

MELALEUCA ON SANIBEL



THE PROBLEM & SOLUTION

A long term plan for controlling and eventually eliminating the exotic tree **Melaleuca quinquenervia** from the City of Sanibel.



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INTRODUCTION

Late in 1983 the City Council of Sanibel Florida passed a resolution to initiate a program to control and eventually eradicate the tree Melaleuca quinquenervia from the island municipality. Recognizing that the exotic invader has rapidly spread across south Florida, outcompeting and choking out native vegetation and drastically altering naturally diverse ecosystems, the Council realized that their island is not immune from its proliferation and that, if reasonable success was to be achieved, control efforts could not be delayed.

The resolution was not, however, passed without public controversy. As the seed source for the spread of Melaleucas to Sanibel's wildlands has been plantings cultured by property owners for landscaping purposes, calls to eliminate the trees from the island have met some objection (although it should be noted that others welcome the removal of the trees from their yards, as they can be a cause of respiratory irritation). In light of such objections, the Council rescinded the mandatory aspects of its control program but is still calling for the removal of all Melaleuca from City properties and supporting and encouraging voluntary removal at city expense on private properties.

The City's commitment to this long term eradication effort is clearly stated in Resolution 84-11 (passed February 7, 1984), which recognizes the importance of Sanibel's diverse native vegetation relative to the aesthetic character of the island, the balance and stability of its natural environment, and in terms of habitat for an abundance of bird and wildlife species. Quoting the resolution, it is the intent of the City Council:

... to ultimately eradicate the tree Melaleuca quinquenervia from the City; to continue with a program of support and assistance to property owners willing to voluntarily remove said trees; and to attempt to educate citizens and owners of property within the City to the potential danger to the City's natural environment posed by said tree ...

This Melaleuca control program document provides the foundation by which the goals of the resolution may be met. Part 1 addresses the problems posed by Melaleuca proliferation, with a comprehensive overview of the tree's physical and biological characteristics. This will hopefully establish a sound educational base to assist landowners in recognizing and understanding the threat that Melaleuca represents to their community. Establishing such understanding becomes particularly important to the success of the control program, for without its original mandatory provisions, interest and voluntary cooperation from the general public has become particularly essential. Part 2 goes on to outline in detail the solution to the problem -- the City of Sanibel's long term plan for controlling and eventually eliminating Melaleuca quinquenervia from the island ecosystem.

PART 1: THE PROBLEM

Origin

Melaleuca quinquenervia, also commonly known as the paper bark, punk, or Cajeput tree, is a native species of Australia. It is a member of the myrtle family and a close relation to the eucalyptus. In recent times the tree has spread from the south Pacific to become a common member of many tropical vegetative communities.

Researchers have investigated the initial introduction of Melaleuca to Florida around the turn of the century. The story is summarized as follows:

In the late 1880's, efforts were made to identify trees of potential economic value that would tolerate the high water table, periodic drought, and frequent fires of southern Florida's subtropical wetlands. In response to at least two independent inquiries to Australian sources, planting of Melaleuca was suggested, and seeds for that purpose were provided ... It is likely that the earliest introduction was around 1906, and attempts to establish widespread populations continued until at least the 1940's.(1)

The town of Estero, about 30 miles south of Sanibel, has been pinpointed as the site of Melaleuca introduction on Florida's west coast, "... and the expanding populations in this region probably originate from trees in this area."(2) Its introduction to the east side of the state occurred a few years earlier in wetlands north of Miami.

Records of formally sanctioned efforts to establish extensive stands of Melaleuca are scanty, but rumor has it that "... back in the 20's or 30's it was seeded from a plane to dry up the Everglades"(3), generally considered in those days to be nothing more than a vast undesirable wetland. In the 1940's the Army Corps of Engineers actively planted Melaleuca saplings on dredge spoils along the shores of Lake Okeechobee "... to prevent storm generated waves from eroding the levee system."(4)

Wildfires and other natural factors encouraged the spread of the tree from areas where it was intentionally planted to outlying forest lands. Melaleuca's widespread use as a landscape ornamental, coinciding with the growth and development of south Florida over the past several decades, has also done much to increase the range of the tree's proliferation. At any rate, it didn't take long for Melaleuca to become a naturalized forest species in the wildlands, and with "... its adaptability to a variety of growth conditions and resistance to damage by insects, disease and fires, it spread rapidly in south Florida."(5)

On Sanibel, the catalyst behind Melaleuca's establishment has been its extensive use as an ornamental, with each of these in turn becoming the potential source of an outbreak of countless wild seedlings. Before the true aggressive nature of the species was understood, Melaleuca was generally considered "the ideal tree" for landscaping purposes, both on Sanibel and

throughout south Florida. In the words of a University of Florida Cooperative Extension Bulletin dating back to 1933:

Cajeput-trees are attractive as accent and specimen trees for shade, flowers and striking effects of shedding and peeling bark. This tree is also used as a background or framing tree for small homes. Since Cajeput is moderately tolerant of salt spray, it can be used in plantings near the seashore. Cajeput is adopted for use as a street tree, base planting for tall buildings and as a plant for a tall hedge on large properties. Insect or disease pests are not known to be a problem.(6)

This and other articles applauding the merits of Melaleuca as an ornamental were being printed as late as the mid 1970's. It is interesting, however, that more than 50 years ago it was being noted that "In a few areas the trees have spread naturally from cultivation ..."(7), certainly a very subtle pronouncement of what was to come in the years ahead.

Other attributes of the Melaleuca that made it so popular for landscaping are its fast growth rate, frost tolerance, ability to withstand a wide range of moisture conditions -- from drought to extended flooding, and its economic cost and relatively care free character. Its salt tolerance was also a particularly desirable factor for places like Sanibel. Such popularity carried the tree across Florida far more rapidly than could ever be accomplished naturally. On Sanibel long time residents observe that as little as 20 years ago it was still very difficult to find a Melaleuca, and that in the Fort Myers area where they are now so abundant, they were just beginning to take hold. "As late as 1973 the punk tree was a standard item in local nurseries, was very popular on Sanibel, and was planted all over the island as part of the landscaping that accompanied Sanibel's rapid post-causeway growth at that time."(8)

IDENTIFICATION

The genus name Melaleuca translates to "black-white", while the species name quinquenervia means "five veins". The original species deliniation was leucadendron, meaning "white tree". Both these names aptly fit the tree, for the two best characteristics to identify it by are probably the peeling white bark and the five distinct veins of the nonserated leaves.

