STATUS OF MANAGEMENT AND CONTROL EFFORTS FOR THE INVASIVE ALIEN TREE *MICONIA CALVESCENS* DC. (MELASTOMATACEAE) IN HANA, EAST MAUI

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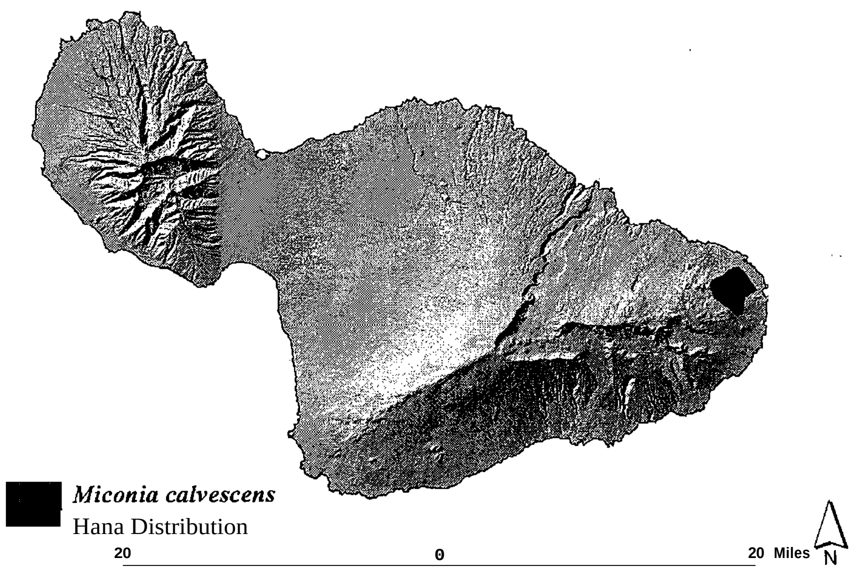

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INTRODUCTION

Miconia calvescens DC. (Melastomataceae), a medium-statured, neotropical tree 12-15 m tall with large, bicolorous leaves (up to over 1 m in length), has gained notoriety as one of the worst invaders and ecosystem modifiers of the Pacific archipelagoes of French Polynesia (Meyer 1996; Meyer and Florence 1996) and the Hawaiian Islands (Medeiros *et al.* 1997). Introduced to the islands of O'ahu and Hawai'i in the early 1960s, and to the island of Maui in the early 1970s (Medeiros *et al.* 1997), it was not until 1991 that Hawaiian biologists began to recognize the seriousness of the threat this tree posed to native Hawaiian ecosystems. A Haleakala National Park botanist first became aware of *M. calvescens*'s great invasive potential on trips to Tahiti in 1977 and 1988 (Gagné *et al.* 1992). In less than 50 years since its introduction in 1937, it had spread widely throughout much of Tahiti's forests (Birnbaum 1991), forming monotypic stands that had, more or less, locally erased the native Tahitian flora (Gaubert 1992, Meyer and Florence 1996). In 1990, this park botanist noticed a single *M. calvescens* tree growing in Ali'i Gardens near Hana, Maui. Its origins were traced to Helani Gardens, another botanical garden and nursery in Hana. It was surmised that *M. calvescens* probably first arrived as part of a horticultural shipment from a neighbor island in the early 1970s, and by 1991, it was well established in Helani Gardens and in several other locations along the windward coast of East Maui. The first attempt at control of this plant occurred in Helani Gardens in June-July 1991, when park personnel and volunteers manually removed over 9000 *M. calvescens* plants, including several fruiting trees over 10 m tall with basal diameters greater than 30 cm (Gagné *et al.* 1992). From 1991-1993, over 20,000 plants were removed from five additional *M. calvescens* populations, and many were optimistic about the prospects for eradication. In September 1993, however, a much larger population of ***M. calvescens*** was located among a thickly vegetated, alien dominated forest upslope and to the northwest of Helani Gardens (Medeiros *et al.* 1997). This population, initially consisting of four discrete stands of canopy-sized trees and widespread outliers, has been the focus of intensive control efforts, beginning with aerial spraying in 1994, and continuing with manual and chemical ground and aerial operations since June 1996. In addition to the 10 populations of *M. calvescens* documented in 1997 (Medeiros *et al.* 1997), additional populations have been discovered, including at Wailuku, and outliers or new populations along the windward coast of East Maui. Since 1991, the Melastome Action Committee (MAC), and now, its current successor, the Maui Invasive Species Committee, has been worlung to combat the spread of *M. calvescens* and other invasive weeds on the island of Maui through continued manual and chemical control efforts of known populations, reconnaissance and surveys for new or undiscovered populations or outliers, continuing public education and outreach, and support tor biocontrol.

This report will exclusively focus on the history and status of manual and chemical control efforts of the Hana *M. calvescens* population and include information and monitoring data cited in previous publications.

BACKGROUND

A. Biology and Ecology of *Miconia calvescens*

Because of its impacts to Tahiti's native ecosystems, *Miconia calvescens* has been singled out as the greatest single plant threat to the remaining wet forest ecosystems of the Hawaiian Islands. The Society Islands and Hawaiian Islands share similar volcanic origins, ages, latitudes from the Equator and continental land masses (16°40'-18°00'S lat. And 19°00'-22°20'N lat. respectively) and are comparable in climate, topography and biota. Both island groups have floras with many common native genera, a diversity of pteridophytes, and a relative paucity of monocots (Florence 1987; Wagner *et al.* 1990). These inherent similarities suggest that. given time, ***M.*** *calvescens* will do to the Hawaiian Islands what it has done, and continues to do to the island of Tahiti, *i.e.* invade, modify and erase native ecosystems.

It has been surmised that the low canopy stature, high forest floor light intensity, and lower tree species diversity of native forests in the Hawaiian and Society Islands as compared to neotropical rainforests contribute to the ability of *M.* ***calvescens*** to invade and modify these island ecosystems (Medeiros *et al.* 1997). In fact, ***M.*** *calvescens* seeds have been shown to germinate in as little as 0.02% of full sunlight, if not in complete dark (Meyer 1994). In the opinions of the authors, this ability has played a significant **role** in enabling *M. calvescens* to gain a foothold in the dark understory of low elevation, alien-dominated forests on windward East Maui and potentially aid in its establishment in the more pristine native forests located upslope.

Other factors which contribute to the success of *M. calvescens* as an invader and modifier of native ecosystems include the rapid growth rate, which ranges from 0.85 m/yr to 1.5 m/yr under optimal conditions (light, water) in Raiatea, French Polynesia (Meyer and Malet 1997). This rapid growth rate allows the potential for a germinating seedling to reach reproductive maturity in as little as 4-5 years (Meyer 1996). In Tahiti, after trees reach reproductive maturity, at a height of approximately 3-4 m, there appear to be three annual peaks of flowering and fruiting, with flowers and fruits often present on any one tree at the same time (Meyer 1996). **A** larger-sized (DBH >4 cm, Meyer 1994) reproductive tree can bear as many as 50-200+ fruiting panicles, containing as many as 210 fruits per infrutescence and 195 seeds per fruit. Thus, a mature tree with 200 fruiting panicles can produce over 8 million seeds in a single season (Medeiros, unpublished data; Meyer 1998).

The ripe fruits of *M. calvescens* are dark purple, globose, and between 5.9 mm (Table 1) to 6.8 mm in diameter (Meyer 1998). The tiny seeds, 0.5 mm in diameter, can remain viable in the soil for at least 4 years (Meyer and Malet 1997), and perhaps as long as eight years (Meyer pers. comm.). Because of the massive numbers of seeds produced annually, and the persistence of seeds in the soil, *M. calvescens,* can, over time, build up quite an impressive seed bank. Meyer (1997) found seed banks from between 4800 to 9500 seeds/m^2 in the most invaded sites on Raiatea, French Polynesia.

The substantial seed bank of *M. calvescens* tends to remain dormant under normal conditions, with only a fraction of the viable seeds actually germinating in the available microsites. Nevertheless, when disturbance is created in the canopy, either naturally through tree falls, or artificially through bulldozer operations, manual tree cutting, or herbicide-induced canopy defoliation, large numbers of seedlings are stimulated to germinate or grow more rapidly. Nine months after defoliation of canopy-sized trees in the Hana population, an average of 346 seedlings were found within a 5.64 m radius (100 m^2) of each tree (n=30), with as many as 1800 under one individual (Table 2). Whether these seedlings were already present and responded to the increase in understory light levels, or whether these were newly germinated seedlings has not been determined.

As stated by Medeiros *et al.* (1997), *M. calvescens* seedlings tend to germinate on preferred microsites, including mineral soil, dead tree boles, moss-covered rocks and other surfaces, and dead *Sadleria* tree fern trunks. Count estimates were made for maximum numbers of seedlings on both cinder substrates and *Sadleria* trunks, using a plastic 0.1 x 0.1 m (100 cm^2) frame. The frames were placed over a seedling bed which covered at least 95% of the surface area, and the number of seedlings was counted without pulling them out. An average of 62 seedling/100 cm^2 cinder soil (n=10) and 101 seedlings/100 cm^2 *Sadleria* trunk were counted using this method (Table 3).

Seedlings of *M. calvescens* have also been observed growing epiphytically on *Cibotium glaucum* tree fern trunks, and on the trunks of both native and non-native trees within the invaded site.

Miconia calvescens berries and seeds are easily and readily dispersed by a number of vectors, including gravity (falling off the tree), wind (very short distances), water, introduced rodents such **as** the Polynesian Rat (*Rattus exulans* Peale), possibly larger mammals such as feral pigs and domestic cattle (in mud clinging to fur or hooves), boot, clothing and equipment contamination by humans traversing through invaded sites, soil movement (heavy machinery or in horticultural media), and by non-native frugivorous birds (Meyer 1994; Medeiros *et al.* 1997). In the Society Islands, *M. calvescens* fruits are consumed and dispersed by the abundant silvereye *Zosterops lateralis* (Gaubert 1992), the red-vented bulbul (*Pycnonotus cafer*) and possibly native fruit doves (Meyer 1994). In the Hawaiian Islands, the ubiquitous Japanese white-eye (*Zosterops japonicus*) and the red-~~billed leiothrix (*Leiothrix lutea*), both of which have been documented to consume berries~~ of another invasive melastome, *Clidemia hirta* (L.) D. Don (Medeiros, unpublished data), are probably important dispersers of *M. calvescens.* Other birds which have been observed in the Hana area and could consume and disperse *M. calvescens* berries include the common mynah *(Acridotheres tristis),* the melodious laughing thrush *(Garrulax canorus),* and the northern cardinal *(Cardinalis cardinalis).* The red-vented bulbul, an important disperser of *M.* ***calvescens*** seeds in Tahiti and established on Oahu since the 1960s (Pratt *et al.* 1987), is not apparently established on Maui. Nevertheless, reports of a “black-headed cardinal that feeds on papayas” from the Hana area (Fern Duvall, pers. comm.) suggest the possibility of an incipient bulbul population. Another potential dispersal agent **is** a growing population of mitred conures *(Aratinga mitrata)* in the Huelo district of windward East Maui, with other, unconfirmed reports from Hana. This small, green parrot, native to the

Andes of South America, has been recorded from elevations of 1000-4000m and is known "to feed on ripening berries" (Juniper and Parr 1998). Along with Japaneses white-eyes, this parrot could hasten the dispersal of *M. calvescens* seeds into the upper reaches of the most pristine wet forests on the island of Maui.

B. The Invasion Site, Hana, Maui

The Hana *Miconia calvescens* population, the largest on Maui, likely originated as an upslope invasion from Helani Gardens, a private botanical garden, in the early 1970s. This garden is located on the windward slopes of East Maui, at an elevation of about 120-400 feet, on the southern side of Kawaipapa Gulch. After initial control efforts removed over 9000 *M. calvescens* plants from the garden in June-July 1991, the focus of control efforts shifted to other sites along the Hana Highway. After discovery of the Hana population north of Kawaipapa Gulch in September 1993, however, the greatest efforts were once again centered in the Hana district.

The current Hana *M. calvescens* infestation occupies approximately 2000 acres, on both the northern and southern sides of Kawaipapa Gulch, from elevations of approximately 100 (and probably lower) to at least 1800 feet (Figures 1 and 2). Average annual rainfall for the Hana site is roughly 2000 mm (78.74 inches) (Giambelluca *et al.* 1986). Four formerly discrete and dense stands of canopy-sized *M. calvescens* trees comprised the heart of the population on a densely vegetated, geologically young, 500-year old lava flow (Crandell 1983). Control efforts, the establishment of a bulldozer road system, and continued bird dispersal and germination, however, have modified the population structure, so that smaller stands of high *M. calvescens* density and numerous outliers in various size classes now make up the population.

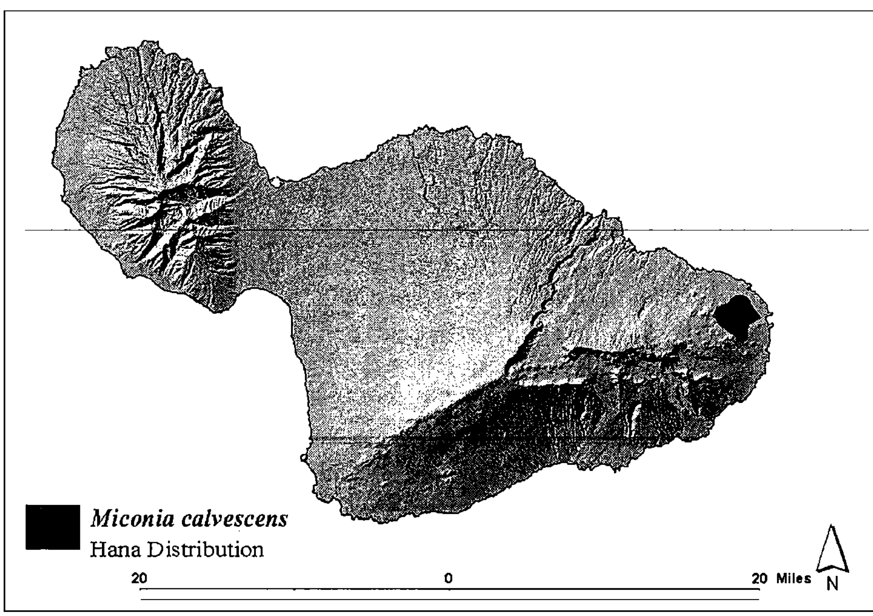

Figure 1. Overview of Hana *M. calvescens* population, island of Maui.

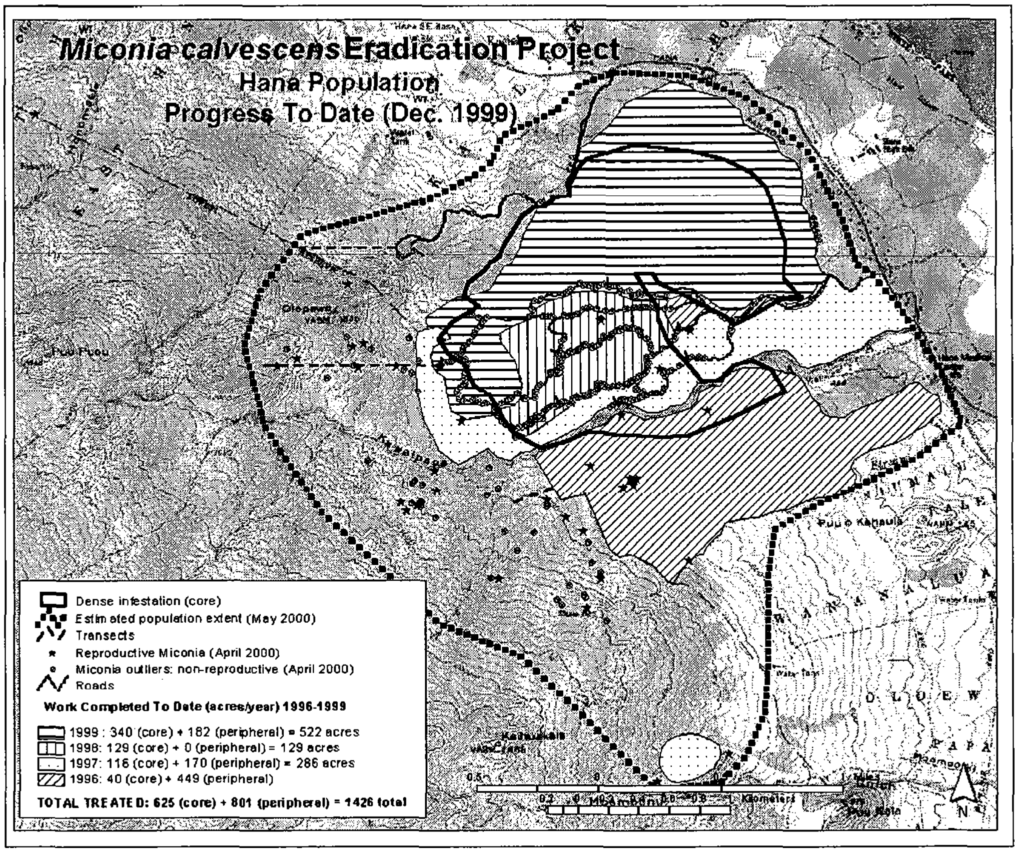

Figure 2. Close-up of Hana *M. calvescens* population, island of Maui.

