

# CONTROL OF INFESTATIONS ORIGINATING FROM SINGLE *MICONIA CALVESCENS* PLANTS ON O'AHU AND KAUA'I, HAWAII LE CONTROLE DE ZONES INFESTÉES PROVENANT DE PLANTS ISOLÉS DE *MICONIA CALVESCENS* À O'AHU ET KAUA'I, HAWAII

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*Miconia calvenscens* has only recently been documented as an extremely invasive and ecologically disruptive introduced plant in Australia, Hawaii, French Polynesia, and a few other oceanic islands. In Hawaii, chemical/mechanical control methods are now being applied to eradicate it locally or contain it where infestations are large. The Hawaii Chapter of the Sierra Club has been instrumental in organizing volunteers to successfully contain the weed at infestation sites on O'ahu. During control actions by volunteers, measurements were made of total number, height, diameter at breast height and reproductive status of all plants too large to hand pull. There are six known infestations of *M.c.* on O'ahu and one on Kaua'i. There were apparently seven known original plantings of the tree on O'ahu and three on Kaua'i. The trees at Tantalus, Waimea and Wahiawa botanical gardens are not known to have produced progeny that reached reproductive size. Two trees on Kaua'i planted remotely from the main infestation were not known to have produced any progeny. All other planted trees on O'ahu (Kalihi, Nuuanu and Manoa) and Wailua on Kaua'i did produce progeny that reached reproductive age. No reproductive-size trees are now known to exist on either island as of August 1997. However, continuing follow up ground and aerial surveys of all infestations over the next decade will be critical to containment of *M.c.*. This containment demonstrates that even in the absence of adequate government financial support, if infestations are detected early, volunteers can get the job done. All known infestations on Kaua'i and O'ahu were started from single reproductive plants. Unfortunately, precise planting dates of the original plants from which infestations originated have been difficult to obtain. Nonetheless, the measurements may be useful in predicting some aspects of population growth of this weed.

*Miconia calvenscens* n'a été que seulement et récemment décrit comme une plante introduite extrêmement envahissante et écologiquement perturbatrice en Australie, à Hawaï, en Polynésie française et dans quelques autres îles océaniques. À Hawaï, les méthodes de lutte chimiques/mécaniques sont maintenant appliquées pour l'éradiquer localement ou le contenir dans les zones fortement infestées. L'action de la section hawaïenne du Sierra Club a été décisive en encadrant des volontaires pour contenir avec succès *M.c.* dans les sites infestés de O'ahu. Durant les efforts de lutte menés par les volontaires, les mesures de quelques paramètres ont été effectuées (nombre, hauteur, dbh, statut reproductif) sur toutes les plantes trop grandes pour être arrachés à la main. Il y a six zones infestées par *M.c.* connues à O'ahu et une à Kaua'i. Sept arbres ont été apparemment plantés à l'origine à O'ahu et trois à Kaua'i. Les arbres plantés de Tantalus, des jardins botaniques de Waimea et de Wahiawa ne sont pas connus pour avoir donné une descendance ayant atteint la taille reproductrice. Deux arbres plantés à Kaua'i loin de la principale zone infestée ne sont pas connus pour avoir donné de descendance. Tous les autres arbres plantés à O'ahu (Kalihi, Nuuanu et Manoa) et Wailua à Kaua'i n'ont pas donné de descendance ayant atteint l'âge reproducteur. On ne connaît aucun arbre à taille reproductrice dans ces deux îles jusqu'en août 1997. Cependant, un suivi continu sur le terrain et une surveillance aérienne de toutes les zones infestées pendant la prochaine décennie sera nécessaire pour contenir l'extension de *M.c.*. Ce contrôle montre que même sans un soutien financier gouvernemental adéquat, et si les zones infestées sont détectées de façon précoce, les volontaires peuvent faire le travail. Toutes les zones connues à O'ahu et Kaua'i ont démarré par un seul pied reproducteur. Malheureusement, les dates précises d'introduction des plantes originelles ont été difficiles à obtenir. Néanmoins, les paramètres mesurés peuvent être utiles pour la prédiction de certains aspects de la croissance des populations de *M.c.*

*Miconia calvenscens* is a small, early successional tree native to the Neotropics and adapted to colonizing light gaps in wet thickets and dense mixed forest (R. Burkhart, pers. comm.). Its adaptations to its habitat have apparently made it a very successful invader in semi-tropical and tropical oceanic islands. The history and spread of this weed in Hawai'i and French Polynesia have been documented (Medeiros *et al.*, 1997; Meyer, 1996), but little is known of its invasiveness in Sri Lanka, Australia, New Caledonia and Grenada (Meyer, this volume). On the island of Tahiti in French Polynesia, it is now known to dominate approximately 65% of the forested area of the island (Meyer 1996). Three other islands there are infested to a lesser degree. In decreasing severity of infestation, they are Moorea, Raiatea and Tahaa (Meyer, this volume). In Hawai'i, four islands are infested and in decreasing order of severity they are: Hawai'i, Maui, O'ahu and Kaua'i (Medeiros *et al.*, 1997). Hawai'i and Maui islands now have small, full-time, paid crews to search for and control infestations (Tavares, this volume; Medeiros, Loope and Hobdy, this volume). On O'ahu and Kaua'i, however, containment has been achieved mostly by volunteers and the part-time effort of state government employees. All of the infestations on these two islands started from intentionally planted single trees. This paper documents the containment of *M.c.* on the islands of Kaua'i and O'ahu and summarizes the parameters measured for each population.