The Melaleuca is a broad leaved evergreen. The tree "... grows to 80 feet high with slender, sometimes pendulous branches, narrow leaves, and conspicuous ... thick soft bark that peels off in thin layers."(9) From a distance the leaves tend to appear smaller, perhaps more sparse, and darker (almost brownish) then the leaves of surrounding vegetation. With some exceptions, its fast rate of growth tends to carry even young Melaleucas above the crowns of most native south Florida tree species, a most helpful characteristic for spotting the tree in the wilds.

Closer observation shows the leaves to be spirally arranged, simple, elliptic, and perhaps two to four inches long. They actually have seven longitudinally parallel basal veins, two of which form the smooth leaf edge. The creamy white, spongy flaking bark sometimes takes on more of a yellowish-gray hue, especially on older specimens.

As *Melaleucas* begin to encroach upon a new area they often occur grouped in stands, or "heads", which "...have a characteristic elliptical appearance, with the oldest and tallest individuals near the center, smallest trees at the perimeter, and a relatively uniform height gradient between the extremes".(10) Quite often mature *Melaleucas* in the wild will show a number of stems emanating from what was originally the initial seedling. Such sprouting can result in individual clumps of a half dozen or more trunks. "Under flooded conditions, *Melaleuca* produces a fibrous sheath of 'water roots' that clothes the base of the trunk up to the high water level. Large tufts or clumps also arise from underground roots for a considerable distance from the stem."(11)

In the Spring, *Melaleucas* show white to pale yellow "bottlebrush" flowers, although not all trees have flowers at the same time. For some people, the odor of the pollen of these flowers can be a significant respiratory irritant. "The flowers are borne on the current season's branch growth with further branch growth and leaves appearing beyond the flowers."(12) There is some secondary reciprocal flowering in the fall as well. On mature trees, the ends of branches are seen laden with thick rows of gray woody pods. Within each of these pods are tiny seeds with an awesome inherent capability to cause rampant proliferation of the exotic invader throughout south Florida.

HABITAT

The naturalized range of *Melaleuca* in Florida appears to extend from a line somewhere around Tampa on south across the state. It is concentrated as thickly in the Lee County wildlands approaching Sanibel as anywhere. As already stressed, within its general range the tree has the capacity to survive a great variety of site-specific environmental conditions.

While *Melaleuca* thrives at high temperatures, it is also relatively frost hardy. The fact that many trees planted far north of the range of naturalized populations survive cold weather seems to suggest that, contrary to what is commonly thought, "...freezing temperatures are not primarily responsible for the northern boundary of that range." (13) The trees do grow faster during warm periods, and cold spells will retard growth, but temperature does not appear to be a key habitat detriment. Still, it is interesting to note that "Southern Florida's temperature regime is similar to that of the *Melaleuca*'s native range in Australia..."(14)

In terms of its moisture requirements, it seems safe to say that *Melaleuca* does best on mesic, relatively poorly drained sites. But as a Forest Service researcher points out:

Melaleuca is anatomically and physiologically well adapted for either a well drained environment or a flooded one. Consequently, it is often found on intermittently flooded

sites. However, when the hurdle of germination and establishment is overcome, Melaleuca can thrive on sites that are either never flooded or continuously flooded. (15)

Another researcher found that "Melaleuca is not only tolerant of flooding but its growth and development is apparently favored by flooding or by some attendant condition of poorly drained sites".(16) He states that "Seedlings maintained in a sodden, although not flooded condition, and seedlings flooded to half their shoot or crown height grew significantly faster than freely drained or completely submerged treatments".(17) At any rate, simple observations indicate that, while Melaleucas seem to flourish in wetter sites, they can also be found in abundance on well drained dry ground as well.

With regard to soil the same inconsistencies seem to hold. As a general statement, however, Melaleuca seems to be more abundant on slightly acidic organic soil sites. This tendency toward organic soil seems to be based more on the relationship of the soil to water availability than to some other physical factor. While sand allows ready water transmission, it has a limited storage capacity. "Thus, in terms of moisture availability, organic soils are more reliable than, for opposite reasons, marls and sands".(18) Also, sandy soils tend to heat up in the sun far faster than others and may cause a lethal burning of the sensitive seed. The level and availability of surface soil nutrients becomes important in germination because, as shall be discussed, tiny Melaleuca seeds have virtually no food reserve of their own during the precarious initial establishment.

Site vegetation characteristics do not appear to be a major limiting factor for Melaleuca. It is a shade tolerant species, evident by the fact that it "...maintains relatively long crowns on seedlings, saplings, and mature trees even in incredibly dense stands".(19) Once Melaleuca seedlings become established, the fast growing trees will quickly outcompete surrounding vegetation for water, nutrients, and before long, for light.

The only native tree stands that may have shade deep enough to inhibit Melaleuca are dense hardwood swamps and hammocks. The canopies of virtually all pine stands and most cypress stands are too open to seriously inhibit Melaleuca establishment.(20)

Even among such prevalent plant species as the Brazilian pepper or the Australian pine, the more aggressive Melaleuca will flourish and eventually prove to dominate.

Relative to its south Florida habitat, it should be mentioned that there are no animal or disease agents known to limit Melaleuca. This, of course, is the nature of an exotic species that finds a niche in a new area. Also, it should be recognized that the environmental factors discussed, or any others, act collectively to limit and define Melaleuca habitat. There is no single "on-off switch". Rather, "The lower the resistance of all factors taken together collectively, the better the chances that establishment can occur at that time and place". (21)

Reproduction

An appreciation of the *Melaleuca* seed -- both its nature and its numbers -- is key to an understanding of the epidemic spread of the exotic across Florida. Seed production in the typical tree begins at as early as three years of age. The seeds, as mentioned, are retained in capsules, each of which has a diameter of perhaps a quarter inch. An average of 250 seeds are contained within an individual capsule.(22) When the sum of each is considered, it has been estimated that "...about 17,000,000 seeds are present on an average-sized tree".(23) Another study found that "A single 10 meter tall open-grown tree stores over 20 million seeds in its capsules".(24)

The period of fruiting for *Melaleuca* is hard "...to define because it is difficult to establish a precise time when capsules are ripe. It is possible that seeds are available throughout much of the year".(25) As the seed capsules are retained on the tree, a stress must be placed upon them to open the pod and release the seeds for possible germination. This is the nature of a serotinous seed tree. "The capsules will only open after a vascular break occurs between the capsules and branch".(26)