C. Vegetation

The thick vegetation and rugged terrain comprising the heart of the Hana *M. calvescens* population make traversing the area a difficult, time consuming, and often hazardous undertaking. The tall, predominantly non-native canopy and dense understory limits sight distance and obscures *M. calvescens* plants from detection on both the ground and from the air. In addition, the hot and humid climate of this rainy site, plagued by clouds of voracious day biting mosquitoes (*Aedes albopictus*), all contribute to the extremely difficult work conditions which have an effect on the morale and efficacy of ground control crews.

The northern side of Kawaipapa Gulch is a densely vegetated forest of low to medium canopy height, dominated by the introduced trees African tulip (*Spathodea campanulata*) and shoebutton ardisia (*Ardisia elliptica*) interspersed with pockets of lowland native wet forest and nearly monotypic, small to medium sized stands of *hau (Hibiscus tiliaceus*), bamboo (*Phyllostachys* cf. *nigra*), rose apple (*Syzygium jambos*), and *'ohe* (*Schizostachyum glaucifolium*). Plant communities being invaded near the Hana area include "*'Ohia/Hala* (*Metrosideros/Pandanus*) Forest", "*'Ohia/Uluhe* (*Metrosideros/Dicranopteris*) Fern Forest" and the "Alien Wet Forest" (Gagné and Cuddihy 1990). *Metrosideros polymovpha* and *Pandanus tectorius* are the dominant native trees mixed with dense blankets of *uluhe* (*Dicranopteris linearis*) and common guava *(Psidium guajava)*, strawberry guava (*P. cattleianum)*, and *kukui (Aleurites moluccana*), in addition to those species already mentioned.

To the west of the forested area, and in the upper elevation reaches (1400 feet and above), the topography of the site changes, with steeply sloped hills creating a formidable barrier to ground and bulldozer access. Large portions of these areas, as well as the more level terrain above, are blanketed in cover by white ginger *(Hedychium coronarium)* and *kahili* ginger *(H. gardnerianum)*, which form thick rhizomatous masses that could possibly exclude establishment of *M. calvescens* and possibly also locally slow the spread of invasion into the forests above. Nevertheless, long-range bird dispersal will likely bypass this barrier and nullify the benefits that these monotypic stands can provide.

The nursery of Helani Gardens still contains seedlings, saplings and reproductive trees of *M. calvescens*. **A** forested area with species characteristic of the forest to the north of the gulch exists above and behind the garden, and both of these areas are bordered to the south by the pastures of Hana Ranch. *M. calvescens* does not occur within the open pastures of Hana Ranch. However, within the ranch pasture are small stands of non-native trees, including *Spathodea campanulata, Psidium guajava,* and *Ardisia elliptica*, which attract birds and provide cover that allows *M. calvescens* to survive. Recent surveys of the area located concentrations of flowering and fruiting *M. culvescens* trees, as well as smaller sized individuals, growing among these dense tree stands and away from cattle. Upslope, at 1100 feet elevation, a tall stand of swamp mahogany *(Eucalyptus robusta)* marks the boundary of the Hana Forest Reserve, with a continuous cover of forest vegetation above.

Another outlying pocket of *M. calvescens* plants, first located in May 1996 and apparently recently established, occurs on the southern side of Hana Ranch, on a small forested hill near Moomoonui Gulch at approximately 1300 feet elevation (Figure 2). This area consists of a mix of native and non-native vegetation, including *Metrosideros polymorpha* and *Psidium guajava*. A large, fruiting *M. calvescens* tree, with a basal diameter of 25 cm, was cut down in 1996, and over 1000 plants in smaller size classes have been removed from the area to date. The size of the reproductive individual matches the size of some of the largest individuals recorded on Maui, suggesting that the tree was the result of an early dispersal event, possibly by birds, pigs, or humans. No other *M. calvescens* plants have, as yet, been located in the native forest communities upslope.

For a listing of plant taxa documented in the Hana population, refer to Appendix I.

STRATEGIES AND PROGRESS

The strategies utilized against *Miconia calvescens* were first presented at a public meeting in Hana in December 1993, and more fully in Conant *et al.* (1997) and Medeiros *et al.* (1998b). The following accounts apply to the Hana *M. calvescens* population and include unpublished data previously alluded to.

A. Helicopter Spraying

As stated in Medeiros *et al.* (1998b), helicopter spraying of ***M.*** *calvescens* was initiated in early 1994, almost immediately after discovery of the large Hana population. It was initially envisioned as a holding action to limit seed production of reproductive trees until such time as better access could be provided for ground crews. Helicopter spraying has since developed in this situation to become one of the primary, cost effective control techniques. The helicopter ball sprayer, developed by drug enforcement agents to control marijuana, **is** attached to a Hughes 500-D helicopter by a cable, and **is** opcratcd b\ .he pilot to deliver controlled doses of the herbicide Garlon **4** (an ester formulation of tricl ›yr) mixed with surfactant and the blue dye, Turfmark, to the crown of selected trees.

1. Assessment of herbicide damage to emergent *Miconia calvescens* trees

a. Methods

In 1994, about one month after the first aerial spray operations were conducted, 110 ***M. calvescens*** trees of various sizes (within an area receiving ½ lb. of Garlon **4** per acre) that were sprayed by helicopter, were tagged and analyzed to determine the initial effectiveness of the aerial spray application.

The following categories were recorded for each tagged tree to aid in quantifying the herbicide's effectiveness:

- Phenology: The codes ST (sterile tree), FL (flowering), FR (fruiting), and FF (flowering and fruiting) were assigned to trccs to indicatc their reproductive status at the time of spraying. Trees classified as sterile include both living and dead trees.

- Basal diameter: in centimeters (cm).

- Height: in meters (m).

- ~~Sun exposure: This number estimates the percentage of a tree's canopy that is~~ exposed to direct sunlight.

- Bark and cambium condition: The following rating scale was used to classify a tree's bark and cambium health at varying heights, determined after scraping away the trees bark.

1=healthy **(dark)** green	4=tan brown
2=unhealthy (pale/mottled) green	5=brown/dead
3=mixed green and brown	

- Cambium, basal: The above rating taken at the base of a sprayed tree's trunk.
- Cambium, breast height: The above rating taken at the breast height of the tree's trunk.

- Cambium, top reach: The above rating taken at the top reach of the observer on the tree's trunk.

- % Canopy defoliation: estimate of canopy defoliation of each tree due to herbicide treatment, to the nearest 5 percent.

Data was collected three months (5/5/94), nine months (11/18/94), and approximately 26 months (4/12/96) after spraying.

b. Results

Complete results are presented in Tables 4-6 (Tables).

The data shows that, three months after being sprayed by herbicide, 74 of the 110 trees (67%) had fruiting panicles present, despite the fact that, on average, each tree lost almost ¾ (73.65%) of its canopy to defoliation (Table 4). Nine months after spraying, however, 96 trees (87.3%) were sterile and only **14 (12.7%)** were reproductive, despite the fact that each tree was still, on average, over 80% defoliated (Table 5). Twenty six months after spraying, 79 trees (71.8%) had died, and of the remaining 31 (28.2%), each had an average of 60% canopy dcfoliation, and only 15 (13.6%) wcrc still reproductive (Table *6)*.

2. Assessment of herbicide damage to *Miconia calvescens* plants in all size ranges

a. Methods

Following the aerial spraying of the Hana *M. calvescens* populations, a series of seven 10 x 10 m (100 m^2) plots was also established in the middle of the sprayed area to assess the effectiveness of the herbicide in reaching individual plants of various size classes. Once the 10 x 10 m plots were established, numbers of *M. calvescens* individuals in various size classes were counted within each plot. Nine size classes represent the following height ranges of individual *M. calvescens* plants, including extremely tiny plants (Minutia) less than 1 cm tall:

SIZE CLASS	HEIGHT
Minutia	< 1 cm
Seedling	1-10cm
1	0.1-<1.0 m
2	1-<2 m
3	2-<4 m
4	4-<6 m
5	6-<8 m
6	8-<10 m
7	10-<12 m

In addition to size class, *M. calvescens* individuals were assessed as to whether or not they showed obvious spray damage. **An** individual plant was considered to have **NO Obvious Spray Damage** if at least 90% of its foliage appeared intact and showed no herbicidal effects. Any plant estimated to have more than 10% of its foliage damaged by herbicide was classified under the category **Obvious Spray Damage.**

b. Results

Within the seven 10 x 10 m plots, a total of **594** *M. calvescens* plants in the nine size classes were counted on 5/12/94. The results of the count and the specific data on numbers of *M. calvescens* per size class can be found in Tables 7-12 (Tables).

After the initial spraying of the Hana ***M.*** *calvescens* population, the data shows that, of the 594 trees measured in the spray zone, 170 (28.6%) showed obvious spray damage (Tables 9 and 11), while 424 (71.4%) showed no obvious spray damage (Tables 10 and 12). Of those that did show obvious spray damage, 122 of 170 (71.8%) were at least **2** meters in height or taller, which is to be expected, as larger trees are more visible **to** the helicopter pilot delivering the herbicide. Of the plants that showed no obvious spray damage, only 82 of 424 (19.3%) were 2 meters in height or taller, with the remaining 342 plants **(80.7%)** less than 2 meters **tall.** The obvious implications of this data are that the majority of the ***M.*** *calvescens* plants in the Hana population are sub-canopy individuals that are most likely not visible from the air. This preliminary spray data emphasized the need for ground control following or in conjunction with aerial spray operations.

3. Assessment of succession following spraying.

On May 5, 1994, 30 of the 110 tagged *M. calvescens* trees (refer to section **A.** 1) were used to assess the effects of Garlon **4** on non-target species and to document changes in vegetation composition and cover over time.

a. Methods

30 of the 110 tagged *M. calvescens* trees were randomly selected and used as the center of 5.64 m radius (100 m^2) circular plots to estimate plant species composition and cover following the initial round of aerial herbicide spraying. Initial cover estimates documented identifiable species killed by herbicide and their associated cover classes.

Within each circular plot, every identifiable species to a height of 5 meters was recorded and assigned a cover value. Cover was estimated to the nearest square meter for those species with a cover value of less than 10 m^2. Cover values for spccics occupying greater than 10 square meters of the plot were estimated to the nearest 5 m^2. Species with a cover less than 1 m^2 were assigned the cover value R (0.1 m^2) or X (0.5 m^2).

Data were recorded for the 30 cover plots three (5/5/94), nine (11/18/94) and 26 months (4/12/96) after spraying. After the last data set, all *M. calvescens* plants were eliminated from the site by ground control operations.

b. Results

The results of the cover estimates have been recorded in Tables 13-17 (Tables).

As the initial data set from May 1994 indicates (Table 13), the non-target species most affected by aerial spraying, as shown by their percentage of dead cover, include the native fern *Dicranopteris linearis* (18.3% dead), and the non-native trees *Spathodea campanulata* (4.5% dead), and *Psidium guajava* (12.9% dead). Dead *M. calvescens* greater than 1 m tall accounted for 13.5% of the total cover.

African tulip (S. *campanulata)* (14.1% live), *M. calvescens* greater than one meter tall *(8.3%* live), *Ardisia elliptica (6.8%* live), ***D.** linearis (6.3%* live), and the non-native fern *Thelypteris parasitica* (4.9% live) made up the majority (39.4%) of the living vegetation in the plots following aerial spraying.

In November 1994, nine months after initial spraying, the non-native vegetation of the site began to recover and dominate the cover of the plots, with *T. parasitica* establishing quickly and covering 19.5% of the plot area, and S. *campanlata,* ***M.** calvescens* (>1 m tall), **A.** *elliptica, P. guajava* and *L. **camara*** together comprising 51.3% of the total area (Tables 14 and 16). Living native vegation, including mostly *Dicranopteris linearis* (5.5%), accounted for only 7.4% of the cover area (Tables 14 and 15).

Twenty-six months after spraying, *M. calvescens* plants greater than one meter tall made up the highest average percentage cover (20.45%) of all plots, and together with *M. calvescens* plants less than one meter tall, accounted for 27.3% of the cover area of all plots. The non-native fern ***T.** parasitica* (17.7% cover) and the non-native trees **A.** *elliptica* (12.2% cover) and S. *campanulata* (11% cover), together with *M. calvescens,* made up 68.2% of the cover of all plots (Tables 14 and 16).

In the 26 months since spraying, non-native vegetation substantially increased in cover, with *M. calvescens* (above and below one meter tall) increasing the most at 16.7% for **a** total cover of 27.3% (Table 16 and 17). The disturbance adapted fern, *T. parastica,* also increased substantially, and does not appear to preclude the re-establishment or germination of future *M. calvescens* generations.

4. Discussion of helicopter spraying

The data demonstrates that helicopter spraying can be an effective tool in reducing canopy-sized individuals of *M. calvescens* in remote or isolated, thickly vegetated areas (Tables 4-6). It also demonstrates, as would be expected, that in heavily infested populations, the initial round of spraying is more effective in damaging canopy-sized trees, but that the majority of sub-canopy individuals remains largely untouched (Tables 7-12). Non-target and cover data suggest that, in heavily infested populations of *M. **calvescens,*** the substantial seed bank of *M. calvescens,* the longevity of seeds in the soil, and *M. calvescens'* rapid growth rate and ability to exploit disturbance enable it to quickly regain cover and grow to dominate an area, even in the presence of a rapidly growing, and highly competitive, predominantly non-native flora (Tables 13-17).

Together, the three data sets demonstrate that, although helicopter spraying is an effective tool in the management of the *M. calvescens* invasion, follow-up operations on the ground are a necessity. Nevertheless, despite the high cost of helicopter rental ($650-$850/hour) and the need for follow-up ground control, helicopter spraying remains an integral part of the control strategy, especially when aerial surveys detect trees on steep, inaccessible slopes or in remote and rugged terrain far from any ground access.

B. Bulldozer Access Roads

To break up the densest areas of the Hana *Miconia calvescens* infestation into management units and to both increase access and enable ground crews to perform more systematic sweeps across the rough lava terrain and thick secondary forest, a network of bulldozer roads has been developed and maintained over the past four years. **A** bulldozer contractor, supervised by Robert Hobdy, DLNR, opened up an existing, but overgrown road through the site in the beginning of 1996. Since that time, over 10 km of new 4-wheel-drive roads have been bulldozed through the area (Figure **3),** with additional routes into the higher elevation regions also planned. Despite concerns that the freshly cut roads would quickly be overrun by a rapid invasion of *M. calvescens* seedlings taking advantage of the artificially disturbed site, the bulldozer access roads appear to have greatly increased the efficacy of ground control operations and have allowed for much more thorough sweeps of the area than would otherwise be possible. *M. calvescens* plants, particularly reproductive sized individuals, occurring along these bulldozer roads have been rapidly dealt with due to their accessibility. In March 2000, a cursory count of *M.* ***calvescens*** plants within five meters of the bulldozer access roads, in which plants were categorized as either reproductive or sterile, recorded only three (0.18%) recently reproducing trees out of total of 1709 smaller plants (Chimera, unpublished). In addition, thcsc non-rcproductivc plants are accessible and can be removed upon showing signs of flowering or fruiting.

C. Ground Crews

Since June 1996, a five person crew, hired from the Hana community and based out of the Hana area, has been working on the ground to remove *Miconia calvescens* plants from the Hana population. Supervised until recently by Robert Hobdy, and currently by Glen Shishido, both of DLNR, this field team has labored in some of the most rugged terrain, to sweep through the entire core, cutting down and chemically treating the stumps of fruiting and larger sized trees, and pulling up or cutting and treating smaller individuals when feasible. Cut stumps are currently being treated with a 5% solution of Garlon 4 with surfactant, despite Big Island trials demonstrating that a 20% solution of Garlon 4 in a carrier oil, applied to the basal bark of plants without cutting, is a more effective method. Over the past four years, the ground crew has covered and removed plants from approximately 1426 acres (Figure 2) of the Hana population, and is now in the process of making a second pass through these areas.

