

Eradications of Potentially Invasive Plant Species



ERADICATIONS OF POTENTIALLY INVASIVE PLANT SPECIES

2003

Prepared for:
Maui Invasive Species Committee

Prepared by:
Forest Starr, Kim Starr, and Lloyd Loope
United States Geological Survey
Biological Resources Division

The following resource provides information on the target species chosen for eradication on Maui. Information provided includes images, maps, and reports for each target species. A CD with the same information is enclosed. Further information, including additional images, can be obtained online at www.hear.org/starr/hiplants.

Proposal to FWS for eradications of potentially invasive plant species on private lands on the island of Maui, Hawaii

Background: Myers and Ware (1992) consider there to be three good options for dealing with non-indigenous species that either may become or already have become invasive weeds: keep them out, eradicate introduced populations while they are still small, or attempt biological control of established populations.

Within the conservation community in Hawaii, it is widely recognized that more restrictive federal and state regulations are needed to prevent new invasive plants from being brought into the state. Hawaii's state noxious weed law, though fairly good by U.S. standards, is not being fully enforced. Efforts are underway to develop a credible risk-assessment procedure that can be used on a voluntary basis, and perhaps eventually given the force of law. Buy-in from the nursery industry and the public is also being sought. Unfortunately, we do not have adequate prevention in Hawaii. At the other end of the spectrum is bio-control, which is often ineffective and is considered a viable strategy as a last resort for only the most severe invasions.

That leaves eradication – an option which is highly attractive theoretically, but not so easy in practice (e.g., Hobbs and Humphries 1995; Mack and Lonsdale 2002; McNeeley, Neville and Rejmanek 2003). Myers and Ware (2002) point out that the opportunity for eradication is often lost by the time the problem is recognized and control projects are considered or actually implemented.

Why is this project needed?: The Maui Invasive Species Committee (MISC) was formed in 1997 with the idea of achieving eradications as “pelts on the wall.” MISC's experience with other target species has shown that eradication can be difficult to achieve within a relatively short timeframe. Nevertheless, MISC has demonstrated the ability to control all known individuals for several target species, e.g., *Aenchaena tomentosa* and *Melastoma candidum*. This project will allow MISC to build upon its past success; fine-tune eradication methodologies with a short-term focus on an expanded list of target species; share knowledge gained with the broader conservation community; and increase public awareness about invasive species. In terms of on-the-ground accomplishments, the project will

eliminate invasive plant species that are ecosystem-modifiers and which would threaten Maui's natural areas if left unchecked.

In cooperation with MISC and Haleakala National Park, USGS recently conducted a survey of incipient invasive plant species to demonstrate the need for stronger prevention laws and to determine potential targets for eradication. Though the final report of that project is not yet available, many of the products (maps, reports, photos) are available at www.hear.org/starr/hiplants. Information from those surveys and from MISC's field experience form the basis for this proposal.

Work Proposed: MISC and USGS propose to attempt island-wide eradication for 8 species, and local eradication of 4 species. This list does not include current MISC target species. For purposes of this proposal, "eradication" of a species means removal of all known individuals from a specific geographical area. Species selected for local eradication have relatively small populations in geographically discrete areas and/or threaten high-value natural areas. Given the difficulties inherent in achieving eradication of any species within a short timeframe, those species deemed eradicable on an island-wide basis will have a higher priority over local eradications. Factors expected to complicate eradication include: ability to obtain access to property; site accessibility; incomplete knowledge regarding species distribution or population; established seed banks in the soil; and continued influx or re-establishment.

The project will use a coordinated effort of a USGS survey team and the MISC crew. The 12 species are listed in Table 1. Several of the species are currently recorded only from Maui by the Hawaiian Biological Survey.

Approach: A USGS team (Starr & Starr) will work closely with a MISC crew to achieve these eradications. The Maui Invasive Species Committee will provide overall direction and prioritization. USGS will be responsible for (1) leading collaborative decision-making on priorities for control; (2) surveying for target species; (3) producing draft materials to inform the public, generate support, and obtain information on new plant locations; (4) refining methodology for data recording and management, in cooperation with relevant invasive species data networks; and (5) synthesizing results to evaluate feasibility of eradications. MISC staff will be responsible for (1) making landowner contacts and obtaining access permissions; (2) removing and treating all known individuals for which access/permission is obtainable;

and (3) interfacing with the news media and public regarding this project, based on draft materials provided by USGS. At the end of the project, the Maui Invasive Species Committee will review the results to assess whether additional work on any target species addressed by this proposal is needed, warranted, and feasible.

Literature Cited:

Hobbs, R. J., and S.L. Humphries. 1995. The ecology and management of plant invasions: an integrated approach. *Conservation Biology* 9(4):761-770.

Mack, R.N., and W.M. Lonsdale. 2002. Eradicating invasive plants: Hard won lessons for islands. Pages 164-172 *in* C.R. Veitch and M.N. Clout (eds.), *Turning the Tide: The Eradication of Invasive Species*. IUCN.

McNeeley, J.A., L.E. Neville, and M. Rejmanek. 2003. When is eradication a sound investment? *Conservation in Practice* 4(1): 30-31.

Myers, J.H., and J. Ware. 2002. Setting priorities for biological control of weeds: What to do and how to do it. Pacific Cooperative Studies Unit, University of Hawaii at Manoa. Technical Report 129. Honolulu, HI.

Table 1. Proposed Target Species for Eradication by MISC / USGS

Species	Est. Time	State Noxious weed	Eradicate From
Target Species for Island-wide Eradication			
+ <i>Acacia auriculiformis</i>	*	--	State
+ <i>Acacia mangium</i>	*	--	State
<i>Acacia podalyriifolia</i>	*	--	State
<i>Acacia retinodes</i>	*	--	State
<i>Macaranga mappia</i>	*	--	Maui
<i>Maclura pomifera</i>	*	--	State
<i>Melastoma sanguineum</i>	*	X	Maui
<i>Morella cerifera</i>	*	--	Maui
<i>Pittosporum viridiflorum</i>	**	--	Maui
<i>Verbascum thapsus</i>	*	X	Maui
Target Species for Local Eradication			
<i>Caesalpinia decapetala</i>	*	--	Ulupalakua
<i>Macaranga tanarius</i>	*	--	E. Maui
<i>Morella faya</i>	*	X	W. Maui
<i>Sideroxylon persimile</i>	*	--	Ulupalakua
Estimated control time (x 5 FTE)			
		Noxious Weed	
* = 1 day		X = Yes	
** = 1 week		-- = No	
+ = Species on original proposal			

Acacia auriculiformis

(Earpod wattle)

Acacia auriculiformis

Earpod wattle -- Fabaceae

Overview: *Acacia auriculiformis* (earpod wattle) is a tree native to Northern Australia, Papua New Guinea, and eastern Indonesia (PIER 2002). *Acacia auriculiformis* is sparingly planted on Maui, and possibly other Hawaiian Islands. This species has been cultivated as a forestry tree in Florida and has escaped from plantings (PIER 2002).

Description: "Tree; leaves simple, sickle-shaped, 5-8 by 1-2 in; pods woody, nearly flat, irregularly twisted and wavy-edged, about 0.5 in wide." (Neal 1965).

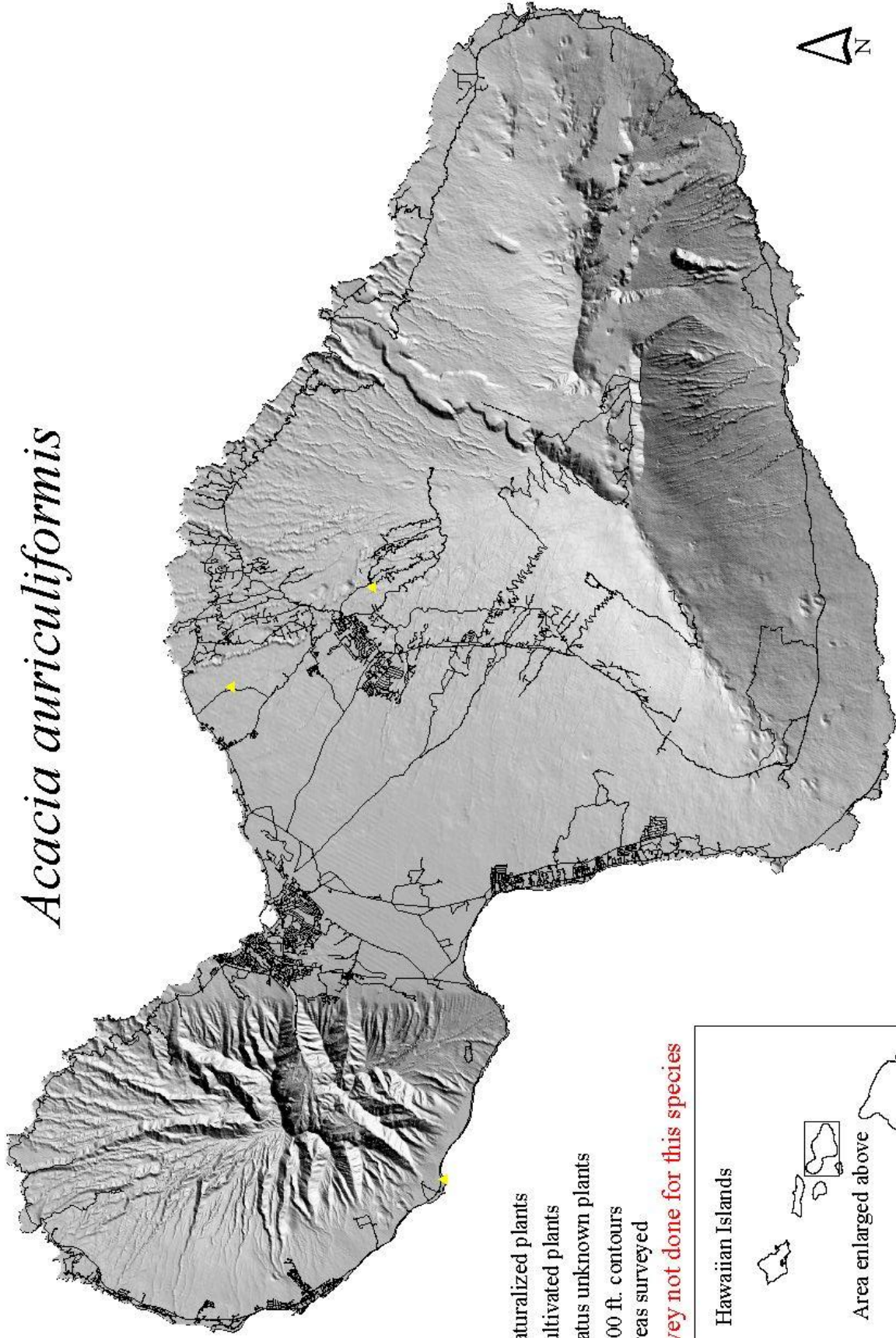
Impact: According to PIER (2002), *Acacia auriculiformis* can become naturalized where planted. It is a pest of southern Florida (Hammer 1996) where it is listed as a category I invasive species by the Florida Exotic Pest Plant Council (FLEPPC). *A. auriculiformis* is adapted to both wet and dry conditions and seed germination may be enhanced by fire (Langeland and Burks 1998).

Distribution: On Maui, *Acacia auriculiformis* is sparingly cultivated in groves at two agriculture experiment stations. This species is also cultivated at Olowalu. There may be other places on Maui where this species is cultivated.

Control Methods: Girdle, pull seedlings (PIER 2002). Triclopyr herbicide mixed with an oil (Hammer 1996).

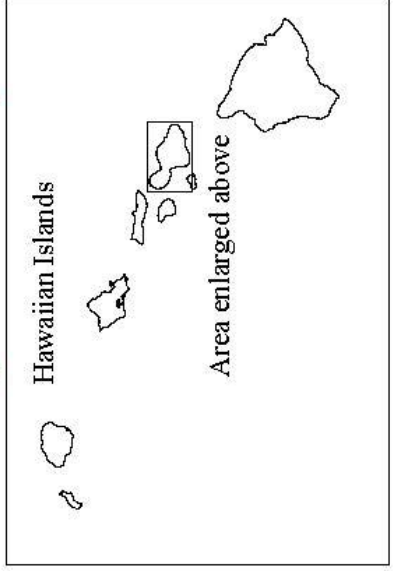


Known distribution on Maui of *Acacia auriculiformis*



- Survey
- Interview
- Naturalized plants
- Cultivated plants
- Status unknown plants
- 1000 ft. contours
- Areas surveyed

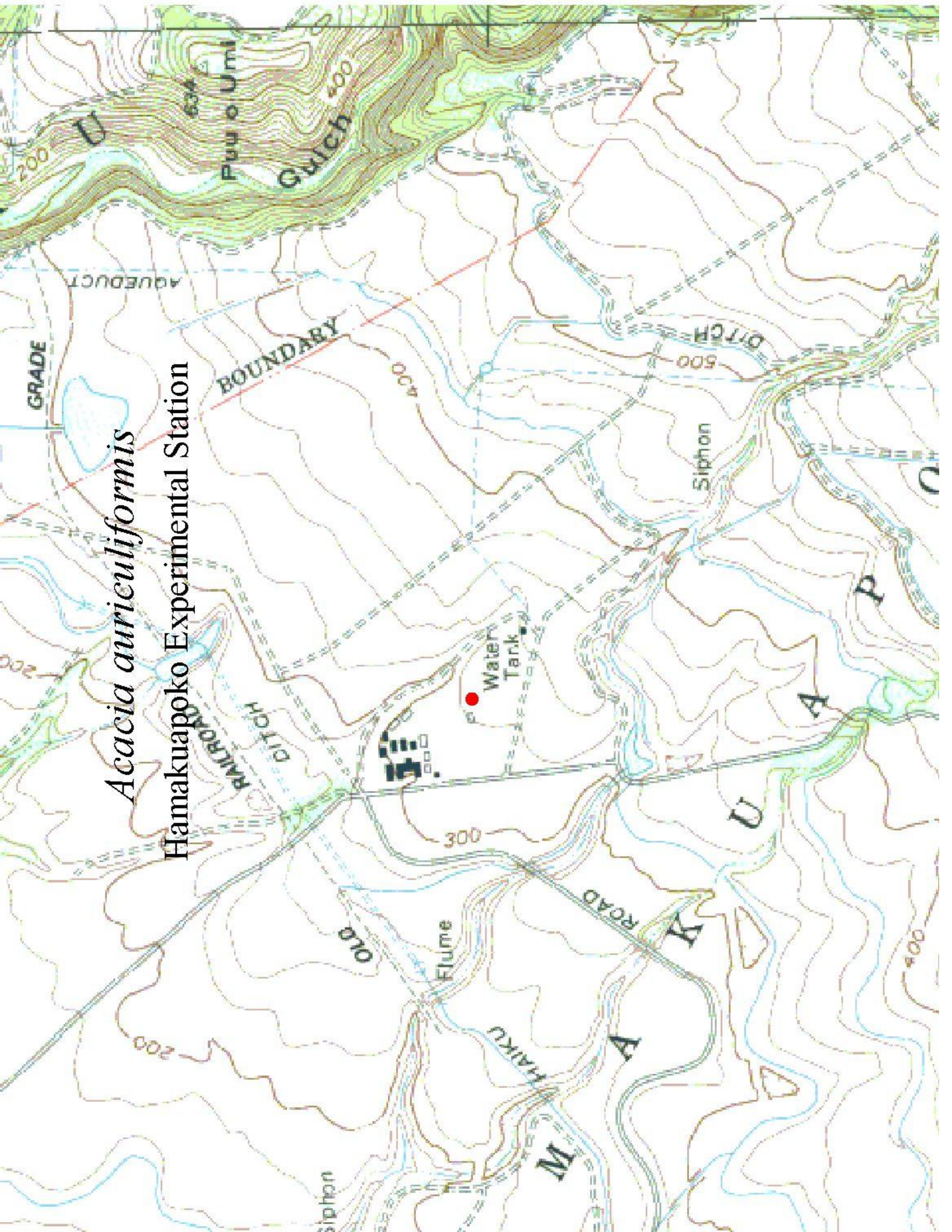
Full survey not done for this species



USGS-BRD Haleakala Field Station (May 2003)

Acacia auriculiformis

Hamakuapoko Experimental Station



Acacia auriculiformis
Piiholo Experimental Station



Acacia duriculisformis

Olowalu - Camp Pecusa



SITE INFORMATION -- *Acacia auriculiformis*

-- Hamakuapoko Experimental Station, Hamakuapoko Rd., Paia.

A grove of large trees previously planted in agricultural experimental plots.

-- Pi'iholo Experimental Station, Pi'iholo Rd., Pi'iholo.

A grove of large trees planted by the agricultural station.

-- Camp Pecusa, Olowalu.

Tree cultivated in yard. Plants originally from the Hamakuapoko ag station.





Acacia auriculiformis

Earpod wattle

Fabaceae

Forest Starr, Kim Starr, and Lloyd Loope
United States Geological Survey--Biological Resources Division
Haleakala Field Station, Maui, Hawai'i

August, 2003

OVERVIEW

Earpod wattle (*Acacia auriculiformis*) is a tree native to Northern Australia, Papua New Guinea, and eastern Indonesia (PIER 2002). *Acacia auriculiformis* is sparingly planted on Maui, and possibly other Hawaiian Islands. This species has been cultivated as a forestry tree in Florida and has escaped from plantings (PIER 2002). With a history of weediness elsewhere and limited distribution on Maui, this species is a good candidate for eradication and control. Further island wide surveys are needed to locate any other sites where *Acacia auriculiformis* grows. It is likely planted on other Hawaiian Islands and surveys there for this species could also be conducted.

