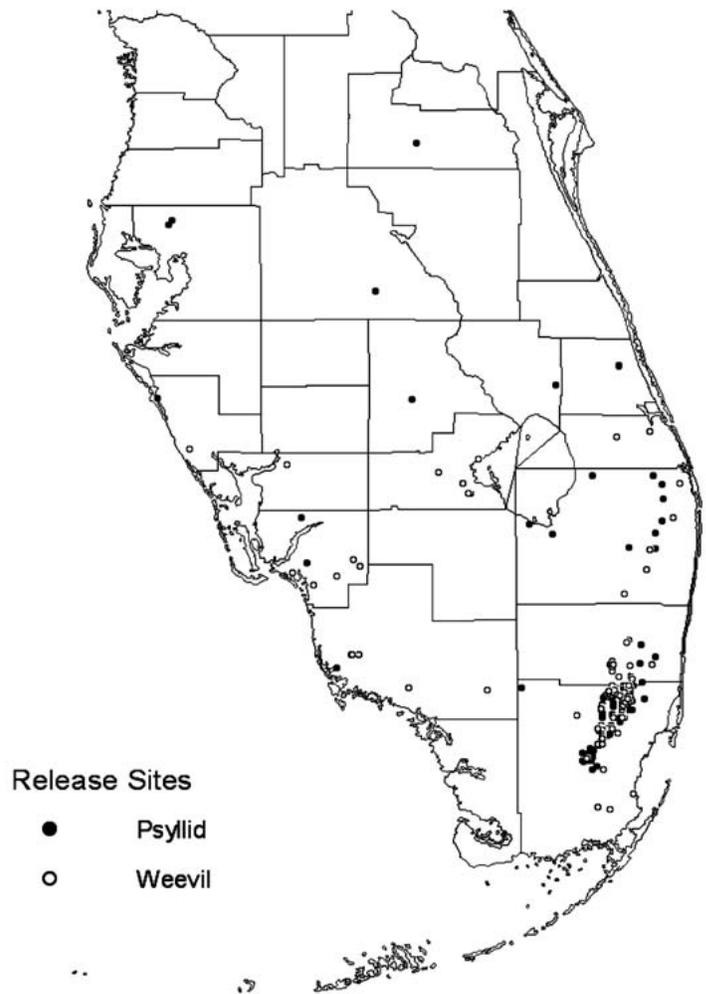


Figure 3. Release locations for melaleuca biological control agents. Since 1997, almost 300,000 weevils have been released at 147 sites and more than 1.6 million psyllids released at 172 sites.

details of implementation to the end user audience. To that end, an areawide pest management project for melaleuca was developed in 2001 with the overall goal of demonstrating and thereby promoting biologically-based integrated management for melaleuca throughout affected regions.

USDA-ARS AREAWIDE PEST MANAGEMENT PROGRAM

E. F. Knippling (1980), a pioneering entomologist with USDA-ARS, was one of the first to advocate an approach to pest suppression that is both areawide and integrated in order to prevent populations from building to economically damaging levels. This approach marked a departure from the common method of treating pests on a farm-to-farm and crop-to-crop basis only when and where they reached economic threshold levels, a practice that was proving to have only temporary and localized effects. Increased research on insect biology and population dynamics coupled with emerging technologies such as host plant resistance, insect attractants, selective insecticides, and insect mass rearing techniques promised a plethora of methods to support areawide management and reduce over-

use of pesticides. Knipling saw that these emerging pest suppression technologies would be most effective when practiced across wide areas; what was lacking was an organized, regional approach to implementation that would ensure the full potentials of these methods were realized.

In the 1990s, ARS launched the Areawide Pest Management Program under the USDA IPM Initiative (Faust and Chandler 1998). The first project in the program used mating disruption as the principle suppression technology for codling moth, *Cidya pomonella* (Linnaeus), in apple and pear production in the Pacific Northwest (Kogan 1996). The Codling Moth Areawide Management Program resulted in significant reductions in insecticide applications for codling moth as well as for secondary pests, a significant reduction in crop damage, and a savings to growers (Calkins and Faust 2003).