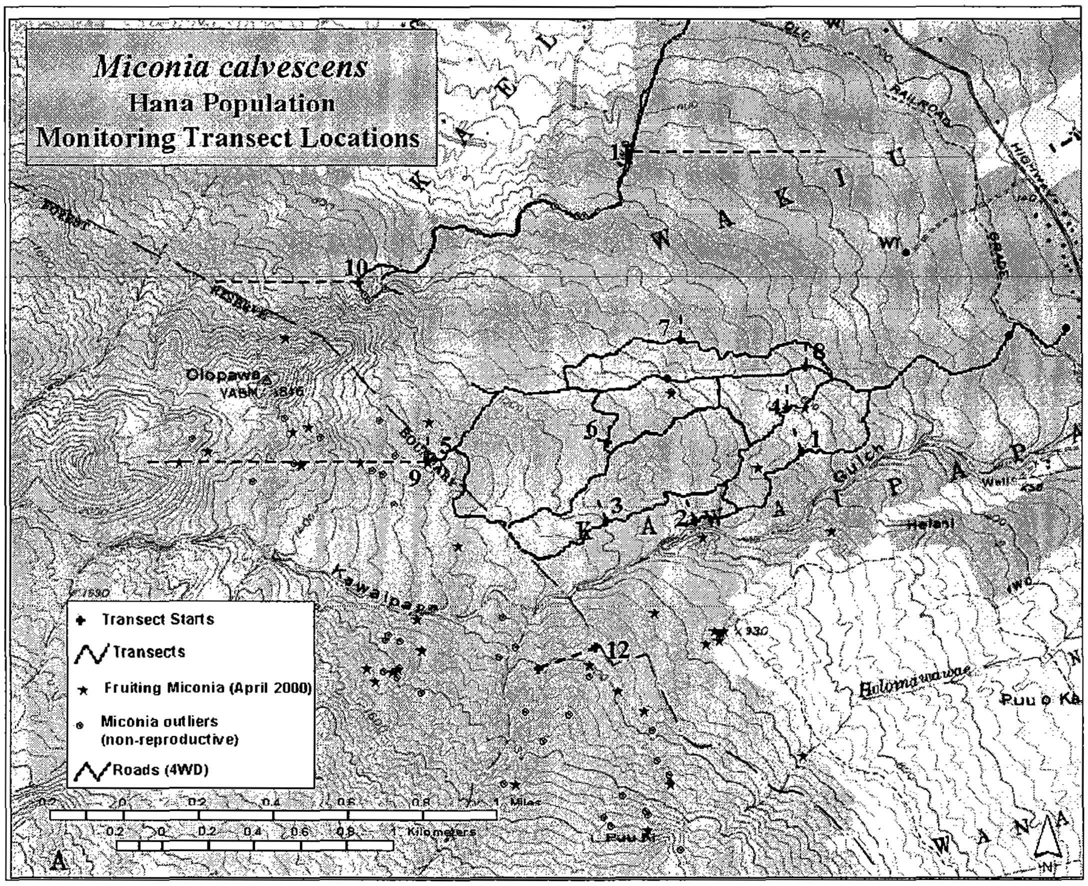

Figure 3. Bulldozer road network and monitoring transect locations, Hana *M. calvescens* population, island of Maui.

1. Assessment of *M. calvescens* reinvasion following ground control

Accessing and working in 1400 acres of rugged, densely vegetated terrain with only five people is a physically demanding and exhausting job. To get an idea of the rate at which *M. calvescens* plants were re-establishing in an area following control sweeps, a series of monitoring transects were utilized in March 2000 to quantify numbers of *M. calvescens* plants within the different areas treated in each of the past four years.

a. Methods

The 1426 acres swept by the ground crew have been divided into four units, based on the years 1996 to 1999 in which each area has been swept (Figure 2). Within each of these areas, two 100 meter belt transects, numbered **1-8,** were established to quantify the number of *M. calvescens* plants in different size classes which were reinvading each site following the sweeps (Figure 3). To locate transect starts within each treatment area, the presence of all *M. calvescens* plants along the bulldozer access roads was first mapped using a Trimble Pro XL Global Positioning System. Using this map data, eight transect starts were randomly selected from the 370 sites in which *M. calvescens* was mapped. Once a transect start was selected, the transects were established on a compass bearing roughly perpendicular to the road. Each transect began 10 meters from the road to minimize the effects of roadside disturbance. **A** metric hip-chain was used to measure transect length. Along a 5 meter band (2.5 meters on either side of the transect) all *M. calvescens* plants were counted and placed into one of the following eight height classes: <1 cm; 1-<10 cm; 10-<50 cm; 50-<100 cm; 100-<200 cm; 200-<500 cm; 5-<10 m; >10 m.

In addition to the belt transects, two 100 m^2 circular count plots (5.64 m radius) were established at the beginning and end of each transect, recording all *M. calvescens* plants in height classes. The presence of all flowering and fruiting trees was also recorded. Finally, the presence of ***M.*** *calvescens* plants was recorded on each meter mark within sight distance, or 25 meters, of either side of the transect to get an estimation of the distribution of *M. calvescens* within an area.

Transects 9-12 (Figure 3) were established around the periphery of the Hana *M. calvescens* core to get an on-the-ground assessment of the presence and distribution of ***M. calvescens*** within these regions, to get a feel for the terrain and conditions in which the *M. calvescens* occurs, and to provide other information that could be used for future ground and aerial operations. More information about these transects is documented under section D. Surveillance.

b. Results

Numbers and percentages of *M. calvescens* plants per height class, in each of the eight transects, have been recorded in Tables **18-34.** The number of meters per transect with *M. calvescens* has been recorded in Tables 34 and 43. Total numbers and percentages of *M. calvescens* per height class, and grouped by the treatment years 1996-1999, have been recorded in Tables **35-42.** Total numbers and percentages of *M. calvescens* plants per height class, for all transects and treatment years combined, has been recorded in Tables 44 and 45. Tables 18-45 are located in Tables.

The results indicate that the area swept by ground crews in 1997 (Treatment Year 1997) had 647 *M. calvescens* plants recorded in the transects, the greatest number for all four treatment years (Table 37), whereas the area swept by ground crews in 1996 (Treatment Year 1996) had only 29 ***M.*** *calvescens* plants recorded (Table 35), the lowest total for all four treatment years. The number **of** meters with *M.* ***calvescens*** was also highest for Treatment Year 1997, at 62%, and lowest for Treatment Year 1996, at 6%.

No flowering or fruiting trees were recorded along any of the transects or within any of the treatment years, but 101 larger sized individuals, including two trees between 5 and 10 meters tall, were recorded on Transects 1 and 2 (Treatment Year 1997, Table 37), and 76 larger individuals, greater than one meter tall, including **24** between two and five meters, were recorded on Transects 5 and 7 (Treatment Year 1999, Table 41).

In looking at all four treatment years combined, the majority of *M. calvescens* plants recorded along the eight transects **(77.9%)** were less than 50 cm tall, and only **3.6%** were greater than two meters tall (Table 45).

c. Discussion

The eight transects in the four treatment areas were intended to compare the numbers and size classes of *M. calvescens* plants present in an area after ground sweeps occurred. Unfortunately, these transects were not in place prior to the inception of ground, **or** aerial, control measures, so there is no baseline data documenting what numbers of *M. calvescens* were present before control sweeps. Field notes, to supplement the transect data, are valuable in providing more information not captured by the transect data.

Although only **29** plants were recorded on Transects **4** and 8 (Treatment Year **1996)**, it should be noted that these transects were located within the core of the Hana population. For Treatment Year **1996,** this was a relatively small area (40 acres), compared to the majority of the **1996** treatment area **(449** acres) located to the south of Kawaipapa (Figure ***2).*** The larger numbers of plants, and the larger sized individuals, recorded on Transects **1** and **2** (Treatment Year **1997)** are to be expected of an area last visited over three years ago, and the 5-10 m tall individuals now present were likely missed when they were 2.5 to 4.5 meters smaller. Transects **3** and **6** (Treatment Year **1998)** had 88.8% of their plants less than 50 cm tall (Table **40)**, suggesting germination within the past year, and indicative of an abundant seed bank or addition of seeds from fruiting trees still in the area. The relatively large number of *M. calvescens* plants recorded on Transects 5 and **7** (Treatment Year **1999)** could also be explained by the large size of the treatment area ***(522*** acres, Figure ***2),*** although the number of individuals **(76** total, Table **41)** greater than one meter tall could be problematic if this area is not retreated for a long time. Such larger sized individuals are already either potentially capable of reproduction, or could be within the next year or two.

As would be expected, the majority of *M. calvescens* plants recorded on all eight transects **(73%,** Table 45) were smaller plants (<50 cm height) which are easily ignored or overlooked. These individuals are obviously of the lowest priority as they are probably ~~three or more years away from first reproduction, given that they all survive. Nevertheless,~~ the relatively large numbers are a reminder of the long-term effort still required to control the Hana *M. calvescens* infestation. Those plants between 50 and <100 cm tall, **10.5%** of the total, are probably between two and four years away from first reproduction, at minimum. 8% of all plants recorded were between 100 and 200 cm tall, which gives them the potential to flower and fruit in as little as one to two years, under ideal growing conditions. The **3.6%** of all plants that were greater than two meters tall are at or above the minimum height necessary for first reproduction, based upon a growth rate of **0.85-1.5** m/year and a minimum age of **4-5** years (Meyer **1994).** Despite the fact that no reproductive individuals were recorded along the transects, the three flowering individuals noted from the roadside survey (see B. Bulldozer Access Roads) were all within the four treatment areas, and others certainly exist.

During the course of collecting the transect data, a total of 30 cut stumps of *M. calvescens* were also noted, and of these, 5 (16.7%) were resprouting, possibly as a result of the herbicide being washed off in the rain.

D. Surveillance

Since the time that Medeiros *et al.* (1997) recorded 10 populations of *M. calvescens* on East Maui, and Pat Bily of The Nature Conservancy discovered a cultivated plant and seedlings in the Wailuku area of West Maui, no dramatic range extensions of existing populations or reports of entirely new plants or populations have been recorded. In addition, all of these populations have been surveyed and existing plants removed at least once. Nevertheless, recent and more systematic aerial surveys of the East Maui watershed, coordinated primarily by the Maui Invasive **Species** Committee, have continually documented new locations of *M. calvescens* plants, many of them isolated individuals which extend the boundaries of the known infestations.

1. Aerial surveys

Recent aerial surveys on the periphery of the Hana *M.* ***calvescens*** population, particularly in the rugged, upper elevations to the west, have mapped numerous canopy-sized, flowering and fruiting individuals which are becoming increasingly distant from the center **of** ground control operations (Figure ***2*** and Figure 3). Individuals in these areas have been, and will continue to be, the target of aerial herbicide treatment. Nevertheless, the number and frequency with which individuals are being detected suggest that a more aggressive strategy, utilizing additional ground crews to attack both the larger trees, and associated sub-canopy individuals undetectable from the air, may be necessary to ensure that more of these isolated individuals do not reach a reproductive stage.

2. Ground surveillance

Four transects of varying length (9-12, Figure 3) were established around the periphery of the Hana *M. calvescens* populations to detect and quantify the distribution of *M. calvescens* in these areas and to supplement data gathered by aerial surveys.

a. Methods

The four monitoring transects were chosen to survey an area on the periphery of the *M. calvescens* core. To roughly follow a straight line, each transect followed an arbitrary compass bearing. Meter marks and transect length were measured using a metric hip-chain. Elevations were recorded from a Thommen altimeter. Along a *25* meter band, or sight distance, to either side of the transect line, presence of any *M. calvescens* at each meter mark was recorded. In addition, along a *5* meter band *(2.5* meters on either side of the transect) all *M. calvescens* plants were counted and placed into one of eight height classes: <1 cm; 1-<10 cm; 10-<50 cm; 50-<100 cm; 100-<200 cm; 200-<500 cm; 5-<10 m; >10 m.

The presence of any reproductive individuals was also recorded and pertinent data taken on each tree.

b. Results

Data from transects 9-12 **has** been recorded in Tables 46-48 (Tables).

c. Discussion

Of the four monitoring transects placed around the periphery of the Hana ***M.*** *calvescens* population, Transect 9, to the west of the core population, was the longest transect and also had both the highest frequency (13.7%) and greatest number (1801) of *M. calvescens* plants occurring along its length (Figure 3, Tables 46 and 47). This transect was also the only one which recorded fruiting *M. calvescens* trees (Table 48). Particularly disturbing was the fruiting individual recorded at an elevation of 1880 feet, thus far the highest documented reproductive tree in the Hana *M. calvescens* population. Other troubling aspects of Transect **9** were the thickness of the vegetation and the rugged, sloping topography of the terrain. These factors combine to make detection of ***M.*** *calvescens* plants from the air and from the ground a more challenging prospect. Furthermore, although the creation of additional bulldozer roads could greatly increase the ability of ground crews to traverse and search this area, it is unknown whether a suitable route can be chosen through this steeply sloping, gulch-dissected, terrain. The large numbers of understory individuals recorded along this transect, in addition to the fruiting trees, further emphasize the need for ground crews to work in the area in combination with aerial spraying. For even if aerial spraying was 100% effective in knoclung out all reproductive and canopy sized individuals within the next year, there would still be an ample number of existing understory plants and ungerminated seeds in the soil to reach reproductive age for at least six additional years.

Transect 10, located to the north of Olopawa (Figure 3), had the second highest frequency (7%) and number (182) of *M. calvescens* located along its length (Tables 46 and 47). This transect also traversed some fairly steep terrain, covered with dense thickets of *Ardisia elliptica* and thick patches of ***Hedychium*** *coronarium*. Most of the M. *calvescens* recorded along this transect was located within dry stream beds and gulches, which suggests water dispersal from a source on Olopawa. This transect also crossed two openings in the forest created by aerial spraying sometime in the past. The still standing, but 100% defoliated and dead trunks of ***M.*** *calvescens* trees were present in both openings. There were also **a few** smaller ***M.*** *calvescens* plants located in the clearings, but not the abundance of seedlings noted in other spray gaps. Based on the appearance of the adult trees, it appears that they were sprayed at least ***6*** months ago, and the understory was beginning to regain a cover of *Rubus rosifolius*. Nevertheless, the understories in both of these clearings were extremely dry. It is possible that drought conditions could be delaying recruitment of *M. calvescens* seedlings or contributing to greater mortality of those that **do** germinate. Time constraints prevented additional exploration in the area of Transect 10. Nevertheless, the vast tracts of secondary forest located to the northwest of Olopawa, and the aerial discovery of a fruiting tree in that direction, but over 1.25 miles away, should make this area a high priority for more reconnaissance once additional crews are available.

Transect 11, to the north, had a very low percentage and number of plants recorded along its length (Tables 46 and 47). The vegetation in this lower elevation area is dominated by *Pandanus tectorius*, *Ardisia elliptica* and *Psidium guajava.* Because of the low density of *M. calvescens,* and the presence of the Olopawa cinder pit access road to the north, the spread of *M. calvescens* should be slow in this direction. **A** cut ***M. calvescens*** plant with a basal diameter of 3.5 cm was observed resprouting along this transect.

Transect 12, beginning at the *Eucalyptus* tree line marking the Hana Forest Reserve Boundary (Figure 3), recorded only one *M. calvescens* plant along its length (Tables 46 and 47). The vegetation in this area was extremely thick. Dense stands of *Ardisia elliptica* made walking almost impossible, and limited sight distance to only a few meters. Despite the almost complete absence of ***M.*** *calvescens* along this transect, a number of fruiting trees and canopy-sized individuals were mapped to the south during aerial surveys (Figure 3). Also, while walking to the start of Transect **12,** a number of fruiting trees were recorded to the east, within Hana Ranch (Figure 3, Table 48). This whole area is a potential source of reproductive individuals, and could be providing an avenue for escape of ***M.*** *calvescens* into forests to the south and west.

The limited information recorded on fruiting *M. calvescens* trees during surveys could be useful in estimating time to first reproduction of plants in the Hana area (Table 48). For instance, Meyer (1996; 1997) surmised that *M. calvescens* has a growth rate of 0.85 m/yr to 1.5 m/yr under optimal conditions, and can reach reproductive maturity in 4-5 years. Using this information, we can get an estimate of the minimum and maximum age of each fruiting tree recorded during this survey (Table 49).

Therefore, with conditions in the Hana area apprently similar to those in French Polynesia, the annual growth rate estimates suggest the possibility that the smallest fruiting tree documented in Table 49 (height = 2.5 m; basal diameter = 8.00 cm) could have reached reproductive maturity in as little as 1.7 to **2.9** years. Using Meyer's (1996; 1997) growth rates, both of these estimates, still fall below the minimum of 4-5 years before first reproduction recorded in French Polynesia. Other fruiting trees measured and recorded in Table 49 also could fruit sooner than generally predicted. Of course, the growth rates recorded in French Polynesia should only be used as generalized estimates, and not absolute truths. Nevertheless, the possibility that trees in the Hana area, or on Maui in general, could reach reproductive age sooner than expected, has serious implications on future management strategies, and rates at which areas need to be treated or swept. Further research on the growth rates, age to first reproduction, as well as soil seed longevity in the Hana area may provide data and information more specific to that site, and could more accurately guide future management decisions.