TAXONOMY

Family: Fabaceae (Pea family) (Wagner et al. 1999).

Latin name: *Acacia auriculiformis* Cunn. ex Benth. (PIER 2002).

Synonyms: *Racosperma auriculiforme* (Benth.) Pedley (Randall 2002).

Common names: Earpod wattle, Papuan wattle, auri, earleaf acacia, northern black wattle, Darwin black wattle (GRIN 2002, PIER 2002).

Taxonomic notes: The genus *Acacia* is made up of about 1,200 species that are widespread but with a large number in Australia (Wagner et al. 1999).

Nomenclature: The genus name is derived from *akakia*, the Greek name for *Acacia arabica* (Lam.) Willd., which is derived from *akis*, a Greek word meaning sharp point, in reference to the thorns of the plant (Wagner et al. 1999).

Related species in Hawai'i: Numerous *Acacia* species are known from Hawai'i, including native species such as *A. koa* and *A. koaia*, and naturalized non-native species such as *A. farnesiana*, *A. confusa*, *A. mearnsii*, and *A. melanoxylon*. Several non-native *Acacia* species have recently been found on Maui that are also potentially invasive including *A. retinodes*, *A. mangium*, and *A. podalyriifolia*.

DESCRIPTION

"Tree; leaves simple, sickle-shaped, 5-8 by 1-2 in; pods woody, nearly flat, irregularly twisted and wavy-edged, about 0.5 in wide." (Neal 1965).

"Evergreen, unarmed tree to 15 m (50 ft) tall, with compact spread, often multi-stemmed; young growth glaucous. Leaves alternate, simple, reduced to phyllodes (flattened leaf stalks), these blade-like, slightly curved, 11-20 cm (5-8 in) long, with 3-7 main parallel veins and a marginal gland near the base; surfaces dark green. Flowers in loose, yellow-orange spikes at leaf axils or in clusters of spikes at stems tips; flowers mimosa-like, with

numerous free stamens. Fruit a flat, oblong pod, twisted at maturity, splitting to reveal flat black seeds attached by orange, string like arils." (Langeland and Burks 1998).

BIOLOGY & ECOLOGY

Cultivation: According to PIER (2002), *Acacia auriculiformis* is a commonly planted forestry tree. This tree is widely cultivated for pulpwood and fuelwood (Langeland and Burks 1998).

Invasiveness: According to PIER (2002), *Acacia auriculiformis* can become naturalized where planted. It is a pest of southern Florida (Hammer 1996). *A. auriculiformis* is adapted to both wet and dry conditions and seed germination may be enhanced by fire (Langeland and Burks 1998).

Pollination: Not known.

Propagation: *A. auriculiformis* is propagated from seeds (PIER 2002). Apparently, seed germination is facilitated by fire (Langeland and Burks 1998).

Dispersal: In Florida, seeds are dispersed by several bird species, including the introduced European starling (Langeland and Burks 1998).

Pests and diseases: Not known.

DISTRIBUTION

Native range: Earpod wattle (*Acacia auriculiformis*) is a tree native to Northern Australia, Papua New Guinea, and eastern Indonesia (PIER 2002), where it is found from dune ridges to river banks (Langeland and Burks 1998).

Global distribution: *Acacia auriculiformis* is naturalized in Florida. It was planted before 1932 for ornament and used extensively as a street tree for many years (Langeland and Burks 1998). It was first documented as spreading by the 1970's and is now common in disturbed areas, but has also invaded threatened native pinelands, scrub, and hammocks in south Florida (Langeland and Burks 1998).

The following describes the distribution of *Acacia auriculiformis* in the Pacific, according to PIER (2003). "American Samoa (cultivated, not common) (Tutuila, Ta'u), Commonwealth of the Northern Mariana Islands (Rota, Saipan), Cook Islands (Rarotonga, Mangaia), Federated States of Micronesia (Chuuk (observed on Weno, Tol and Fefan; probably on other islands as well), Kosrae, Pohnpei), Guam, Marshall Islands (Majuro (cult.)), Palau, Papua New Guinea (native), Samoa (Upolu, Sava'i), Tonga (Lifuka (cult.))" and "Christmas Island, Mauritius, Reunion, Rodrigues." PIER notes that there is little natural regeneration of this species seen in Micronesia. Some naturalization noted mostly on bare soil, on Mangaia, Cook Islands.

State of Hawai'i distribution: *Acacia auriculiformis* is sparingly cultivated on Maui. It is likely present on other Hawaiian Islands. An *Acacia* species with curly seed pods that

appears similar to *Acacia auriculiformis* was observed on Kaua'i, planted near an agricultural experiment station near the Opaeka'a area. It is not certain which species this tree represents.

Island of Maui distribution: *Acacia auriculiformis* is sparingly cultivated in groves at two agriculture experiment stations. These stations apparently introduced and planted numerous species in Hawai'i to evaluate their potential for cultivation. The first location is in Paia, approximately 300 ft (91 m) elevation, in warm moist lowlands surrounded by agriculture (sugar cane). The site is an abandoned school that has also been used as an agriculture experiment station. The site is about to become County property. The second location is also at an agricultural experiment station in Pi'iholo, approximately 1,700 ft (518 m) elevation, in disturbed moist area bounded by agriculture (pineapple) below, residential Pi'iholo above, and Makawao Forest Reserve to the east. Both plantings are limited to small areas where trees were planted in groves. This species is also cultivated at Olowalu in the garden of a former agriculture station employee. There may be other places on Maui where this species is cultivated.

CONTROL METHODS

Physical control: Girdle, pull seedlings (PIER 2002).

Chemical control: Triclopyr herbicide mixed with an oil (Hammer 1996).

Biological control: None known.

Cultural control: This species could be discontinued in plantings in Hawai'i.

Noxious weed acts: None known, though listed as a category I invasive species in Florida by the Florida Exotic Pest Plant Council (FLEPPC).

MANAGEMENT RECOMMENDATIONS

Acacia auriculiformis is widely planted in the Pacific and elsewhere as a forestry tree and for other purposes. It has become invasive in southern Florida where it invades natural areas. In Hawai'i, it is sparingly cultivated on Maui. Other forestry areas and agriculture stations on Maui should be surveyed to find new locations. Other Hawaiian Islands may want to survey for this species in similar areas. Eradication and control of this tree now may help to avoid its eventual invasion.

REFERENCES

Hammer, R.L. 1996. In: Randall, J.M. and J. Marinelli, ed. Invasive plants: weeds of the global garden. Brooklyn Botanic Garden Handbook 149.

Langeland, K.A. and K.C. Burks. 1998. Identification and Biology of Non-Native Plants in Florida's Natural Areas. University Press of Florida, Gainesville, FL.

Neal, M.C. 1965. *In Gardens of Hawai'i*. Bernice P. Bishop Museum Special Publication 40, Bishop Museum Press, Honolulu, HI.

PIER (Pacific Islands Ecosystems at Risk). 2002. Invasive Plant Species: *Acacia auriculiformis*. Available: <http://www.hear.org/pier> (Accessed: July 25, 2002).

Randall, R. 2002. The Global Compendium of Weeds: *Acacia auriculiformis*. Department of Agriculture, Western Australia. Available: <http://www.hear.org/gcw> (Accessed: July 25, 2002).

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1999. *Manual of the Flowering Plants of Hawai'i*. 2 vols. Bishop Museum Special Publication 83, University of Hawai'i and Bishop Museum Press, Honolulu, HI.

Acacia mangium

(Mangium wattle)

Acacia mangium

Mangium wattle -- Fabaceae

Overview: *Acacia mangium* (mangium) is a tree native to Queensland, Australia, Molluccan Islands, Papua New Guinea, and Indonesia (PIER 2003). *Acacia mangium* is sparingly planted on Maui, and possibly other Hawaiian Islands. This species has been cultivated in various places as a forestry tree and has escaped from plantings (PIER 2003).

Description: "Medium to tall, spreading tree; branches glabrous; phyllodes 10-20 cm x 5-10 cm, lanceolate or ovate, conspicuously veined, light or dark green; flower-heads rod-like, 6-10 cm long, white, sparse, on hairy peduncles about 1 cm long; pods long, slender, coiled or twisted and contorted." (Elliot and Jones 1982).

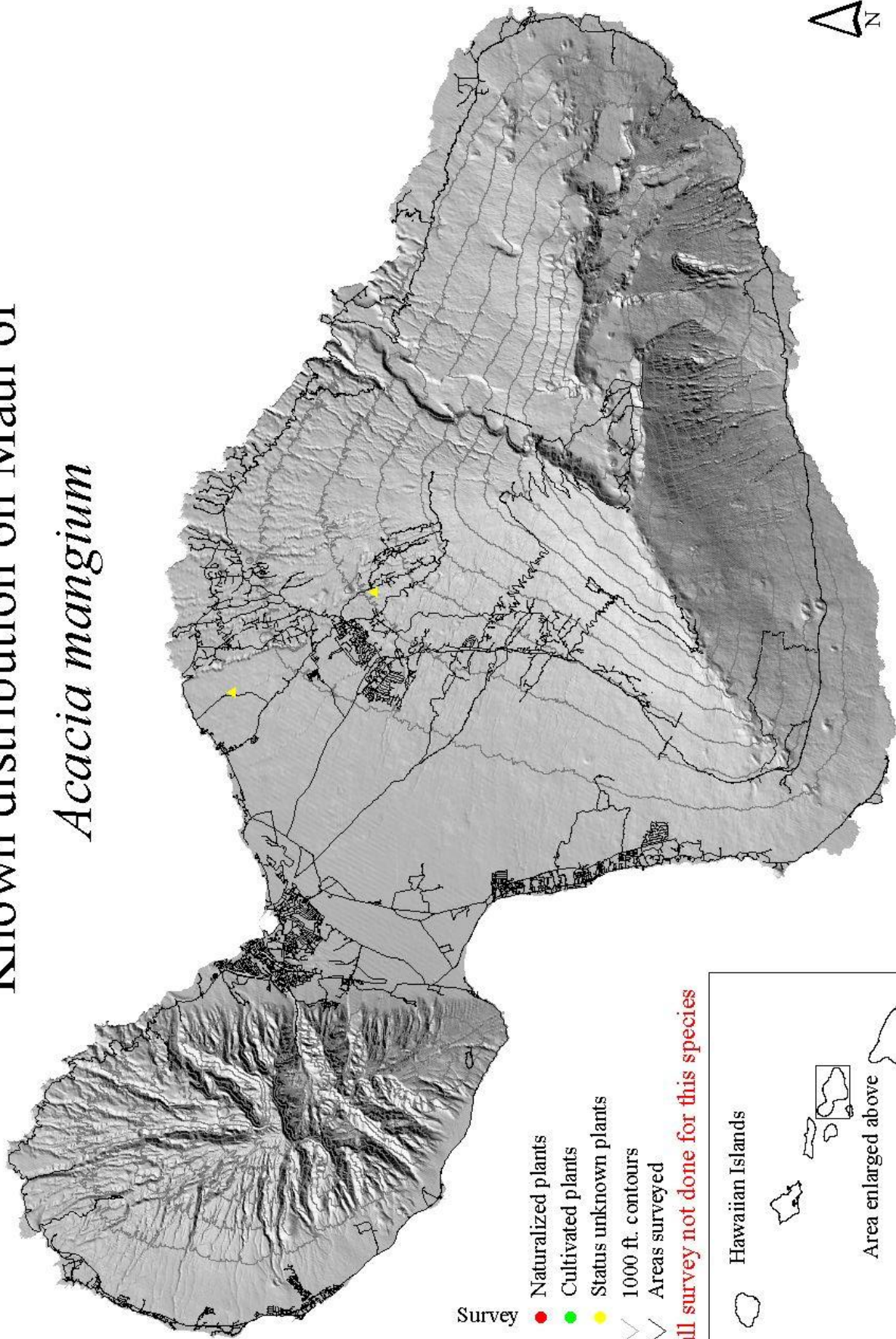
Impact: According to PIER (2003), *Acacia mangium* can become naturalized where planted and is known to spread on Saipan, Pohnpei, Yap, Sabah, Africa, Melville Island, and northern Australia. *A. mangium* is a very fast growing tree that produces numerous seeds. This species apparently outperforms other weedy trees such as *Falcataria moluccana* on degraded volcanic soils (Duke 1983).

Distribution: On Maui, *Acacia mangium* is sparingly cultivated in groves at two agriculture experiment stations. Both plantings are limited to small areas where trees were planted in groves. There may be other places on Maui where this species is cultivated.



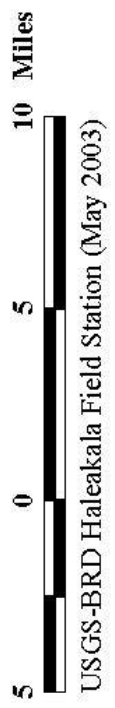
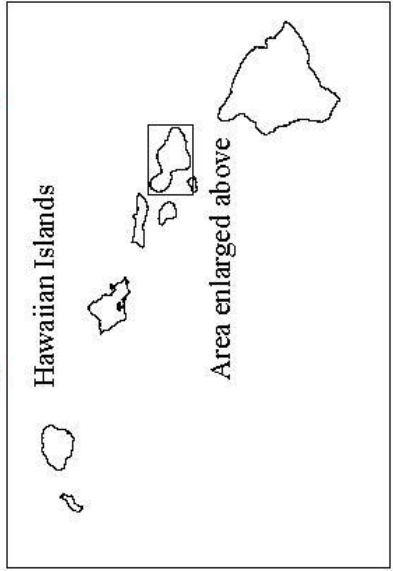
Control Methods: Girdle, pull seedlings (PIER 2003). Triclopyr herbicide mixed with an oil.