With the codling moth project serving as a successful template, ARS expanded the Areawide Pest Management Program to include other key pests of crops and rangeland, people, animals, and structures. Common to all projects is that an economically and environmentally sound management technique was available that would be most effective when applied across a region and that would improve current management (Faust and Chandler 1998). Also essential to each project is high stakeholder participation and collaboration, demonstration of the advantages of an IPM approach implemented across a large region, and a resultant areawide pest management system that is operational, affordable, and adoptable. The melaleuca management effort meets all these criteria, making melaleuca a promising target for an areawide pest management project.

AREAWIDE MELALEUCA PROJECT— INDICATORS OF SUCCESS

The Areawide Melaleuca Project was proposed because melaleuca is a key pest for which effective management approaches have been developed (herbicidal, mechanical and physical), and for which a new one (biological control) has emerged that could further improve and expand management successes. An areawide project would provide an opportunity to demonstrate and promote adoption of the latest melaleuca management techniques across the region affected by this invasive tree.

Chemical and mechanical management options are effective in killing melaleuca, but may be cost-prohibitive for some land owners (Laroche and McKim 2004), affect only the immediate area treated, and require vigilant follow-up monitoring and treatment for seedlings and re-growth. Unmanaged infestations—located on land whose owners are unmotivated, under funded or ill equipped to treat—continue unchecked and threaten to seed additional infestations. Biological control provides a new economically and environmentally sound technology to address these management gaps. Feeding by melaleuca biological control agents can result in defoliation (Pratt et al. 2004a, Morath et al. 2006), reduced seed production (Pratt et al. 2005), and increased seedling mortality (Wineriter et al. 2003, Franks et al. 2006), all of which may help suppress dominance and reproduction of unmanaged infestations. In areas where chemical and mechanical treatments have been administered, insect feeding

can increase seedling mortality and stunt stump re-growth (Silvers 2004), possibly giving managers more time before follow-up treatments are required. A management program based on integrating the benefits of biological control with the benefits of chemical and mechanical applications uses the insects to reduce vitality and reproduction of mature trees, to stunt and delay reproduction in vegetation recovering from cut stumps and in young saplings, and to kill small seedlings. By suppressing existing and emerging infestations and checking the spread of unmanaged melaleuca, such an integrated approach may extend the effectiveness of chemical and mechanical techniques and perhaps lessen the intensity of management required.

Adding to the likelihood of an areawide melaleuca project succeeding is that biological control agents are easy to implement, self-sustaining and dispersing, and may reduce the costs required to contain infestations. And because the considerable expense of developing the biological control program is funded by public agencies, the resulting agents are available to end users at little or no cost. An areawide project would help maximize the benefits of biological control by increasing distribution of the insects, by informing resource managers and land owners about how to recognize the insects and their damage, and how to take advantage of them.

Another reason melaleuca represented a good target for an areawide project was the precedent for effective collaboration and high stakeholder involvement in melaleuca management efforts. The coalition of government resource management agencies, non-governmental organizations, and researchers that produced the Melaleuca Management Plan specifically mentioned biological control as a necessary component of success to complement herbicidal and mechanical approaches, and facilitated the consistent focus and funding required for developing a biological control program. Consequently, biological control has been an anticipated addition to the melaleuca management system for years, so little resistance to the concept was expected from among the land management community.

Homeowners may not be as informed about melaleuca nor as primed for the arrival of biological control. Additional educational efforts must be made with this group to emphasize the negative impacts of melaleuca on Florida's unique environment, local economies and neighborhoods, specifically through increased fire risks. Combined with information on state and federal statutes prohibiting melaleuca and mandating its removal, this may provide incentive for homeowners and small private landowners to manage their infestations in whatever way they can. Biological control provides a cost effective melaleuca management tool for this group. And because of its self-dispersing and self-perpetuating nature, biological control can contribute to areawide melaleuca management even without full participation of every landowner with an infestation.

THE AREAWIDE MANAGEMENT AND EVALUATION OF MELALEUCA (TAME MELALEUCA)

TAME Melaleuca was initiated in 2001 with a five-year grant from the ARS Areawide Pest Management Program. While it is an ARS project, its success depends on collabora-

tion with the many federal, state, municipal, and private organizations also working to suppress melaleuca. The established infrastructure of working relationships among these groups and their accumulated expertise provides a rich resource for TAME's approach of compiling information on all effective management techniques and disseminating it to a wide range of end users. This approach also helps identify areas in our collective understanding of melaleuca that may need further investigation.