## HISTORY OF *MICONIA CALVESCENS* INFESTATIONS ON O'AHU AND KAUA'I

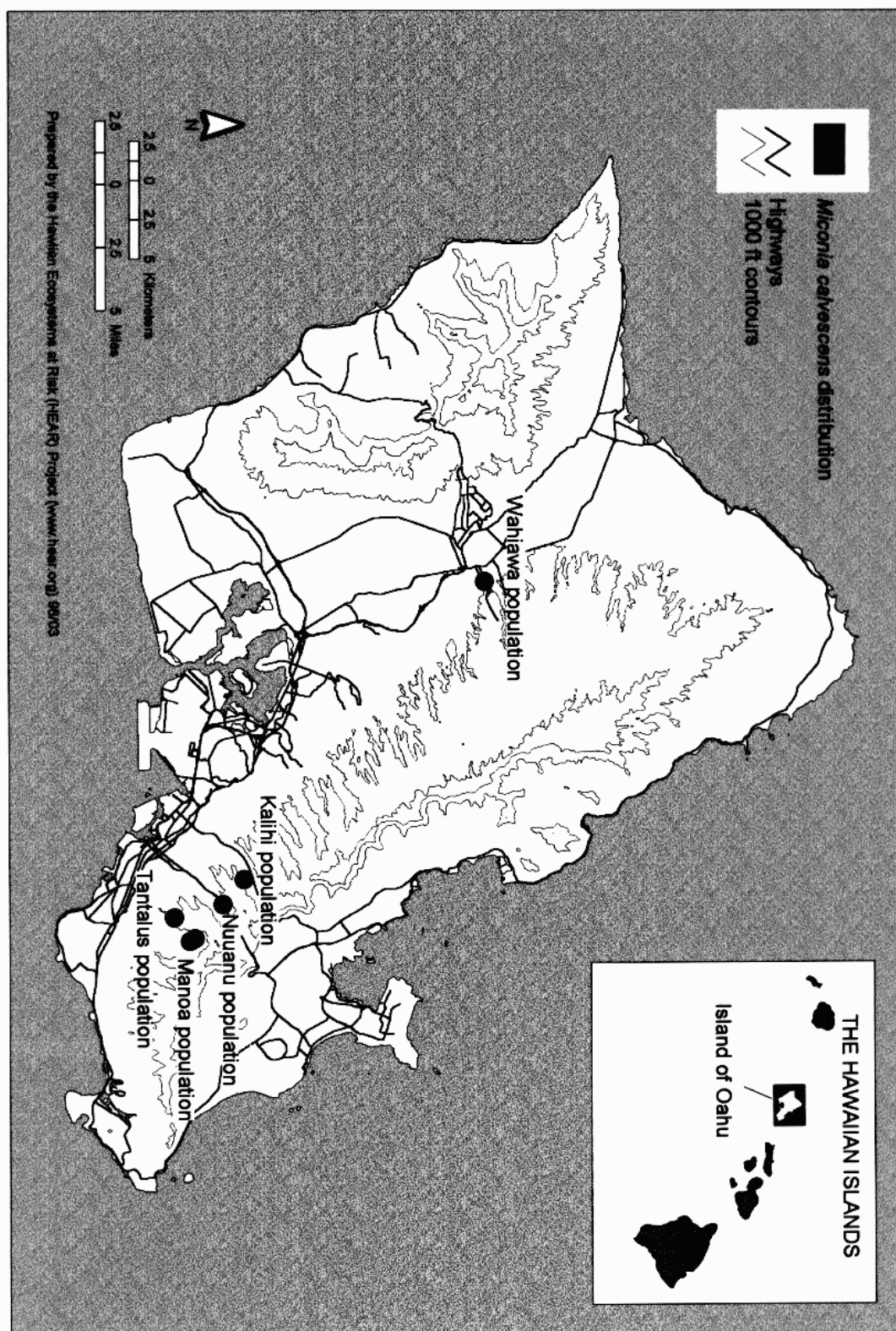
Medeiros *et al.* (1997) reviewed the history and status of *M.c.* in Hawai'i by island. We will update that information here, and add detail to the historical record. The information in Medeiros *et al.* (1997) for the infestation sites on the island of Kaua'i is still current. The planting date of the original tree remains unknown. The description presented in Medeiros *et al.* (1997) of the O'ahu infestations lacks some details, which should be documented to understand the spread of the weed on that island. There are presently six known original plantings of individual *M. calvenscens* plants on O'ahu (Fig. 1). Medeiros *et al.* (1997) described five of these sites, some in greater detail than others. Some additional information will be presented here, by site, and the sixth site is discussed.

### O'AHU

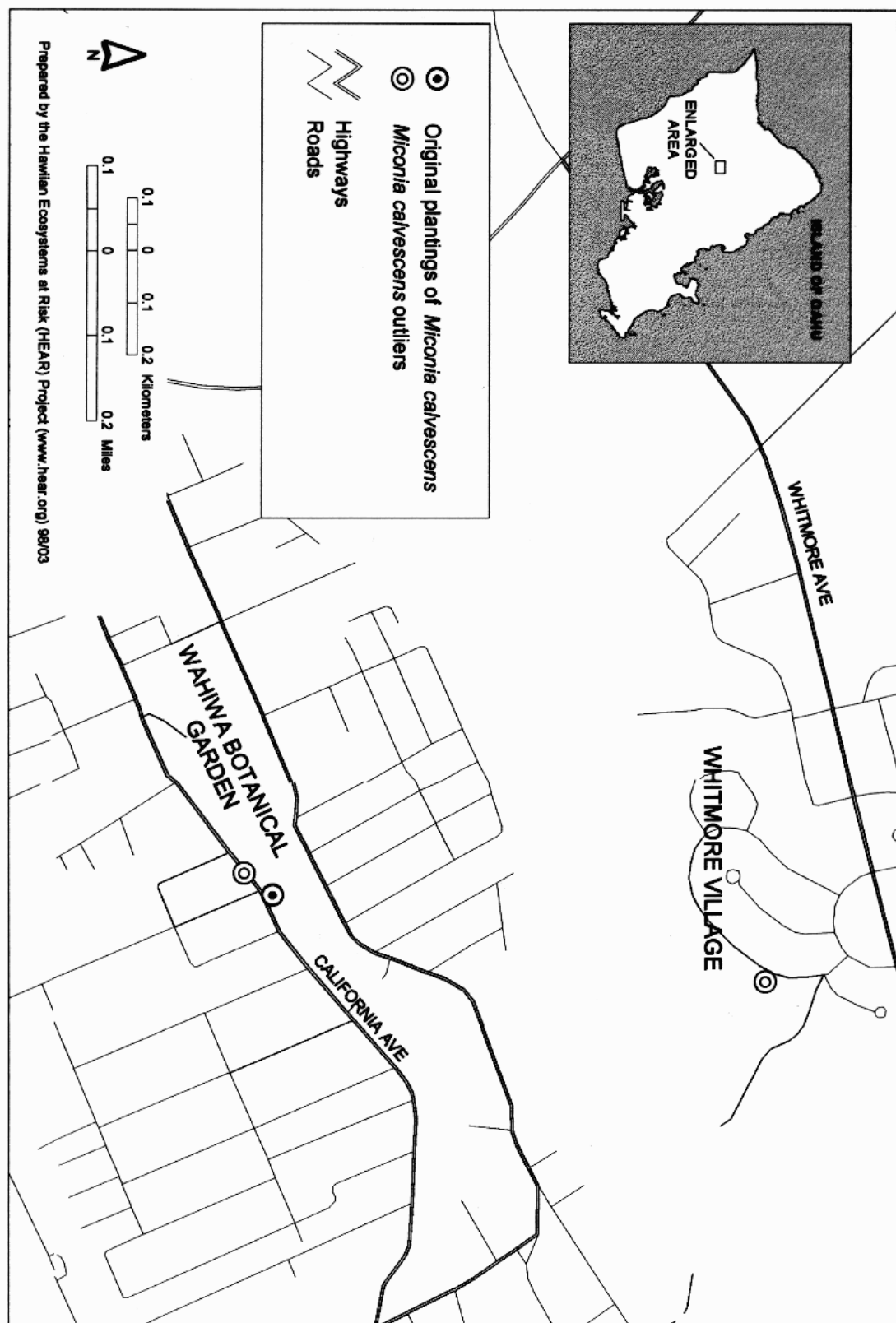
**Waimea Valley and Wahiawa**--No new finds of *M.c.* have been made in these areas. The original specimen planted in 1976 at Waimea Botanical Garden was removed when it was only about 1m tall according to K. Wooliams (pers. comm.) so it never flowered. The original Wahiawa Botanical Garden specimen, planted in 1961, was donated by the famous naturalist Joseph Rock. Only two progeny are known to have escaped the grounds of the garden. Of the two saplings pulled up in 1995 and 1996, one was across the street from the arboretum, and the other was in Helemano housing area and was apparently large enough to have fruited (Fig. 2). The property owner did report pulling up seedlings near this 7.6 cm dbh tree. It is important to note that the original Wahiawa Botanical Garden specimen was reported to be kept pruned over its lifetime (J. Sands, pers. comm.), which may have reduced fruiting.