Known distribution on Maui of *Acacia mangium*

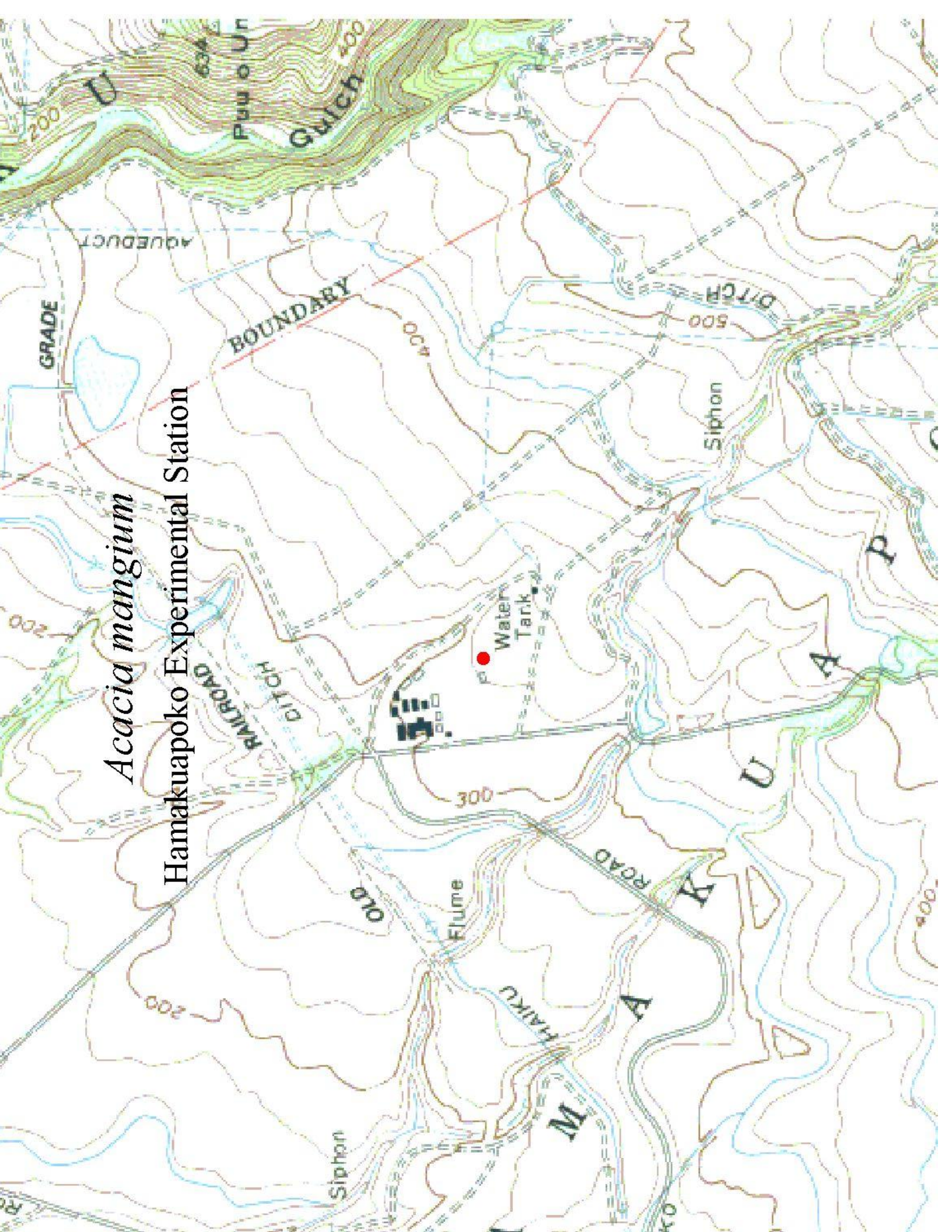


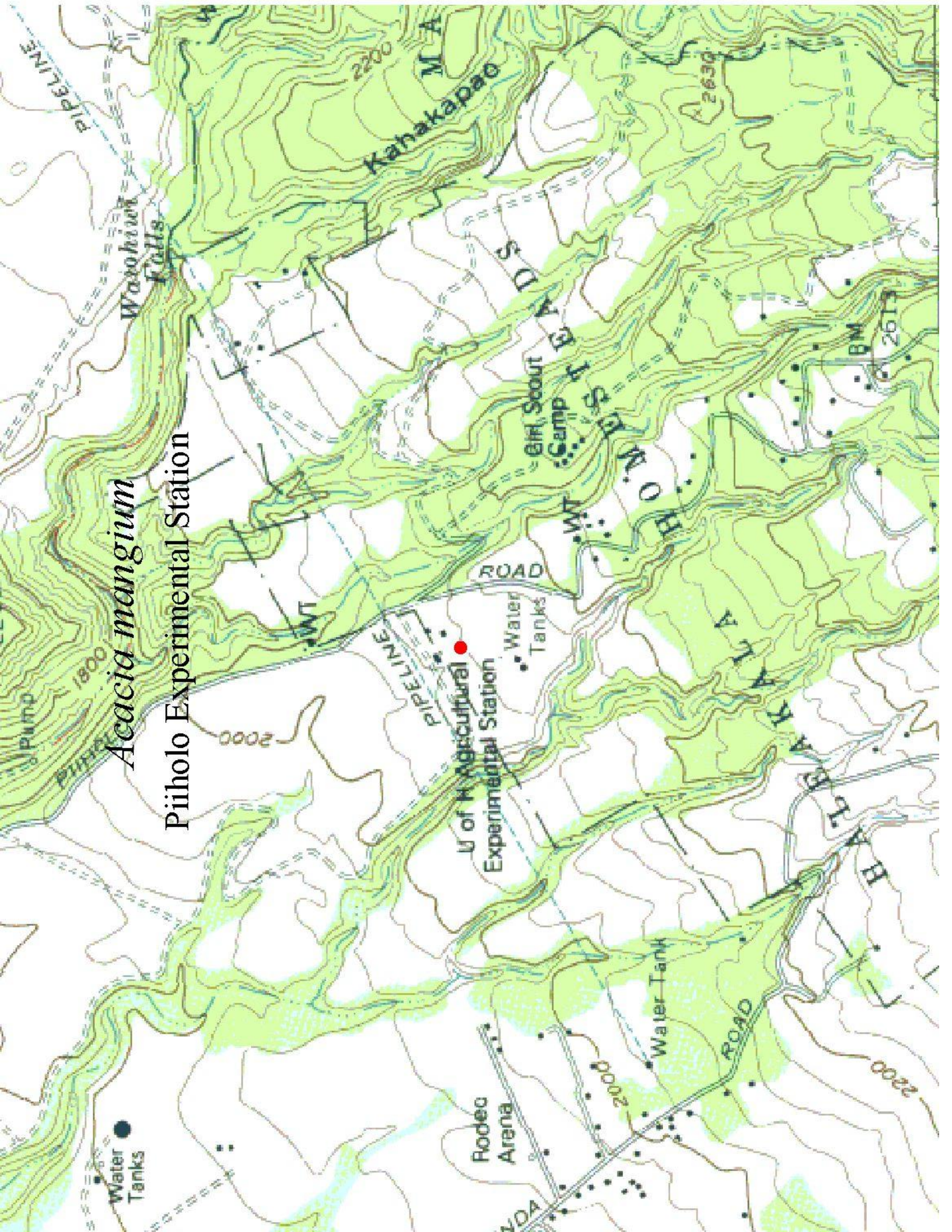
- Survey
- Interview
- Naturalized plants
- Cultivated plants
- Status unknown plants
- 1000 ft. contours
- Areas surveyed

Full survey not done for this species



Acacia mangium
Hamakuapoko Experimental Station





Acacia mangium

Piiholo Experimental Station

SITE INFORMATION -- *Acacia mangium*

-- Hamakuapoko Experimental Station, Hamakuapoko Rd., Paia.

A grove of large trees previously planted in agricultural experimental plots.

-- Pi'iholo Experimental Station, Pi'iholo Rd., Pi'iholo.

A grove of large trees planted by the agricultural station.





Acacia mangium

Mangium wattle

Fabaceae

Forest Starr, Kim Starr, and Lloyd Loope
United States Geological Survey--Biological Resources Division
Haleakala Field Station, Maui, Hawai'i

April, 2003

OVERVIEW

Acacia mangium (Mangium) is a tree native to Queensland, Australia, Molluccan Islands, Papua New Guinea, and Indonesia (PIER 2003). *Acacia mangium* is sparingly planted on Maui, and possibly other Hawaiian Islands. This species has been cultivated in various places as a forestry tree and has escaped from plantings (PIER 2003). With a history of weediness elsewhere and limited distribution on Maui, this species is a good candidate for eradication and control. Further island wide surveys are needed to locate any other sites where *Acacia mangium* grows. It is likely planted on other Hawaiian Islands and surveys there for this species could also be conducted.

TAXONOMY

Family: Fabaceae (Pea family) (Wagner et al. 1999).

Latin name: *Acacia mangium* Willd. (PIER 2003).

Synonyms: None known.

Common names: Mangium, Mangium wattle, mange, forest mangrove (Duke 1983, PIER 2003).

Taxonomic notes: The genus *Acacia* is made up of about 1,200 species that are widespread but with a large number in Australia (Wagner et al. 1999). *Acacia mangium* hybridizes naturally with *Acacia auriculiformis*, producing hybrids which grow faster than either parent, but tend to retain the poor form of *A. auriculiformis* (Duke 1983).

Nomenclature: The genus name is derived from *akakia*, the Greek name for *Acacia arabica* (Lam.) Willd., which is derived from *akis*, a Greek word meaning sharp point, in reference to the thorns of the plant (Wagner et al. 1999).

Related species in Hawai'i: Numerous *Acacia* species are known from Hawai'i, including native species such as *A. koa* and *A. koaia*, and naturalized non-native species such as *A. farnesiana*, *A. confusa*, *A. mearnsii*, and *A. melanoxylon*. Several non-native *Acacia* species have recently been found on Maui that are also potentially invasive including *A. auriculiformis*, *A. retinodes*, and *A. podalyriifolia*.

DESCRIPTION

"Medium to tall, spreading tree; branches glabrous; phyllodes 10-20 cm x 5-10 cm, lanceolate or ovate, conspicuously veined, light or dark green; flower-heads rod-like, 6-10 cm long, white, sparse, on hairy peduncles about 1 cm long; pods long, slender, coiled or twisted and contorted." (Elliot and Jones 1982).

"Tree to 30 m tall, bole often straight, to over half the total tree height. Branchlets, phyllodes and petioles glabrous or slightly scurfy. Phyllodes 5-10 cm broad, 2-4 times as long as broad, dark green, chartaceous when dry. The phyllodes have (3-)4 longitudinal main nerves which join on the dorsal margin at the base of the phyllode, secondary nerves fine and inconspicuous. Flowers in loose spikes to 10 cm long, solitary or paired in the upper axils. Flowers pentamerous, the calyx 0.6-0.8 mm long, with short obtuse lobes, the corolla twice as long as the calyx. Pods linear, glabrous, 3-5 mm broad, ca 7.5 cm long when green, woody, coiled and brackish-brown when mature, depressed between the seeds. Seeds lustrous, black, ellipsoid, ovate or oblong, 3.5-2.5 mm, the orangish funicle forming a fleshy aril beneath the seed." (Duke 1983).

BIOLOGY & ECOLOGY

Cultivation: *Acacia mangium* is a commonly planted forestry tree. This tree is widely cultivated for firewood and for furniture making (Duke 1983).

Invasiveness: According to PIER (2003), *Acacia mangium* can become naturalized where planted and is known to spread on Saipan, Pohnpei, Yap, Sabah, Africa, Melville Island, and northern Australia. *A. mangium* is a very fast growing tree that produces numerous seeds. This species apparently outperforms other weedy trees such as *Falcataria moluccana* and *Gmelina arborea* on degraded volcanic soils (Duke 1983).

Pollination: Not known.

Propagation: *A. mangium* flowers and fruits profusely (NAS 1979) and plants are propagated from seeds. Seeds are sometimes sown directly in the soil (NAS 1979).

Dispersal: *A. mangium* may be spread by birds.

Pests and diseases: Duke (1983) reports the following pests of *A. mangium*. "There are problems with leaf insects. Mangium has symbioses with the bacterium *Rhizobium* and the fungus *Thelephora*. Specimens (ca 12%) in Sabah suffer from a heart rot and a pink disease (*Corticium salmonicolor*). Seedlings in Hawaiian nurseries are attacked by a powdery mildew (*Oidium* sp.). Three pinhole borers attack the tree in Sabah, especially on poorer sites. Carpenter ants (*Camponotus* sp.) form galleries in the heartwood of young trees. Wood borers of the genus *Xylocopa* may be a problem. Seedlings may be defoliated by *Hypomeces squamosus*. Scale insects and mealy bugs may also be problematic with young plants (NAS 1983)."

DISTRIBUTION

Native range: *Acacia mangium* is native to Queensland, Australia, Molluccan Islands, Papua New Guinea, and Indonesia (Irian Jaya) (PIER 2003).

Global distribution: *Acacia mangium* has been introduced to Bangladesh, Cameroon, Costa Rica, Hawai'i, Indonesia, Malaysia, Nepal, Papua, and the Philippines (NAS 1983). Duke (1983) report the following. "Often in grasslands and on margins of lowland primary forests at altitudes of 10-50 m (33-164 ft). Probably capable of ranging from

tropical very dry to moist through subtropical dry to wet forest life zones. Mangium withstands annual precipitation of 10 to 45 dm (254 to 1,143 in) or more and mean maximum temperature of 31-34 C (88-93 F) in summer and 12-25 C (54-77 F) in winter." PIER (2003) reports the following. "A small amount of planting on Saipan. One isolated individual naturalized seedling was noted on disturbed soil. On Pohnpei, a patch of naturalized seedlings without a local seed source was noted. Should be monitored for naturalization and spread. Spreading from an old species trial on Yap. Reported as invasive in Sabah and Africa. Reported to be invasive on Melville Island, Australia."

State of Hawai'i distribution: *Acacia mangium* is sparingly cultivated on Maui. It is likely present on other Hawaiian Islands.

Island of Maui distribution: *Acacia mangium* is sparingly cultivated in groves at two agriculture experiment stations. These stations apparently introduced and planted numerous species in Hawai'i to evaluate their potential for cultivation. The first location is in Paia, approximately 300 ft (91 m) elevation, in warm moist lowlands surrounded by agriculture (sugar cane). The site is an abandoned school that has also been used as an agriculture experiment station. The site is about to become County property. The second location is also at an agricultural experiment station in Pi'iholo, approximately 1,700 ft (518 m) elevation, in disturbed moist area bounded by agriculture (pineapple) below, residential Pi'iholo above, and Makawao Forest Reserve to the east. Both plantings are limited to small areas where trees were planted in groves. There may be other places on Maui where this species is cultivated.

CONTROL METHODS

Physical control: Girdle, pull seedlings (PIER 2003).

Chemical control: Triclopyr herbicide mixed with an oil.

Biological control: None known.

Cultural control: This species could be discontinued in plantings in Hawai'i.

Noxious weed acts: None known.

MANAGEMENT RECOMMENDATIONS

Acacia mangium is widely planted in the Pacific and elsewhere as a forestry tree and for other purposes. It grows rapidly, produces numerous seeds, and spreads in areas where it is planted. It tolerates degraded areas and seems to prefer moist to wet sites. In Hawai'i, it is sparingly cultivated on Maui. Other forestry areas and agriculture stations on Maui should be surveyed to find new locations. Other Hawaiian Islands may want to survey for this species in similar areas. Removal of this tree now may help to avoid its eventual invasion.

REFERENCES

Duke, J.A. 1983. Handbook of Energy Crops. unpublished. Available: http://www.hort.purdue.edu/newcrop/duke_energy/Acacia_mangium.html (Accessed: April 3, 2003).

Elliot, W.R. and D.L. Jones. 1982. Encyclopedia of Australian plants, volume two. Lothian Publishing Co., Melbourne, AU.

NAS (National Academy of Sciences). 1979. Tropical legumes: resources for the future. National Academy Press, Washington, DC.

NAS (National Academy of Sciences). 1983. Mangium and other acacias of the humid tropics. National Academy Press, Washington, DC.

PIER (Pacific Islands Ecosystems at Risk). 2003. Invasive Plant Species: *Acacia mangium*. Available: <http://www.hear.org/pier> (Accessed: April 3, 2003).

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1999. *Manual of the Flowering Plants of Hawai'i*. 2 vols. Bishop Museum Special Publication 83, University of Hawai'i and Bishop Museum Press, Honolulu, HI.

Acacia podalyriifolia

(Queensland silver wattle)

Acacia podalyriifolia

Queensland silver wattle -- Fabaceae

Overview: *Acacia podalyriifolia* (Queensland silver wattle) is a silver leaved large shrub to small tree native to Queensland Australia. *A. podalyriifolia* is commonly cultivated in gardens and as a street tree in other parts of Australia and elsewhere in the world. In Victoria, Australia, this species has become locally invasive, spreading from initial plantings to nearby dry sclerophyll forest and woodland (Carr et al. 1992, Blood et al. 1998). In Hawai'i, *A. podalyriifolia* was recently discovered being cultivated on Maui.



sites on Maui where *A. podalyriifolia* is located.

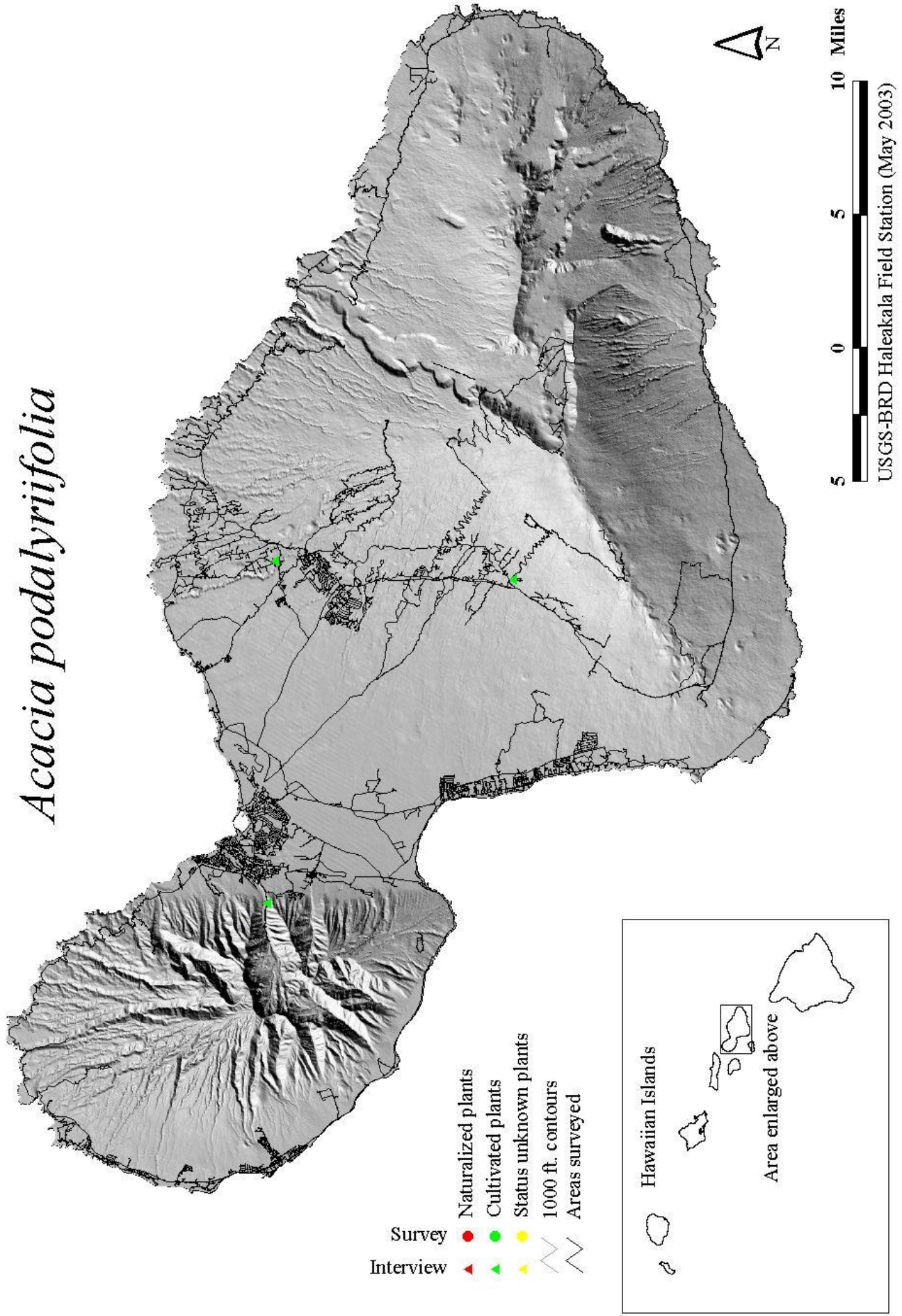
Description: "Tall, glaucous, pubescent shrub; phyllodes ovate or oblong, to 1 1/2 in. long; fl. heads in long racemes; fr. to 3 in. long (Bailey and Bailey 1976).