The most efficient such stress factor is undoubtedly fire, the heat of which apparently reduces the moisture content of the capsules. When a loss of perhaps 25 percent occurs, seed release is triggered. It does however take "...several days for the capsules to open so there is no threat of the seeds being exposed and consumed in the fire. The capsules themselves are unlikely to ignite, probably because they are dense woody structures and because crown fires have short residence times". (27)

Although *Melaleuca* shows particularly efficient propagation following a wildfire, there are also other types of stresses that can release large volumes of seeds at a given time. These may include such factors as frost, drought, extended flooding, herbicide application, possibly even salt spray. Also natural twig mortality causes less dramatic but continuous releases of seeds, "... some of which find suitable microsites for subsequent seedling establishment". (28)

While "The invasion of *Melaleuca* into new areas is geared more to a slow inexorable expansion that radiates out from each mother tree rather than to long-distance seed dispersal", (29) it is important to recognize that upon release a seed can carry a very long distance from its original source. The weight of an average seed grain is only 1/30,000 of a gram, (30) so depending on the height of the mother tree and wind speed at the time of release, airborne travel by a dust-like seed can be surprisingly far. On Sanibel, *Melaleuca* "wildlings" (plant species originally cultivated but now growing wild) can be found in many secluded areas with no seed sources visible in the vicinity, evident examples of impressive long distance seed dispersal capabilities. It has been found that a tree can be established over 1½ miles from its seed source, (31) although this would be a low probability case. Forest Service researchers find the consistent maximum distance of effective seed deposition to be something closer to 200 yards.(32) As the seeds can float, the fact that they can be carried a considerable distance on water is also something to be considered. At any rate, between the huge crop of seeds a *Melaleuca* produces each year and the distances that these seeds may be carried, it is easy to see how the tree can spread so rapidly, and also why comprehensive control efforts

become increasingly difficult to carry out with the creation of each new seed source.

Sprouting, while a relatively insignificant factor in long-distance *Melaleuca* proliferation, is a very effective method of reproduction and expansion within the general limits of a given stand. Unlike the initial stages of a *Melaleuca* incursion, where young seedlings are found singular and spread apart, more advanced stages show very dense clumps of many trees that have sprouted from the original seedling source. One researcher describes such sprouting as follows:

... *Melaleuca* is capable of surviving many natural and man-made adversities by virtue of its ability for vegetative regeneration. Even seedlings less than one-quarter inch in diameter are found capable of sprouting from the stem in response to cold or fire damage. Trees of all ages are observed producing stump or branch sprouts as a result of felling or mechanical breakage ... The usual end result of both sprouting and tropic responses (growth toward light) is the production of several erect, seed-bearing trunks where only one formerly existed.(33)

Obviously, sprouting becomes another factor that must be considered for any effective, long term control program. A multiplicity of new trunks and crowns sprouted about an original seedling site, while making for a much denser stand, does not in itself do much to increase the actual physical spread of *Melaleuca* beyond the general stand area. What it does do, however, is geometrically increase the seed stock of the stand which in turn significantly improves the chances for and increases the rate of *Melaleuca* seedling proliferation. Control efforts require use of an appropriate herbicide to completely treat a *Melaleuca* site if sprout regeneration is to be prevented.

Life History

In contrast to the *Melaleuca*'s hardy, stress tolerant character as a mature tree, its earliest stage as a germinant can only be described as extremely delicate, requiring very specific site conditions for establishment to eventually occur. This seemingly inconsistent nature is common to many flora that bear such small seeds. Unlike larger, more self-sufficient seeds, those of the *Melaleuca* are greatly dependent on the surrounding micro habitat. Thus continued viability upon release from the parent tree is very much dependent on the particular physical conditions of the site on which a seed chances to fall.

Prior to germination, however, seeds can survive for at least a limited duration on their own. Researchers have found that, "If seeds are superficially buried in the soil ... they can remain viable for at least 10 months while waiting for conditions favorable for germination".(34) Apparently they can also survive being inundated in water for extended periods. Once the proper conditions occur to trigger germination, however, such favorable conditions must be steadily maintained if establishment is to succeed.

For seeds that are released early in the season, premature germination will often cause mortality. Seed germination "...may be triggered by a brief rain storm, or possibly even by dew or fog, that does not provide sufficient moisture for continued development".(35) Thus even with the seed's ability to remain viable over an extended period, the timing of its release from the parent tree can be critical. "Seedlings that either germinate before a site becomes flooded, or that pass the wet season under water as seeds and then germinate immediately after the flood water recedes, have the best chance of surviving the dry season."(36)

In addition to timing, specific on-site factors can also be critical relative to a seed's chances for successful germination and survival. Regarding food energy requirements, for example, "A germinating *Melaleuca* seed depends on nutrients available in the top few centimeters of soil because it does not have sufficient food reserves to produce a deep-rooted seedling. The germinant is 'on its own' almost from the start."(37) In terms of water needs, the germinating seed is again dependent on both the actual availability of moisture and the physical nature of the micro site. Growth of a new germinant is slow, and if the elongating root has to penetrate a litter layer or algal mat, chances for survival will be very low unless moisture conditions remain near the optimum, as "...germinants are very susceptible to desiccation".(38) Also, "...*Melaleuca*'s germinative ability varies with the soil type and is considerably better on acid soils than on alkaline soils, especially marls".(39) In standing water, seedlings will not become established, primarily due to a lack of oxygen.