**Lyon Arboretum (upper Manoa Valley)**--Since the original specimen planted in 1964 began to fruit, *M.c.* seedlings continue to be found by arboretum staff, primarily in the northwest sections of the maintained grounds. The most recent find of a fruiting tree was in January 1997 on the forested unmaintained montane lands. Surveys of Lyon Arboretum upper elevation lands have been temporarily suspended to allow seedlings to grow taller and become more visible. The arboretum staff has cut trails into the most infested gully to search for and remove seedlings.

**Fig. 1.** *M.c.* distribution on O'ahu (March 1998). Points shown reflect locations from hand-sketched maps and Global Positioning System coordinates.



**Fig. 2.** *M.c.* locations in Wahiawa (March 1998). Original Wahiawa Botanical Garden plant shown with its two known progeny. Points shown reflect locations from hand-sketches maps and Global Positioning System coordinates.



**Paradise Park property (upper Manoa Valley)**--W. Wong (pers. comm.) of Paradise Park Community Foundation believes the original specimen was planted on the premises of that institution next to the main building was in 1978. Saplings too large to pull up (TLPU) continue to be found by the Hawaii Department of Agriculture (HDOA) and the Department of Land and Natural Resources, Division of Forestry and Wildlife, Natural Area Reserve System (DOFAW-NARS) staff on the western slope of the Paradise Park property (**Fig. 3**). However, no reproductive plants have been found since May of 1996.

**Nuuanu Valley**--The planting date of the original tree at the Marks Estate on Old Pali Road is uncertain (Conant, 1996), but according to E. Marks Stack (pers. comm.), it was probably planted about 1961. The large size (17 cm diameter at breast height or dbh) that the tree attained supports this estimated date. Periodic roguing sweeps of the neighborhood by HDOA staff remove a few seedlings each time, and numbers are steadily decreasing (**Fig. 3**).

**Kalihi Uka, Kalihi Valley**--The original tree in Kalihi was planted on government land leased to a private plant nursery. The year is unknown but according to the son of the now deceased owner, it was most likely before 1970, when the owner of the nursery died (C. Choi, pers. comm.). The nursery was eventually abandoned and the tree was left to grow in an adjacent gully. It was rediscovered by a Sierra Club member in December of 1994 who had previously worked at the nursery (C. Yamane, pers. comm.). By that time, it had attained a dbh of 12cm and was producing fruit. The Hawaii Chapter of the Sierra Club service trips to contain *M.c.* at that site have continued since April of 1995. Since the publication of Medeiros *et al.* (1997), the perimeter of the infestation has been expanded slightly by the discovery of a few plants two gullies to the southwest of the original plant (**Fig. 3**).

**Puu Kakea, Tantalus**--A single *M.c.* was reported on April 24, 1997 by a property owner at Puu Kakea, near Mt. Tantalus. The identification of a 0.5m tall seedling was confirmed by N. Matayoshi of HDOA (pers. comm.). A subsequent visit to the site revealed a large mature tree that had recently fruited and on which bare panicles were still visible. A plastic pot remnant still partially surrounded the base of the tree, indicating it was a planted specimen. Two saplings (about 1.5 and 3m tall) were also removed nearby. A total of nine seedlings, all less than 0.5m tall have since been removed in a small area about 100m from the planted tree (**Fig. 3**).

## KAUA'I

**Wailua and Kapaa Homesteads**--No new reports of any *M.c.* have been made anywhere on Kaua'i since the publication of Medeiros *et al.* (1997) (**Fig. 4**). The original tree was planted in a commercial nursery. Birds apparently moved seed off the property into the surrounding rural area and the drainage of Wailua River. Using GPS coordinates of the outlier plants of the infestation, The Hawai'i Ecosystems at Risk Project has estimated the area of this infestation to be 220 hectares, excluding two known planted specimens north of the infestation. The original tree produced at least four progeny that reached reproductive age and a few others of similar size. The outlier planted trees are both within a four km. distance of the core infestation. Neither of those are known to have produced progeny, although one had panicles when it was found (**Fig. 5**).

**Fig. 3.** *M.c.* locations infestation extents in South O'ahu (March 1998). Points shown reflect locations from hand-sketched maps and Global Positioning System coordinates.