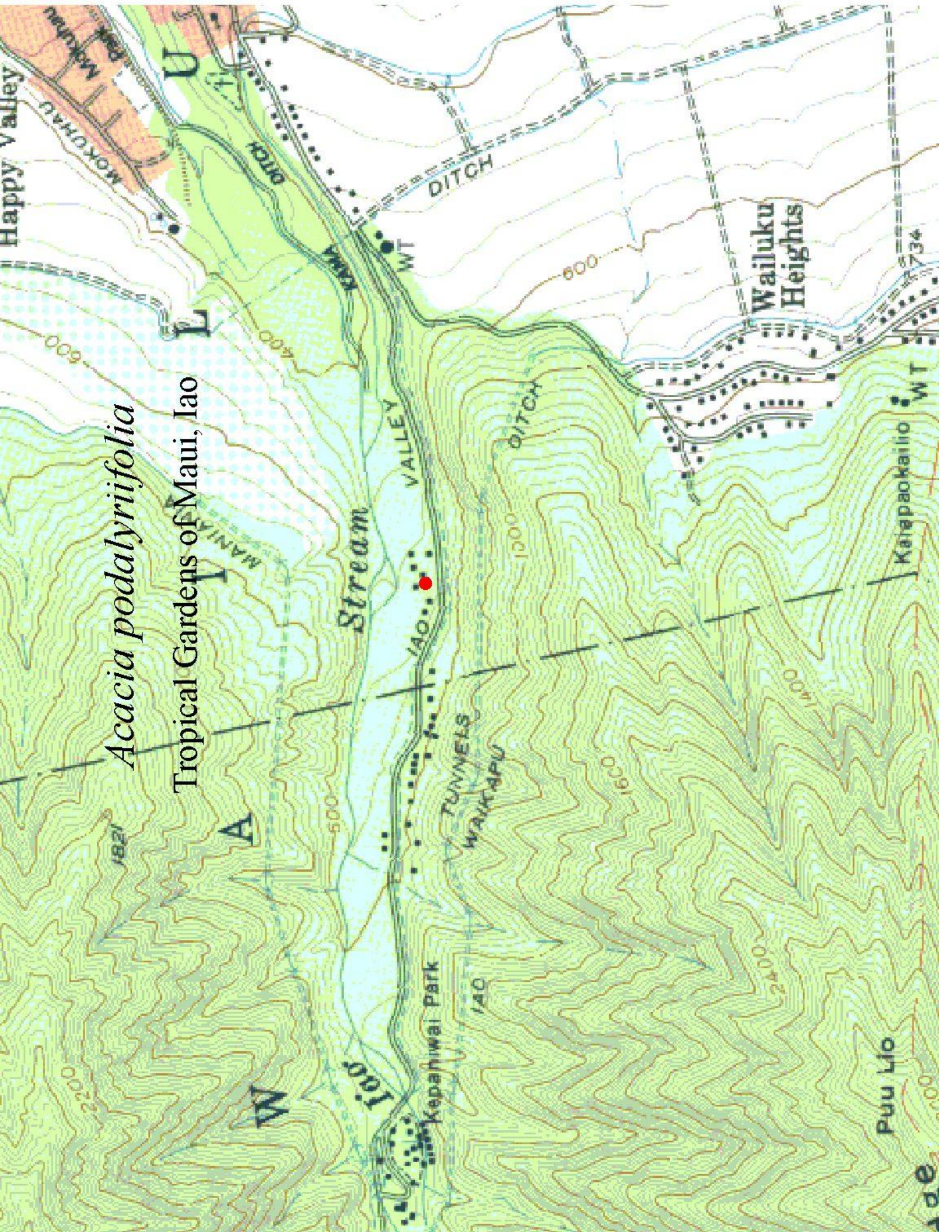
Impact: *Acacia podalyriifolia* can become naturalized where planted (Simmons 1987). It is a pest in dry scrub and woodland of Victoria, Australia, where it is planted as an ornamental garden plant and street tree (Carr et al. 1992, Blood et al. 1998). It is considered a threat to one or more vegetation types there (Carr et al. 1992). This relatively quick growing tree flowers by the second year (ASGAP 2001). It is well suited to a wide variety of climates, particularly dry areas, and tolerates mild frost (ASGAP 2001).

Distribution: On Maui, *Acacia podalyriifolia* is known from a few cultivated trees in gardens, in Kula, Ha'iku, and Iao. There are likely other

Control Methods: Girdle, pull seedlings (Swarbrick and Skarratt 1994). Cut stump or basal bark methods using a suitable herbicide (Swarbrick and Skarratt 1994).

Known distribution on Maui of *Acacia podalyriifolia*



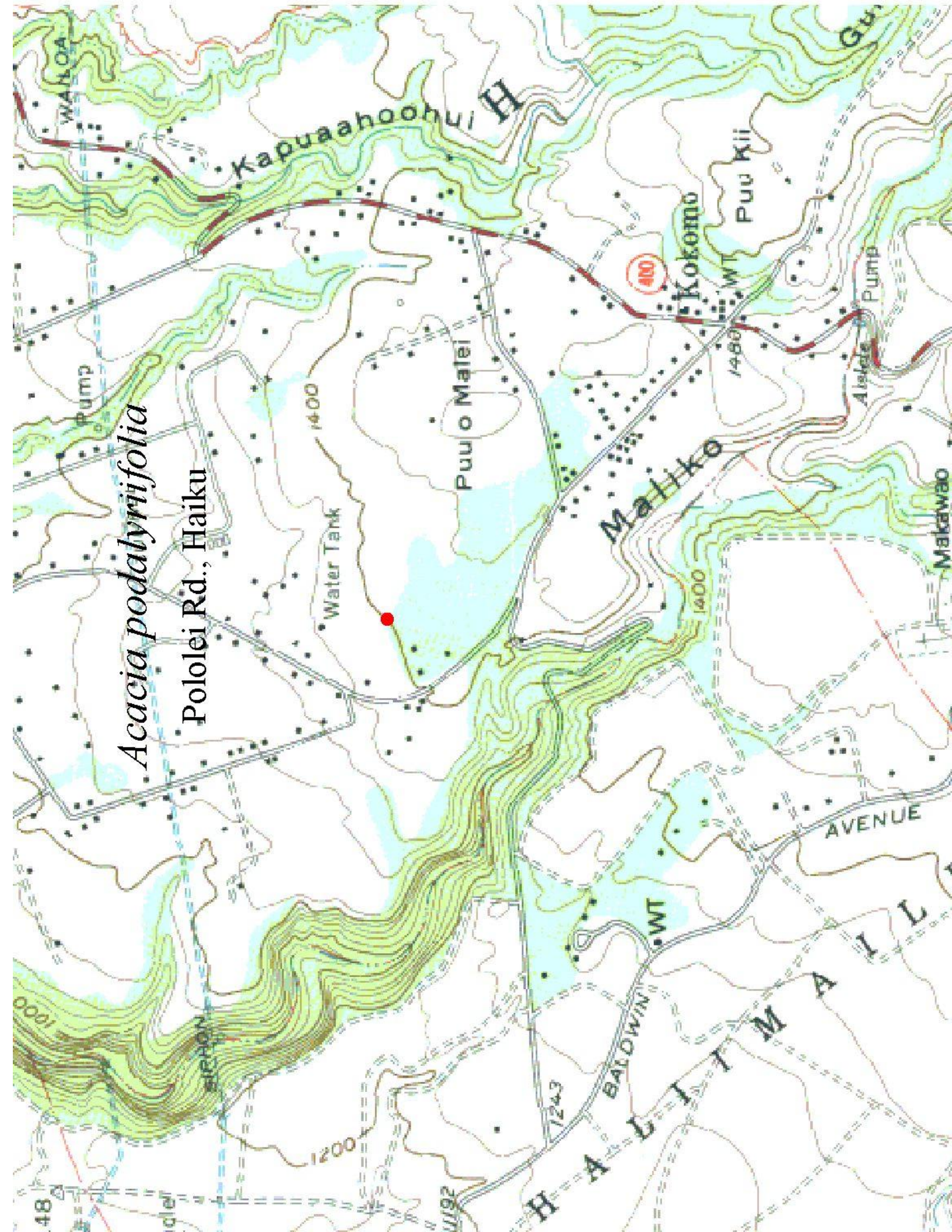


Acacia podalyriifolia

Tropical Gardens of Maui, Iao

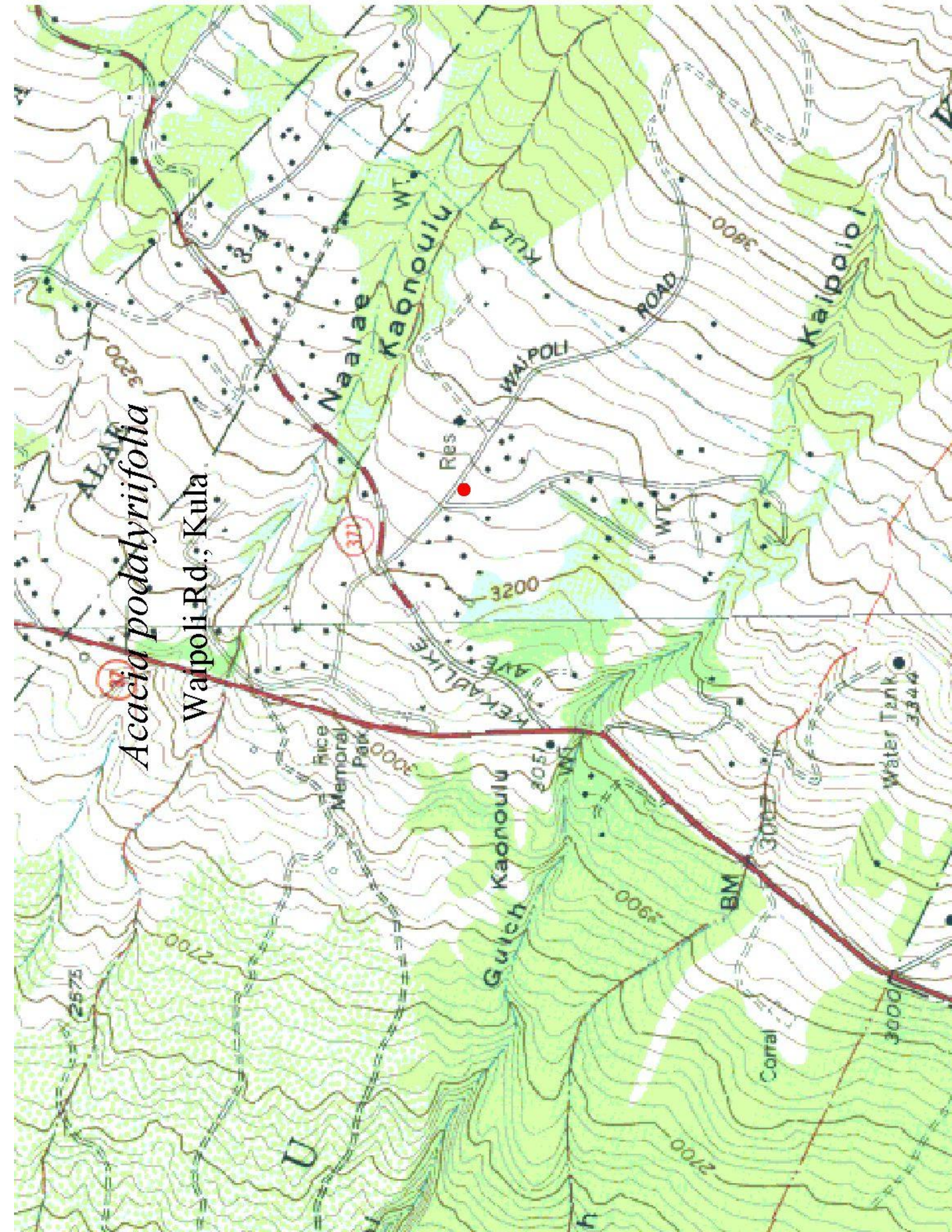
Acacia podalyrifolia

Pololei Rd., Haiku



Acacia podalyriifolia

Waipoli Rd., Kula



SITE INFORMATION -- *Acacia podalyriifolia*

-- Waipoli Rd., Kula.

A few medium sized trees located in yard, can be seen from the road, on west side of road. Planted with several other *Acacia* species.

-- Pololei Rd., Ha'iku.

Tree cultivated in yard.

-- Tropical Gardens of Maui, Iao.

Iao Valley Rd., Wailuku.

Plant cultivated in botanical garden.

Acacia podalyriifolia

Queensland silver wattle

Fabaceae

Forest Starr, Kim Starr, and Lloyd Loope
United States Geological Survey--Biological Resources Division
Haleakala Field Station, Maui, Hawai'i

October, 2003

OVERVIEW

Acacia podalyriifolia (Queensland silver wattle) is a silver leaved large shrub to small tree native to Queensland Australia. *A. podalyriifolia* is commonly cultivated in gardens and as a street tree in other parts of Australia and elsewhere in the world. In Victoria, Australia, this species has become locally invasive, spreading from initial plantings to nearby dry sclerophyll forest and woodland (Carr et al. 1992, Blood et al. 1998). The seeds are believed to be dispersed by birds and ants and reach peak germination after fires (Blood et al. 1998). *A. podalyriifolia* is considered a threat in one or more vegetation types in Australia (Carr et al. 1992). In Hawai'i, *A. podalyriifolia* was recently discovered being cultivated on Maui and is known from gardens in a few locations, Waipoli Rd., Ha'iku, and Iao Valley. With a history of weediness elsewhere and limited distribution on Maui, this species is a good candidate for eradication and control. Further island wide surveys are needed to locate any other sites where *Acacia podalyriifolia* occurs. Surveys on other Hawaiian Islands are also needed.

TAXONOMY

Family: Fabaceae (Pea family) (Wagner et al. 1999).

Latin name: *Acacia podalyriifolia* A. Cunningham ex G. Don (PLANTS 2003).

Synonyms: *Racosperma podalyriifolium* (A. Cunn. ex G. Don) Pedley (GRIN 2003).

Common names: Queensland silver wattle, Mount Morgan wattle, pearl wattle, pearl acacia (Swarbrick and Skarrat 1994, Blood et al. 1998, GRIN 2003, PLANTS 2003).

Taxonomic notes: The genus *Acacia* is made up of about 1,200 species that are widespread but with a large number in Australia (Wagner et al. 1999).

Nomenclature: The genus name is derived from *akakia*, the Greek name for *Acacia arabica* (Lam.) Willd., which is derived from *akis*, a Greek word meaning sharp point, in reference to the thorns of the plant (Wagner et al. 1999).

Related species in Hawai'i: Numerous *Acacia* species are known from Hawai'i, including native species such as *A. koa* and *A. koaia*, and naturalized non-native species such as *A. farnesiana*, *A. confusa*, *A. mearnsii*, and *A. melanoxydon*. Several non-native *Acacia* species have recently been found on Maui that are also potentially invasive including *A. auriculiformis*, *A. retinodes*, and *A. podalyriifolia*.

DESCRIPTION

"Tall, glaucous, pubescent shrub; phyllodes ovate or oblong, to 1 1/2 in. long; fl. heads in long racemes; fr. to 3 in. long (Bailey and Bailey 1976).

"A tall shrub or small tree which reaches about 5 m in height by a similar spread. With phyllodes silvery grey, oval, and 20-30 mm long. Flowers occur in ball shaped clusters in the axils of the phyllodes and a golden yellow color." (ASGAP 2001).

BIOLOGY & ECOLOGY

Cultivation: *Acacia podalyriifolia* is widely available in nurseries in Australia and is often cultivated for ornament and as a street tree (Blood et al. 1998). It is also cultivated in other warm regions of the world, including California (PLANTS 2003).

Invasiveness: *Acacia podalyriifolia* can become naturalized where planted (Simmons 1987). It is a pest in dry scrub and woodland of Victoria, Australia, where it is planted as an ornamental garden plant and street tree (Carr et al. 1992, Blood et al. 1998). It is considered a threat to one or more vegetation types there (Carr et al. 1992). This relatively quick growing tree flowers by the second year (ASGAP 2001). It is well suited to a wide variety of climates, particularly dry areas, and tolerates mild frost (ASGAP 2001).

Pollination: Not known.

Propagation: *A. podalyriifolia* is propagated from seeds which may have a prolonged dormancy. Germination of seeds peaks after fires (Swarbrick and Skarratt 1994).

Dispersal: In Australia, seeds are thought to be dispersed by birds and ants (Blood et al. 1998).

Pests and diseases: *A. podalyriifolia* is susceptible to sooty mold and borer attack and is considered to be relatively short lived (10-15 years) (Simmons 1981).

DISTRIBUTION

Native range: Queensland silver wattle (*Acacia podalyriifolia*) is native to Queensland, Australia (Carr et al. 1992).

Global distribution: *Acacia podalyriifolia* is naturalized in many warm areas of the world where it is planted (Simmons 1981).

State of Hawai'i distribution: *Acacia podalyriifolia* is sparingly cultivated on Maui. It is likely present on other Hawaiian Islands.

Island of Maui distribution: *Acacia podalyriifolia* is known from a few cultivated trees in gardens, in Kula, Ha'iku, and Iao. In Kula, a few trees can be readily seen along Waipoli Rd. and appear to have been planted with other *Acacia* species (*Acacia retinodes*) in a garden/residential yard setting. The area is relatively arid with a cool climate and is located at approximately 3,200 ft (975 m) elevation. The Ha'iku tree is a single tree in cultivation that was grown from a cutting from the Kula trees. This is a warm, moist, lowland residential area, at approximately 1,400 ft (427 m) elevation. A.

podalyriifolia is also cultivated at a botanical garden in Iao Valley. There are likely other sites on Maui where *A. podalyriifolia* is located. Island wide surveys are still needed.