Under even the best of conditions the chances of any single seed surviving and successfully germinating are extremely low. With millions of seeds being released from a single mature tree, however, the odds become considerably improved and the threat of *Melaleuca* proliferation remains high. And occasionally, nature produces a set of conditions that are particularly ideal for the reproduction, establishment, and growth of a given plant type, causing its numbers to soar at an unprecedented rate. Scientists refer to such conditions as an episode. An episodic type of biological establishment occurs "...when an entire area may be suddenly invaded by a species which was seldom found before that particular environmental episode".(40)

For *Melaleuca*, ideal episodic conditions occur when an appropriate stress is placed upon mature trees that will initiate especially high seed release while physical and chemical conditions of surrounding lands are particularly agreeable to seed germination and establishment. The best example of this might be a wildfire. As reported by the U. S. Forest Service Southeastern Forest Experiment Station:

Fire performs a number of functions that help to optimize the chances of successful *Melaleuca* colonization. Depending on intensity, fire triggers seed release, clears the site of competing plant species, consumes the litter which produces a mineral soil seedbed and temporarily fireproofs the area thereby protecting the *Melaleuca* germinates, ...recycles nutrients making them readily available to the newly established seedlings, ...and protects the tree crowns from another fire for several years by removing the loose bark ...Crown fires temporarily halt transpiration so that

subsequent rains will keep the soil moist for longer periods of time. Further, destruction of the existing canopy increases sunlight penetration which promotes germination and growth while the standing trunks provide partial shade that moderates soil surface temperatures.(41)

Wildfires occur frequently in south Florida, and resulting *Melaleuca* incursions are readily apparent. Indeed, it has been shown that there is a general correlation between wildfire burn areas and the recent spread of *Melaleuca*. And while the importance of fire as a factor in *Melaleuca* proliferation should not be overplayed, as the tree can still spread very well on its own, it should be noted that the threat of an extensive burn on Sanibel is very real. With almost half of the island being vegetated wildland, the chance of a fire episode occurring is certainly not unlikely, and the resulting spread of *Melaleuca* would be catastrophic.

With the *Melaleuca* being a relative newcomer to Florida, researchers are only beginning to understand its life history. And while the relationship of the tree to fire seems clear, other episodic occurrences that trigger such drastic *Melaleuca* proliferation are still open to conjecture, although there is no doubt that a number of conditions can easily evolve to create other types of episodes, or elements thereof. Any type of earth cultivation, movement, or other disturbances, for example, expose soil and greatly assist *Melaleuca* regeneration. Extended periods of rain may also produce ideal *Melaleuca* conditions, as the tree does particularly well in wet habitats, although there are plenty of examples of natural establishment on perennially dryland sites as well. Flooding or frost, in conjunction with other appropriate conditions might also be suitable causes for an episode, as would be a hurricane, with flooding and widespread seed dispersal.

But again the importance of the episode as a factor in *Melaleuca* proliferation should be kept in perspective. While such an occurrence can definitely cause an overwhelming onslaught of the exotic at any given time, the spread of *Melaleuca* in south Florida -- and on Sanibel -- is a constant, sometimes slow but always inexorable, ongoing process, certainly not dependent on an episode. And as the process continues, the threat that *Melaleuca* poses to remaining natural ecosystems, especially in the event of an episode, steadily increases in geometrical proportions.

"Documented reports of *Melaleuca* growth rates indicate that it can be rapid under the best conditions but is not impressive under marginal conditions."(42) Height increases in seedlings have been reported ranging between one and two meters a year and at a little over a meter for mature trees (43), but again such data is very much site dependent. Mean annual girth increments can be expected to range between one and two centimeters, although "...45 centimeter logs have been produced within 10 to 12 years". (44)

As a very general rule, *Melaleuca* on dry sites tend to grow more slowly than comparable age stands on more moist sites, where it has been found that "...saturated soil stimulates height growth at the expense of diameter growth." (45) For any site type there are "...recurrent growth peaks in spring - early summer and in late summer - early fall" (46), with perhaps the most growth occurring in June. Maximum attained heights for *Melaleuca* are probably in the area of 25 meters, with the highest in Florida recorded at 27 meters. (47)

In the course of its unyielding invasion of south Florida's wildlands, *Melaleuca* shows a marked tendency to form stands whose members are all of the same relative age class. Younger stands become very dense, almost impassable, totally without the lush diverse undergrowth typical of subtropical vegetative communities. Later, "An almost complete lack of minor vegetation within well-developed stands..."(48) is a distinctive characteristic, as is the lack of *Melaleuca* reproduction under fully mature trees. Basically, the end result of the introduction of the species to an area will be a *Melaleuca* monoculture, as it will out compete and eventually eliminate all other tree types. While dense *Melaleuca* stands can possibly support some forms of wildlife, there is no denying that vast sweeps of nothing but *Melaleuca* trees offer very minimal bird or wildlife habitat possibilities and truly are "biological deserts" when compared to the diverse, thriving natural forest ecosystems of south Florida.

The Threat

Sanibel Island is currently at a cross roads regarding at least one aspect of its ecological future -- the continued maintenance and viability of its natural vegetative system. Most people would likely agree that it is the diverse plant life, and the animal life that depends on it, that makes Sanibel a unique and attractive place to live, so the road that is chosen seems very critical. It is fortunate that perspective citizens of the island have recognized the threat posed by *Melaleuca* to Sanibel, and that the City Council has had the foresight to pay heed to such warnings. One doesn't have to go far off island, however, to easily see that it would be fool hardy indeed to ignore the potential ecological impacts of *Melaleuca* proliferation.

It is said that *Melaleuca* on Sanibel is currently at the stage where another exotic -- Brazilian Pepper (*Schinus terebinthifolius*) -- was 30 years ago, and few would argue that the spread of the pepper has been very detrimental to the island. Certainly the *Melaleuca* is a more palatable tree -- in fact a pretty tree in moderation; but its ability to overwhelm natural vegetative communities is devastating, even in comparison to the pepper. If it is to be controlled on Sanibel, now is certainly the time to do it, while its numbers are still relatively limited. Meanwhile, new seedlings can easily be found cropping up in remote wildlands, and should the right combination of environmental conditions occur to cause reproduction to really take off, it might be too late to consider realistic control measures.

It should be noted that the introduction of exotic plant species in south Florida is far from unusual. In the past several decades literally thousands of plants have been brought into the state for agricultural and horticultural purposes. Of these, however, only "...about 250 species are capable of reproducing in this environment".(49) And narrowing this number much further, "...only a half dozen of these plants have demonstrated the ability to aggressively colonize and dominate the landscape".(50) Of these, *Melaleuca* by far and away shows the greatest ability to overwhelm a natural ecosystem.

There are plenty of places in south Florida where, following initial introduction of *Melaleuca*, early recognition of its spreading went unheeded and the problem quickly compounded to get much worse than would have been the case if swift control actions had been taken. Big Cypress National Preserve provides

one such example. The earliest planting of Melaleuca within the preserve is thought to have occurred in 1944.(51) As late as 1960, no regeneration was detected from these trees, but today the area of the original plantings "...hosts several dense monospecific stands and has expanded to include approximately ten sections of land".(52) Expansion of Melaleuca in the preserve has been attributed...