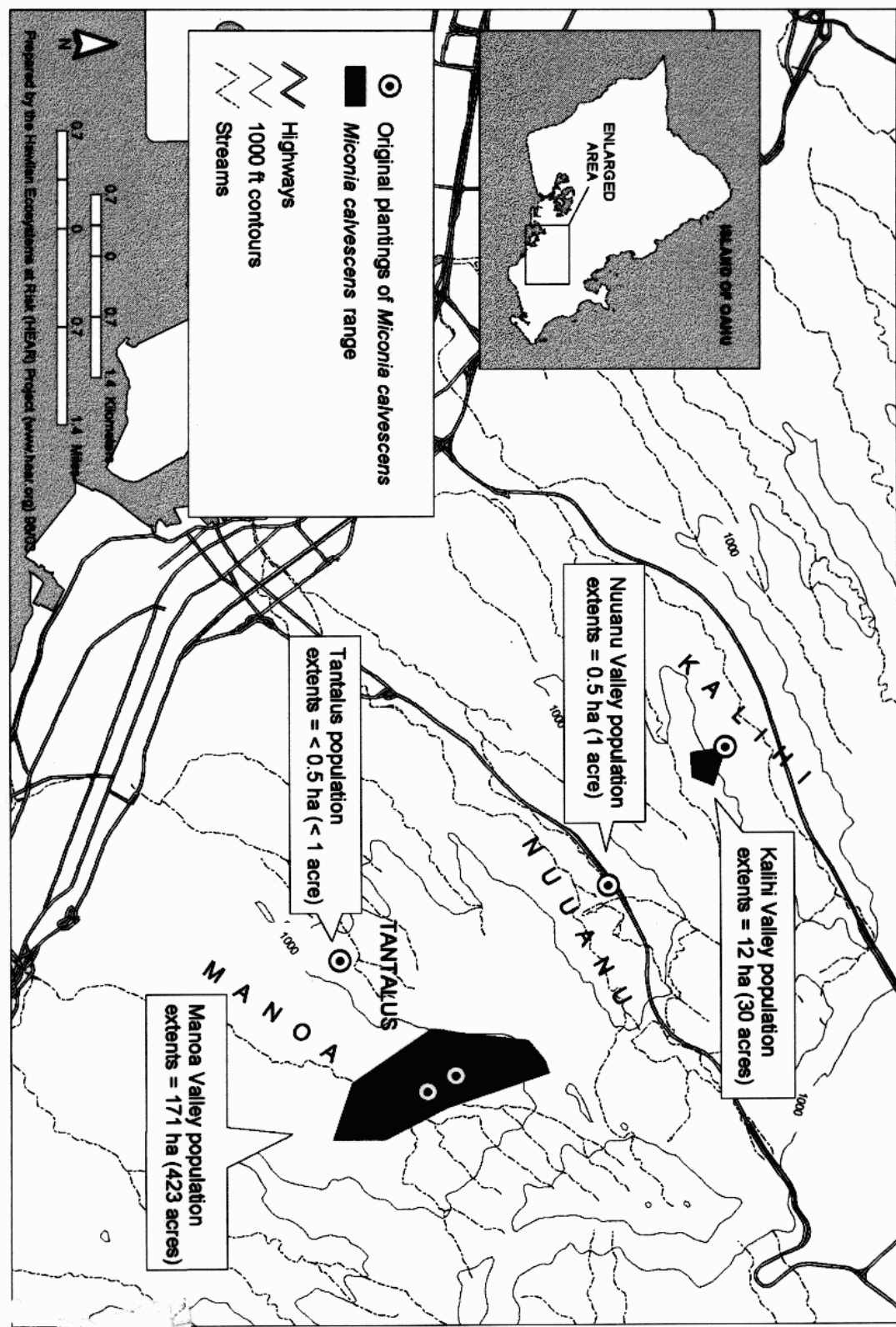
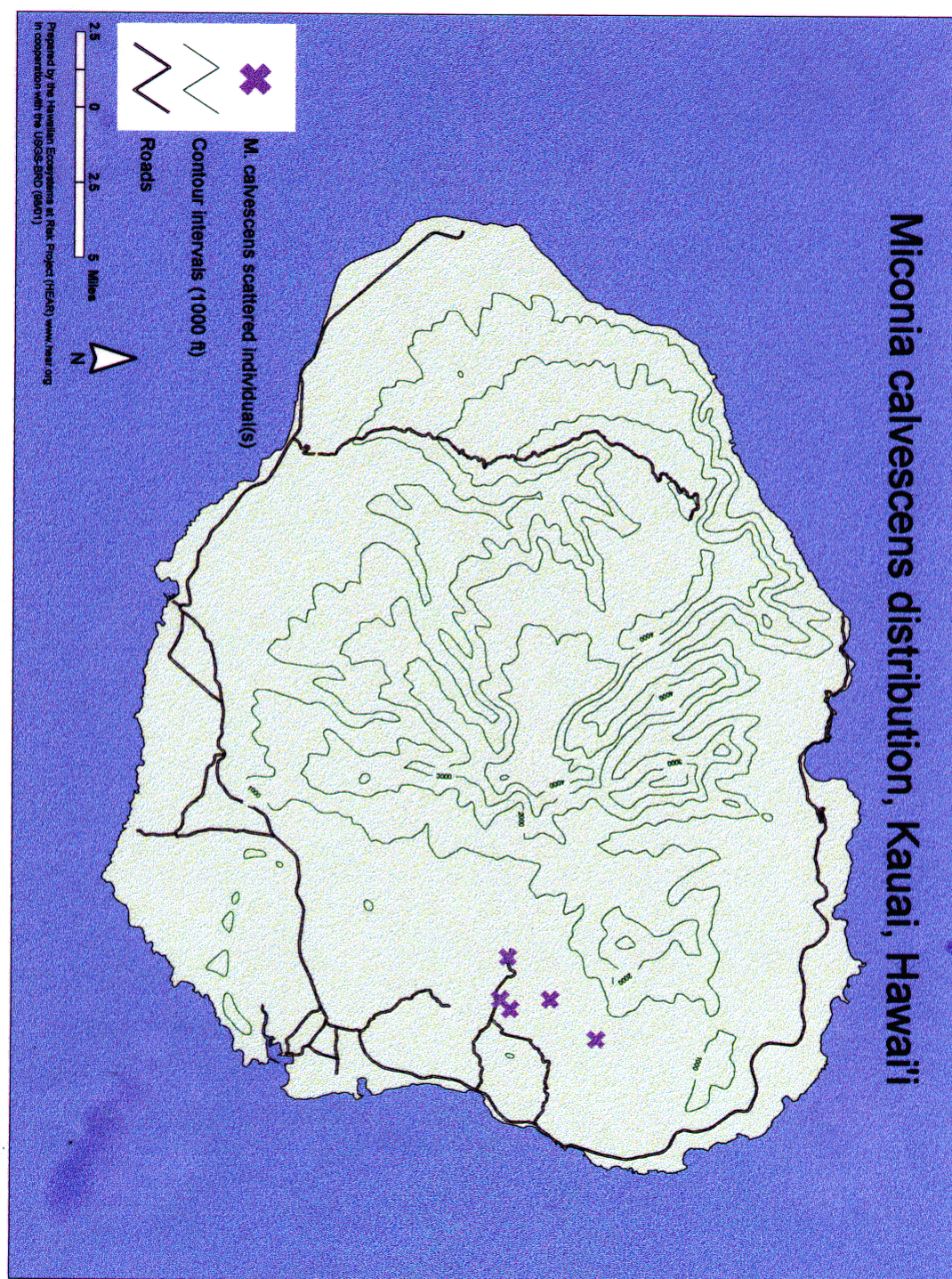