E. Measures To Prevent Seed Dispersal

Since a single *Miconia calvescens* seedling was discovered in Kipahulu Valley in February 1994, in the vicinity of Australian tree fern plots, and presumably dispersed on the gear of researchers (Medeiros *et al.* 1998a), the strictest of measures have been implemented to ensure that *M. calvescens* does not get inadvertently dispersed into areas outside of its current range. Deidicated gear, clothing, boots and tools, marked for use only in areas infested with *M. calvescens,* have been utilized by the Hana crew since the beginning of control operations. A boot cleaning and changing station at the access gate to the Hana population is also in place to ensure that gear does not get worn outside of the control area. Volunteers have been issued rubber boots dedicated to the *M. calvescens* project, which are not worn anywhere else, and which are more easily cleaned of soil and seeds than laced, leather hiking boots. In addition, bulldozers and other vehicles used in the area are supposed to be pressure washed after leaving the site. Because of the long term duration of the project, however, lapses in protocol sometimes occur, and it is difficult to closely monitor each and every situation in which the seeds of *M. calvescens* could be dispersed. In addition, hunters or other individuals that have access to *M. calvescens* infested areas outside of the core population cannot be monitored, but only educated of the threats that *M. calvescens* poses to the watershed. Furthermore, although elimination of all fruiting *M. calvescens* trees is the goal, recent ground surveys have indicated that this is a difficult objective to achieve. This makes short or long distance bird dispersal a real and continued threat. New bird species introductions (e.g. parrots) also potentially increase long range dispersal. Nevertheless, the sanitation measures that have been adopted and implemented are the best option available in this real world situation in which ground access to the site is a necessity if control measures are to succeed in the long run.

F. Biological Control

At a conference (May 2000) dedicated to the subject of biological control of invasive plants in the Hawaiian Islands, Eloise Killgore of the Hawai'i Department of Agriculture, Plant Pest Control Branch, gave an update on the status of biological control organisms tested against *Miconia calvescens.* Killgore and Sugiyama (1999) first reported on the evaluation of the fungus *Colletotrichum gloesporioides* f.sp. *miconiae* as a potential biological control agent against *M. calvescens*. This fungus has been shown, in both lab and field trials, to cause "chlorotic halos", "extensive leaf necrosis" and "defoliation of moderately to severely infected leaves...30 days after inoculation" (Killgore and Sugiyama 1999). Field visits to Big Island locations indicated that the fungus was established in 7 of 9 inoculated sites, as well as one control site, with the described effects clearly visible on infected leaves. First attempts to establish the fungus in the Hana population, however, were unsuccessful, possibly as a result of prolonged drought following the release. The original inoculated trees were subsequently cut down and are no longer available for evaluation. The fungus does, however, show promise as one tool to be used in the management of *M. calvescens* and has recently been released on the island of Tahiti (J-Y Meyer pers. comm.). There are also plans to reinoculate plants in the Hana population, once climatic conditions become more conducive to its establishment. In addition, Killgore reported on two other fungal pathogens, *Pseudocercospora miconiae* and *Cocodiella* *myconae,* which both show promise and seem to be even more damaging to infected *M. calvescens* leaves. The biggest concern with *P. miconiae* is that, in addition to infecting the leaves of *M. calvescens,* it has also been shown to cause spots on leaves of *Metrosideros polymorpha* and *Syzygium* spp., a genus which includes the endemic species S. *sandwicensis.* In the meantime, the general consensus among managers and biologists is that exploration for biocontrol agents against ***M.*** *calvescens* should be pursued as possibly the best long term solution for management of this invader, but that current chemical and mechanical control efforts should continue unabated.

G. Monitoring of Progress and Further Research

This report is a conglomeration of the research and monitoring that has been conducted in the area of the Hana *Miconia calvescens* population since this weed was addressed as a biological threat to native Hawaiian ecosystems in 1991. Despite the amount of time that was spent in the area, and the abundance of useful information that was gathered during the course of the past nine years, many important questions concerning the biology and ecology of ***M.*** *calvescens,* particularly as they apply to the Hawaiian Islands, have yet to bc answered. Information on growth rates and age to first reproduction in each invasion site, with records of concurrent rainfall, temperature, elevation, and other pertinent data, would be invaluable in prioritizing managcmcnt and control efforts in each area based upon **the** numbers and sizes of the individuals present. Seed longevity and viability studies could assist in establishment of retreatment regimens in formerly invaded sites free of reproductive individuals. In addition, they could provide estimations of the duration of time in which control measures would be necessary, thus allowing for more accurate calculations of budgetary requirements. **A** study of avian dispersal vectors, investigating which species consume ***M.*** *calvescens* berries, the distances in which they travel, seasonal migratory patterns, passage time of seeds and their resultant viability, would also be valuable in the shaping and prioritization of management strategies on each invaded island.

To monitor the progress and effectiveness of the various chemical and mechanical control measures being employed against *M. calvescens,* it would be valuable to establish a new series of permanent monitoring plots or transects to provide a temporal record of the numbers and sizes of individuals both removed and reestablishing in the control areas. Unfortunately, the markers delimiting the boundaries of the monitoring plots established in 1994 to document effectiveness and non-target effects of aerial spraying have been lost, as these plots would have continued to provide this important, long-term reinvasion data. Nevertheless, as recent surveys of the site suggcst, control, or elimination, of *M. calvescens* from the area is several years off at best and could continue indefinitely until all fruiting trees are eradicated. Therefore, it is not too late to start recollecting this monitoring data and further contribute to the expanding base of knowledge being used to guide present and future management decisions.

In addition to ground monitoring, a study conducted by TerraSystems, lnc. to explore the feasibility of detecting individual, canopy-sized *M. calvescens* trees using spectral sensitive aerial photography was begun in late 1997, and was originally planned for completion within one year (Medeiros *et al.* 1998b). Despite high hopes by biologists and managers, feedback from TerraSystems has indicated that M. *calvescens* is difficult to detect using this method, possibly due both to the variable signatures given off by its leaves as well as to the frequent, low level cloud cover obscuring visibility of the canopy.

CONCLUSIONS

The prolific fruit production of M. *calvescens,* its pollinator independence and its ability to produce seed through self-fertilization (Meyer 1998), its tolerance of elevations as high as 1800 m (>5900 feet) in its native range (Wurdack 1980), its potential for long-range avian dispersal, and its dense stand structure that precludes native species make this plant the most formidable invader and greatest threat to the species rich, native wet forest communities in upper elevations of East Maui. Therefore, even though eradication, or containment, of this invader on the island of Maui is at best a long-term prospect, it must be pursued with the vigor that eradication efforts demand. In addition to the five person crew based in the Hana area and exclusively dedicated to M. *calvescens* eradication, the field crew of the Maui Invasive Species Committee has dedicated 50% of its field time towards the control of this weed in all locations on Maui, and an as yet to be hired National Park Service alien plant swat team will also spend between 10-25% of its time to further these efforts. Perhaps biocontrol will make the situation more manageable in the future, but given its worldwide success of between 20-40% (Julien 1982, Hobbs and Humphries 1995), biocontrol should be viewed as only one of several tools used to manage this invasion, and should not be viewed as a "silver bullet" that will "bail us out" if manual and chemical control efforts fail or do not meet desired expectations. To quote **Art** Medeiros, "dealing with the ***M.*** *calvescens* invasion is like trying to defend against Michael Jordan in basketball". This weed has so many ways to succeed in its spread into and domination of native communities that biologists and managers must rely on every tool at their disposal if they are to succeed in stopping the invasion. Ultimately, the future of every other conservation effort in the remaining native wet forest communities of the Hawaiian Islands could depend on it.

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TABLES

Table 1. Diameters of 250 ripe berries of M. *calvescens*, Hana, Maui.

#	Diam. (mm)	#	Diam. (mm)	#	Diam. (mm)	#	Diam. (mm)	#	Diam. (mm)	#	Diam. (mm)
1	6.20	44	6.25	87	6.10	130	5.45	173	4.75	216	6.85
2	4.85	45	7.05	88	5.95	131	6.70	174	5.45	217	6.05
3	5.95	46	5.70	89	6.10	132	5.85	175	5.65	218	5.10
4	6.05	47	6.05	90	5.70	133	6.05	176	5.45	219	5.45
5	6.90	48	6.05	91	5.55	134	4.70	177	6.05	220	5.45
6	6.95	49	6.65	92	6.40	135	5.60	178	5.85	221	6.25
7	6.85	50	6.15	93	6.00	136	5.10	179	5.75	222	5.95
8	5.50	51	6.15	94	6.25	137	6.35	180	5.50	223	4.30
9	6.10	52	6.00	95	6.05	138	5.50	181	6.05	224	6.15
10	6.10	53	6.85	96	6.20	139	5.80	182	5.05	225	5.50
11	6.60	54	6.65	97	5.95	140	5.00	183	4.65	226	5.00
12	6.00	55	6.85	98	6.05	141	5.55	184	5.85	227	6.05
13	6.00	56	6.05	99	5.10	142	5.50	185	5.85	228	5.70
14	5.95	57	6.35	100	6.25	143	5.80	186	5.45	229	4.65
15	6.75	58	6.40	101	4.65	144	5.50	187	5.25	230	6.00
16	5.60	59	5.95	102	6.05	145	5.85	188	5.50	231	5.65
17	6.65	60	6.00	103	5.25	146	6.20	189	5.65	232	5.95
18	6.85	61	6.05	104	5.45	147	6.40	190	5.50	233	5.80
19	6.80	62	6.45	105	5.50	148	5.25	191	5.50	234	6.25
20	6.95	63	7.05	106	5.75	149	5.75	192	5.05	235	5.95
21	6.75	64	5.80	107	5.95	150	6.70	193	5.80	236	5.55
22	6.10	65	6.75	108	7.10	151	5.60	194	5.00	237	6.00
23	6.15	66	6.50	109	5.45	152	5.75	195	5.55	238	6.05
24	5.50	67	6.90	110	5.75	153	5.10	196	5.85	239	5.65
25	6.20	68	5.85	111	4.95	154	5.10	197	4.20	240	5.40
26	6.25	69	6.40	112	5.90	155	6.10	198	5.60	241	5.85
27	6.85	70	5.90	113	6.35	156	5.10	199	6.20	242	5.55
28	7.30	71	5.75	114	4.05	157	6.10	200	6.10	243	5.65
29	6.10	72	6.05	115	5.05	158	6.45	201	5.05	244	5.05
30	6.25	73	7.15	116	5.85	159	5.55	202	4.60	245	6.00
31	6.50	74	6.05	117	5.80	160	6.15	203	5.70	246	5.50
32	6.10	75	5.35	118	6.20	161	6.05	204	5.50	247	6.15
33	6.40	76	6.20	119	5.45	162	6.05	205	6.05	248	6.20
34	5.45	77	6.00	120	5.25	163	5.65	206	6.20	249	5.70
35	6.90	78	6.60	121	5.55	164	5.85	207	6.65	250	5.00
36	6.45	79	6.10	122	5.15	165	5.70	208	5.00		
37	6.00	80	5.85	123	5.10	166	5.65	209	5.50		
38	5.70	81	6.50	124	6.05	167	5.85	210	5.95		
39	5.15	82	6.25	125	5.60	168	5.25	211	5.25		
40	6.60	83	6.65	126	5.95	169	5.85	212	5.00		
41	5.95	84	6.25	127	5.55	170	5.35	213	6.85	MEAN	5.88
42	6.25	85	5.75	128	5.95	171	6.30	214	6.15	MIN	4.05
43	6.45	86	6.05	129	5.40	172	5.85	215	5.15	MAX	7.30

Table 2. Numbers of *M. calvescens* seedlings within a 100 m^2 area of 30 adult *M. calvescens* trees, 9 months after herbicidal defoliation, Hana, Maui.

Number	# *Miconia* seedlings	% Sun Exposure	Number	# *Miconia* seedlings	% Sun Exposure
1	50	95	16	0	80
2	300	70	17	250	50
3	1800	60	18	200	60
4	700	60	19	1600	80
5	200	90	20	250	60
6	50	70	21	0	90
7	50	70	22	100	50
8	100	40	23	1200	50
9	25	40	24	200	90
10	50	60	25	1000	80
11	25	70	26	200	80
12	25	80	27	0	80
13	50	70	28	250	40
14	300	70	29	500	60
15	300	70	30	600	70
			MEAN	**345.83**	**67.83**
			MIN	**0**	**40**
			MAX	**1800**	**95**

Table 3. Seedling counts of *M. calvescens* per 100 cm^2, on cinder soil and *Sadleria* substrates, Hana, Maui.

Count Plot #	Cinder Soil	*Sadleriu* Trunk
1	84	136
2	80	135
	74	129
	65	121
	65	102
6	63	90
7	57	89
8	53	78
9	**41**	67
10	**37**	**63**
Mean	**61.9**	**101**
Min	**37**	**63**
Max	**84**	**136**

Tables **4-6:** Helicopter Spraying, Assessment of herbicide damage to emergent ***Miconia calvescens*** trees

Phenology	**# of Plants**	Ave. Bas. Diameter (cm)	**Ave.** Ht. **(m)**	Ave. Sun **Exposure**	Ave. Cambium, basal	Ave. Cambium, breast **ht.**	Ave. Cambium, top **reach**	Ave. % Canopy **Defoliation**
FR	74	7.66	5.83	55.95	3.95	3.80	3.28	73.65
ST	**36**	**4.63**	**4.18**	**56.67**	**3 75**	**3 39**	**3 19**	**77 7R**

Table **5.** Condition of **110** M. ***calvescens*** trees on November **18,1994 (9** months after spraying).

Phenology	**# of Plants**	**Ave. Bas. Diameter (cm)**	**Ave. Ht. (m)**	**Ave. Sun Exposure**	**Ave. Cambium, basal**	**Ave. Cambium, breast ht.**	**Ave. Cambium, top reach**	**Ave. % Canopy Defoliation**
FF	8	7.75	6.06	62.50	4.00	4.00	4.00	79.38
FL	5	8.00	6.80	66.00	4.00	4.00	3.80	80.80
FR	1	7.00	4.50	60.00	4.00	4.00	4.00	80.00
ST	96	6.50	5.16	68.07	4.58	4.47	4.29	95.55

Table **6.** Condition of **110** M. ***calvescens*** trees on April **12,1996 (26** months after herbicide spraying).

Phenology	**# of Plants**	**Ave. Bas. Diameter (cm)**	**Ave. Ht. (m)**	**Ave. Sun Exposure**	**Ave. Cambium, basal**	**Ave. Cambium, breast ht.**	**Ave. Cambium, top reach**	**Ave. % Canopy Defoliation**
FF	8	7.75	6.06	62.50	4.00	4.00	4.00	67.50
FL	5	8.00	6.80	66.00	4.00	4.00	3.80	70.00
FR	2	7.00	4.50	60.00	4.00	4.00	4.00	30.00
ST (living)	16	6.50	5.16	68.07	4.58	4.47	4.29	73.75
ST (dead)	79	NA	NA	NA	5.00	5.00	5.00	100.00

Tables 7-12: Helicopter Spraying, Assessment of herbicide damage to *Miconia calvescens* plants in all size ranges

Table 7. Total number of individuals of *M. calvescens* within 7 monitoring plots.

	SIZE CLASSES								
Plot #	**Seedling**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Totals**
1	1	3	2	0	3	3	0	0	12
2	2	2	2	8	9	3	0	0	26
3	0	10	2	4	6	7	0	0	29
4	4	17	13	12	5	5	0	0	56
5	71	94	16	7	8	9	0	0	205
6	35	66	7	26	16	19	0	0	169
7	4	28	11	16	23	15	0	0	97
Totals	**117**	**220**	**53**	**73**	**70**	**61**	**0**	**0**	**594**

Table 8. Percentages of total number of individuals (594) within 7 monitoring plots.

	SIZE CLASSES								
Plot #	**Seedling**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Totals**
1	0.17%	0.51%	0.34%	0.00%	0.51%	0.51%	0.00%	0.00%	2.02%
2	0.34%	0.34%	0.34%	1.35%	1.52%	0.51%	0.00%	0.00%	4.38%
3	0.00%	1.68%	0.34%	0.67%	1.01%	1.18%	0.00%	0.00%	4.88%
4	0.67%	2.86%	2.19%	2.02%	0.84%	0.84%	0.00%	0.00%	9.43%
5	11.95%	15.82%	2.69%	1.18%	1.35%	1.52%	0.00%	0.00%	34.51%
6	5.89%	11.11%	1.18%	4.38%	2.69%	3.20%	0.00%	0.00%	28.45%
7	0.67%	4.71%	1.85%	2.69%	3.87%	2.53%	0.00%	0.00%	16.33%
Totals	19.70%	37.04%	8.92%	12.29%	11.78%	10.27%	0.00%	0.00%	100.00%

Table 9. Number of individuals showing obvious spray damage.

	SIZE CLASSES								
Plot #	**Seedling**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Totals**
1	0	0	1	0	1	1	0	0	3
2	0	0	1	6	9	0	0	0	16
3	0	4	1	3	6	6	0	0	20
4	0	2	5	7	1	4	0	0	19
5	0	2	7	4	4	4	0	0	21
6	0	0	0	4	5	6	0	0	15
7	1	13	11	15	21	15	0	0	76
Totals	**1**	**21**	**26**	**39**	**47**	**36**	**0**	**0**	**170**

Table 10. Number of individuals showing no obvious spray damage

	SIZE CLASSES								
Plot #	**Seedling**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Totals**
1	1	3	1	0	2	2	0	0	9
2	2	2	1	2	0	3	0	0	10
3	0	6	1	1	0	1	0	0	9
4	4	15	8	5	4	1	0	0	37
5	71	92	9	3	4	5	0	0	184
6	35	66	7	22	11	13	0	0	154
7	3	15	0	1	2	0	0	0	21
Totals	**116**	**199**	**27**	**34**	**23**	**25**	**0**	**0**	**424**

Table 11. Percentage of each size class showing obvious spray damage.