CONTROL METHODS

Physical control: Girdle, pull seedlings (Swarbrick and Skarratt 1994).

Chemical control: Cut stump or basal bark methods using a suitable herbicide (Swarbrick and Skarratt 1994).

Biological control: None known.

Cultural control: This species could be discontinued in plantings in Hawai'i.

Noxious weed acts: None known.

MANAGEMENT RECOMMENDATIONS

Acacia podalyriifolia is widely planted in the Pacific and elsewhere as an ornamental, as a forestry tree, and for other purposes. It has become invasive in areas where it is planted. In Hawai'i, it is sparingly cultivated on Maui. Island wide surveys on Maui should be done to find new locations. Other Hawaiian Islands may also want to survey for this species. Control of this tree now may help to avoid its eventual invasion.

REFERENCES

ASGAP (Association of Societies for Growing Australian Plants). 2001. The Magic of Australian Native Plants. ASGAP. Available: <http://farrer.riv.csu.edu.au/ASGAP/> (Accessed: April 3, 2003).

Bailey, L.H. and E.Z. Bailey. 1976. *Hortus*. 3rd ed. Macmillan General Reference, NY.

Blood, K., U. Taylor, T. Nugent, and S. Timmins. 1998. Weed Navigator: Resource Guide. CRC for Weed Management Systems, New Zealand.

Carr, G.W., J.V. Yugovic, and K.E. Robinson. 1992. Environmental weed invasions in Victoria. Department of Conservation and Environment, Melbourne, Australia.

GRIN (Germplasm Resources Information Network). 2003. Online Database. United States Department of Agriculture, Agricultural Research Service, National Germplasm Resources Laboratory, Beltsville, MD. Available: <http://www.ars-grin.gov/> (Accessed: April 3, 2003).

PLANTS (National Plants Database). 2003. Online database. United States Department of Agriculture, Natural Resources Conservation Services, National Plant Data Center, Baton Rouge, LA. Available: <http://plants.usda.gov> (Accessed: April 3, 2003).

Simmons, M. 1981. Acacias of Australia. Thomas Nelson, Melbourne.

Swarbrick, J.R. and D.B. Skarratt. 1994. The Bushweed 2 Data Base of Environmental Weeds in Australia. The University of Queensland, Brisbane, Australia.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1999. *Manual of the Flowering Plants of Hawai'i*. 2 vols. Bishop Museum Special Publication 83, University of Hawai'i and Bishop Museum Press, Honolulu, HI.

Acacia retinodes

(Water wattle)

Acacia retinodes

Water wattle -- Fabaceae

Overview: *Acacia retinodes* (water wattle) is a small tree native to Australia that is commonly cultivated in warm regions of the world as an ornamental tree and for other various purposes. It is known to spread from initial plantings in at least California (CalFlora 2002). In Hawai'i, *A. retinodes* was recently discovered spreading from cultivated plants on Maui.



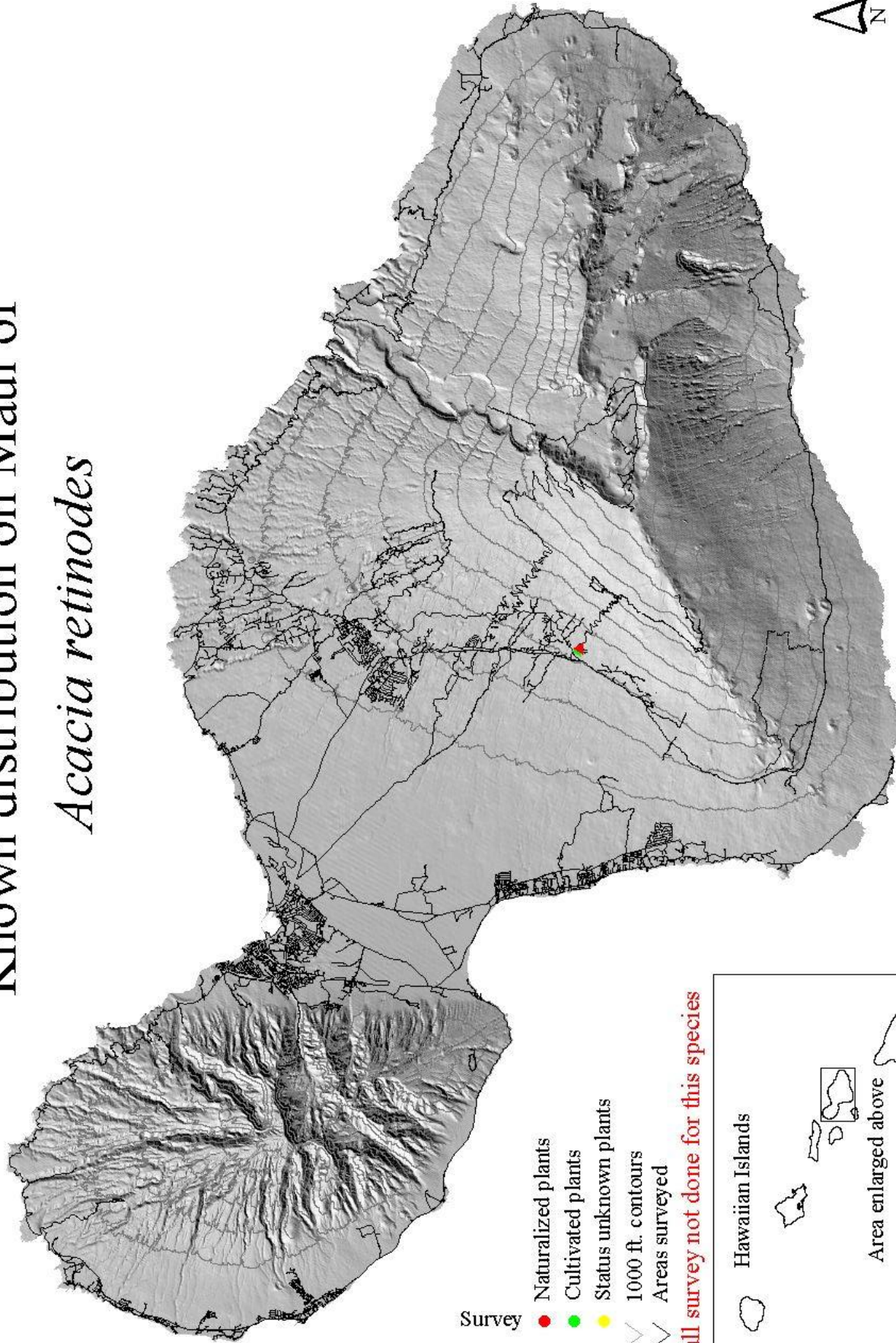
Description: "Shrub or small tree; phyllodes linear-lanceolate, to 5 in long, nearly straight, with gland near base; fl. heads 1/4 in. across, in branched racemes shorter than phyllodes; fr. narrow, to 8 in. long." (Bailey and Bailey 1976).

Impacts: *Acacia retinodes* is spreading from plantings in coastal counties of central and southern California (CalFlora 2002). In Florida, *A. retinodes* is known from central Florida and the Keys (Wunderlin and Hansen 2000).

Distribution: On Maui, *Acacia retinodes* is known from a few cultivated trees in a gardens in Kula. A few trees are sparingly naturalized in nearby scrub. The parent trees can be seen along Waipoli Rd. and appear to have been planted with other *Acacia* species in a garden/residential yard setting.

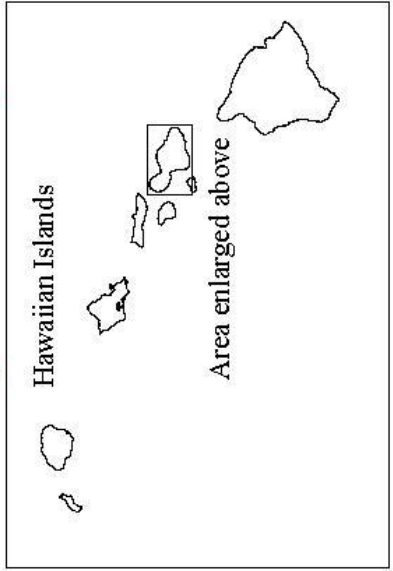
Control Methods: Girdle, pull seedlings (Swarbrick and Skarratt 1994). Cut stump or basal bark methods using a suitable herbicide is suggested for other *Acacia* species (Swarbrick and Skarratt 1994).

Known distribution on Maui of *Acacia retinodes*

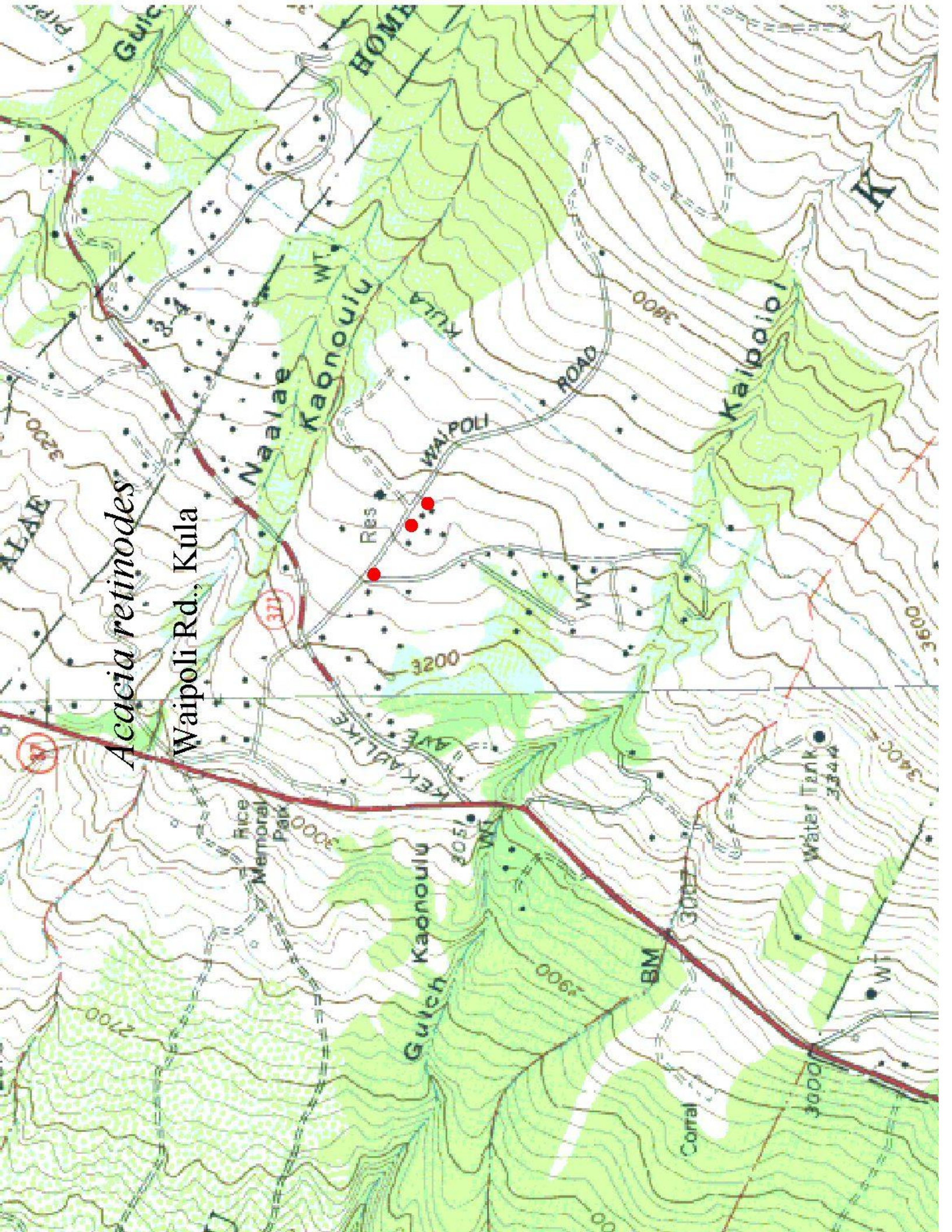


- Survey
 - Naturalized plants
 - Cultivated plants
 - Status unknown plants
- Interview
 - ▲
 - ▲
 - ▲
- 1000 ft. contours
- Areas surveyed

Full survey not done for this species



USGS-BRD Haleakala Field Station (May 2003)



Acacia retinodes

Waipoli Rd., Kula

Ries

Water Tank
3344

BM
3007

Corral

Rice
Memorial
Park

KEKAPILIKE
AVE

Gulch
Kadnoulu

KULA

WAI POLI
ROAD

Kaipolo

Maalae
Kadnoulu

HOMI

Gulch

ALAE

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

WT

SITE INFORMATION -- *Acacia retinodes*

-- Waipoli Rd., Kula.

A few medium sized trees located in yard, can be seen from the road, on west side of road. A few trees spreading in unmaintained areas nearby.





Acacia retinodes

Water wattle

Fabaceae

Forest Starr, Kim Starr, and Lloyd Loope
United States Geological Survey--Biological Resources Division
Haleakala Field Station, Maui, Hawai'i

April, 2003

OVERVIEW

Acacia retinodes (water wattle) is a small tree native to Australia that is commonly cultivated in warm regions of the world as an ornamental tree and for other various purposes. It is known to spread from initial plantings in at least California (CalFlora 2002). In Hawai'i, *A. retinodes* was recently discovered being cultivated on Maui and is known from a garden on Waipoli Rd. With a history of weediness elsewhere and limited distribution on Maui, this species is a good candidate for eradication and control. Further island wide surveys are needed to locate any other sites where *Acacia retinodes* occurs. Surveys on other Hawaiian Islands are also needed.

TAXONOMY

Family: Fabaceae (Pea family) (Wagner et al. 1999).

Latin name: *Acacia retinodes* Schldl. (CalFlora 2002).

Synonyms: None known.

Common names: Water wattle, swamp wattle, everblooming acacia (Wunderlin and Hansen 2000, CalFlora 2002).

Taxonomic notes: The genus *Acacia* is made up of about 1,200 species that are widespread but with a large number in Australia (Wagner et al. 1999).

Nomenclature: The genus name is derived from *akakia*, the Greek name for *Acacia arabica* (Lam.) Willd., which is derived from *akis*, a Greek word meaning sharp point, in reference to the thorns of the plant (Wagner et al. 1999).

Related species in Hawai'i: Numerous *Acacia* species are known from Hawai'i, including native species such as *A. koa* and *A. koaia*, and naturalized non-native species such as *A. farnesiana*, *A. confusa*, *A. mearnsii*, and *A. melanoxylon*. Several non-native *Acacia* species have recently been found on Maui that are also potentially invasive including *A. auriculiformis*, *A. mangium*, and *A. podalyriifolia*.

DESCRIPTION

"Shrub or small tree; phyllodes linear-lanceolate, to 5 in long, nearly straight, with gland near base; fl. heads 1/4 in. across, in branched racemes shorter than phyllodes; fr. narrow, to 8 in. long." (Bailey and Bailey 1976).

BIOLOGY & ECOLOGY

Cultivation: *Acacia retinodes* is cultivated in warm regions of the world including California and Florida (PLANTS 2003).

Invasiveness: *Acacia retinodes* is spreading from plantings in California (CalFlora 2002).

Pollination: Not known.

Propagation: *A. retinodes* is propagated from seeds.

Dispersal: In Australia, seeds of other *Acacia* species are thought to be dispersed by birds and ants (Carr et al. 1992, Blood et al. 1998).

Pests and diseases: Not known.

DISTRIBUTION

Native range: Water wattle (*Acacia retinodes*) is native from coastal South Australia, Tasmania (Flinders Island), and Victoria, Australia (GRIN 2003).

Global distribution: *A. retinodes* is naturalized in coastal counties of central and southern California between 0 and 2,952 ft (900 m) elevation (CalFlora 2002). In Florida, *A. retinodes* is known from central Florida and the Keys (Wunderlin and Hansen 2000).

State of Hawai'i distribution: *Acacia retinodes* is sparingly cultivated on Maui. It is likely present on other Hawaiian Islands.

Island of Maui distribution: *Acacia retinodes* is known from a few cultivated trees in a gardens in Kula. A few trees are sparingly naturalized in nearby scrub. The parent trees can be seen along Waipoli Rd. and appear to have been planted with other *Acacia* species (*Acacia podalyriifolia*) in a garden/residential yard setting. The area is relatively arid with a cool climate and is located at approximately 3,200 ft (975 m) elevation. There are likely other sites on Maui where *A. retinodes* is located. Island wide surveys are still needed.

CONTROL METHODS

Physical control: Girdle, pull seedlings (Swarbrick and Skarratt 1994).

Chemical control: Cut stump or basal bark methods using a suitable herbicide is suggested for other *Acacia* species (Swarbrick and Skarratt 1994).

Biological control: None known.

Cultural control: This species could be discontinued in plantings in Hawai'i.

Noxious weed acts: None known.

MANAGEMENT RECOMMENDATIONS

Acacia retinodes is occasionally cultivated in warm regions of the world. It has become naturalized in areas where it is planted, including California. In Hawai'i, it is sparingly cultivated and naturalized on Maui. Island wide surveys on Maui should be done to find new locations. Other Hawaiian Islands may also want to survey for this species. Control of this tree now may help to avoid its eventual invasion on Maui.