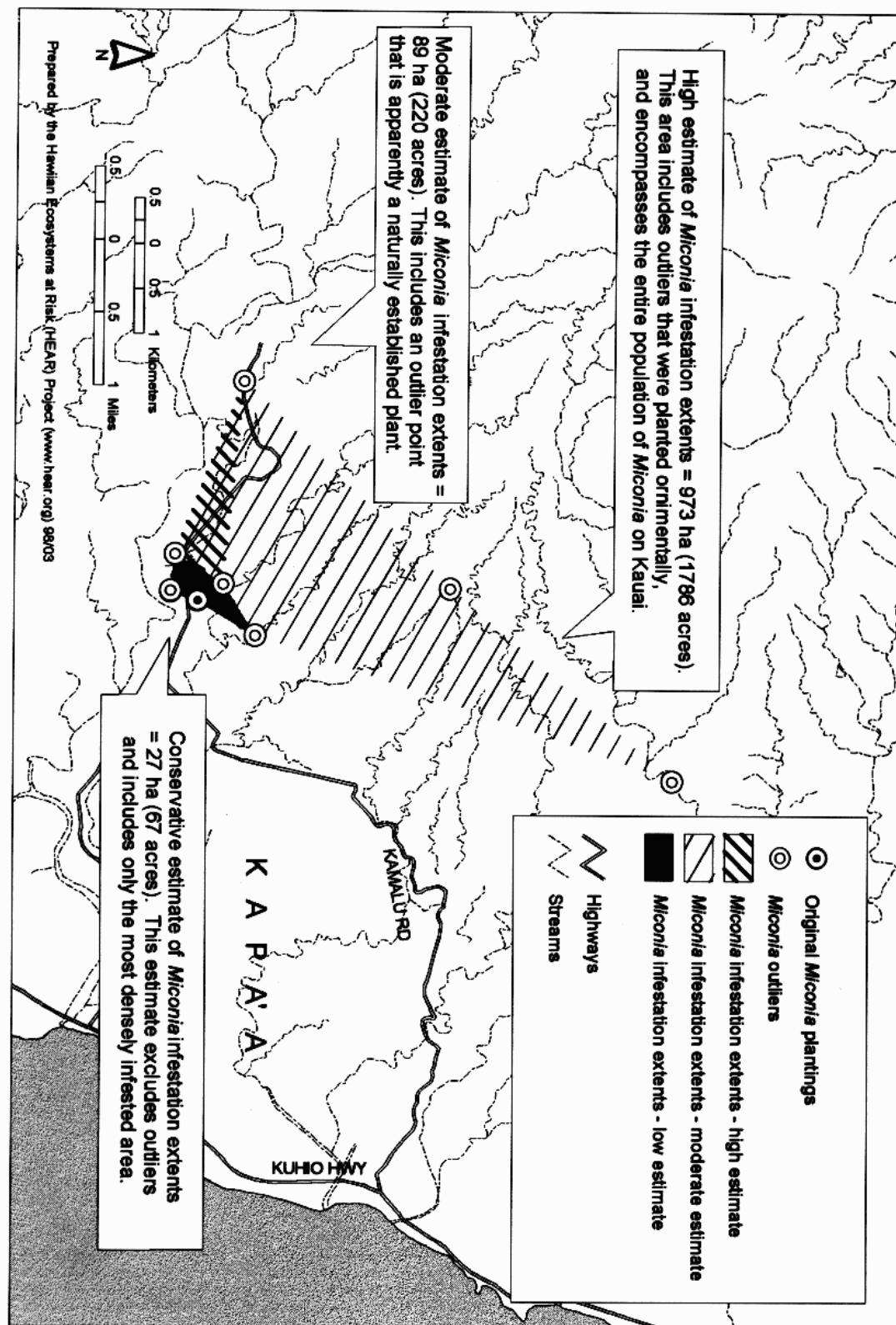


Fig. 4. *M.c.* distribution on Kaua'i (January 1998).





**Fig. 5.** *M.c.* locations infestation extents on Kaua'i (March 1998). Points shown reflect locations from hand-sketched maps and Global Positioning System coordinates.





## MATERIALS AND METHODS

The containment of *M.c.* on O'ahu and Kaua'i has been accomplished by the efforts of volunteers and the staff of the Department of Agriculture, Plant Pest Control Branch (HDOA-PPC), Department of Land and Natural Resources, Division of Forestry and Wildlife, Natural Area Reserve System (DOFAW-NARS), and the Lyon Arboretum, University of Hawai'i. In the early stage of the containment operations on both islands, little data was collected on the characteristics of the infestations. As the peak of seedling removal was passed, efforts to measure a few parameters of the plants were begun. However, on the island of Kaua'i, most of the plants were destroyed before many measurements were taken. On O'ahu, since April of 1993, all *M.c.* plants too large to pull up (TLPU; greater than about ca. 2-3m tall) had measurements of dbh, estimated height, presence of flowers or fruit, number of panicles and presence of seedlings below the trees. Counts of smaller plants were initially deemed too unreliable due to their large numbers and the potential error in reporting.

All TLPU plants were treated with full strength Garlon 3A by notching the trunk. If fruit was present, the tree was cut down and the stump was treated with the same herbicide concentrate. Fruit was bagged and carried out for disposal. Mapping of the extent of each infestation has been done using county tax maps, topographical maps, and both hand-held and helicopter-mounted Global Positioning System (GPS) units. The Geographic Information System of the Hawai'i Ecosystems at Risk Project database has stored the GPS coordinates that outline the outliers of the Manoa and Kalihi infestations and also the Kaua'i infestation. The other infestations on O'ahu are much smaller and are recorded on paper maps kept in HDOA files.

## RESULTS AND DISCUSSION

The infestations of *M.c.* on O'ahu and Kaua'i are unusual in that the exact location of all the original plantings of the weed are apparently known. In all cases, only a single specimen was planted, which then would have had to self-pollinate to start an infestation. Germination of seeds of *M.c.* is known to be up to 90% under optimal laboratory conditions (Meyer, 1994). Mature reproductive age trees on O'ahu have typically had very low numbers of seedlings under them. There are several possible explanations for this: soil conditions are not conducive to germination; birds or rodents are efficiently carrying seeds far off-site; a single reproductive plant does not by itself create a large seed bank in the first 15-20 years of growth; or, the low light levels on the forest floor inhibit germination. Lloyd Loope (pers. comm.) believes the most plausible explanation is that this is a result of low light conditions on the forest floor in the typically dense canopy alien forest that *M.c.* occupies in Hawai'i. This is supported by observations on Maui where defoliation of the canopy by aerial herbicide spraying did produce copious germination of seeds on the ground (L. Loope, pers. comm.).