...to several epic events: land clearing for vegetable farming during the 1960's; conflagrations in 1962, 1971, 1974 and 1981 that burned thousands of acres; and hurricanes in 1960 and 1965. The distribution of Melaleuca today can be categorized in seven major areas where most originated from intentional planting. ...these include ... some 60 square miles of melaleuca infested land in the preserve when considering everything from outliers to dense stands.(53)

Now a preserve official reports that, in just the past year, over a half million Melaleuca trees have been treated and a half million seedlings pulled.

The situation at Lake Okeechobee has been similar, following the Corps of Engineers plantings of Melaleuca saplings in the 1940's. "From those limited plantings, Melaleuca has now spread into many hundred hectares of marsh along Lake Okeechobee's northwestern and southwestern shores".(54) Like scenarios can be traced at Everglades National Park, Loxahatchee National Wildlife Refuge, and many other tracts of land across south Florida.

Being a relatively small (11,000 acres), partially developed island, Sanibel is probably less susceptible to the massive, epic type Melaleuca proliferation that other parts of Florida have experienced. Wildfires, for example, do occur periodically, but large uncontrolled burns are less likely to be a factor on Sanibel than on vast undeveloped lands elsewhere. The numerous roads and subdivisions across the island also impede the rapid spread of Melaleuca to some degree.

Still, over half of Sanibel is wildland. The J.N. "Ding" Darling National Wildlife Refuge comprises 4,900 acres, and the Sanibel-Captiva Conservation Foundation holds close to 1,000 acres. The City also owns several large undeveloped tracts. Much of these lands have just the right sort of conditions to make them especially susceptible to Melaleuca invasions which, on some sites, have already begun. Furthermore, it is important to recognize that there are many smaller wild tracts scattered across the island and also that many subdivisions and large house lots on Sanibel are often left in a considerably more natural vegetated state than is typical elsewhere. The fact is, both the wild wetlands of the island and many of its smaller, semi developed tracts are very much threatened by Melaleuca, which are estimated to already number somewhere around 3,500 trees (with perhaps a little less than half of them having been planted). And whether Sanibel experiences an "epic" or not, there can be no denying that a slow but steady, relentless takeover of naturally diverse native vegetation is occurring. Melaleuca "wildlings" (plant species originally cultivated but now growing wild) have reached the borders of the national wildlife refuge lands, have appeared on City owned properties, and have sprung up in considerable numbers on Conservation Foundation lands in the heart of the island, with larger mature trees casting their thousands of seeds to outlying areas.

Back in 1975, the comprehensive "Sanibel Report" land use plan stated that "Isolated seedbearing trees were noted in several locations".(55) A decade later it is obvious, even from preliminary surveys, that Melaleuca wildlings are found in alot more than a few locations. The situation can only compound to get increasingly out of hand. Clearly the lessons of many other places across south Florida and simple ecological common sense make it clear that, if Melaleuca on Sanibel is to be controlled, the time to act is now.

Landowners should look beyond their own yards or properties and recognize that, while the Melaleucas that they planted may provide shade or form a desireable landscaping hedge, they really do threaten the very values that likely drew them to Sanibel in the first place, making the island the unique and picturesque sort of place they've come to know. A wholistic attitude beyond individual homeowner disires, and general support of the City's control efforts, will greatly benefit the entire island community. In moderation, the Melaleuca could be a distinctive, attractive addition to sub-tropical forest ecosystems. But dense, impassible stands of Melaleuca, devoid of lush undergrowth, sterile, unproductive, and lacking bird or wildlife habitat, truly is a sad price to pay for a narrow minded view of the threat posed by the exotic.

PART 2: THE SOLUTION

A Unique Program

The City of Sanibel's Melaleuca control program is somewhat unique compared to other such efforts in south Florida. It is certainly a smaller scale project than most, covering 6,000 acres and comparatively few trees. Almost half of the Melaleucas currently found on Sanibel were probably planted, primarily around home sites, with proliferation from these seed sources at the early stages and still relatively limited. Furthermore, the program is more political and public relations oriented than others, relying more on public interest and cooperation than large expenditures and sweeping eradication efforts. Perhaps the most significant difference is that the long term prospect for winning over the exotic invader may be more realistic, and more readily at hand, on Sanibel than elsewhere. Being a small island with at least some isolation from mainland seed sources, and with a City government dedicated to the eradication of Melaleuca (with the island's other major land holding entity, the J. N. "Ding" Darling National Wildlife Refuge likewise committed to Melaleuca control), the problem can be beat.

Political Background

Sanibel's control effort had its beginnings in the fall of 1983 when the City passed a resolution to initiate a program to control and eventually eradicate Melaleuca from the island. Recognizing that the exotic has rapidly spread across south Florida, outcompeting and choking out native vegetation and drastically altering naturally diverse ecosystems, the Council recognized that their island is not immune from its proliferation. If reasonable success was to be achieved against the invader, control efforts could not be delayed.

The original control program called for the mandatory removal of all Melaleuca trees from the island at City expense. Under this plan, property owners having the tree on their land had five years to contact the City and request removal. A City crew was to handle smaller jobs, with larger, more difficult tree removals bidded out to contractors (it was expected that, by lining up a number of jobs for a single bid, overall costs could be reduced considerably). After the five year period, people who had not agreed to have their trees removed by the City would be required by law to remove any Melaleucas from their property at their own expense.

While this plan seemed an efficient and decisive manner in which to handle the Melaleuca problem, it met with unexpectedly vocal opposition. In fact, it probably caused as big a controversy as the City has seen in its first decade of incorporation. Much of this objection was based on the City's "big brother" approach to the problem. Others simply like the Melaleuca for the shade or hedging it provides around a homesite or as an ornamental. Especially after the trees had been so highly recommended for planting by "experts" the idea of being forced to remove them seemed unacceptable.

Furthermore, many Sanibel residents simply do not believe that Melaleuca poses a threat to the island environment. While they can easily see the way the tree is spreading only a few miles away on the mainland, they seem to think that

the trees on Sanibel don't have the same seeding capabilities. They often make claims that particular trees found on their property have caused no problem, an understandable statement from their perspective of a mowed and manicured yard. Unfortunately, they are unaware of the situation in the island's wilds, where Melaleuca's are appearing in alarming numbers, the result of seeding from the very trees that are said to be completely harmless.