REFERENCES

Bailey, L.H. and E.Z. Bailey. 1976. *Hortus*. 3rd ed. Macmillan General Reference, NY.

Blood, K., U. Taylor, T. Nugent, and S. Timmins. 1998. *Weed Navigator: Resource Guide*. CRC for Weed Management Systems, New Zealand.

CalFlora. 2002. CalFlora Taxon Report: *Acacia retinodes*. CalFlora database, Berkeley, CA. Available: <http://www.calflora.org/> (Accessed: July 25, 2002).

Carr, G.W., J.V. Yugovic, and K.E. Robinson. 1992. *Environmental weed invasions in Victoria*. Department of Conservation and Environment, Melbourne, Australia.

GRIN (Germplasm Resources Information Network). 2003. Online Database. United States Department of Agriculture, Agricultural Research Service, National Germplasm Resources Laboratory, Beltsville, MD. Available: <http://www.ars-grin.gov/> (Accessed: April 3, 2003).

PLANTS (National Plants Database). 2003. Online database. United States Department of Agriculture, Natural Resources Conservation Services, National Plant Data Center, Baton Rouge, LA. Available: <http://plants.usda.gov> (Accessed: April 3, 2003).

Swarbrick, J.R. and D.B. Skarratt. 1994. *The Bushweed 2 Data Base of Environmental Weeds in Australia*. The University of Queensland, Brisbane, Australia.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1999. *Manual of the Flowering Plants of Hawai'i*. 2 vols. Bishop Museum Special Publication 83, University of Hawai'i and Bishop Museum Press, Honolulu, HI.

Wunderlin, R. and B. Hansen. 2003. *Atlas of Florida Vascular Plants*. Institute for Systematic Botany, University of South Florida, Tampa, FL. Available: <http://www.plantatlas.usf.edu/> (Accessed: April 3, 2003).

Caesalpinia decapetala

(Cats claw)

Caesalpinia decapetala

Cats claw -- Fabaceae

Overview: *Caesalpinia decapetala* is a woody vine with sharp thorns and yellow flowers that forms impenetrable thickets (Wagner et al. 1999). On Maui, *C. decapetala* is known from two locations. The larger of the two infestations is located at Halehaku (Kakipi) gulch area and side tributaries. The second infestation was recently found in Ulupalakua. This small patch has not yet spread far and may be containable.

Description: "Climbers or shrubs with sprawling branches, forming large impenetrable thickets, with recurved prickles on young branches and leaf rachises. Leaves with 3-15 pairs of pinnae, leaflets 5-12 pairs per pinna, oblong-elliptic, 1-2.2 cm long, 0.4-1.1 cm wide, apex rounded, stipules deciduous, obliquely ovate, 8-20 mm long, entire. Flowers perfect, 25-30 mm in diameter, in axillary and / or terminal racemes, when axillary often serial; petals yellow, upper one veined or blotched with red, 12-15 mm long. Pods dehiscent, slightly swollen, 6.5-11 cm long, 2-3 cm wide. Seeds 4-9 black, ellipsoid, laterally flattened, 8-12 mm long, 6-8 mm wide." (Wagner et al. 1999).

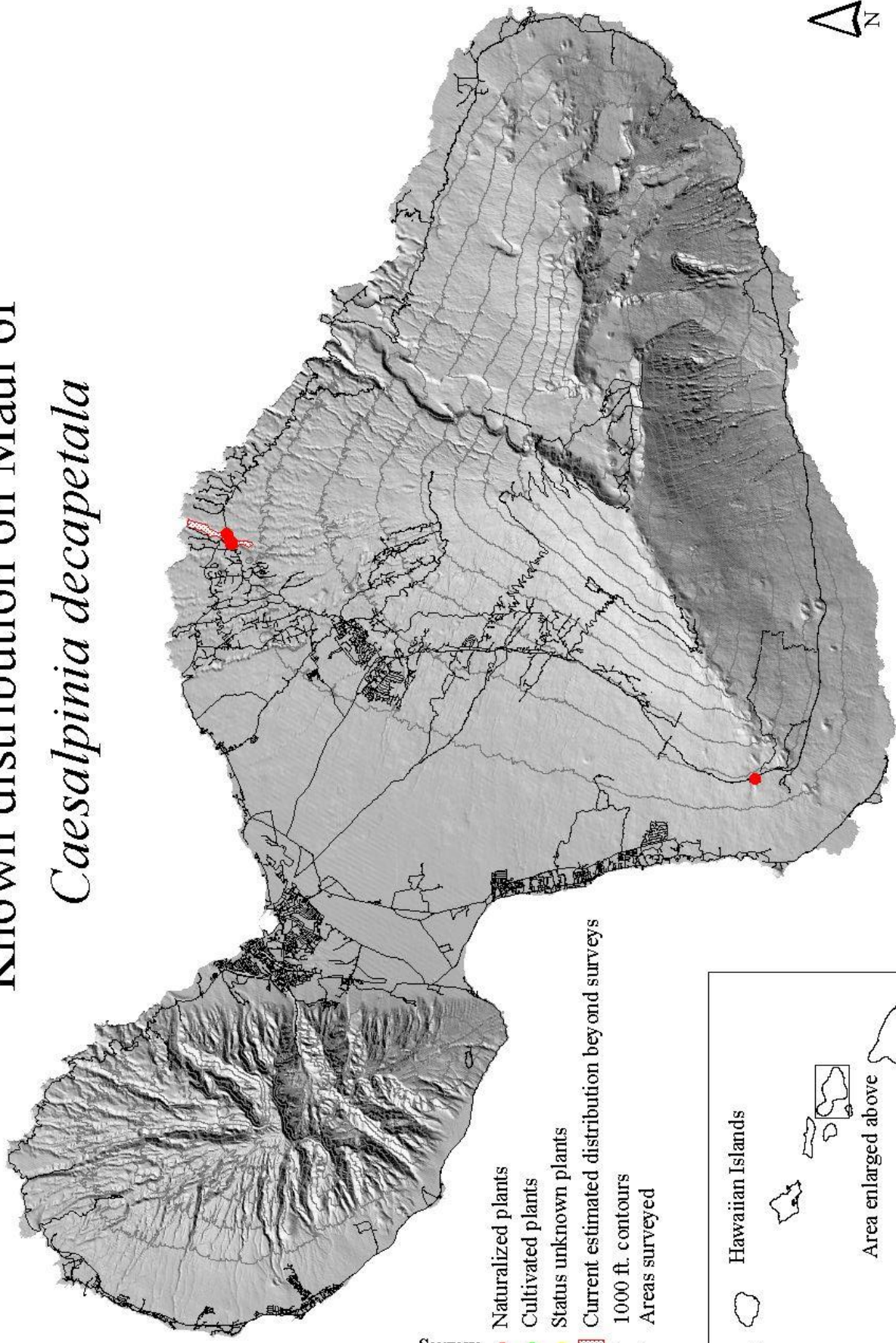
Impact: *C. decapetala* forms impenetrable brambles, climbs high up trees, closes off pastures to animals, and impedes passage in forests. It is a hazard to animals, which can become trapped in thickets (Motooka et al. 2002).



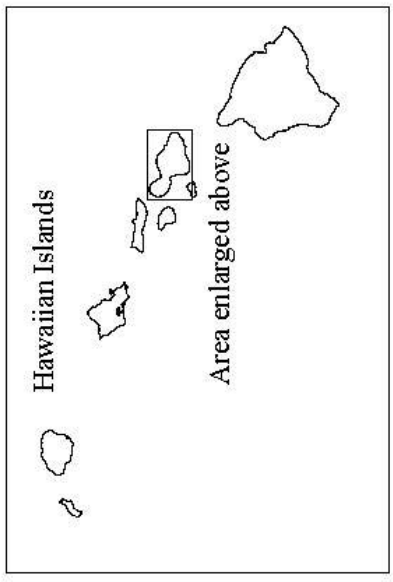
Distribution: On Maui, *C. decapetala* can be found along the Hana Hwy. at Halehaku gulch, close to sea level. Recently, a second small population was found in Ulupalakua.

Control Methods: The following control information for *C. decapetala* is from Motooka et al. (2002). "Sensitive to foliar applications of Glyphosate and triclopyr, and to soil applications of tebuthiuron. Adequate coverage of cats claw foliage in dense infestations is difficult. Timely repeat applications (3-9 months) of triclopyr ester at 0.25 lb/acre allows gradual reductions and opening of the canopy and eventual control. This strategy not only stresses the cats claw over a longer period but also controls newly germinated cats claw seedlings. Accessible stems may be treated basal bark with triclopyr ester at 20% product in diesel or crop oil in very low volume applications."

Known distribution on Maui of *Caesalpinia decapetala*



- | | | |
|-----------|---|---|
| Survey | ● | Naturalized plants |
| Interview | ▲ | Cultivated plants |
| | ▲ | Status unknown plants |
| | ■ | Current estimated distribution beyond surveys |
| | — | 1000 ft. contours |
| | — | Areas surveyed |



5 0 5 10 Miles

USGS-BRD Haleakala Field Station (May 2003)

SITE INFORMATION -- *Caesalpinia decapetala*

-- Ulupalakua Ranch, Ulupalakua.
Small patch located near the house.



Caesalpinia decapetala

Cats claw

Fabaceae

Forest Starr, Kim Starr, and Lloyd Loope
United States Geological Survey--Biological Resources Division
Haleakala Field Station, Maui, Hawai'i

October, 2003

OVERVIEW

Caesalpinia decapetala is a woody vine with sharp thorns and yellow flowers that forms impenetrable thickets (Wagner et al. 1999). This native of tropical Asia can be found on Ni'ihau, Kaua'i, O'ahu, East Maui, Hawai'i (Wagner et al. 1999), and Moloka'i (Tina Lau pers. comm.). This species was introduced as a fence plant for ranches before 1910 (Wagner et al. 1999), but the recurved thorns proved lethal, killing a cow on Kaua'i (Robert Hobdy pers. comm.). *C. decapetala* is widespread on Kaua'i, O'ahu, and Hawai'i. On Maui, *C. decapetala* is known from two locations. The larger of the two infestations is restricted to the Halehaku (Kakipi) gulch area and side tributaries. This population is thought to have come in on equipment from another island during construction of the new bridge. With sharp thorns all the way to the ground, controlling *C. decapetala* in this steep gulch would be difficult. At this location, *C. decapetala* may not be a feasible target for eradication, but through delineation of the area and education, it may be possible to keep it from invading throughout the watershed. The second infestation was recently found in Ulupalakua. This small patch has not yet spread far. *C. decapetala* has also been targeted for eradication on Moloka'i by the Moloka'i Invasive Species Committee (MOMISC).

TAXONOMY

Family: Fabaceae (pea family) (Wagner et al. 1999).

Latin name: *Caesalpinia decapetala* (Roth) Alston (Wagner et al. 1999).

Synonyms: *Reichardia decapetala* Roth; *Biancaea sepiaria* (Roxb.) Tod.; *Caesalpinia sepiaria* Roxb. (Haselwood et al. 1983, Wagner et al. 1999).

Common names: Cats claw, wait-a-bit, Mysore thorn, thorny poinciana, *puakelekino* (Wagner et al. 1999).

Taxonomic notes: *Caesalpinia* is a diverse genus of 70 or more species of trees, scandent to climbing shrubs (often thorny), and perennials found in scrub and lowland rainforest, and on mountain slopes in tropical and subtropical areas (Brickell and Zuk 1997). Most *Caesalpinia* are evergreen, some lose leaves in the tropical dry season. The leaves of all *Caesalpinia* are bipinnate, some very large with numerous leaflets, the flowers are in spikes from the upper leaf axils and may be quite showy, mostly in shades of red, yellow or cream, with separate petals and often conspicuous stamens. The seeds are in typical leguminous pods (Turner and Wasson 1997). The widespread species *C. bonduc*, *C. crista*, and *C. major* have been greatly confused since Linnaeus applied *C. bonduc* to two different species. A survey of the nomenclatorial history is given by

Hattink (1974); his conclusions have been followed here. Thus for Hawai'i the species generally known as *C. crista* is referred to *C. bonduc*, and *C. jabayo* becomes *C. major*.
Nomenclature: Named in honor of Cesalpino (1519-1603), Italian botanist, philosopher, and physician to Pope Clement VIII (Wagner et al. 1999).

Related species in Hawai'i: Other *Caesalpinia* species known to be occurring in the state of Hawai'i include *C. bonduc* (indigenous), *C. kawaiensis* (endemic and endangered), *C. major* (introduced), and *C. pulcherrima* (introduced) (Neal 1965, Wagner et al. 1999).

DESCRIPTION

"Climbers or shrubs with sprawling branches, forming large impenetrable thickets, with recurved prickles on young branches and leaf rachises. Leaves with 3-15 pairs of pinnae, leaflets 5-12 pairs per pinna, oblong-elliptic, 1-2.2 cm long, 0.4-1.1 cm wide, apex rounded, stipules deciduous, obliquely ovate, 8-20 mm long, entire. Flowers perfect, 25-30 mm in diameter, in axillary and / or terminal racemes, when axillary often serial; petals yellow, upper one veined or blotched with red, 12-15 mm long. Pods dehiscent, slightly swollen, 6.5-11 cm long, 2-3 cm wide. Seeds 4-9 black, ellipsoid, laterally flattened, 8-12 mm long, 6-8 mm wide." (Wagner et al. 1999).

BIOLOGY & ECOLOGY

Cultivation: *C. decapetala* is cultivated and naturalized in tropical regions throughout the world (GRIN 2002). *C. decapetala* can be used as a fence plant for ranches, as it forms impenetrable thorny hedges. In Hawai'i, it was introduced as an ornamental fence plant as early as 1888 (Wester 1992).

Invasiveness: *C. decapetala* is extremely thorny and aggressive. It climbs on vegetation, has a smothering habit, and makes walking impossible. In Australia, *C. decapetala* is listed as an environmental weed of subtropical rainforest and remnants in New South Wales (Nagle 1995). In Hawai'i, *C. decapetala* presents a formidable opposition for ranches and has the capability to take over large areas of land. State Forester Robert Hobdy saw a dead cow in a thicket on Kaua'i. Apparently the animal had gotten caught and struggled to free itself. The cow ended up suspended on the thicket four feet above ground with its four legs sticking straight up (Robert Hobdy pers. comm.). Besides taking over pasture, *C. decapetala* can engulf native forest, water delivery systems, and utility right of ways.

Pollination: Large numbers of yellow flowers tend to appear during winter and spring on Maui. Insects found on *C. decapetala* on Maui include the Sonoran carpenter bee (*Xylocopa sonorina*), bean butterfly (*Lampides boeticus*), honey bee (*Apis mellifera*), and crazy ants (*Technomyrmex albipes*). The first three were found on the flowers and could potentially be pollinating the flowers. The ants were found in the seed pods.

Propagation: *C. decapetala* can be propagated from seeds. It can also be propagated from cuttings. According to Hosaka and Thistle (1954), "Wherever the vine-like stems touch moist ground they take root and form new plants. Even old trunks, cut and used for fence posts, will take root and grow."

Dispersal: The medium sized seeds may be dispersed by rodents and granivorous birds, but man is almost certainly the principal dispersal agent in Hawai'i (Smith 1985). Hosaka and Thistle (1954) note that the seed is spread considerable distances by running water. It is thought that the Maui plants may have been the result of seeds in mud on large machinery used to do road work on the Hana Hwy. (R. Hobby pers comm.).

Pests and Diseases: Fungal canker, dieback, spider mite, whitefly, and mealy bug problems can occur on *C. decapetala* (Brickell and Zuk 1997).

DISTRIBUTION

Native range: *C. decapetala* is native to tropical Asia, India, and China (Haselwood et al. 1983; Turner and Wasson 1997). The native range includes Asia - temperate regions of China, Japan, and Korea; and Asia - tropical regions of Bhutan, India, Indonesia, Laos, Malaysia, Myanmar, Nepal, Philippines, Sri Lanka, Thailand, Vietnam (GRIN 2002). Average temperatures in these areas range from 50-over 68 F (10-over 20 C) in January to 68-over 86 F (20-over 30 C) in July (Hammond 1986). Average annual rainfall in these areas is approximately 40-over 80 in (100-over 200 cm) (Hammond 1986).

Global distribution: *C. decapetala* is cultivated and naturalized in tropical regions throughout the world (GRIN 2002). *C. decapetala* has successfully invaded Africa, Hawai'i, Australia, subtropical New Zealand islands, Fiji, French Polynesia, and New Caledonia (PIER 1999, Wagner et al. 1999, Spriggs 2001). In South Africa, *C. decapetala* is a declared noxious weed (PIER 1999) and is reported to invade disturbed lowland moist forest margins, threatening the bio-diversity of the forests (Spriggs 2001). In the Pacific, *C. decapetala* is currently under a control program on Raoul, Kermadec Islands (PIER 1999). Missouri Botanical Garden (2002) specimen database includes the following collection locations. South America: Columbia, 1,580 m (5,184 ft), 2.32.34N and 76.34.4W; and Peru, 700-2,475 m (2,297-8,120 ft), 4.34-13.38 S and 72.52-79.32W. Africa: Burundi, 1,450 m (4,757 ft); Tanzania, 1,162-2,088 m (3,812-6,850 ft), 01.01.32-03.16.03S and 031.25-037.54.10E; and Uganda, 1,200 m (3,937 ft), .37N and 32.35E.