The project is directed and coordinated by scientists at the USDA-ARS Invasive Plant Research Laboratory in Fort Lauderdale, Florida and at the South Florida Water Management District, one of the largest resource management agencies in the state. An oversight committee consists of representatives from the U.S. Department of Interior's National Park Service, the U.S. Army Corps of Engineers, the South Florida Water Management District, the University of Florida, and the Florida Department of Environmental Protection. These agencies are collectively responsible for vegetation management decisions on more than 1.4 million ha of natural areas in Florida. Scientists from these agencies are also cooperating on several research and operational components of the project, as are scientists from the University of Miami. Other contributors to TAME include representatives from The Nature Conservancy, the Audubon Society, Lee County Parks and Recreation Department, the county cooperative extension service, and private property owners.

TAME Melaleuca has five principal objectives: 1) demonstrate the impacts of biological control and its integration with current mechanical removal and herbicide application techniques; 2) assess treatment efficacies; 3) survey melaleuca distribution in Florida and elsewhere outside its native range; 4) assess socio-economic factors associated with current and proposed melaleuca control tactics; and 5) transfer effective technologies and information to property owners and land managers.

Results from all aspects of the project will be compiled and made available through a variety of outlets, including peer-reviewed journals, trade magazines, extension bulletins and TAME project publications.

Demonstration sites—Melaleuca affects everyone from home gardeners and small landowners to ranchers to refuge managers responsible for thousands of hectares. Outreach approaches must accommodate these diverse audiences and the diversity of melaleuca management methods they may require. The central component of the TAME project's educational efforts is a series of demonstration sites (Figure 4; Table 1). These sites are located in five southern Florida counties, on muck soils of the east coast and sandy soils of the west coast of the state, on public land and private property, and in residential, agricultural, and conservation areas. Sites range in size from less than 4 to more than 40 ha and showcase treatment options most suitable to the type of site represented. Each site consists of multiple treatment plots, each with a unique treatment or treatment combination. Treatments to be highlighted include herbicide applications using frill and girdle (hack and squirt), cut stump and aerial techniques, tree removal with heavy equipment, and of course biological control alone and as a means to reduce regrowth and seedling emergence in other treatment plots.

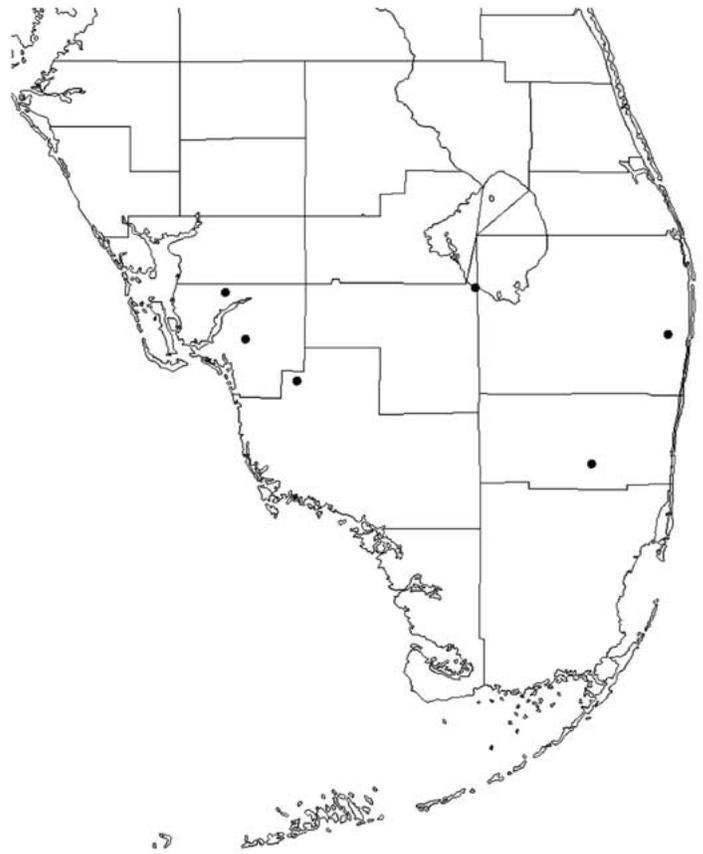


Figure 4. T.A.M.E. Melaleuca project demonstration site locations.