It should be noted that such opposition came from a minority of islanders. Others with a greater ecological awareness pushed hard for the control effort, although in general, many supporters seemed to think that the City's primary motive behind the program was the elimination of an allergy source. Somehow people seem better able to relate to fighting an allergen problem than to protecting natural habitat from the exotic tree's onslaught. At any rate, the City deemed it politically expedient to yield to the objections to the plan and rescinded the mandatory aspects of the program.

Resolution

Nevertheless, the City remains very much dedicated to the long term goal of Melaleuca control and eradication. This commitment is clearly stated in Resolution 84-11 (passed February 7, 1984), which recognizes the importance of Sanibel's diverse native vegetation relative to the aesthetic character of the island, the balance and stability of its natural environment, and as habitat for an abundance of bird and wildlife species. Quoting the resolution, it is the intent of the City Council:

... to ultimately eradicate the tree Melaleuca quinquenervia from the City; to continue with a program of support and assistance to property owners willing to voluntarily remove said trees; and to attempt to educate citizens and owners of property within the City to the potential danger to the City's natural environment posed by said tree...

To carry out this goal, the City hired a "Noxious Plant Control Officer" to administer its control program. He is charged with publicizing the urgent need to rid the island of seed sources, surveying the island and recording the locations where Melaleuca are found, treating trees that have seeded into the wildlands, and removing trees from private properties as requested. As originally planned, the City will handle relatively easy removal jobs and contract out larger projects. The success of the program will depend on catching the wildlings that have seeded into the island's heartland before they have further opportunity to reproduce and on the public's voluntary cooperation in eliminating seed sources. If it appears likely that the spread of Melaleuca can be stopped on Sanibel, and if control efforts receive favorable public acceptance, Council has indicated that it may decide to reinstate the mandatory provisions of the program at some future date.

It should be mentioned that, since 1976, it has been illegal to plant Melaleuca on Sanibel. The City also enforces a standing regulation requiring removal of all Melaleuca (and Brazilian pepper) from a property as a prerequisite for the issuance of a development permit. This serves as a sort of second "arm" toward meeting Sanibel's Melaleuca control goals and has undoubtedly lessened proliferation potentials to at least some degree in the years before the City's current program was initiated.

Preliminary Research

Before any large scale, comprehensive Melaleuca control program is initiated by the City of Sanibel, it is important to fully research the life history and reproductive characteristics of the exotic. Such findings are discussed at length in Part 1 of this control program document, generally a culmination of various studies, personal contacts, and correspondences with individuals or organizations involved with Melaleuca control at both scientific and practical levels.

To date, contact has been made with interested officials in the National Park Service, the Army Corps of Engineers, the Fish and Wildlife Service, University botany and forestry departments, chemical companies, the Sanibel-Captiva Conservation Foundation, the City's Vegetation Committee, several biological stations and preserves, and other individuals too numerous to mention. Having accumulated a sound foundation of knowledge, the City will continue to gather additional information, as well as share its own experiences and findings from a rather unique control effort with others. There is still much to be learned about this relatively new exotic invader, and any control plan should remain flexible enough to utilize new research findings.

Public Relations and Awareness

Because of the voluntary nature of the City of Sanibel's Melaleuca control program, public relations and awareness is key to the success of the effort. If Sanibel's citizens are to be expected to cooperate in the campaign, an understanding of the threat posed by Melaleuca will be essential. Part 1 of this control program document provides the basis of the educational effort in this regard, and copies should be available for public review. In addition, a one page bulletin will be distributed to property owners with Melaleuca on their land. It will describe in basic terms the exotic's awesome ability to proliferate and the urgent need to remove seed sources from the island as soon as possible.

In addition, the City's Noxious Plant Control Officer, as administrator of the control program, will conduct seminars to inform interested parties about the Melaleuca threat. A slide show and descriptive maps will be developed to go along with such talks. Newspapers and other media will be updated periodically with findings and progress reports.

Field Survey

An accurate, comprehensive, continually updated and maintained field survey record is another key to a successful, long term Melaleuca control program. Approximately 6,000 acres will have to be covered in the survey, the 5,000 acre National Wildlife Refuge, with its own exotic control program, being excluded from the City effort. Survey records will be based on a set of 25 City street maps, with Melaleuca sites marked on the maps and data logged on corresponding record sheets, one for each map. These record sheets will list a site number, address (if available), details on location, the number of trees, their age, the

relative degree of proliferation hazard posed by the site, and comments on removal difficulties.

Regarding the statement of number of trees, it should be recognized that Melaleuca, especially in its older stages, often occurs in clumps, so the "quantity" category of the survey record can be deceiving, providing, if anything, a conservative figure of the number of seed sources found on the island. Perhaps Melaleuca "site" would be a more appropriate term than "tree", as a single tree in the record often includes multiple stems of up to a half dozen or more, forming a clump with a huge seed capacity.

The age category can likewise be misleading, as it provides only a general indication of the age, or really more the size, of the trees found in any particular numbered site (precise age estimates are very difficult to obtain from Melaleuca). Ages range from 1 to 3, with 1 being a seedling, 2 an established seed bearing tree, and 3 being a large, older tree with substantial height and girth.

Hazard ratings are also very general estimates based primarily on the proximity of the site to substantial tracts of wildlands where a Melaleuca infestation is likely to occur. Thus a site with Melaleucas on the far east end of the island, which is heavily developed, with house lots mowed and manicured in the traditional sense, would rate as a lower hazard than sites closer to the island's mid section, which is largely undeveloped, with large tracts of highly susceptible wetlands (although it is important to remember that under the right conditions a seed can carry more than a mile from the parent tree, so in fact all of the island's Melaleuca's should still be considered critical). Trees in the vicinity of the National Wildlife Refuge or the Sanibel-Captiva Conservation Foundation would be considered particular hazards. The number of trees on a site and their age might also be taken into account to formulate a hazard rating, which also goes from a low of 1 to a high hazard rating of 3.

Generally, the island survey will be conducted from east to west. The east end has more of the older subdivisions, and consequently more of the planted Melaleucas. As the central wetlands are again considered to be most critical relative to Melaleuca proliferation, however, surveys may be carried out around Sanibel's mid section before those to the east are completed, although covering such wild tracts will be considerably more difficult. At any rate, by the end of 1984 the entire 6,000 acres of the City of Sanibel should be completely surveyed, with each of the 25 maps and their corresponding record sheets providing a permanent record of Melaleuca locations. Again, the City's Melaleuca control program needs to be seen as very much a long term effort, making accurate, permanent record keeping invaluable.