State of Hawai'i distribution: *C. decapetala* was first recorded in Hawai'i in 1888 (Wester 1992). *C. decapetala* can now be found naturalized along roadsides, in gulches, along stream beds, in moist regions, near abandoned house sites, and other disturbed areas, 0 – 250 m (820 ft), on Ni'ihau, Kaua'i, O'ahu, Lana'i, Moloka'i, East Maui, and Hawai'i (Wagner et al. 1999, Tina Lau pers. comm.). *C. decapetala* is a weed in pastures, range lands, and waste places (Haselwood et al. 1983). Infestations can be found along the Honouliuli trail of the Wai'anae Mountains and on the windward side of O'ahu, the upper pastures and adjacent forest of much of northeastern Kaua'i, and Halehaku gulch and Ulupalakua, Maui (Wagner et al. 1999). On the island of Hawai'i, *C. decapetala* is locally common in Ka'u and perhaps elsewhere. On Moloka'i, *C. decapetala* is known from 3 populations in Kalae defined by interconnected gulches (Tina Lau pers. comm.).

Island of Maui distribution: *C. decapetala* can be found along the Hana Hwy. at Halehaku gulch, close to sea level. Average annual rainfall in this area is 60-80 in (152-203 cm) (Juvik and Juvik 1998). The yellow flowered vine can be seen growing on the walls and flat surfaces of the valley. The greatest density is found near the bridge on Hana highway. The density drops off on either side, but *C. decapetala* can be found all the way to the ocean and almost a mile upslope of the Hana highway. The upper extent in the gulch is not known and may need aerial surveys. A satellite patch was found in a nearby tributary, just East of Halehaku gulch. Recently, a second small population was found in Ulupalakua, at approximately 1,800 ft (549 m). The area receives average annual rainfall of about 20-30 in (51-76 cm) (Juvik and Juvik 1998). This site is far from the larger established site at Halehaku gulch and is being considered for control by the Maui Invasive Species Committee (MISC). The potential distribution on Maui could be much larger than it currently is, occupying disturbed areas, margins of mesic forests, gulches, and pastures from sea level to at least 1,800 ft (549 m) and possibly higher.

CONTROL METHODS

Physical control: *C. decapetala* is extremely prickly, and attempts at physical control must be done carefully. MOMISC has targeted *C. decapetala* for eradication and is experimenting with control methods. Heavy machinery would not be an option in Halehaku gulch due to steep and difficult terrain.

Chemical control: A visit to the site on July 25, 1998, showed that plants at the side tributary population had been controlled. It appeared to have been controlled by a foliar spray with an herbicide. This patch seemed relatively controlled by August 2002. It is not known who did the control or what was used. Plants encroaching on the road are sprayed by the road crew. Possible control methods include helicopter foliar, ground foliar, cut stump, and basal bark. Foliar spray, while costly, may be the best way to treat plants due to the numerous thorns and thicket like structure that would make basal bark or cut stump treatments difficult. The following control information for *C. decapetala* is from Motooka et al. (2002). "Sensitive to foliar applications of Glyphosate and triclopyr, and to soil applications of tebuthiuron. Adequate coverage of cats claw foliage in dense infestations is difficult. Timely repeat applications (3-9 months) of triclopyr ester at 0.25 lb/acre allows gradual reductions and opening of the canopy and eventual control. This strategy not only stresses the cats claw over a longer period but also controls newly germinated cats claw seedlings. Accessible stems may be treated basal bark with triclopyr ester at 20% product in diesel or crop oil in very low volume applications."

Biological control: Potential for biological control has not been evaluated (Smith 1985).

Cultural control: The residents of Maui could be discouraged from planting or spreading *C. decapetala*. Machinery and gear should be cleaned, especially if working in areas of *C. decapetala*.

Noxious weed acts: *C. decapetala* is currently not on the Hawai'i state noxious weed list, but is a good candidate for listing. *C. decapetala* is declared a noxious weed in South Africa (PIER 1999). It is also listed as a weed by the following three sources:

Greening Australia project, University of Hawai'i Botany Department, and Hawai'i Department of Land and Natural Resources.

MANAGEMENT RECOMMENDATIONS

C. decapetala is only found from two locations on the entire island of Maui. The first location is a large infestation at Halehaku gulch. The second is a small patch in Ulupalakua. For the Halehaku site, controlling upslope and lateral spread along with notifying the principal land owner / lessee and nearby residents and ranchers may be a goal to work towards. *C. decapetala* may be a good candidate for NRCS's EQUIP program which shares costs with landowners in efforts to eradicate harmful weeds. In the future, local distribution should be refined and updated, especially upslope of the road. Aerial surveys while the plant is in flower (January/February) may be the best way to refine mapping. The second site at Ulupalakua is still small and controllable. *C. decapetala* appears to be a prolific seed producer, and seed production, fertility, and viability data may be useful. Control trials should be done to test the most efficient control methods.

REFERENCES

- Brickell, C. and J. D. Zuk. 1997. *The American Horticultural Society A-Z Encyclopedia of Garden Plants*. DK Publishing, Inc., NY.
- Hammond Incorporated. 1986. *Hammond Citation World Atlas*. Hammond Incorporated, Maplewood, NJ.
- Haselwood, E.L. and G.G. Motter, eds. 1983. *Handbook of Hawaiian Weeds*. 2nd ed., revised and expanded by R.T. Hirano. Harold L. Lyon Arboretum, University of Hawai'i, Honolulu, HI.
- Hattink, T.A. 1974. A revision of Malesian *Caesalpinia*, including *Mezonuron* (Leguminosae-Caesalpinaceae). *Reinwardtia* 9:1-69.
- Hosaka, E.Y. and A. Thistle. 1954. *Noxious Plants of the Hawaiian Ranges*. Extension Bulletin 62. College of Agriculture, Agricultural Extension Service, University of Hawai'i, HI.
- Juvik, S.P and J.O. Juvik. 1998. *Atlas of Hawai'i*. 3rd ed. Department of Geography, University of Hawai'i press, Honolulu, HI.
- Missouri Botanical Garden. 2002. W3TROPICOS: Specimen database. Available: http://mobot.mobot.org/cgi_bin/search_vast (Accessed: November 13, 2002).
- Motooka, P., L. Castro, D. Nelson, G. Nagai, and L. Ching. 2002. *Weeds of Hawai'i's Pastures and Natural Areas: An Identification and Management Guide*. College of Tropical Agriculture and Human Resources, University of Hawai'i at Manoa, Honolulu, HI.

Nagle, John. 1995. Weeds of Rainforest. Greening Australia. Available: <http://www.nor.com.au/environment/greenwork/werain.htm> (Accessed: January 19, 1999).

Neal, M.C. 1965. *In Gardens of Hawai'i*. Bernice P. Bishop Museum, Special Publication 40, Honolulu, HI.

PIER (Pacific Islands Ecosystems at Risk). 1999. Invasive Plant Species: *Buddleia madagascariensis*. Available: <http://www.hear.org/pier> (Accessed: January 19, 1999).

Smith, Clifford W. 1985. Impact of alien plants on Hawai'i's native biota. In: Charles P. Stone and J. Michael Scott, eds., *Hawai'i's Terrestrial Ecosystems: Preservation and Management*. Cooperative National Park Resources Studies Unit, University of Hawai'i, Manoa, HI. p. 187.

Spriggs, A. 2001. Eastern Zimbabwe montane forest-grassland mosaic. World Wildlife Fund. Available: http://www.worldwildlife.org/wildworld/profiles/terrestrial/at/at1006_full.html (Accessed: November 13, 2002).

Stone C.P., C.W. Smith, and J.T. Tunison. 1992. *Alien Plant Invasions in Native Ecosystems of Hawai'i: Management and Research*. University of Hawai'i Cooperative National park Resources Studies Unit, Honolulu, HI.

Tanimoto, V.M. and W.P. Char. 1992. Alien plant control on state lands including natural areas. In: Stone C.P., C.W. Smith, and J.T. Tunison. eds., *Alien Plant Invasions in Native Ecosystems of Hawai'i: Management and Research*. University of Hawai'i Cooperative National park Resources Studies Unit, Honolulu, HI.

Turner, R. J. Jr. and E. Wasson. 1997. *Botanica*. Mynah, USA.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1999. *Manual of the Flowering Plants of Hawai'i*. 2 vols. Bishop Museum Special Publication 83, University of Hawai'i and Bishop Museum Press, Honolulu, HI.

Wester, L. 1992. Origin and distribution of adventive alien flowering plants in Hawai'i. In: *Alien Plant Invasions in Native Ecosystems of Hawai'i*. C.P. Stone, C.W. Smith, and J.T. Tunison, eds. University of Hawai'i Press, Honolulu, HI.

Macaranga mappia

(Bingabing)

Macaranga mappa

Bingabing -- Euphorbiaceae

Overview: *Macaranga mappa* is a large leaved plant native to the Philippines that is cultivated in Hawai'i and elsewhere as a tropical ornamental and as a forestry tree (Skolmen 1960, Neal 1965). *M. mappa* was supposedly aurally seeded by plane after a large fire swept through Hilo, Hawai'i. *M. mappa* now forms large dense stands in this area and is naturalized in low elevation moist to mesic areas on O'ahu and Hawai'i (Wagner et al. 1999). On Maui, *M. mappa* is known from a single plant in cultivation.

Description: "Trees 5-10 m tall. Leaves very large, peltate, orbicular-ovate to broadly ovate, 60-100 cm long, petioles 30-60 cm long, stipules 6-15 cm long. Staminate flowers in panicles 15-20 cm long, bracts and calyx pink, stamens \pm 10, anthers tetralothecal; pistillate flowers in dense, bracteate clusters, ovary 2-celled, styles ca. 10 mm long, connate at base. Capsules 2-3 celled, 8-10 mm long, glabrous, each valve armed with 2 spine-like processes." (Wagner et al. 1999).

Impact: On the island of Hawai'i, *M. mappa* forms large dense thickets on roadsides, gulches, and disturbed forests in the Hilo vicinity. This large leaved tree has dense growth that can crowd and shade out other vegetation.

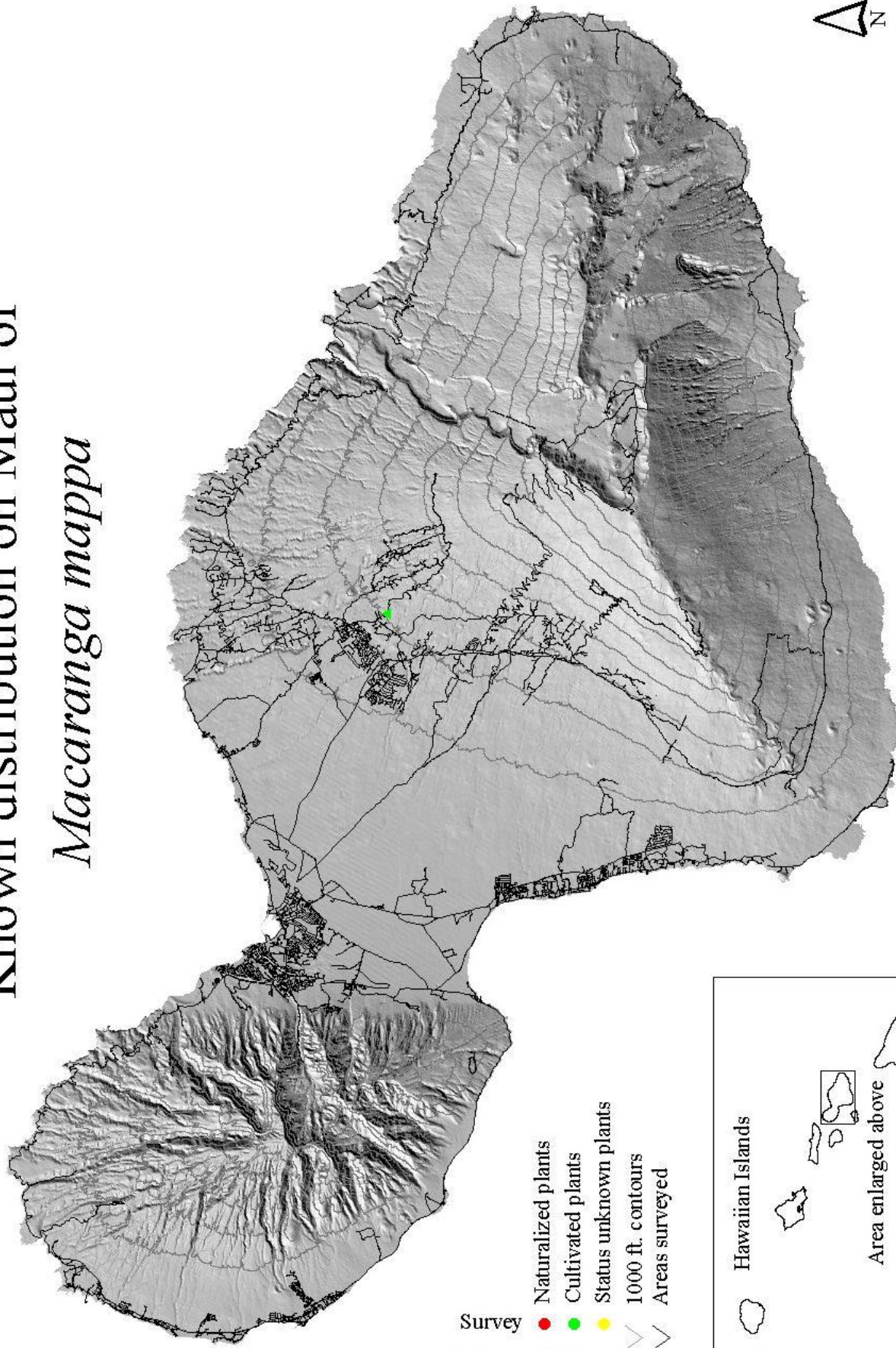
Distribution: On Maui, a single *M. mappa* tree was found being cultivated as an ornamental plant in Olinda. The plant is located at a residence along



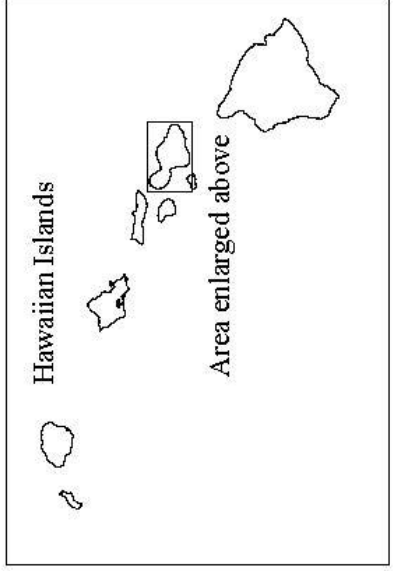
Olinda Rd. where there is no obvious sign of spread yet.

Control Methods: Control methodology for *M. mappa* has yet to be refined for Hawai'i. It is uncertain whether cutting at the base would completely control this tree or if application of herbicides are necessary.

Known distribution on Maui of *Macaranga mappa*



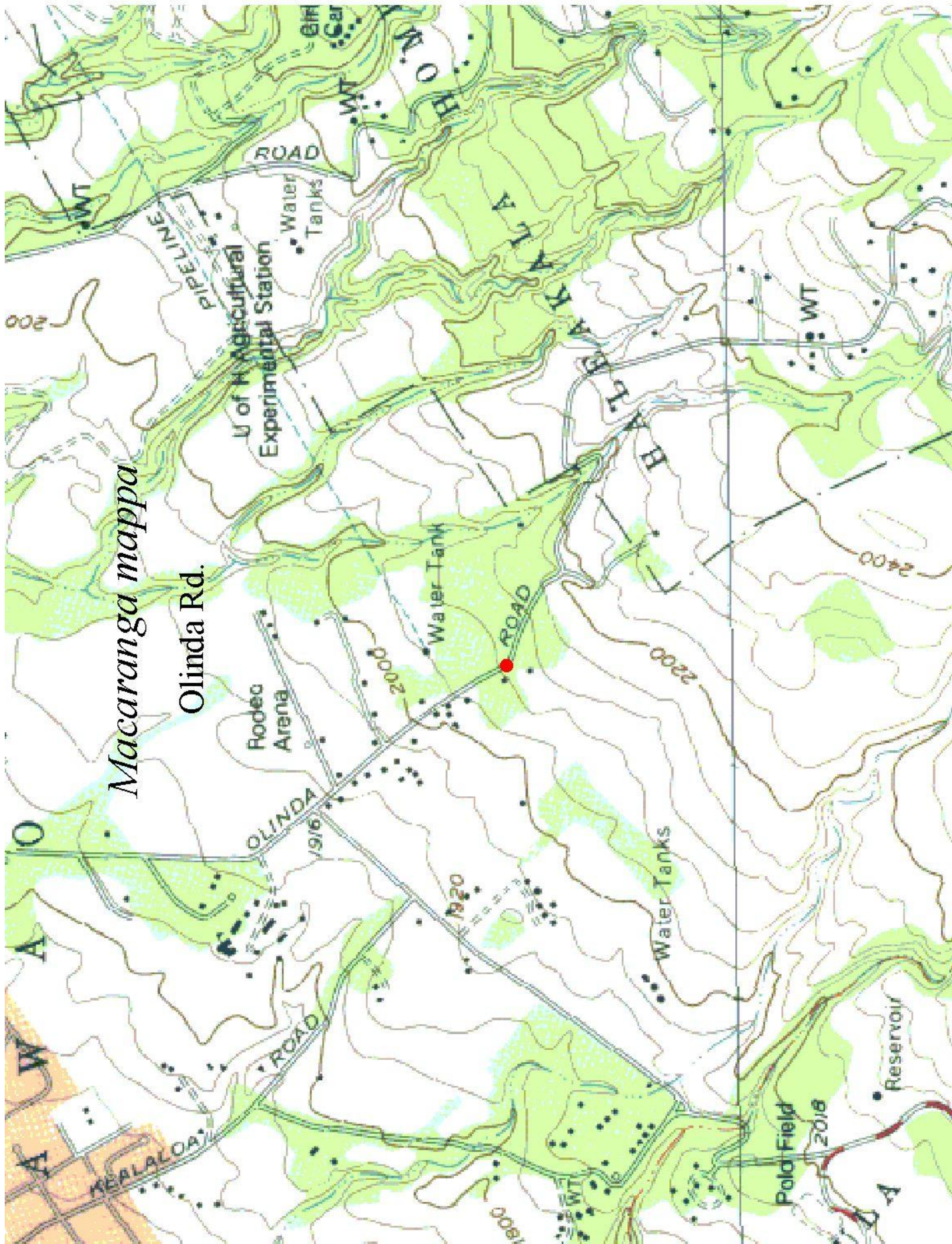
- | | | |
|-----------|---|-----------------------|
| Survey | ● | Naturalized plants |
| Interview | ▲ | Cultivated plants |
| | ● | Status unknown plants |
| | — | 1000 ft. contours |
| | — | Areas surveyed |



5 0 5 10 Miles
USGS-BRD Haleakala Field Station (May 2003)

Macaranga mappa

Olinda Rd.