	SIZE CLASSES								
Plot #	**Seedling**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Totals**
1	0.00%	0.00%	0.17%	0.00%	0.17%	0.17%	0.00%	0.00%	0.51%
2	0.00%	0.00%	0.17%	1.01%	1.52%	0.00%	0.00%	0.00%	2.69%
3	0.00%	0.67%	0.17%	0.51%	1.01%	1.01%	0.00%	0.00%	3.37%
4	0.00%	0.34%	0.84%	1.18%	0.17%	0.67%	0.00%	0.00%	3.20%
5	0.00%	0.34%	1.18%	0.67%	0.67%	0.67%	0.00%	0.00%	3.54%
6	0.00%	0.00%	0.00%	0.67%	0.84%	1.01%	0.00%	0.00%	2.53%
7	0.17%	2.19%	1.85%	2.53%	3.54%	2.53%	0.00%	0.00%	12.79%
Totals	0.17%	3.54%	4.38%	6.57%	7.91%	6.06%	0.00%	0.00%	28.62%

Table 12. Percentage of each size class showing no obvious spray damage.

	SIZE CLASSES								
Plot#	**Seedling**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**Totals**
1	0.17%	0.51%	0.17%	0.00%	0.34%	0.34%	*0.00%*	*0.00%*	1.52%
2	0.34%	0.34%	0.17%	0.34%	0.00%	0.51%	0.00%	*0.00%*	**1.68%**
3	0.00%	1.01%	0.17%	0.17%	0.00%	0.17%	*0.00%*	0.00%	1.52%
4	0.67%	2.53%	1.35%	0.84%	0.67%	0.17%	0.00%	0.00%	6.23%
5	11.95%	15.49%	1.52%	0.51%	0.67%	0.84%	0.00%	0.00%	30.98%
6	5.89%	11.11%	1.18%	3.70%	1.85%	2.19%	0.00%	0.00%	25.93%
7	0.51%	2.53%	0.00%	0.17%	0.34%	0.00%	0.00%	*0.00%*	3.54%

Totals	**19.53%**	**33.50%**	**4.55%**	**5.72%**	**3.87%**	**4.21%**	**0.00%**	**0.00%**	**71.38%**

Tables 13-17: Helicopter Spraying, Assessment of herbicide damage to non-target species

Table 13. Average live and dead covers of non-target species in thirty 100 m^2 circular plots following aerial spraying of *M. calvescens*, Hana population, May 5,1994.

Plant taxa	Ave. cover, live	Ave. cover, dead	Plant taxa	Ave. cover, live	Ave. cover, dead
Bare ground	**29.40%**	**29.40%**	***Pandanus tectorius***	**0.17%**	**0.00%**
Andropogon virginicus	0.17%	0.00%	*Paspalum conjugatum*	1.78%	2.27%
Angiopteris evecta	0.07%	0.00%	*Paspalum urvillei*	0.05%	0.07%
Ardisia elliptica	6.77%	2.83%	*Passiflora subpeltata*	0.03%	0.03%
Ardisia elliptica (seedling)	2.79%	0.65%	*Passiflora subpeltata (seedling)*	0.07%	0.00%
Arundina graminifolia	0.50%	0.00%	*Phymatosorus scolopendria*	0.13%	0.02%
Thelypteris parasitica	4.94%	3.74%	*Pluchea symphytifolia*	0.00%	0.87%
Cibotium glaucum	**0.37%**	**0.08%**	*Polygala paniculata*	0.04%	0.00%
Cocculus trilobus	**0.01%**	**0.00%**	***Polypodium pellucidum***	**0.00%**	**0.00%**
Cordyline fruticosa	2.10%	1.27%	*Psidium cattleianum*	0.01%	0.00%
Desmodium sp.	0.12%	0.07%	*Psidium guajava*	3.38%	12.93%
Dicranopteris linearis	**6.30%**	**18.33%**	***Psilotum nudum***	**0.01%**	**0.00%**
Dioscorea pentaphylla	0.02%	0.07%	***Psychotria sp.***	**0.20%**	**0.00%**
Gonocormus minutus	**0.00%**	**0.00%**	***Psychotria sp. (seedling)***	**0.01%**	**0.00%**
Hoya bicarinata	0.03%	0.00%	*Rubus rosifolius*	0.07%	1.77%
Kyllinga brevifolia	0.17%	0.00%	*S. campanulata (seedling)*	0.92%	0.33%
Lantana camara	3.45%	2.85%	*Sacciolepis indica*	0.07%	0.00%
Machaerina mariscoides	**0.40%**	**0.28%**	***Sadleria cyatheoides***	**0.17%**	**0.13%**
Mariscus sp.	0.00%	0.00%	*Spathodea campanulata*	13.17%	4.47%
Melinis minutiflora	0.17%	0.07%	*Spathoglottis plicata*	0.79%	0.18%
Merremia aegyptia	0.12%	0.00%	***Sphenomeris chinensis***	**0.24%**	**0.37%**
Metrosideros polymorpha	**0.63%**	**0.30%**	*Sporobolus indicus*	0.01%	0.00%
Miconia (< 1m ht.)	1.32%	1.00%	*Stachytarpheta sp.*	0.03%	0.00%
Miconia (> 1m ht.)	8.20%	13.50%	*Triumfetta semitriloba*	0.02%	0.02%
Mucuna gigantea	**0.03%**	**0.20%**	*Unid. shrub (seedling)*	0.01%	0.00%
Nephrolepis multiflora	1.67%	3.87%	*Unidentified vine*	0.03%	0.00%
Ophioglossum pendulum	**0.01%**	**0.00%**			

Native taxa in BOLD print.

Table 14. Average percent cover (most to least common) in thirty 100 m^2 circular plots following aerial spraying of *M. calvescens*, Hana population (May 1994, November 1994, April 1996)

Taxon	4ve. % Cover: 5/5/94	Taxon	Ave. % Cover: 11/18/94	Taxon	Ave. % Cover: 4/12/96
BARE GROUND	29.40	*Thelypteris parasitica*	19.50	*Miconia* (>1 m ht.)	20.45
Spathodea campanulata	13.17	BARE GROUND	11.37	*Thelypteris parasitica*	17.70
Micotiia (>1 m ht.)	9.20	*Spathodea campanulata*	11.23	*Ardisia elliptica*	12.17
Ardisia elliptica	6.73	*Miconia* (>1 m ht.)	10.97	*Spathodea cattipanulata*	10.98
Dicranopteris linearis	6.30	*Ardisia elliptica*	10.22	BARE GROUND	8.57
Thelypteris parasitica	4.94	*Psidium guajava*	9.63	*Miconia* (<1 m ht.)	6.82
Psidium guajava	3.38	*Lantana camara*	9.23	*Dicranopteris linearis*	6.53
Lantana camara	3.12	*Dicranopteris dead*	7.83	*Lantana camara*	4.88
Ardisia seedling	2.72	*Dicranopteris linearis*	5.50	*Ardisia* seedling	2.83
Cordyline fruticosa	2.14	*Nephrolepis multiflora*	3.33	*Nephrolepis multiflora*	2.82
Paspalutn conjugatum	1.78	*Ardisia* seedling	3.03	*Psidium guajava*	2.17
Nephrolepis multiflora	1.67	*Spathodea* (seedling)	2.27	*Spathodea* (seedling)	2.35
Micotiia (<1 m ht.)	1.38	*Cordyline fruticosa*	2.12	*Rubus rosifolius*	1.93
Spathodea (seedling)	0.89	*Miconia* (<1 m ht.)	2.00	*Cordyline fruticosa*	1.42
Spathoglottis plicata	0.79	*Dioscorea pentaphylla*	1.60	*Paspalum conjugatum*	1.13
Metrosideros polymorpha	0.63	*Polygala paniculata*	1.50	*Pipturus albidus*	0.90
Arundina graminifolia	0.50	*Paspalum conjugatum*	1.47	*Psidium cattleianum*	0.88
Mackaerina mariscoides	0.40	*Rubus rosifolius*	0.82	*Spathoglottis plicata*	0.67
Cibotiutn glaucum	0.37	*Arundina graminifolia*	0.68	*Cibotium glaucum*	0.40
Splienomeris chinensis	0.24	*Sacciolepis indica*	0.67	*Melinis minutiflora*	0.38
Psycliotria mariniana	0.21	*Metrosideros polymorpha*	0.60	*Dioscorea pentaphylla*	0.37
Melinis minutiflora	0.17	*Melinis minutiflora*	0.52	*Polygala paniculata*	0.37
Andropogon virginicus	0.17	*Kyllinga brevifolia*	0.50	*Arundina graminifolia*	0.33
Kyllinga brevifolia	0.17	*Desmodium* sp.	0.47	*Machaerina mariscoides*	0.33
Pandanus tectorius	0.17	*Spathoglottis plicata*	0.45	*Desmodium sandwicense*	0.27
Sadleria cyatlieoides	0.17	*Pipturus albidus*	0.32	*Ageratina riparia*	0.20
Pliymatosorus scolopendria	0.13	*Stachytarpheta urticifolia*	0.30	*Metrosideros polymorpha*	0.18
Dcsmodium sp.	0.12	*Ageratum conyzoides*	0.27	*Pluchea symphytifolia*	0.18
Merretnia aegyptia	0.12	*Psidium cattleianum*	0.27	*Stachytarpheta urticifolia*	0.17
Angiopteris evecta	0.07	*Fimbrystylis dichotoma*	0.18	*Pycreus polystachyos*	0.13
Rubus rosifolius	0.07	*Machaerina mariscoides*	0.18	*Ageratum conyzoides*	0.10
Sacciolepis indica	0.07	*Cibotium glaucum*	0.17	*Mucuna gigantea*	0.10
Paspalum urvillei	0.05	*Sporobolus indicus*	0.17	*Sacciolepis indica*	0.10
Polygala paniculata	0.04	Unidentified tall grass	0.17	*Cocculus trilobus*	0.08
Passiflora subpeltata	0.04	*Cocculus trilobus*	0.15	*Hoya bicarinata*	0.08
Hoya bicarinata	0.03	*Passiflora subpeltata*	0.15	*Crassocephalum crepidioides*	0.07
Passiflora edulis	0.03	*Pluchea symphytifolia*	0.15	*Ipomoea alba*	0.07
Stachytarpheta urticifolia	0.03	*Erechtites valerianifolia*	0.10	*Sphenomeris chinensis*	0.07
Unidentified vine	0.03	*Pandanus tectorius*	0.10	*Desmodium intortum*	0.05
Mucuna gigantean	0.03	*Sphenomeris chinensis*	0.10	*Desmodium* sp.	0.05
Dioscorea pentaphylla	0.02	*Ageratina riparia*	0.08	*Digitaria* sp.	0.05
Triutnfetta semitriloba	0.02	*Andropogon virginicus*	0.08	*Ophioglossum pendulum*	0.05
Ophioglossum pendulum	0.01	*Hoya bicarinata*	0.08	*Phymatosorus scolopendria*	0.05
Psidiuni cattleianum	0.01	*Psilotum nudum*	0.08	*Psychotria* seedlings	0.05
Psilotutn nudum	0.01	*Pycreus polystachyos*	0.08	*Kyllinga brevifolia*	0.03
Cocculus trilobus	0.01	*Sadleria cyatheoides*	0.08	*Paspalum urvillei*	0.03

Table 14. Continued

Taxon	Ave. % Cover: 5/5/94	Taxon	Ave. % Cover: 11/18/94	Taxon	Ave. % Cover: 4/12/96
Sporobolus indicus	0.01	*Ophioglossum pendulum*	0.07	*Passiflora subpeltata*	0.03
Unid. *shrub* (seedling)	0.01	*Phymatosorus scolopendria*	0.07	*Pleopeltis thunbergiana*	0.03
Gonocormus minutus	0.00	*Chamaecrista nictitans*	0.05	*Psycliotria tnariniana*	0.03
Mariscus sp.	0.00	*Ipomoea indira*	0.05	*Sporobolus indicus*	0.03
Polypodiutti pellucidum	0.00	*Mucuna gigantea*	0.05	*Clermontia kakeana*	0.02
Ageratina riparia	0.00	*Pleopeltis tliunbergiana*	0.05	*Indigofera suffruticosa*	0.02
Ageratum conyzoides	0.00	*Crassocephalum crepidioides*	0.03	*Ipomoea indica*	0.02
~~*Amauropelta globulifera*~~	~~0.00~~	~~*Amauropelta globulifera*~~	~~0.02~~	~~*Michelia champaca*~~	~~0.02~~
Chamaecrista nictitans	0.00	*Crotolaria pallida*	0.02	*Sadleria cyatheoides*	0.02
Clermontia **kakeana**	0.00	*Cyperus gracilis*	0.02	*Tiboucliina herbacea*	0.02
Crassocephalum crepidioides	0.00	*Diplazium sandwichianum*	0.02	*Triumfetta semitriloba*	0.02
Crotolaria pallida	0.00	*Indigofera suffruticosa*	0.02	*Amauropelta globulifera*	0.00
Cyperus gracilis	0.00	*Michelia champaca*	0.02	*Andropogon virginicus*	0.00
Deanodiuni intortum	0.00	*Panicuni maximum*	0.02	*Angiopteris evecta*	0.00
Desmodium sandwicense	0.00	*Passiflora edulis*	0.02	*Chamaecrista nictitans*	0.00
Dicranopteris dead	0.00	*Psycliotria mariniana*	0.02	*Crotolaria pallida*	0.00
Digitaria sp.	0.00	*Setaria gracilis*	0.02	*Cyperus gracilis*	0.00
Diplazium sandwichianum	0.00	*Tibouchina Iierbacea*	0.02	*Dicranopteris* dead	0.00
Erechtites valerianifolia	0.00	*Triumfetta semitriloba*	0.02	*Diplazium sandwichianum*	0.00
Fimbrystylis dichotoma	0.00	Unidentified large leaf grass	0.02	*Erechtites valerianifolia*	0.00
Indigofera suffruticosa	0.00	Unidenrified native fern cf. Hoio	0.02	*Fimbrystylis dichoroma*	0.00
Ipomoea alba	0.00	*Angiopteris evecta*	0.00	*Gonocormus minutus*	0.00
Ipomoea indica	0.00	*Clermontia kakeana*	0.00	*Mariscus sp.*	0.00
Michelia **ckampaca**	0.00	*Desmodium intortum*	0.00	*Merremia aegyptia*	0.00
Panicum maximum	0.00	*Desmodium sandwicense*	0.00	*Pandanus tectorius*	0.00
Pipturus albidus	0.00	*Digitaria sp.*	0.00	*Panicum maximum*	0.00
Pleopeltis tliunbergiana	0.00	Gonocormus minutus	0.00	*Passiflora edulis*	0.00
Pluchea symphytifolia	0.00	*Ipomoea alba*	0.00	*Polypodium pellucidum*	0.00
Psycliotria seedlings	0.00	*Mariscus sp.*	0.00	*Psilotum nudum*	0.00
Pycreus polystachyos	0.00	*Merremia aegyptia*	0.00	*Setaria gracilis*	0.00
Setaria gracilis	0.00	*Paspalum urvillei*	0.00	Unid. *shrub* (seedling)	0.00
Tibouckina lierbacea	0.00	*Polypodiumpellucidum*	0.00	Unidentified large leaf grass	0.00
Unidentified large leaf grass	0.00	*Psycliotria* seedlings	0.00	Unidentified native fern cf. Hoi	0.00
Unidentified native fern cf. Hoi	0.00	Unid. **Shrub** (seedling)	0.00	**Unidentified tall grass**	***0.00***
Unidentified tall grass	0.00	Unidentified vine	0.00	Unidentified vine	0.00

Native Taxa	Ave. % Cover: 5/5/94	Native Taxa	Ave. % Cover: 11/18/94	Native Taxa	Ave. % Cover: 4/12/96
Dicranopteris linearis	6.30	*Dicranopteris dead*	7.83	*Dicranopteris linearis*	6.53
Metrosideros polymorpha	0.63	*Dicranopteris linearis*	5.50	*Pipturus albidus*	0.90
Machaerina mariscoides	0.40	*Metrosideros polymorpha*	0.60	*Cibotium glaucum*	0.40
Cibotium glaucum	0.37	*Pipturus albidus*	0.32	*Machaerina mariscoides*	0.33
Sphenomeris chinensis	0.24	*Fimbrystylis dichotoma*	0.18	*Metrosideros polymorpha*	0.18
Psychotria mariniana	0.21	*Machaerina mariscoides*	0.18	*Pycreus polystachyos*	0.13
Pandanus tectorius	0.17	*Cibotium glaucum*	0.17	*Mucuna gigantea*	0.10
Sadleria cyatheoides	0.17	*Pandanus tectorius*	0.10	*Cocculus trilobus*	0.08
Ophioglossum pendulum	0.01	*Sphenomeris chinensis*	0.10	*Ophioglossum pendulum*	0.05
Psilotum nudum	0.01	*Psilotum nudum*	0.08	*Psychotria* seedlings	0.05
Cocculus trilobus	0.01	*Pycreus polystachyos*	0.08		
		Sadleria cyatheoides	0.08		

Table 16. Most common non-native plants by percent cover in thirty 100 m^2 circular plots following aerial spraying of *M. calvescens*, Hana, Maui.