Figures 6 through 9 show the size classes of progeny of TLPU saplings of the original planted trees at the larger O'ahu infestation sites. Note that very few progeny of original plants had approached reproductive size (approximately 4cm dbh; J.-Y. Meyer, pers comm), in Nuuanu or Kalihi (Fig. 6 and Fig. 7). Figures 8 and 9, however, show that several saplings greater than 4cm dbh were removed in the contiguous Paradise Park and Lyon Arboretum infestations in Manoa. It should be noted that both the original Nuuanu and Wahiawa trees were apparently kept somewhat pruned, which may have reduced fruit set and numbers of progeny (Fig. 8 and Fig. 9). Relatively few progeny of original trees were found with flowers or fruit. In both Kalihi and Nuuanu, only one progeny plant had fruit or flowers. Paradise Park Property had two such plants while Lyon Arboretum had five. However, it is unclear whether these counts may be only a reflection of the seasonal phenology of the plant (plants were not in reproduction at the time they were found) or, may indicate many plants were too young to begin reproduction.

Fig. 6. Dbh classes of TLPU saplings at Nuuanu.

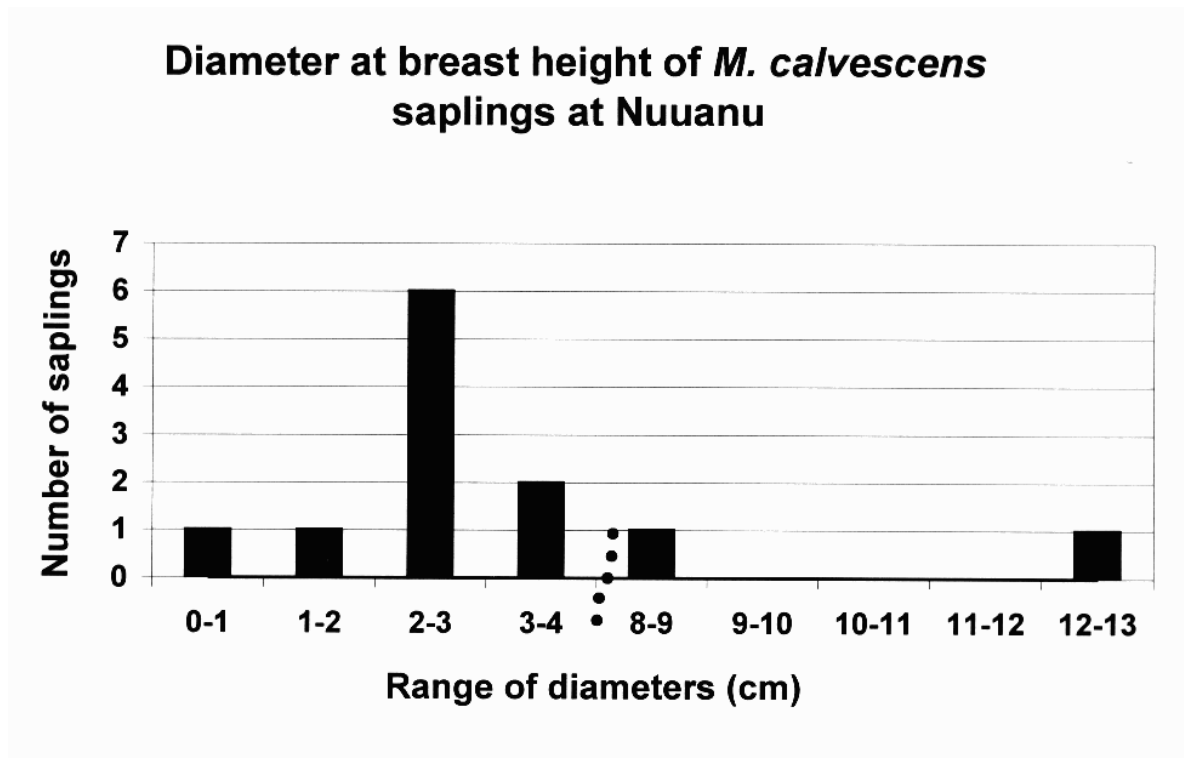
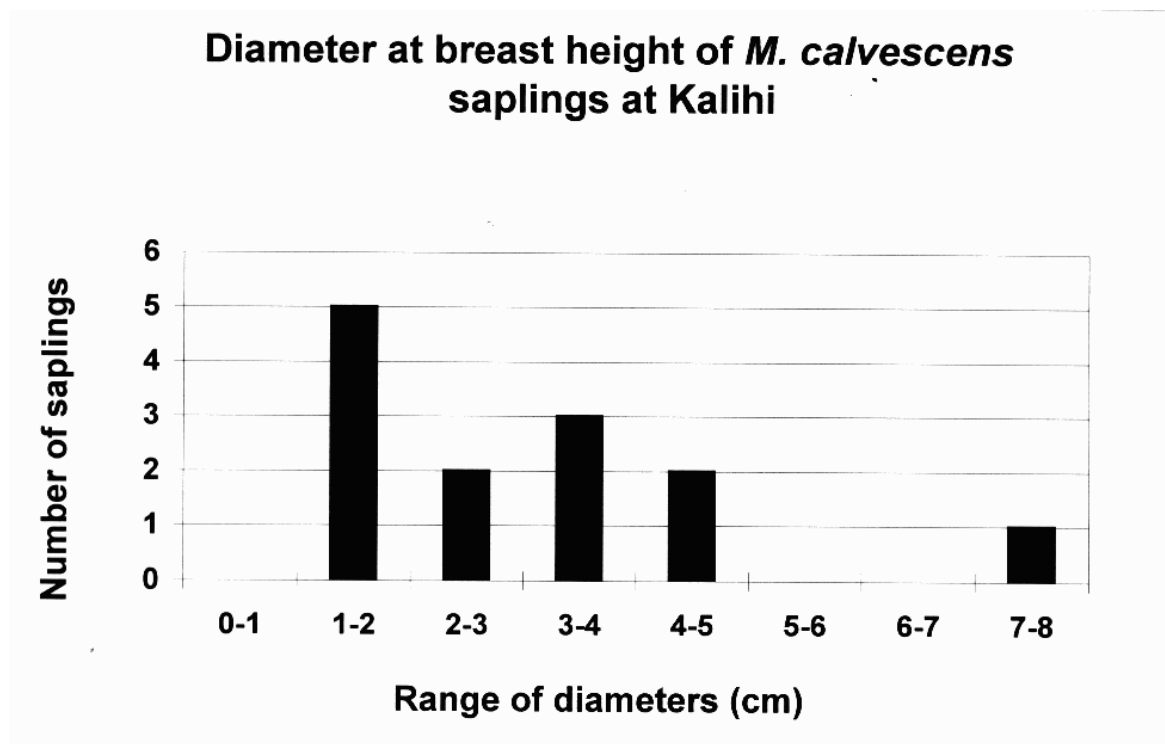
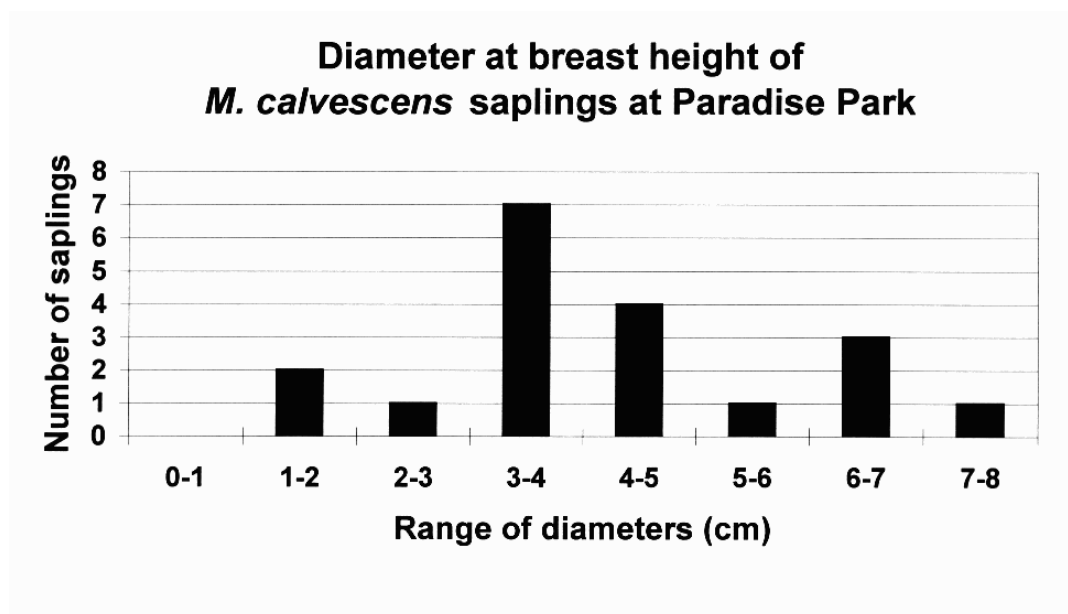
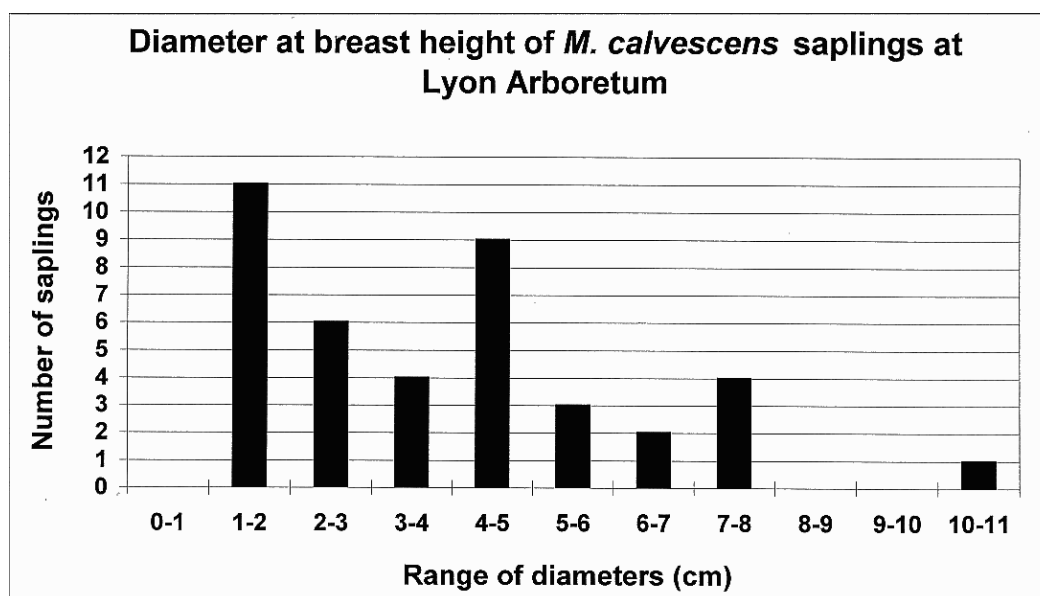