TAME demonstration sites offer land managers, extension personnel, government agencies, home owners and other interested audiences the opportunity to see different melaleuca management strategies in various real-life settings and learn which strategies might be appropriate for managing their site-specific melaleuca problems.

Additional research—Although research is not a primary objective of TAME Melaleuca, supporting research projects continue to inform our understanding of both the problems and potential solutions associated with melaleuca invasions. Improved understanding of the biology and ecology of melaleuca, the weevil and the psyllid provides a stronger foundation for implementation of the biological control program and its integration with conventional strategies.

Melaleuca distribution—The development of effective and coordinated melaleuca management strategies depends upon accurate information concerning the extent, distribution, composition, and dynamics of its non-indigenous populations. The South Florida Water Management District and the National Park Service have been conducting aerial surveys since 1993 to estimate plant species and densities for exotic plants, including melaleuca, in the region south of Lake Okeechobee (Ferriter et al. 2005). Through the TAME Melaleuca project, survey boundaries are being extended north to Gainesville to encompass the majority of the range of melaleuca in Florida.

Melaleuca is present in several other southern states, from Georgia to Texas and California, and in Hawaii where over

TABLE 1. SUMMARY CHARACTERISTICS OF T.A.M.E. MELALEUCA PROJECT DEMONSTRATION SITES IN SOUTH FLORIDA.

Site	County	Size (ac)	Soil	Hydrology	Vegetation	Ownership/use
Fort Myers	Lee	18	Sand	Dry	Pasture grasses, coppicing melaleuca	Private, rangeland
Prairie Pines	Lee	64	Sand	Seasonally flooded	Multi-aged melaleuca; slash pine, saw palmetto, other native wetland plants	Public preserve
Corkscrew Swamp	Collier	13	Sand	Seasonally flooded	Dense melaleuca saplings; other exotics; native wetland vegetation	Private residential; private preserve
Clewiston	Hendry	33	Muck	Seasonally to permanently flooded	Large, mature melaleuca; Brazilian pepper, Australian pine; aquatic plants	Private, undeveloped
Lake Worth	Palm Beach	2	Sand	Dry	Mature melaleuca; Australian pine, Brazilian pepper; mix of exotics, natives	Private residential
Holiday Park	Broward	105	Muck	Seasonally flooded	Dense, mature melaleuca; other exotics; mix of natives	Public, Everglades buffer area

one million trees were planted as part of reforestation projects (Serbesoff-King 2003). Reports suggest naturalized populations in these states may occur, but the extent and status of these possible invasions is uncertain. Regional and major herbaria collections in these states will be searched to better document melaleuca's range and verify identifications. A national spatial database of the locations and extent of current melaleuca infestations is being developed based on results of aerial surveys and herbaria investigations, and will be available on a web-based map server.

U.S. borders, however, do not limit the invasive potential of melaleuca. Other humid tropical and subtropical regions with wet summers, dry winters and frequent fires may also be at risk. Possible melaleuca infestations outside of Florida not only pose a risk to the ecologies of those regions, but may also serve to increase reinvasion pressures in Florida. The TAME project's melaleuca distribution research and outreach efforts therefore extend throughout the Caribbean Basin and Gulf Coast to include all possible areas of infestation.

Socio-economic influences—Economic assessment is a critical component in any discussion of pest management. New management strategies are unlikely to be adopted unless the benefit-cost ratio is an improvement upon or at least comparable to current approaches. Therefore another important objective of the TAME project is to assess the socio-economic factors associated with current and proposed control tactics. This is being done through a series of studies conducted by economists at the University of Florida's Institute of Food and Agricultural Sciences (UF IFAS). Results from these studies will be made available through the UF IFAS Electronic Document Information System, or EDIS (<http://edis.ifas.ufl.edu/>).

A regional economic impact assessment is investigating changes in the south Florida economy attributable to changes in the melaleuca infestation level, including expansion under little or no control and reduction due to adoption of recommended control strategies. Potential areas of positive economic impacts from melaleuca control include economic benefits associated directly with restoration of native wetland function, increased eco-tourism, improved cattle grazing areas, and general enhancement of regional economic activity beyond the direct sales of these enterprises.