Non-native Taxa	Ave. % Cover: 5/5/94	Non-native Taxa	Ave. % Cover: 11/18/94	Non-native Taxa	Ave. % Cover: 4/12/96
Spathodea campanulata	13.17	*Thelypteris parasitica*	19.50	***Miconia* (>1 m ht.)**	**20.45**
***Miconia* (>1 m ht.)**	**9.20**	*Spathodea campanulata*	11.23	*Thelypteris parasitica*	17.70
Ardisia elliptica	6.73	***Miconia* (>1 m ht.)**	**10.97**	*Ardisia elliptica*	12.17
Thelypteris parasitica	4.94	*Ardisia elliptica*	10.22	*Spathodea campanulata*	10.98
Psidium guajava	3.38	*Psidium guajava*	9.63	***Miconia* (<1 m ht.)**	**6.82**
Lantana camara	3.12	*Lantana camara*	9.23	*Lantana camara*	4.88
Ardisia seedling	2.72	*Nephrolepis multiflora*	3.33	*Ardisia seedling*	2.83
Cordyline fruticosa	2.14	*Ardisia seedling*	3.03	*Nephrolepis multiflora*	2.82
Paspalum conjugatum	1.78	*Spathodea* (seedling)	2.27	*Psidium guajava*	2.77
Nephrolepis multiflora	1.67	*Cordyline fruticosa*	2.12	*Spathodea* (seedling)	2.35
BARE GROUND	**29.40**	BARE GROUND	**11.37**	BAREGROUND	**8.57**

Table 17. Changes in cover in thirty 100 m^2 plots from May 1994 to April 1996 following aerial spraying of *M. calvescens*, Hana, Maui.

Taxon	Loss In % Cover: 5/5/94 to 4/12/96	Taxon	Gain In % Cover: 5/5/94 to 4/12/96
BARE GROUND	-20.83	*Thelypteris parasitica*	12.76
Spathodea campanulata	-2.18	*Miconia* (>1 m ht.)	11.25
Cordyline fruticosa	-0.72	*Miconia* (<1 m ht.)	5.43
Paspalum conjugatum	-0.65	*Ardisia elliptica*	5.43
Psidium guajava	-0.62	*Rubus rosifolius*	1.87
Metrosideros polymorpha	-0.45	*Lantana camara*	1.77
Psychotria mariniana	-0.18	*Spathodea* (seedling)	1.46
Sphenomeris chinensis	-0.17	*Nephrolepis multiflora*	1.15
Arundina graminifolia	-0.17	*Pipturus albidus*	0.90
Andropogon virginicus	-0.17	*Psidium cattleianum*	0.87
Pandanus tectorius	-0.17	*Dioscorea pentaphylla*	0.34
Sadleria cyatheoides	-0.15	*Polygala paniculata*	0.33
Kyllinga brevifolia	-0.13	*Desmodium sandwicense*	0.27
Spathoglottis plicata	-0.12	*Dicranopteris linearis*	0.23
Merremia aegyptia	-0.12	*Melinis minutiflora*	0.21
Phymatosorus scolopendria	-0.08	*Ageratina riparia*	0.20
Machaerina mariscoides	-0.07	*Pluchea symphytifolia*	0.18
Angiopteris evecta	-0.07	*Pycreus polystachyos*	0.13
Desmodium sp.	-0.07	*Stachytarpheta urticifolia*	0.13
Passiflora edulis	-0.03	*Ardisia seedling*	0.11
Unidentified vine	-0.03	*Ageratum conyzoides*	0.10
Paspalum urvillei	-0.02	*Cocculus trilobus*	0.08
Psilotum nudum	-0.01	*Mucuna gigantea*	0.07
Unid. shrub (seedling)	-0.01	*Crassocephalum crepidioides*	0.07
Passiflora subpeltata	0.00	*Ipomoea alba*	0.07
Gonocormus minutus	0.00	*Desmodium intortum*	0.05
Mariscus sp.	0.00	*Digitaria sp.*	0.05
Polypodium pellucidum	0.00	*Hoya bicarinata*	0.05
Amauropelta globulifera	0.00	*Psychotria seedlings*	0.05
Chamaecrista nictitans	0.00	*Ophioglossum pendulum*	0.04
Crotolaria pallida	0.00	*Cibotium glaucum*	0.03
Cyperus gracilis	0.00	*Sacciolepis indica*	0.03
Dicranopteris dead	0.00	*Pleopeltis thunbergiana*	0.03
Diplazium sandwichianum	0.00	*Sporobolus indicus*	0.03
Erechtites valerianifolia	0.00	*Clermontia kakeana*	0.02
Fimbrystylis dichotoma	0.00	*Indigofera suffruticosa*	0.02
Panicum maximum	0.00	*Ipomoea indica*	0.02
Setaria gracilis	0.00	*Michelia champaca*	0.02
Triumfetta semitriloba	0.00	*Tibouchina herbacea*	0.02
Unidentified large leaf grass	0.00		
Unidentified native fern cf. Hoio	0.00		
Unidentified tall grass	0.00		

Tables 18-45: Ground Crews, Assessment of reinvasion of *M. calvescens* into sites following ground control

Table 18. Number of *Miconia calvescens* plants per height class, Transect 1, Treatment Year 1997.

	Seedlings (<1 cm)	1-<10 (cm)	10 -<50 (cm)	50-<100 (cm)	100-200 (cm)	200-500 (cm)	5-10 (m)	>10 m	Total
Station 1 (5.64 m radius)	50	51	160	33	42	17	2	0	355
# Flwr/Frt Trees (St.1)	0	0	0	0	0	0	0	0	0
5 m Band Between Stns	0	10	24	9	5	5	0	0	53
# Flwr/Frt (Between Stns)	0	0	0	0	0	0	0	0	0
Station 2 (5.64 m radius)	0	4	3	0	2	0	0	0	9
# Flwr/Frt Trees (St.2)	0	0	0	0	0	0	0	0	0
Totals	50	65	187	42	49	22	2	0	417

Table 19. Percentage of *M. calvescens* plants per height class, Transect 1, Treatment Year 1997,

	Seedlings (<1 cm)	1-<10 (cm)	10 -<50 (cm)	50-<100 (cm)	100-200 (cm)	200-500 (cm)	5-10 (m)	>10 m	Totals
Station 1 (5.64 m radius)	11.99%	12.23%	38.37%	7.91%	10.07%	4.08%	0.48%	0.00%	85.13%
# Flwr/Frt Trees (St.1)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
5 m Band Between Stns	0.00%	2.40%	5.76%	2.16%	1.20%	1.20%	0.00%	0.00%	12.71%
# Flwr/Frt (Between Stns)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Station 2 (5.64 m radius)	0.00%	0.96%	0.72%	0.00%	0.48%	0.00%	0.00%	0.00%	2.16%
# Flwr/Frt Trees (St.2)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Totals	11.99%	15.59%	44.84%	10.07%	11.75%	5.28%	10.48%	0.00%	100.00%

Table 20. Number of *M. calvescens* plants per height class, Transect 2, Treatment Year 1997

	Seedlings (<1 cm)	1-<10 (cm)	10 -<50 (cm)	50-<100 (cm)	100-200 (cm)	200-500 (cm)	5-10 (m)	>10 m	Totals
Station 1 (5.64 m radius)	10	9	10	5	2	5	0	0	41
# Flwr/Frt Trees (St.1)	0	0	0	0	0	0	0	0	0
5 m Band Between Stns	0	35	40	14	11	3	0	0	103
# Flwr/Frt (Between Stns)	0	0	0	0	0	0	0	0	0
Station 2 (5.64 m radius)	0	44	30	5	4	3	0	0	86
# Flwr/Frt Trees (St.2)	0	0	0	0	0	0	0	0	0
Totals	10	88	80	24	17	11	0	0	230

Table 21. Percentage of *M. calvescens* plants per height class, Transect 2, Treatment Year 1997

	Seedlings (<1 cm)	1-<10 (cm)	10 -<50 (cm)	50-<100 (cm)	100-200 (cm)	200-500 (cm)	5-10 (m)	>10 m	Totals
Station 1 (5.64 m radius)	4.35%	3.91%	4.35%	2.17%	0.87%	2.17%	0.00%	0.00%	17.83%
# Flwr/Frt Trees (St.1)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
5 m Band Between Stns	0.00%	15.22%	17.39%	6.09%	4.78%	1.30%	0.00%	0.00%	44.78%
# Flwr/Frt (Between Stns)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Station 2 (5.64 m radius)	0.00%	19.13%	13.04%	2.17%	1.74%	1.30%	0.00%	0.00%	37.39%
# Flwr/Frt Trees (St.2)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Totals	4.35%	38.26%	34.78%	10.43%	7.39%	4.78%	0.00%	0.00%	100.00%

Table 22. Number of *M. calvescens* plants per height class, Transect 3, Treatment Year 1998

	Seedlings (<1 cm)	1-<10 (cm)	10 -<50 (cm)	50-<100 (cm)	100-200 (cm)	200-500 (cm)	5-10 (m)	>10 m	Totals
Station 1 (5.64 m radius)	0	4	3	1	2	0	0	0	**10**
# Flwr/Frt Trees (St.1)	0	0	0	0	0	0	0	0	**0**
5 m Band Between Stns	0	25	21	11	3	0	0	0	**60**
# Flwr/Frt (Between Stns)	0	0	0	0	0	0	0	0	**0**
Station 2 (5.64 m radius)	20	26	8	8	0	0	0	0	**62**
# Flwr/Frt Trees (St.2)	0	0	0	0	0	0	0	0	**0**
Totals	**20**	**55**	**32**	**20**	**5**	**0**	**0**	**0**	**132**

Table 23. Percentage of *M. calvescens* plants per height class, Transect 3, Treatment Year 1998

	Seedlings (<1 cm)	1-<10 (cm)	10 -<50 (cm)	50-<100 (cm)	100-200 (cm)	200-500 (cm)	5-10 (m)	>10 m	Totals
Station 1 (5.64 m radius)	0.00%	3.03%	2.27%	0.76%	1.52%	0.00%	0.00% 0.00%	0.00% 0.00%	**7.58%**
# Flwr/Frt Trees (St.1)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00% 0.00%	0.00% 0.00%	**0.00%**
5 m Band Between Stns	0.00%	18.94%	15.91%	8.33%	2.27%	0.00%	0.00% 0.00%	0.00% 0.00%	**45.45%**
# Flwr/Frt (Between Stns)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00% 0.00%	0.00% 0.00%	**0.00%**
Station 2 (5.64 m radius)	**15.15%**	19.70%	6.06%	6.06%	0.00%	0.00%	0.00% 0.00%	0.00% 0.00%	**46.97%**
# Flwr/Frt Trees (St.2)	**0.00%**	0.00%	0.00%	0.00%	0.00%	0.00%	0.00% 0.00%	0.00% 0.00%	**0.00%**
Totals	**15.15%**	**41.67%**	**24.24%**	**15.15%**	**3.79%**	**0.00%**	**0.00%**	**10.00%**	**100.00%**

Table 24. Number of M. *calvscens* plants per height class, Transect 4, Treatment Year 1996

	Seedlings (<1 cm)	1-<10 (cm)	10 -<50 (cm)	50-<100 (cm)	100-200 (cm)	200-500 (cm)	5-10 (m)	>10 m	Totals
Station 1 (5.64 m radius)	0	0	0	0	1	0	0	0	1
# Flwr/Frt Trees (St.1)	0	0	0	0	0	0	0	0	0
5 m Band Between Stns	0	0	0	0	0	0	0	0	0
# Flwr/Frt (Between Stns)	0	0	0	0	0	0	0	0	0
Station 2 (*5.64* m radius)	0	0	0	0	0	0	0	0	0
# Flwr/Frt Trees (St.2)	0	0	0	0	0	0	0	0	0
Totals	0	0	0	0	1	0	0	0	1

Table 25. Percentage of M. *calvescens* plants per height class, Transect 4, Treatment Year 1996

	Seedlings (<1 cm)	1-40 (cm)	10-<50 (cm)	50-<100 (cm)	100-200 (cm)	200-500 (cm)	5-10 (m)	>10 m	Totals
Stntion 1 (5.64 m radius)	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00% 0.00%	0.00% 0.00%	100.00% 100.00%
# Flwr/Frt Trees (St.1)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00% 0.00%	0.00% 0.00%	0.00% 0.00%
5 m Band Between Stns	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00% 0.00%	0.00% 0.00%	0.00% 0.00%
# Flwr/Frt (Between Stns)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00% 0.00%	0.00% 0.00%	0.00% 0.00%
Station 2 (*5.64* m radius)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00% 0.00%	0.00% 0.00%	0.00% 0.00%
# Flwr/Frt Trees (St.2)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00% 0.00%	0.00% 0.00%	0.00% 0.00%
Totals	0.00%	0.00%	0.00%	0.00%	100.00%	0.00%	0.00%	0.00%	100.00%

	Seedlings (<1 cm)	1-<10 (cm)	10 -<50 (cm)	50-<100 (cm)	100-200 (cm)	200-500 (cm)	5-10 (m)	>10 m	Totals
Station 1 (5.64 m radius)	0	0	0	2	7	0	0	0	**9**
# Flwr/Frt Trees (St.1)	0	0	0	0	0	0	0	0	**0**
5 m Band Between Stns	0	54	113	56	28	23	0	0	**274**
# Flwr/Frt (Between Stns)	0	0	0	0	0	0	0	0	**0**
Station 2 (5.64m radius)	*0*	0	3	*0*	*0*	*0*	*0*	**0**	**3**
# Flwr/Frt Trees *(St.2)*	*0*	0	*0*	0	*0*	*0*	*0*	**0**	**0**
Totals	**0**	**54**	**116**	***58***	**35**	**23**	**0**	**0**	***286***

Table 27. Percentage of *M. calvescens* plants per height class, Transect 5, Treatment Year 1999

	Seedlings (<1 cm)	1-<10 (cm)	10 -<50 (cm)	50-<100 (cm)	100-200 (cm)	200-500 (cm)	5-10 (m)	>10 m	Totals
Station 1 (5.64 m radius)	*0.00%*	*0.00%*	*0.00%*	**0.70%**	**2.45%**	*0.00%*	*0.00%*	*0.00%*	**3.15%**
# Flwr/Frt Trees (St.1)	0.00%	0.00%	0.00%	*0.00%*	*0.00%*	0.00%	0.00%	0.00%	**0.00%**
5 m Band Between Stns	*0.00%*	18.88%	39.51%	19.58%	9.79%	8.04%	0.00%	0.00%	**95.80%**
# Flwr/Frt (Between Stns)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	**0.00%**
Station 2 (5.64 m radius)	0.00%	0.00%	1.05%	0.00%	0.00%	0.00%	0.00%	0.00%	**1.05%**
# Flwr/Frt Trees (St.2)	*0.00%*	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	**0.00%**
Totals	**0.00%**	**18.88%**	**40.56%**	**20.28%**	**12.24%**	**8.04%**	**0.00%**	**0.00%**	**100.00%**

Table 28. Number of *M. calvescens* plants per height class, Transect 6, Treatment Year 1998

	Seedlings (<1 cm)	1-<10 (cm)	10 -<50 (cm)	50-<100 (cm)	100-200 (cm)	200-500 (cm)	5-10 (m)	>10 m	Totals
Station 1 (5.64 m radius)	47	24	1	2	1	0	0	0	75
# Flwr/Frt Trees (St.1)	0	0	0	0	0	0	0	0	0
5 m Band Between Stns	30	70	60	10	7	0			
# Flwr/Frt (Between Stns)	0	0	0	0	0	0			
Station 2 (5.64 m radius)	20	36	18	5	1	1			
# Flwr/Frt Trees (St.2)	0	0	0	0	0	0			
Totals	97	130	79	17	9	1	0	0	333

Table 29. Percentage of M. *calvescens* plants per height class, Transect 6, Treatment Year 1998

	Seedlings(<1 cm)	1-<10 (cm)	10-<50 (cm)	50-<100 (cm)	100-200 (cm)	200-500 (cm)	5-10 (m)	>10 m	Totals
Station 1 (5.64 m radius)	14.11%	7.21%	0.30%	0.60%	0.30%	0.00%	0.00%	0.00%	22.52%
# Flwr/Frt Trees (St.1)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
5 m Band Between Stns	9.01%	21.02%	18.02%	3.00%	2.10%	0.00%	0.00%	0.00%	53.15%
# Flwr/Frt (Between	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Station 2 (5.64 m radius)	6.01%	10.81%	5.41%	1.50%	0.30%	0.30%	0.00%	0.00%	24.32%
# Flwr/Frt Trees (St.2)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Totals	29.13%	39.04%	23.72%	5.11%	2.70%	0.30%	10.00%	0.00%	100.00%