In addition, each of the field survey record sheets will have a corresponding "Melaleuca Site Ownership and Notification Record" and a "Melaleuca Treatment Record." The ownership record will provide the name of the owner of a designated Melaleuca site, his address, phone number, the date and manner in which he was notified regarding removal of his trees, and the response. The treatment record notes the date of a removal job at a particular site, the number of trees removed, comments on the job, and any special terms that were agreed upon regarding the work. All of these records will be continually updated, with fully treated sites so indicated on the maps and survey sheets. As Melaleucas may also be removed by property owners as part of

a City permit requirement or for power line maintenance or some other project, such information should likewise be duly noted.

Surveys of the island's developed neighborhoods are generally relatively easy to conduct. Walking about the subdivisions, Melaleuca can usually be spotted from the street or by following the property perimeters for a closer look where observation from the front yard is obscured. Surveys of heavily wooded wildlands, on the other hand, are considerably more difficult to undertake. Because Sanibel is essentially without significant topography, only limited areas can be scanned from any particular vantage point.

Fortunately, several characteristics of the Melaleuca prove to be an aid in spotting it in the wild. Foremost is the fact that the tree tends to have a tall crown that rises above other Sanibel vegetation, the Australian pine being the particularly notable exception. Thus, when viewing a wooded area on Sanibel, Melaleucas tend to stand out distinctly above other trees. A rapid growth ability -- more than 6 feet a year -- might also be seen as a beneficial survey aid. While such growth is also threatening in that it makes the potential for Melaleuca proliferation that much greater, it can also be said that if a seedling is not seen during one survey, a year or two later, when another is conducted, the fast growing exotic is bound to be spotted. Therefore, latent Melaleuca seedlings, which might never be found in Sanibel's dense undergrowth during the initial survey, really need not be considered a major problem, as long as the City remains committed to continued future surveillance. Soon enough such wildlings will be spotted, and probably before they bear many seeds. Finally, Melaleuca's distinctive appearance, bright whitish paper bark and somewhat brownish leaves, as well as its tall, relatively confined shape, also help to make the tree easier to spot.

It has been suggested that the use of high rise bucket trucks could assist in field surveys of Sanibel's wildlands. Aerial observations or photographs might also offer mixed successes. Experience thus far dictates, however, that the island's wildland's are reasonably accessible, and that simply plunging into the brush and covering as much ground as possible is fairly effective. Perhaps for future surveys, when most wildlings have been treated and any new ones to appear will likely be few and far between, more sophisticated high profile methods could be utilized to periodically check for new growth. But for now, in carrying out surveys through the wildlands on foot, numerous paths, power line rights-of-way, and relatively high canal banks can assist in access and orientation. Often an Australian pine, or even a Melaleuca, is handy to climb and obtain a better view of the surrounding area. A canoe on the Sanibel River or its various tributaries will provide still another vantage for Melaleuca observations.

There will be some tracts of wildland, however, where no points of orientation are available over a considerable area. Consequently some Melaleuca wildlings will prove difficult to accurately map, with no nearby landmark by which to pinpoint their location. In such cases, only the approximate area in which wildlings were found will be indicated on the map. Still, it is important to fix as near a location as possible in the wilds, as a return to and retreatment of the site may well be necessary (see the Wildlands Treatment section).

It is possible that in large, heavily wooded tracts of land like those owned by the Conservation Foundation, a flagged line could be run between parallel paths or some other landmarks to establish a sort of grid system, allowing a more thorough and efficient search of the section as marked than would otherwise be possible. One line could then be moved beyond the other, forming another grid section to be inspected. Hopefully these types of innovative survey techniques will evolve with experience.

As a general rule for all surveys, however, it would seem that, at least initially, quantity should take precedence over quality. In other words, while it is important that surveys be as comprehensive as possible, 6,000 acres of Sanibel need to be covered, and it would be better to get a basic grasp of Melaleuca localities across the island than to try to inspect every last inch "with a fine tooth comb". There will be plenty of trees to be treated over the next several years, and more exacting surveys of critical areas can be carried out in the future.

Bearing this in mind, it is likely that some Melaleucas will be overlooked in the course of the survey, a few in subdivisions, probably more in the wilds. Again, however, this need not be seen as a critical problem, as long as further periodic surveys are planned for the future. In such later surveys, perhaps just a portion of the island might be checked each year, assuming that the majority of the exotics have been located and are being removed. It might be said that, as long as continuous surveillance is maintained, a Melaleuca that is missed really need not be seen as a problem until it is large enough to be noticed. All Melaleucas should be eliminated from Sanibel, but the larger seed trees represent the greatest hazard to the island ecosystem. Again, persistence and vigilance over the long run is essential. Probably all Melaleuca will never be eliminated from the island, but if a watchful eye is constantly maintained for new seedlings, while the number of existing trees continues to decline, a problem that is becoming very much out of control in much of south Florida will be beat on Sanibel.

Removal Request Notification

Two basic types of Melaleuca removal situations will be encountered in the City of Sanibel's Melaleuca control program; those on private property homesites, or neighborhood treatments, and those on larger privately owned wildland tracts. In both cases, permission will have to be sought and obtained from the landowners before treatments may be pursued. This will be done through a personal letter, along with the Melaleuca bulletin. As mentioned, responses will be recorded on the "Melaleuca Site Ownership and Notification Record. When necessary, follow up letters, a phone call, or a personal visit will be made to landowners as seems appropriate. Perhaps in some cases, the program's emphasis on education will make a difference with a property owner reluctant to part with Melaleucas.

Some Melaleucas are also found on City properties. Their treatment, of course, requires no permission and should be expeditiously carried out. If the City expects the general public to cooperate with its Melaleuca control program, it seems important that it "clean its own house" first.

If a landowner's name and address is not readily available for a formal removal request, it should be available through tax records. In the earlier stages of the program, people with relatively easily treated trees (those that City personnel can handle efficiently and without special equipment) will be contacted first. Just getting out in the neighborhoods and doing good "showpiece" treatment jobs will be some of the best public relations the City can gain. At the same time, wildland treatments should be considered the program's overall priority, as they are the habitats most critical to protect. As wildlings are found on such properties, permission for treatment should be sought without delay. Generally owners of undeveloped wildlands should have little hesitation granting permission for wildling removals. Of course, the Sanibel-Captiva Conservation Foundation, the island's largest private land holder, is already a strong supporter of the Melaleuca program.