Fig. 7. Dbh classes of TLPU saplings at Kalihi.



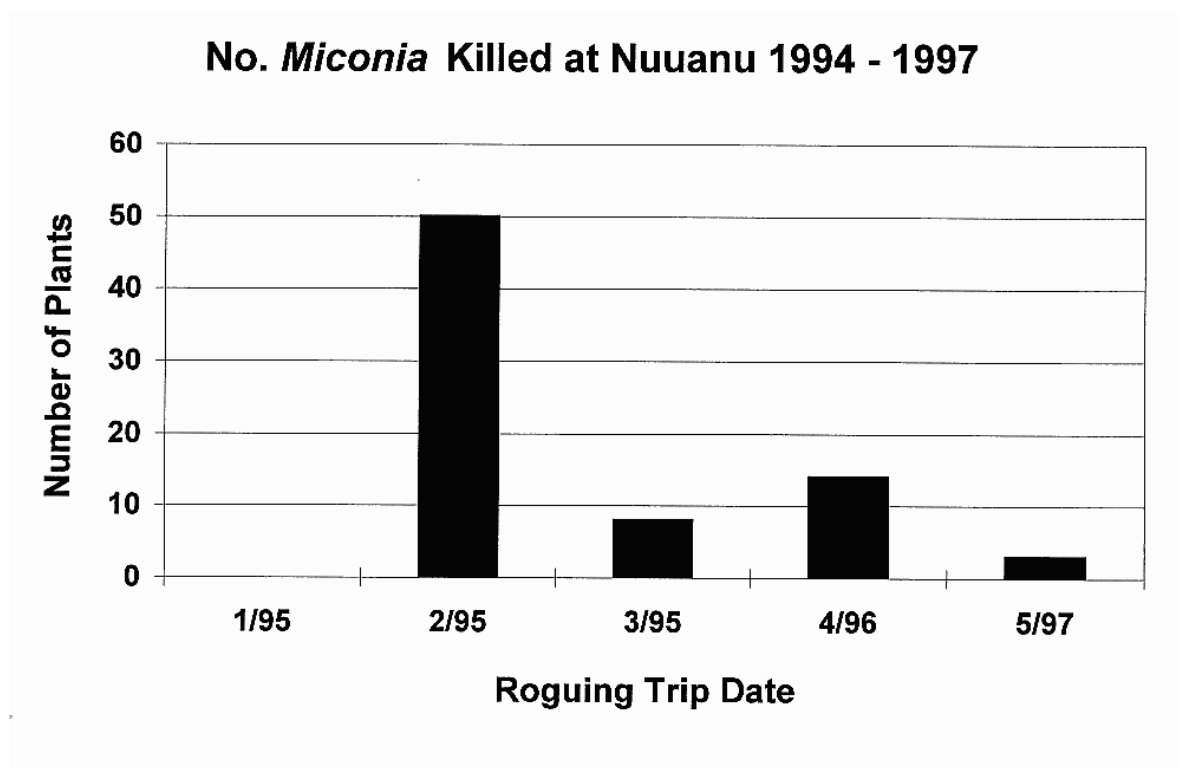
**Fig. 8.** Dbh classes of TLPU saplings at Paradise Park, Manoa**Fig. 9.** Dbh classes of TLPU saplings at Lyon Arboretum, Manoa

Meyer and Malet (1997) found that seeds survived in soil up to four years (when experiments were terminated) in Tahiti. Our observations at infestation sites on O'ahu indicate that seed banks at some sites are becoming exhausted through the periodic roguing of new seedlings. Unfortunately, counts of seedlings were not always made initially at infestation sites because of the potential for inaccurate counts of large numbers of seedlings. However, complete counts of plants removed were made from the beginning of the control effort at the Nuuanu infestation. Figure 10 shows that the counts of rogued seedling at Nuuanu has dropped to a very low level in slightly over two years (**Fig. 10**).

It is unfortunate that the precise planting date of all the original trees is not known. This information would make the determination of the rate of dispersal and age composition of the progeny more precise. Nonetheless, the data that have been collected indicates that all the infestations on O'ahu and Kaua'i have been successfully contained. Surveys will need to continue at all sites indefinitely to remove plants before they reach reproductive age. Helicopter surveys are critical to finding large emergent trees and ground surveys are needed to search under the canopy.

On Kaua'i, an early, concerted effort to find and remove all *M.c.* at the known infestation site led to apparent containment in the relatively short period of six months. No precise numbers of progeny large enough to reproduce were kept. However, only four plants were ever found with flowers and all flowers seen were immature. Three helicopter searches have been conducted since the last plant was found but no new finds have been made. The total number of plants found so far is 62, and 26 of these were found on the property of the nursery that had the original plant.

**Fig. 10.** Total number of *M.c.* killed at Nuuanu: 1994 through 1997





## USE OF VOLUNTEER WORKERS

Volunteers have been a critical component of the containment of *M.c.* on Kaua'i and O'ahu. On Kaua'i, volunteers distributed "*Miconia* fliers" house-to-house throughout the entire area surrounding the infestation site. This effort led to reports of outlying plants and was critical to defining the area of the infestation. On O'ahu, volunteers from the Girl Scouts of America, 4-H Club, Hawaiian Botanical Society, and Kamehameha Schools distributed fliers door to door. The Hawaii Chapter of the Sierra Club has done the bulk of the roguing work at the two largest infestation sites, Manoa and Kalihi Uka. Sierra Club members and accompanying volunteers from the community have invested over 835 man hours searching for and removing *M.c.* in these two valleys. Table 1 shows the costs incurred so far in the O'ahu containment program, excluding the all volunteer canvassing effort. It is obvious that using a primarily volunteer effort has kept the cost of containment low (Table 1). The Sierra Club Hawaii Chapter newsletter, *Malama I Ka Honua*, advertises the *Miconia* removal service trips in the hike schedule and a small notice often also appears in the weekend activity sections of a local newspaper. One-page announcements are also sent by fax to several conservation-related organizations prior to each event. The awareness of the general public has been kept high through periodic media reports on the threat of *M.c.* Without this awareness, volunteer participation would probably be much less.

The two large *M.c.* infestations on O'ahu, Manoa and Kalihi Uka, are both primarily on steep rugged terrain. The Manoa site in particular has little level ground except where the Arboretum staff manage the vegetation. It became increasingly clear with each monthly removal trip that all volunteers were eager to help, but not all of them were comfortable climbing steep slippery slopes. It became necessary to advertise the missions as being "strenuous, off-the-trail and on steep slippery terrain". Also, to allow everyone to participate, the volunteer group on each trip was split into two teams, one for more level terrain and one for steeper terrain. This worked very well for the Kalihi Uka site but not in Manoa, where the remaining unsearched areas were all steep. Allowing everyone who volunteers to actively participate in control work helps keep up enthusiasm among the pool of community volunteers.

**Table 1.** Costs incurred on O'ahu for containment of *M.c.*

ITEM	DOLLAR VALUE	MAN HOURS
1 liter garlon 3A (HDOA <sup>1</sup> )	25.00	----
rubber gloves, goggles calipers (HDOA <sup>1</sup> )	75.00	----
5.5 hrs. helicopter time (DOFAW <sup>2</sup> or HECO <sup>3</sup> )	3,500.00	13 (HDOA <sup>1</sup> , DOFAW <sup>2</sup> , LA-UH <sup>3</sup> )
C/M work in Manoa, Kalihi, Nuuanu, Wahiawa	3,525.00	235 (HDOA <sup>1</sup> & DOFAW-NARS <sup>2</sup> staff)
confirmation of <i>Miconia</i> reports		80 (HDOA <sup>1</sup> staff)
Sierra Club Service Trips: Manoa, Kalihi	no cost	>835 (Sierra Club volunteers and LA <sup>4</sup> staff)
TOTALS	\$7,125	1,163 man hrs.

<sup>1</sup>Hawaii Department of Agriculture; <sup>2</sup>Hawaii Division of Forestry and Wildlife, Natural Areas System ;

<sup>3</sup>Hawaiian Electric Co.; <sup>4</sup>Lyon Arboretum, University of Hawai'i

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