Table 30. Number of *M. calvescens* plants per height class, Transect 7, Treatment Year 1999

	Seedlings (<1 cm)	1-<10 (cm)	10 -<50 (cm)	50-<100 (cm)	100-200 (cm)	200-500 (cm)	5-10 (m)	>10 m	Totals
Station 1 (5.64 m radius)	0	6	4	2	8	0	0	0	20
# Flwr/Frt Trees (St.1)	0	0	0	0	0	0	0	0	0
5 m Band Between Stns	10	59	56	7	9	1	0	0	142
# Flwr/Frt (Between Stns)	0	0	0	0	0	0	0	0	0
Station 2 (5.64 m radius)	12	38	32	0	0	0	0	0	82
# Flwr/Frt Trees (St.2)	0	0	0	0	0	0	0	0	0
Totals	22	103	92	9	17	1	0	0	244

Table 31. Percentage of M. *culvescens* plants per height class, Transect 7, Treatment Year 1999

	Seedlings (<1 cm)	1-<10 (cm)	10 -<50 (cm)	50-<100 (cm)	100-200 (cm)	200-500 (cm)	5-10 (m)	>10 m	Totals
Station 1 (5.64 m radius)	0.00%	2.46%	1.64%	0.82%	3.28%	0.00%	0.00%	0.00%	8.20%
# Flwr/Frt Trees (St.1)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
5 m Band Between Stns	4.10%	24.18%	22.95%	2.87%	3.69%	0.41%	0.00%	0.00%	58.20%
# Flwr/Frt (Between Stns)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Station 2 (5.64 m radius)	4.92%	15.57%	13.11%	0.00%	0.00%	0.00%	0.00%	0.00%	33.61%
# Flwr/Frt Trees (St.2)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Totals	9.02%	42.21%	37.70%	3.69%	6.97%	0.41%	0.00%	0.00%	100.00%

Table 32. Number of M. *calvescens* plants per height class, Transect 8, Treatment Year 1996

	Seedlings (<1 cm)	1-<10 (cm)	10-<50 (cm)	50-<100 (cm)	100-200 (cm)	200-500 (cm)	5-10 (m)	>10 m	Totals
Station 1 (*5.64* m radius)	0	0	1	*0*	*0*	0	0	0	1
# Flwr/Frt Trees (St.1)	*0*	*0*	*0*	*0*	*0*	0	0	0	0
5 m Band Between Stns	0	9	12	6	0	0	0	0	27
# Flwr/Frt (Between Stns)	*0*	0	*0*	*0*	*0*	0	0	0	0
Station 2 (*5.64* m radius)	0	0	0	0	0	0	0	0	0
# Flwr/Frt Trees (St.2)	0	0	0	0	0	0	0	0	0
Totals	0	9	13	6	0	0	0	0	28

Table 33. Percentage of M. *calvscens* plants per height class, Transect 8, Treatment Year 1996

	Seedlings (<1 cm)	1-<10 (cm)	10-<50 (cm)	50-<100 (cm)	100-200 (cm)	200-500 (cm)	5-10	>10 m	Totals
Station 1 (5.64 m radius)	*0.00%*	*0.00%*	3.57%	0.00%	0.00%	0.00%	0.00%	0.00%	3.57%
# Flwr/Frt Trees (St.1)	0.00%	0.00%	*0.00%*	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
5 m Band Between Stns	*0.00%*	32.14%	42.86%	21.43%	0.00%	0.00%	0.00%	0.00%	96.43%
# Flwr/Frt (Between Stns)	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	0.00%	0.00%	0.00%	0.00%
Station 2 (5.64 m radius)	0.00%	*0.00%*	*0.00%*	0.00%	*0.00%*	*0.00%*	0.00%	0.00%	0.00%
# Flwr/Frt Trees (St.2)	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	*0.00%*	0.00%	0.00%	0.00%
Totals	0.00%	32.14%	46.43%	21.43%	0.00%	0.00%	0.00%	0.00%	100.00%

Table 34. Number of meters per 100 meter transect with *M. calvescens*, Treatment Years 1996-1999

Transect #	Treatment Year	# of meters with *M. calvescens*
1	1997	57
2	1997	*67*
3	1998	47
4	1996	1
5	1999	*63*
6	1998	45
7	1999	37
8	1996	11
Total	**1996-1999**	**328**

Table 35. Total number of *M. calvescens* plants per height class, Treatment Year 1996 (Transects 4 and 8)

	Seedlings (<1 cm)	1-40 (cm)	10 -<50 (cm)	50-<100 (cm)	100-200 (cm)	200-500 (cm)	5-10 (m)	>10 m	Total
Station 1 (5.64 m radius)	0	0	1	0	1	0	0	0	2
# Flwr/Frt Trees (St.1)	0	0	0	0	0	0	0	0	0
5 m Band Between Stns	0	9	12	6	0	0	0	0	27
# Flwr/Frt (Between Stns)	0	0	0	0	0	0	0	0	0
Station 2 (5.64 m radius)	0	0	0	0	0	0	0	0	0
# Flwr/Frt Trees (St.2)	0	0	0	0	0	0	0	0	0
Totals	0	9	13	6	1	0	0	0	29

Table 36. Total percentage of *M. calvescens* plants per height class, Treatment Year 1996 (Transects 4 and 8).

	Seedlings (<1 cm)	1-<10 (cm)	10 -<50 (cm)	50-<100 (cm)	100-200 (cm)	200-500 (cm)	5-10 (m)	>10 m	Totals
Station 1 (5.64 m radius)	0.00%	0.00%	3.45%	0.00%	3.45%	0.00%	0.00%	0.00%	6.90%
# Flwr/Frt Trees (St.1)	0.00%	0.00%					0.00%	0.00%	0.00%
5 m Band Between Stns	0.00%	31.03%	41.38%	20.69%	0.00%	0.00%	0.00%	0.00%	93.10%
# Flwr/Frt (Between Stns)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Station 2 (5.64 m radius)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
# Flwr/Frt Trees (St.2)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00% 0.00%	0.00% 0.00%	0.00% 0.00%
Totals	0.00%	31.03%	44.83%	20.69%	3.45%	0.00%	0.00%	0.00%	100.00%

Table 37. Total number of ***M. calvescens*** plants per height class, Treatment Year 1997 (Transects 1 and **2).**

	Seedlings (<1 cm)	1-<10 (cm)	10-<50 (cm)	50-<100 (cm)	100-200 (cm)	200-500 (cm)	5-10 (m)	>10 m	Totals
Station 1 (5.64 m radius)	60	60	170	38	44	22	2	0	396
# Flwr/Frt Trees (St.1)	0	0	0	0	0	0	0	0	0
5 m Band Between Stns	0	45	64	23	16	8	0	0	156
# Flwr/Frt (Between Stns)	0	0	0	0	0	0	0	0	0
Station 2 (5.64 m radius)	0	48	33	5	6	3	0	0	95
# Flwr/Frt Trees (St.2)	0	0	0	0	0	0	0	0	0
Totals	60	153	267	66	66	33	2	0	647

Table 38. Total percentage of ***M. calvescens*** plants per height class, Treatment Year 1997 (Transects 1 and **2).**

	Seedlings (<1 cm)	1-<10 (cm)	10 -<50 (cm)	50-<100 (cm)	100-200 (cm)	200-500 (cm)	5-10 (m)	>10 m	Totals
Station 1 (5.64 m radius)	9.27%	9.27%	26.28%	5.87%	6.80%	3.40%	0.31%	0.00%	61.21%
# Flwr/Frt Trees (St.1)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
5 m Band Between Stns	0.00%	6.96%	9.89%	3.55%	2.47%	1.24%	0.00%	0.00%	24.11%
# Flwr/Frt (Between Stns)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Station 2 (5.64 m radius)	0.00%	7.42%	5.10%	0.77%	0.93%	0.46%	0.00%	0.00%	14.68%
# Flwr/Frt Trees (St.2)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Totals	9.27%	23.65%	41.27%	10.20%	10.20%	5.10%	0.31%	0.00%	100.00%

Table 39. Total number of *M. calvescens* plants per height class, Treatment Year 1998 (Transects 3 and 6).

	Seedlings (<1 cm)	1-<10 (cm)	10 -<50 (cm)	50-<100 (cm)	100-200 (cm)	200-500 (cm)	5-10 (m)	>10 m	Totals
Station 1 (5.64m radius)	47	28	4	3	3	0	0	0	85
# Flwr/Frt Trees (St.1)	0	0	0	0	0	0	0	0	0
5 m Band Between Stns	30	95	81	21	10	0	0	0	237
# Flwr/Frt (Between Stns)	0	0	0	0	0	0	0	0	0
Station 2 (5.64 m radius)	40	62	26	13	1	1	0	0	143
# Flwr/Frt Trees (St.2)	0	0	0	0	0	0	0	0	0
Totals	117	185	111	37	14	1	0	0	465

Table 40. Total percentage of M. *calvescens* plants per height class, Treatment Year 1998 (Transects 3 and 6).

	Seedlings (<1 cm)	1-<10 (cm)	10 -<50 (cm)	50-<100 (cm)	100-200 (cm)	200-500 (cm)	5-10 (m)	>10 m	Totals
Station 1 (5.64 m radius)	10.11%	6.02%	0.86%	0.65%	0.65%	0.00%	0.00%	0.00%	18.28%
# Flwr/Frt Trees (St.1)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
5 m Band Between Stns	6.45%	20.43%	17.42%	4.52%	2.15%	0.00%	0.00%	0.00%	50.97%
# Flwr/Frt (Between Stns)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Station 2 (5.64 m radius)	8.60%	13.33%	5.59%	2.80%	0.22%	0.22%	0.00%	0.00%	30.75%
# Flwr/Frt Trees (St.2)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Totals	25.16%	39.78%	23.87%	7.96%	3.01%	0.22%	0.00%	10.00%	100.00%

Table **41.** Total number **of** M. ***calvescens*** plants per height class, Treatment Year **1999** (Transects **5** and **7).**

	Seedlings (<1 cm)	1-40 (cm)	10-<50 (cm)	**50-<100** (cm)	100-200 (cm)	**200-500** (cm)	5-10 (m)	**>10** m	**Total**
Station 1 (5.64 m radius)	0	6	4	4	15	0	0	0	**29**
# Flwr/Frt Trees (St.1)	**0**	0	0	0	0	0	0	0	**0**
***5* m Band** Between Stns	10	**113**	***169***	**63**	**37**	**24**	0	0	**416**
# Flwr/Frt (Between **Stns)**	0	0	0	0	0	0	0	0	**0**
Station 2 (5.64 m radius)	12	38	35	0	0	0	0		
# Flwr/Frt Trees (St.2)	0	0	0	0	0	0	0		
Totals	22	157	208	67	52	24	0	0	530

Table **42.** Total percentage **of** M. ***calvescens*** plants per height class, Treatment Year **1999** (Transects **5** and 7)

	Seedlings **(<1** cm)	**1-<10** (cm)	10**-<50** (cm)	50-<100 (cm)	100-200 (cm)	200-500 (cm)	5-10 (m)	**>10 m**	**Totals**
Station 1 (5.64 m radius)	0.00%	1.13%	0.75%	0.75%	2.83%	0.00%	0.00%	0.00%	**5.47%**
# Flwr/Frt Trees (St.1)	0.00%	**0.00%**	*0.00%*	**0.00%**	**0.00%**	**0.00%**	0.00%	0.00%	**0.00%**
5 m Band Between Stns	1.89%	21.32%	31.89%	11.89%	6.98%	4.53%	0.00%	0.00%	78.49%
# Flwr/Frt (Between **Stns)**	**0.00%**	0.00%	0.00%	0.00%	*0.00%*	**0.00%**	0.00%	0.00%	**0.00%**
Station 2 (5.64 m radius)	2.26%	7.17%	6.60%	0.00%	0.00%	0.00%	0.00%	0.00%	16.04%
# Flwr/Frt Trees (St.2)	**0.00%**	**0.00%**	*0.00%*	**0.00%**	**0.00%**	*0.00%*	0.00%	0.00%	0.00%
Totals	4.15%	29.62%	39.25%	12.64%	9.81%	4.53%	0.00%	0.00%	**100.00%**

Table **43.** Number of meters (out of 200) with M. ***calvescens,*** per Treatment Years **1996-1999**

Treatment **Year**	# of meters with M.	***% with M. calvescens***
1998	92	**46%**
1999	100	50%
Total	**328**	**100%**

Table 44. Total number of *M. calvescens* plants per height class, All Treatment Years (1996-1999)

	Seedlings (<1 cm)	1-<10 (cm)	10 -<50 (cm)	50-<100 (cm)	100-200 (cm)	200-500 (cm)	5-10 (m)	>10 m	Totals
Station 1 (5.64 m radius)	107	94	179	45	63	22	2	0	**512**
# Flwr/Frt Trees (St.1)	0	0	0	0	0	0	0	0	**0**
5 m Band Between Stns	40	262	326	113	63	32	0	0	**836**
# Flwr/Frt (Between Stns)	0	0	0	0	0	0	0	0	**0**
Station 2 (5.64 m radius)	52	148	94	18	7	4	0	0	**323**
# Flwr/Frt Trees (St.2)	0	0	0	0	0	0	0	0	**0**
Totals	**199**	**504**	**599**	**176**	**133**	**58**	**2**	**0**	**1671**

Table 45. Total percentage of *M. calvescens* plants per height class, All Treatment Years (1996-1999)

	Seedlings (<1 cm)	1-<10 (cm)	10 -<50 (cm)	50-<100 (cm)	100-200 (cm)	200-500 (cm)	5-10 (m)	>10 m	Totals
Station 1 (5.64 m radius)	6.40%	5.63%	10.71%	2.69%	3.77%	1.32%	0.12%	0.00%	30.64%
# Flwr/Frt Trees (St.1)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
5 m Band Between Stns	2.39%	15.68%	19.51%	6.76%	3.77%	1.92%	0.00%	0.00%	50.03%
# Flwr/Frt (Between Stns)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Station 2 (5.64 m radius)	3.11%	8.86%	5.63%	1.08%	0.42%	0.24%	0.00%	0.00%	19.33%
# Flwr/Frt Trees (St.2)	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%	0.00%
Totals	11.91%	30.16%	35.85%	10.53%	7.96%	3.47%	0.12%	0.00%	100.00%

Tables 46-48: Ground Surveillance

Table 46. Numbers of *M. calvescens* per height class, Transects 9-12.

	Transect 9	Transect 10	Transect 11	Transect 12	Totals
Length (meters)	1200	630	830	287	NA
Compass bearing	270	270	90	240	NA
Elevation (start)	1100	950	500	1100	NA
Elevation (end)	2000	1200	480	1160	NA
Seedlings (<1 cm)	518	0	0	0	**518**
1-<10 (cm)	682	13	3	0	**698**
10 -<50 (cm)	329	47	4	0	**380**
50-<100 (cm)	133	54	1	0	**188**
100-200 (cm)	79	36	1	0	**116**
200-500 (cm)	49	32	0	1	**82**
5-10 (m)	7	0	0	0	**7**
>10 m	0	0	0	0	**0**
Flw/Frt Trees	4	0	0	0	**4**
Totals	**1801**	**182**	**9**	**1**	**1993**

Table 47. Number of meters per transect (9-12) with *M. calvescens*.

Transect Number	Transect Length (m)	# of meters with *M. calvescens*	% of transect with *M. calvescens*	1st m mark with *M. calvescens*	last m mark with *M. calvescens*
9	1200	164	13.70%	3	1077
10	630	44	7.00%	41	576
11	830	10	1.20%	446	786
12	287	1	0.30%	37	37

Table 48. Data on twenty fruiting *M. calvescens* trees, April 2000, Hana, Maui.