Negotiation and Treatment Options

While the disastrous impacts caused by Melaleuca proliferation should seem obvious to even the casual observer, Sanibel residents do have mixed feelings regarding their removal. The City's control program has been a controversial issue. While many property owners have readily consented to or even requested Melaleuca removals, due to allergy problems or simply to cooperate with the City's efforts, other homeowners have voiced strong opposition. Having originally planted the Melaleucas, often on "expert" advice, they do not like the idea of suddenly being asked to have them removed.

With this in mind, the City is willing to go to considerable lengths to bend to homeowners needs and concerns, especially when the trees in question are on a high hazard site. Depending on the situation, for example, the City will offer to plant replacement stock, primarily green buttonwood, from a special nursery established for that sole purpose. The buttonwood is a hardy, low maintenance native species that has growth characteristics that make it attractive as a replacement to trees that were an important visual element of a landscaped yard or provided screening or shade. Assistance from volunteers from the City's Vegetation Committee and the Conservation Foundation may be sought in this aspect of the program. In other situations, the City may be willing to remove half of an individual's Melaleuca at one time, then return a year or two later to remove the remainder, the idea being to reduce the impact of the loss of a large number of trees at any one time. With flexibility shown by the City and a recognition that both parties are helping each other for the overall good of the island, additional contingencies can be worked out as they develop.

Neighborhood Treatments

Good public relations and educational efforts notwithstanding, general acceptance and cooperation relative to Sanibel's Melaleuca control program will be much more likely as long as the highest quality of work is maintained for individual home site treatments. Such removal jobs will be highly visible, and "word of mouth" regarding the program will quickly carry about the island. Thus great care must be taken in any neighborhood treatment effort, from ensuring that there is no damage to surrounding structures and a minimum of damage to

nearby vegetation to carefully cleaning up all sticks and twigs from the site. Naturally all wood debris will be hauled away from the neighborhood lot. All stumps will be cut as close to the ground as possible. In a few cases they might be removed, although this should be avoided if possible due to the exorbitant cost. The last few inches of a stump should decompose rapidly enough. In some cases it could be covered with soil and a ground planting to expedite the process.

In all cases, whatever is left of a Melaleuca stump will be treated with the herbicide Garlon 3A. Produced by DOW Chemical, it is a hormone-type herbicide (active ingredient 44.5 percent triclopyr) which readily translocates through roots for a complete kill. While Garlon 3A is one of the most effective herbicides available, it does not build up in the environment, with its active ingredient beginning to break down in as little as ten days after application. The undiluted chemical will be sprayed primarily onto the exposed cambium layer adjacent to the outer bark. A relatively small amount evenly applied all around is all that is necessary to ensure a complete kill. The importance of poisoning should be stressed, as Melaleuca will otherwise show a remarkable regenerative ability to grow root suckers and sprouts off the stump. Application certification is not required for Garlon 3A.

Neighborhood sites that have relatively small, easily removed Melaleucas may be treated by City personnel, with wood debris trucked to a temporary City dump site for eventual removal from the island. For larger or more difficult tree removals, the work will be contracted out to professional tree companies. Again, the hazard rating of a site may determine when it is treated. Jobs may be contracted individually or, if enough work is lined up, bids will be sought for a large scale effort. Such a large volume of work would likely reduce overall removal costs. All contracted removal operations will be supervised, or at least inspected upon completion, by a City official, who will also poison the remaining stumps. Cooperation will also be sought from Lee County Electric Cooperative and any other utilities who are concerned with trimming and wherever possible removing Melaleuca from their rights-of-way. Generally, upon request from the City, they will prove to be more than happy to act on a chance to be rid of a Melaleuca problem.

Wildland Treatments

All wildland treatments will be carried out by City personnel. As compared to neighborhood jobs, they should present few problems, with no physical obstructions to cause removal difficulties. This is not to say the task will be easy, however, as simply attempting to make one's way through the thick undergrowth of forest or swamp to a Melaleuca tree can prove to be extremely arduous. The more important difference between wildland treatments and the neighborhood jobs, however, is that the branches of the wildland trees, often laden with seed, will remain on site following treatment, as it would obviously be very impractical to try to carry them out. This means that there is likely to be some future germination at the site after it has been treated, as the severed branches will cause the seed capsules to break open, initiating the release of thousands of seeds. As the tree will be cut near ground level, however, and sawed into sections with the slash piled as compactly as possible, it can at least be assumed that any germination will occur within a very close

proximity to where the parent tree stood. During the initial treatment, of course, the surrounding area should be scanned for wildlings that may have been overlooked in the survey.

It would certainly be easier to simply poison a standing tree, injecting herbicide into its bark. The resulting long distance loss of seeds that could then occur, however, could under the right conditions create a mini epic in itself, with wildlings becoming established far and wide from the parent seed source. At any rate, the anticipated germination that's likely to occur at treated wildling site will necessitate a return to remove any new seedlings. Again, this makes careful record of the treatment site location very important. Probably a two year wait (but no more) would be about the right timing for a return visit, as new seedlings will have grown tall enough to easily spot but still be too young to have seeds of their own. Once these secondary seedlings are then removed, with other *Melaleuca* sites in the vicinity likewise treated, the occurrence of any new germinants is unlikely.

CONCLUSION

There should really be no conclusion to this Melaleuca control plan, as it must be seen as a long term, neverending effort. Over the next several years, the intensity of the program may be reduced, as the island's wildlands are secured of wildlings and more and more of the planted seed sources are removed, either through voluntary cooperation with the City or as part of special permit requirements. But it is quite likely that all of the Melaleuca's on Sanibel may never be completely eliminated. Certainly seed sources across San Carlos Bay or on nearby Captiva Island could easily find their way to Sanibel.

The program therefore must not be seen as a one time, sweeping solution to the Melaleuca problem. Accurate, permanent record keeping is essential, as is having an employee charged with at least a part time commitment to Melaleuca surveys and spot removals. As more people learn about the Melaleuca hazard, and as more people have their trees successfully, professionally removed, it seems unlikely that too many of Sanibel's citizens will hold out against the aims of the control program. The natural beauties of Sanibel simply outweigh any arguments to keep the exotic tree. Unfortunately the remainder of south Florida will likely have more than enough Melaleuca to appease anyone. But on Sanibel, with a strong showing of cooperation, vigor, and vigilance, the natural values of the island can be preserved and a lush, diverse, productive ecosystem will prevail over the exotic Melaleuca invader.

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