Economic and sociological influences on adoption of the integrated management practices promoted by TAME are also being assessed. Questionnaires mailed to residents and

professional land managers gauge awareness of melaleuca and melaleuca management tactics among these groups, and identify what influences their melaleuca management decisions. Follow-up surveys will measure changes in public awareness, adoption of recommended control practices, and appropriateness of current policy and control programs. Questionnaires will also help identify areas for improved public education and training on melaleuca and its management.

Technology transfer—The main objective of TAME Melaleuca is to gather all of the information relevant to melaleuca management and make it available to land owners and managers throughout the state that may be combating melaleuca. A series of workshops and tours centered on project demonstration sites serve as the primary tool for transferring information to audiences. Entitled Melapaleuca, the series consists of two types of workshops, one type oriented towards professional land managers and one towards homeowners and other interested members of the public. Both consist of classroom presentations on the impacts of melaleuca and management options followed by a guided tour of treatment plots at one of the demonstration sites. Field tours allow participants hands-on experience in identifying the biological control agents and recognizing their damage. Participants also see for themselves the results of all the control tactics discussed. And in contrast to the formal educational experience provided by the classroom sessions, the field portion allows for greater interaction between and among attendees and presenters, often to the benefit of all involved.

Through collaboration with scientists and extension personnel at the University of Florida, additional outreach tools are being developed. A TAME Melaleuca website, <http://tame.ifas.ufl.edu>, serves as a repository for all information collected and created for the project, including reports and publications of results. Other technology transfer tools include brochures in English, Spanish and French; treatment handbooks; and videos for distribution to individuals, organizations and public television outlets.

Additional technology transfer efforts continue distribution of biological control agents throughout melaleuca-infested areas of Florida to supplement the insects' natural abilities to disperse, establish and maintain populations. Insect redistribution efforts are executed in collaboration with the Florida Department of Environmental Protection and the UF IFAS/St. Lucie County Cooperative Extension office.

IMPACTS & EXPECTATIONS

For more than twenty years the coordinated work of public agencies to create and execute a comprehensive melaleuca management program has reaped many successes. The Melaleuca Management Plan helped secure legislative support and consistent funding, increased public awareness, and encouraged continued research, development and implementation of effective treatments. As a result, resource managers have the support and technology needed to make melaleuca management a top priority and an attainable goal. In many publicly managed natural areas, melaleuca infestations are decreasing rather than increasing and acreage under maintenance control is increasing (Laroche 1998). With the successful introduction of biological control agents, the components originally deemed necessary by the Melaleuca Management Plan for long term melaleuca management are realized.

TAME Melaleuca essentially serves as an extension of the Melaleuca Management Plan. It takes all the elements described in the plan, including the recent biological control agents, and puts them together for the first time to demonstrate their combined potential and instruct end users on their implementation. And by distributing biological control agents, TAME is making melaleuca suppression possible on a much wider scale than before. Through its core principles of demonstration and dissemination, TAME is working to sustain the management successes already seen on public lands and extend them to private lands.

Ultimately, TAME Melaleuca hopes to impart on resource managers and land owners the tools required for sustained melaleuca management, the skills to recognize biological control agents and their impacts, and the confidence that melaleuca is under sufficient biological control so that intensive management of the tree may no longer be necessary in some areas. The associated savings in herbicide use and program costs may increase resources available for the continual fight against other equally destructive pest species emerging on the horizon. Perhaps the resources, partnerships and successes accumulated throughout TAME's tenure may also serve as a template for future projects to promote collaborative, integrated approaches for successful management of an invasive plant.

ACKNOWLEDGMENTS

The authors thank the many collaborators and participants involved in the TAME Melaleuca project, among them: Ken Langeland, François Laroche, Michael Meisenburg, and Cheryl McCormick-Rote for their essential work on demonstration sites and technology transfer activities; Alan Hodges for managing the socio-economic components; Tony Pernas for assisting with melaleuca detection surveys; and project advisory committee members Dan Thayer, Bob Doren, Randall Stocker and Charlie Ashton for their ongoing counsel. Chad Prosser and Gerald Anderson of TEAM Leafy Spurge also provided valuable advice in the early stages of project development. Thanks to Robert Faust, Ernest Delfosse and to the USDA ARS National Program Staff for funding through the Areawide Pest Management Program. We also thank two anonymous reviewers for their constructive comments.

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