	Location	Phenology	Height (m)	Basal Diam (cm)	Visible from air	Notes
1	Tr.9, 291 m mark, 1220 feet	Imm. Fruit	7.00	13.20	?	Possibly visible from air but overtopped by canopy of Spa cam, Ard ell, Met pol and Psi gua. Mostly imm frt but a few dark purple; girdled tree.
2	TR.9, 552 m mark, 1500 feet	Imm. Fruit	6.50	15.90	?	Near a light gap, but mixed in with canopy of Spa cam & Met pol; 100s of seedlings below & around tree.
3	TR.9, 552 m mark, 1500 feet	Imm. Fruit	5.00	16.10	?	Tree with split trunk; vertical fallen trunk with 4 upright trunks growing out of it; 100s of seedlings & saplings in light gap.
4	Tr.9, 1070 m mark, 1880 feet	Imm. Fruit	6.00	11.40	Yes	Fruiting tree on slope above core population with 10 seedlings (1-10 cm tall) & 1 sapling (1.5 m tall) nearby.
5	near start of Tr.9, roadside, 1100 feet	Imm. & Mat. Fruit	2.50	8.00	Yes	Small fruiting tree on side of westernmost spur road; 4 panicles on tree with 98% Imm. Frt. & 2% Mat Frt.
6	southeast of heli-pad, 820 feet	Imm. Fruit	6.00	8.80	?	Tree under canopy of African tulip (Spa cam) ; mid & understory full of Ard ell; canopy obscures *Miconia*, but does not provide dense shade.
7	Hana Ranch, 900 feet	Imm. Fruit	6.00	12.60	Yes	Under & among canopy of African tulip (Spa cam).
8	Hana Ranch, 900 feet	Imm. Fruit	6.00	8.00	Yes	Under & among canopy of African tulip (Spa cam).
9	Hana Ranch, 900 feet	Imm. Fruit	6.00	11.50	Yes	Under & among canopy of African tulip (Spa cam).
10	Hana Ranch, 900 feet	Imm. Fruit	5.00	8.20	Yes	Mixed in with canopy of *Ardisia elliptica.*
11	Hana Ranch, 900 feet	Imm. Fruit	6.00	8.00	Yes	Mixed in with canopy of *Ardisia elliptica.*
12	Hana Ranch, 900 feet	Imm. Fruit	5.00	6.70	Yes	Mixed with *Psidium guajava* canopy right on pasture edge.
13	Hana Ranch, 900 feet	Imm. Fruit	3.00	5.60	Yes	Two panicles on small, fruiting tree.
14	Hana Ranch, 900 feet	Imm. Fruit	4.00	8.00	Yes	Fallen tree with multiple trunks, near small stream.
15	Hana Ranch, 900 feet	Imm. Fruit	4.00	11.10	Yes	Tree with two trunks; only measured larger; Imm fruits are both pink & green.
16	Hana Ranch, 900 feet	Imm. Fruit	3.00	8.00	Yes	Tree on pasture edge; definitely visible from air.
17	Hana Ranch, 900 feet	Imm. Fruit	3.50	7.70	Yes	Tree on pasture edge; definitely visible from air.
18	Hana Ranch, 900 feet	Imm. Fruit	3.50	8.10	Yes	Tree on pasture edge; definitely visible from air.
19	Hana Ranch, 900 feet	Imm. Fruit	3.50	11.00	Yes	Tree on pasture edge; definitely visible from air.
20	Hana Ranch, 1000 feet	Imm. Fruit	4.50	10.20	Yes	Tree on ranch roadside; visible from air.

Table 49. Possible minimum and maximum age of reproductive *M. calvescens* trees, April 2000, Hana, Maui.

	Location	Phenology	Height (m)	Basal Diam (cm)	Possible Minimum Age (years)	Possible Maximum Age (years)
1	Tr.9, 291 m mark, 1220 feet	Imm. Fruit	7.00	13.20	4.67	8.24
2	TR.9, 552 m mark, 1500 feet	Imm. Fruit	6.50	15.90	4.33	7.65
3	TR.9, 552 m mark, 1500 feet	Imm. Fruit	5.00	16.10	3.33	5.88
4	Tr.9, 1070 m mark, 1880 feet	Imm. Fruit	6.00	11.40	4.00	7.06
5	near start of Tr.9, roadside, 1100 feet	Imm. & Mat. Fruit	2.50	8.00	1.67	2.94
6	southeast of heli-pad, 820 feet	Imm. Fruit	6.00	8.80	4.00	7.06
7	Hana Ranch, 900 feet	Imm. Fruit	6.00	12.60	4.00	7.06
8	Hana Ranch, 900 feet	Imm. Fruit	6.00	8.00	4.00	7.06
9	Hana Ranch, 900 feet	Imm. Fruit	6.00	11.50	4.00	7.06
10	Hana Ranch, 900 feet	Imm. Fruit	5.00	8.20	3.33	5.88
11	Hana Ranch, 900 feet	Imm. Fruit	6.00	8.00	4.00	7.06
12	Hana Ranch, 900 feet	Imm. Fruit	5.00	6.70	3.33	5.88
13	Hana Ranch, 900 feet	Imm. Fruit	3.00	5.60	2.00	3.53
14	Hana Ranch, 900 feet	Imm. Fruit	4.00	8.00	2.67	4.71
15	Hana Ranch, 900 feet	Imm. Fruit	4.00	11.10	2.67	4.71
16	Hana Ranch, 900 feet	Imm. Fruit	3.00	8.00	2.00	3.53
17	Hana Ranch, 900 feet	Imm. Fruit	3.50	7.70	2.33	4.12
18	Hana Ranch, 900 feet	Imm. Fruit	3.50	8.10	2.33	4.12
19	Hana Ranch, 900 feet	Imm. Fruit	3.50	11.00	2.33	4.12
20	Hana Ranch, 1000 feet	Imm. Fruit	4.50	10.20	3.00	5.29
				MEAN	**3.20**	**5.65**
				MIN	**1.67**	**2.94**
				MAX	**4.67**	**8.24**

APPENDIX I: Checklist of the native and non-native vascular plants in the area of the Hana, *Miconia calvescens* Population, Hana, East Maui

The following checklist is an incomplete record of the naturalized native and non-native vascular plants documented during field work in the various areas comprising the extents of the Hana *M. calvescens* population. The systematics and distributions for flowering plants, as well as the use of Hawaiian plant names, follows Wagner, Herbst and Sohmer (1990). The systematics and distributions for pteridophytes largely follows the Hawaiian pteridophyte work of the late Warren H. Wagner Jr. (University of Michigan) and Kenneth Wilson (California State University).

The following letters have been used to designate the range of the species.

A = NON-NATIVE: introduced either directly or indirectly as a consequence of human intervention.

I & E = NATIVE: naturally occurring in an area without human intervention. In the Hawaiian Islands, the term is generally used to describe species that are either endemic or indigenous.

E = ENDEMIC: native species naturally occurring only in a specific region or locality of the Hawaiian Islands.

I = INDIGNEOUS: growing and living naturally in a particular locality. In the Hawaiian Islands, the term is most often used to describe species which are native but not endemic. For instance, the *moa* or whisk fern (*Psilotum nudum*) is an indigenous species that occurs naturally in the Hawaiian Islands as well as the continental U.S., Asia, Africa and other Pacific Islands.

Families are listed alphabetically within the classes of pteridophytes, monocotyledons and dicotyledons.

PLANT TAXA	STATUS	FAMILY	HAWAIIAN OR COMMON NAME
PTERIDOPHYTES			
Asplenium contiguum	E	Aspleniaceae	NA
Asplenium lobulatum	I	Aspleniaceae	*PI`I-PI`I-LAU-MANAMANA, `ANALI`I*
Asplenium nidus	I	Aspleniaceae	*`EKAHA*, BIRD'S NEST FERN
Asplenium unilaterale	I	Aspleniaceae	*PAMOHO*
Pityrogramma calomelanos	A	Adiantaceae	SILVERFERN
Sadleria cyatheoides	E	Blechnaceae	*`AMA`U, `AMA`UMA`U*
Cibotium glaucum	E	Dicksoniaceae	*HAPU`U*
Cibotium menziesii	E	Dicksoniaceae	*HAPU`U `I`I*
Diplazium esculentum	A	Dryopteridaceae	*PACO*
Diplazium sandwichianum	E	Dryopteridaceae	*HO`I`O, POHOLE*
Dryopteris wallichiana	I	Dryopteridaceae	*LAU-KAHI*
Nephrolepis exaltata	E	Dryopteridaceae	*KUPUKUPU*
Nephrolepis multiflora	A	Dryopteridaceae	*`OKUPUKUPU*
Elaphoglossum crassifolium	E	Elaphoglossaceae	NA
Dicranopteris linearis	I	Gleicheniaceae	*ULUHE*
Adenophorus tamariscinus	E	Grammitidaceae	*WAHINE NOHO MAUNA*
Callistopteris baueriana	I	Hymenophyllaceae	NA
Gonocormus saxifragoides	I	Hymenophyllaceae	NA
Mecodium recurvum	E	Hymenophyllaceae	*`OHI`A-KU*
Vandenboschia cyrtotheca	E	Hymenophyllaceae	*PALAI-HIHI*
Vandenboschia davallioides	E	Hymenophyllaceae	*PALAI-HIHI, KILAU*

Sphenomeris chinensis	I	Lindsaeceae	*PALA`A, PALAPALA`A, PA`U-O-PALA`E*
Phlegmariurus phyllanthus	I	Lycopodiaceae	*WAWAEIOLE*
Angiopteris evecta	A	Marattiaceae	MULE'S FOOT FERN
Ophioglossum pendulum	I	Ophioglossaceae	*POLOLEI,. LAUKAHI, PUAPUA-MOA*
Microsorum spectrum	E	Polypodiaceae	*PE`AHI*
Phymatosorus scolopendria	A	Polypodiaceae	*LAUA`E, LAUWA`E*
Polypodium pellucidum	E	Polypodiaceae	*`A`E, `A`AE, AE-LAU-NUI*
Psilotum nudum	I	Psilotaceae	*MOA*
Amauropelta globulifera	E	Thelypteridaceae	*PALAPALAI-A-KAMA-PUA`A*
Thelypteris cyatheoides	E	Thelypteridaceae	*KIKAWAIO, KUPUKUPU-MAKALI`I*
Thelypteris dentata	A	Thelypteridaceae	*OAK FERN, PAI`I`IHA*
Thelypteris. parasitica	A	Thelypteridaceae	DOWNY WOOD FERN
Thelypteris hudsoniana	E	Thelypteridaceae	NA

MONOCOTYLEDONS

Cordyline fruticosa	A	Agavaceae	*KI, TI*
Epipremnum pinnatum	A	Araceae	TARO VINE, POTHOS
Cyperus gracilis	A	Cyperaceae	MC COY GRASS
Fimbrystylis dichotoma	I	Cyperaceae	NA
Kyllinga brevifolia	A	Cyperaceae	*KILI`O`OPU*
Machaerina mariscoides	I	Cyperaceae	*`AHANIU, `UKI*
Mariscus sp.	?	Cyperaceae	?
Pycreus polystachyos	I	Cyperaceae	NA
Dioscorea alata	A	Dioscoraceae	*UHI*
Dioscorea pentaphylla	A	Dioscoraceae	*PI`A*
Arundina graminifolia	A	Orchidaceae	BAMBOO ORCHID
Phaius tankarvilleae	A	Orchidaceae	CHINESE GROUND ORCHID
Spathoglottis plicata	A	Orchidaceae	PHILIPPINE GROUND ORCHID
Freycinetia arborea	I	Pandanaceae	*`IE`IE*
Pandanus tectorius	I?	Pandanaceae	*HALA, PU HALA*
Andropogon virginicus	A	Poaceae	BROOMSEDGE, YELLOW BLUESTEM
Isachne distichophylla	E	Poaceae	*`OHE*
Melinis minutiflora	A	Poaceae	MOLASSES GRASS
Oplismenus hirtellus	A	Poaceae	BASKETGRASS, *HONOHONO*
Panicum maximum	A	Poaceae	GUINEA GRASS
Paspalum conjugatum	A	Poaceae	HILO GRASS
Paspalum urvillei	A	Poaceae	VASEY GRASS
Phyllostachys nigra	A	Poaceae	BLACK BAMBOO
Sacciolepis indica	A	Poaceae	GLENWOOD GRASS
Schizostachyum glaucifolium	A?	Poaceae	*`OHE*
Setaria gracilis	A	Poaceae	YELLOW FOXTAIL
Sporobolus indicus	A	Poaceae	SMUTGRASS
Hedychium coronarium	A	Zingiberaceae	WHITE GINGER
Hedychium gardnerianum	A	Zingiberaceae	*KAHILI* GINGER

DICOTYLEDONS

Mangifera indica	A	Anacardiaceae	MANGO
Ilex anomala	I	Aquifoliaceae	*KAWA`U*
Tetraplasandra hawaiensis	E	Araliaceae	*`OHE*
Hoya bicarinata	A	Asclepiadaceae	WAX PLANT

Ageratina adenophora	A	Asteraceae	*PAMAKANI HAOLE*
Ageratina riparia	A	Asteraceae	HAMAKUA PAMAKANI
Ageratum conyzoides	A	Asteraceae	*MAILE HOHONO*
Crassocephalum crepidioides	A	Asteraceae	NA
Erechtites valerianifolia	A	Asteraceae	FIREWEED
Pluchea symphytifolia	A	Asteraceae	SOURBUSH
Spathodea campanulata	A	Bignoniaceae	AFRICAN TULIP TREE
Clermontia kakeana	E	Campanulaceae	*`OHA WAI*
Perrottetia sandwicensis	E	Celastraceae	*OLOMEA, WAIMEA*
Ipomoea indica	I	Convolvulaceae	*KOALI-AWAHIA*
Merremia aegyptia	A?	Convolvulaceae	HAIRY MERREMIA
Aleurites moluccana	A	Euphorbiaceae	*KUKUI*
Antidesma platyphyllum	E	Euphorbiaceae	*HAME, HA`A, MEHAME*
Caesalpinia bonduc	I	Fabaceae	*KAKALAIOA*
Chamaecrista nictitans	A	Fabaceae	PARTRIDGE PEA
Crotolaria pallida	A	Fabaceae	SMOOTH RATTLEPOD
Desmodium incanum	A	Fabaceae	SPANISH CLOVER
Desmodium intortum	A	Fabaceae	NA
Indigofera suffruticosa	A	Fabaceae	*`INIKO, INIKOA, KOLU*
Mucuna gigantea	I	Fabaceae	*SEA BEAN, KA`E`E*
Mucuna sloanei var. persericea	I	Fabaceae	COW-ITCH PLANT, SEA BEAN
Cyrtandra hawaiensis	E	Gesneriaceae	*HA`IWALE, KANAWAO KE`OKE`O*
Cyrtandra spathulata	E	Gesneriaceae	*HA`IWALE, KANAWAO KE`OKE`O*
Broussaisia arguta	E	Hydrangeaceae	*`KANAWAO*
Plactranthus scutellarioides	I	Lamiaceae	*COLEUS, WELEWEKA*
Cuphea carthagenensis	A	Lythraceae	TARWEED, COLOMBIAN CUPHEA
Hibiscus furcellatus	I	Malvaceae	*`AKIOHALA, HAU HELE*
Hibiscus tiliaceus	I?	Malvaceae	*HAU*
Michelia champaca	A	Magnoliaceae	ORANGE (FRAGRANT) CHAMPAK,
Clidemia hirta	A	Melastomataceae	KOSTER'S CURSE
Medinilla magnifica	A	Melastomataceae	MEDINILLA
Miconia calvescens	A	Melastomataceae	MICONIA
Tibouchina herbacea	A	Melastomataceae	GLORYBUSH
Cocculus trilobus	I	Menispermaceae	*HUEHUE*
Ardisia elliptica	A	Myrsinaceae	SHOEBUTTON ARDISIA
Eucalyptus robusta	A	Myrtaceae	SWAMP MAHOGANY
Metrosideros polymorpha	E	Myrtaceae	*`OHI`A LEHUA*
~~*Psidium cattleianum*~~	~~A~~	~~Myrtaceae~~	~~STRAWBERRY GUAVA~~
Psidium guajava	A	Myrtaceae	GUAVA
Syzygium cumini	A	Myrtaceae	JAVA OR JAMBOLAN PLUM
Syzygium jambos	A	Myrtaceae	ROSE APPLE
Pisonia umbellifera	I	Nyctaginaceae	*PAPALA KEPAU*
Ludwigia octovalis	A?	Onagraceae	*KAMOLE, ALOHALUA*
Passiflora edulis	A	Passifloraceae	PASSION FRUIT
Passiflora subpeltata	A	Passifloraceae	WHITE PASSION FLOWER
Peperomia sp.	E	Piperaceae	*`ALA`ALA WAI NUI*
Piper methysticum	A	Piperaceae	*`AWA, PU`AWA, KAVA*
Polygala paniculata	A	Polygalaceae	MILKWORT
Rubus rosifolius	A	Rosaceae	THIMBLEBERRY
Bobea elatior	E	Rubiaceae	*`AHAKEA LAU NUI*
Hedyotis terminalis	E	Rubiaceae	*MANONO*
Psychotria hawaiiensis	E	Rubiaceae	*KOPIKO `ULA*

Psychotria mariniana	E	Rubiaceae	*KOPIKO*
Castilleja arvensis	A	Scrophulariaceae	INDIAN PAINTBRUSH, PAINTED-CUP
Triumfetta semitriloba	A	Tiliaceae	SACRAMENTO BUR
Trema orientalis	A	Ulmaceae	GUNPOWDER OR CHARCOAL TREE
Pipturus albidus	E	Urticaceae	*MAMAKI*
Touchardia latifolia	E	Urticaceae	*OLONA*
Clerodendrum philippinum	A	Verbenaceae	*PIKAKE HOHONO*
Lantana camara	A	Verbenaceae	LANTANA
Stachytarpheta urticifolia	A	Verbenaceae	OI