SITE INFORMATION -- *Macaranga mappia*

-- Olinda Rd., Makawao.

On right side of road driving mauka, a single tall plant located near the driveway entrance.





Macaranga mappa

Bingabing
Euphorbiaceae

Forest Starr, Kim Starr, and Lloyd Loope
United States Geological Survey--Biological Resources Division
Haleakala Field Station, Maui, Hawai'i

January, 2003

OVERVIEW

Macaranga mappa is a large leaved plant native to the Philippines that is cultivated in Hawai'i and elsewhere as a tropical ornamental and as a forestry tree (Skolmen 1960, Neal 1965). *M. mappa* was supposedly aerially seeded by plane after a large fire swept through Hilo, Hawai'i. *M. mappa* now forms large dense stands in this area and is naturalized in low elevation moist to mesic areas of lowlands, 0-220 m (722 ft), on O'ahu and Hawai'i (Wagner et al. 1999). On Maui, *M. mappa* is known from a single plant in cultivation. It is currently being considered as a potential target species for eradication by the Maui Invasive Species Committee (MISC). Control of this specimen now may prevent larger infestations in the future. Future efforts should also include monitoring to locate any other *M. mappa* on Maui. In addition, placing this species on the Hawai'i state noxious weed list would provide legal authority to help prevent further sale and transport.

TAXONOMY

Family: Euphorbiaceae (spurge family) (Wagner et al. 1999).

Latin name: *Macaranga mappa* (L.) Mull. Arg. (Wagner et al. 1999).

Synonyms: *Ricinis mappa* L., *Croton grandifolius* Blanco, *Macaranga grandifolia* (Blanco) Merr. (Wagner et al. 1999).

Common names: Bingabing, *Macaranga* (Neal 1965, Wagner et al. 1999)

Taxonomic notes: The genus, *Macaranga*, is made up of 250-280 species from tropical Africa, Madagascar, and Malesia to Australia and some parts of the Pacific, though none are native to Hawai'i (Wagner et al. 1999).

Nomenclature: The name refers to the native Madagascar name for these plants (Wagner et al. 1999).

Related species in Hawai'i: Also known from Hawai'i is *Macaranga tanarius* (L.) Mull. Arg. which is distinguished by having smaller leaves (8-30 cm long), and bracts and calyx pale green to yellowish green (Wagner et al. 1999). A third as yet unidentified *Macaranga* species was recently observed on Maui.

DESCRIPTION

"Trees 5-10 m tall. Leaves very large, peltate, orbicular-ovate to broadly ovate, 60-100 cm long, petioles 30-60 cm long, stipules 6-15 cm long. Staminate flowers in panicles 15-20 cm long, bracts and calyx pink, stamens \pm 10, anthers tetrathecal; pistillate flowers in dense, bracteate clusters, ovary 2-celled, styles ca. 10 mm long, connate at base. Capsules 2-3 celled, 8-10 mm long, glabrous, each valve armed with 2 spine-like processes." (Wagner et al. 1999).

BIOLOGY & ECOLOGY

Cultivation: *M. mapp*a is a tropical ornamental with large showy leaves and tree like habit. It is cultivated in Hawai'i and other tropical regions of the world for ornament and in reforestation projects.

Invasiveness: On the island of Hawai'i, *M. mapp*a was seeded from airplanes along with many other weedy forestry species near Hilo after a fire. The area is warm and moist and many species, including *M. mapp*a, thrived. Today, *M. mapp*a lines roadsides, gulches, and disturbed forests in the vicinity. This large leaved tree has dense growth that can crowd and shade out other vegetation. *M. mapp*a is listed as a weed in Western Australia's global compendium of weeds (Randall 2002).

Pollination: Unknown. The related species, *M. tanarius*, is wind pollinated (World Agroforestry Centre 2002), and it is likely that *M. mapp*a is as well.

Propagation: *M. mapp*a is propagated by seeds.

Dispersal: Long distance dispersal of *M. mapp*a is achieved primarily through humans who use the plant in ornamental landscaping or reforestation.

Pests and Diseases: Unknown. Plants in Hilo, Hawai'i did not appear to have any obvious insect damage or predation.

DISTRIBUTION

Native range: *M. mapp*a is native to the Philippines (Wagner et al. 1999).

Global distribution: *M. mapp*a is cultivated in tropical regions throughout the world.

State of Hawai'i distribution: In Hawai'i, *M. mapp*a is known to be naturalized on the islands of O'ahu and Hawai'i in low elevation mesic to wet areas and disturbed mesic valleys, 0-220 m (0-721 ft) (Wagner et al. 1999). Apparently, the abundance of *M. mapp*a in the Hilo, Hawai'i vicinity is a result of seeds that were sown from aircraft after a large fire. The area is wet receiving annual rainfall amounts of approximately 120 in (305 cm). In this area, *M. mapp*a is abundant and healthy and seems to thrive in the moist warm climate. Forestry records list several plantings (as *M. grandifolia*) on O'ahu, including 20 trees planted in the Honouliuli Forest Reserve in 1927 and 107 trees planted in Honolulu in 1928 (Skolmen 1960). On Kaua'i, a total of 81 *M. mapp*a were planted in the Lihue-Koloa Forest Reserve in 1927 (Skolmen 1960). There are currently no reports of this species being naturalized on the island of Kaua'i and the current status of this early forestry planting is uncertain. It is also possible that *M. mapp*a exists on other islands but it has not been reported as so yet.

Island of Maui distribution: During island wide surveys in 2000, a single *M. mapp*a tree was found being cultivated as an ornamental plant in Olinda, Maui. The plant is located at a residence along Olinda Rd., approximately 2,000 ft (610 m) elevation and the

climate is cool with average annual rainfall averaging about 40 in (102 cm). There is currently no sign of spread there yet, perhaps due to the arid climate, the lack of numerous trees for reproduction to occur, or lack of time to naturalize.

CONTROL METHODS

Control methodology for *M. mappa* has yet to be refined for Hawai'i. It is uncertain whether cutting at the base would completely control this tree or if application of herbicides are necessary. Further testing is necessary to be sure.

Physical control: Most likely, seedlings and small plants can be dug up. In ornamental situations if the stand is reasonable size, digging the plant up may be the preferred method.

Chemical control: In large wild stands, perhaps a cut stump or basal bark herbicide method would be effective. Foliar spray may be costly due to the large size of the leaves and biomass. Foliar spray would also not be advised in areas where non-target plants were present.

Biological control: None known.

Cultural control: The public could be discouraged from planting *M. mappa*, especially near natural or wet areas.

Noxious weed acts: None known.

MANAGEMENT RECOMMENDATIONS

M. mappa is cultivated in Hawai'i and is naturalized in low wet areas of O'ahu and Hawai'i (Wagner et al. 1999). This large leaved tree forms dense thickets in the Hilo area, crowding out other plants and forming deep shade areas. On Maui, there is a single known plant that is currently being considered for eradication by MISC. Eradication of this weedy species now may save time, money, and resources in the future. The Kaua'i forestry planting's status is unknown and should be updated and removed if deemed appropriate. Other islands free of *M. mappa* should be advised of the potential for *M. mappa* to spread and form dense thickets in moist areas.

REFERENCES

- Neal, M. C. 1965. In Gardens of Hawai'i. Bernice P. Bishop Museum Special Publication 40, Bishop Museum Press, Honolulu, HI.
- Randall, R. 2002. Global Compendium of Weeds. Department of Agriculture - Western Australia. Available: <http://www.hear.org/gcw> (Accessed: August 22, 2002).
- Skolmen, R.G. 1960. *Plantings on the Forest Reserves of Hawai'i: 1910-1960*. Institute of Pacific Islands Forestry, Pacific Southwest Forest and Range Experiment Station, United States Forest Service, Honolulu, HI.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1999. *Manual of the Flowering Plants of Hawai'i*. 2 vols. Bishop Museum Special Publication 83, University of Hawai'i and Bishop Museum Press, Honolulu, HI.

World Agroforestry Centre. 2002. Botanic Nomenclature to Agroforestry trees: *Macaranga tanarius*. World Agroforestry Centre. Available: <http://www.worldagroforestrycentre.org> (Accessed: August 22, 2002).

Macaranga tanarius

(Parasol leaf tree)

Macaranga tanarius

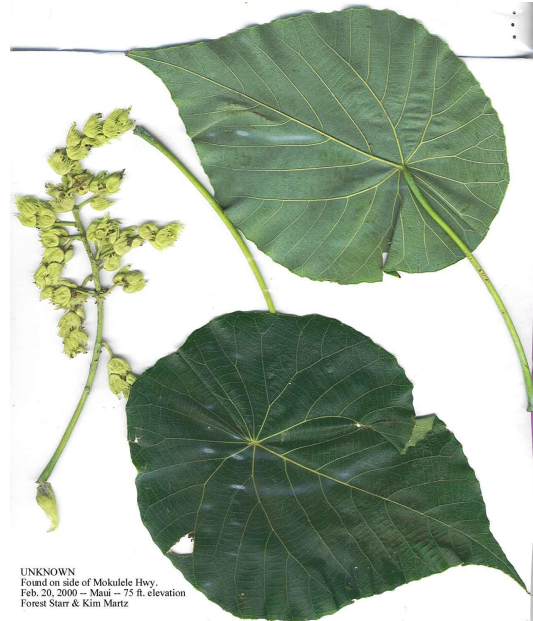
Parasol leaf tree -- Euphorbiaceae

Overview: *Macaranga tanarius*, native to Malaysia, is a medium size tree that is cultivated for ornament and reforestation in Hawai'i and other tropical regions of the world. In Hawai'i, *M. tanarius* is naturalized in disturbed mesic valleys on Kaua'i, O'ahu, and Maui (Oppenheimer et al. 1999, Wagner et al. 1999). On Maui, *M. tanarius* is widely naturalized in the Waikapu area of West Maui where it forms dense thickets in mesic valleys and streams. On East Maui, only a single cultivated tree is currently known.

Description: "Dioecious trees 4-10(-20) m tall. Leaves peltate, ovate to oblong-ovate, 8-30 cm long, petioles 6-25 cm long, stipules oblong to narrowly ovate, 1-3 cm long, quickly deciduous. Staminate flowers in open panicles 13-35 cm long, bracts and calyx pale green to yellowish green, stamens (3)4-6(-10), anthers tetrathecal; pistillate flowers in panicles 8-30 cm long, ovary 2-3 celled, styles 5-8 mm long. Capsules 2-3-valved, 10-12 mm long, covered with pale waxy glands and soft, scattered, elongate, spine-like processes." (Wagner et al. 1999).

Impact: *M. tanarius* forms dense thickets in streams, valleys, and moist areas which crowd out desirable vegetation. This prolific tree also invades roadsides, fencelines, and disturbed areas.

Distribution: On Maui, the major *M. tanarius* infestation occurs on West Maui, in the Waikapu area. Here, *M. tanarius* fills valleys, streams, ridges,

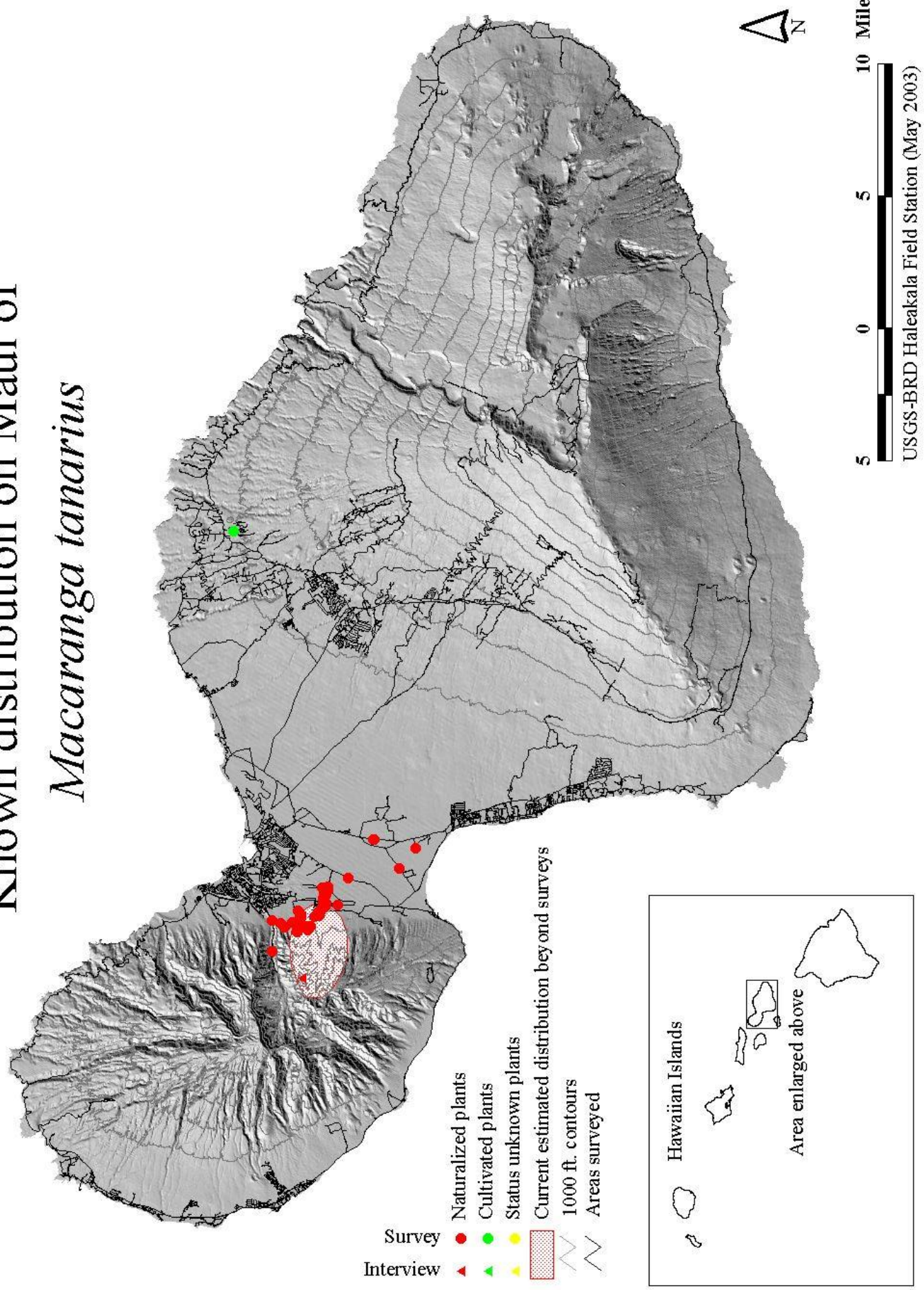


UNKNOWN
Found on side of Mokuale Hwy.
Feb. 20, 2000 -- Maui -- 75 ft. elevation
Forest Starr & Kim Martz

and disturbed areas up to the summit of Kapilau. On East Maui, only a single cultivated specimen is currently known from a residence in Ulumalu, Ha'iku.

Control Methods: Control methodology for *M. tanarius* has yet to be refined for Hawai'i. It is uncertain whether cutting at the base would completely control this tree or if application of herbicides are necessary.

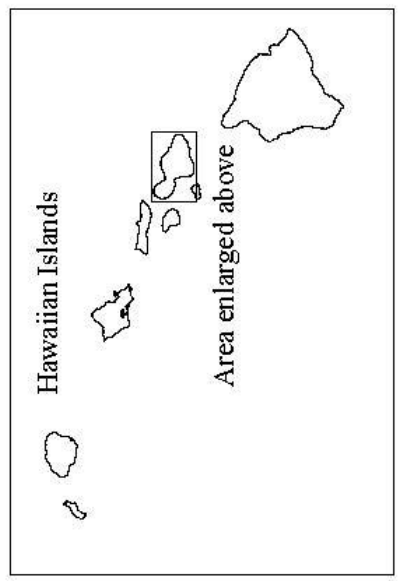
Known distribution on Maui of *Macaranga tanarius*



Survey Interview

- ▲
- ▲
- ▲
-
- ~
- ~

Naturalized plants
Cultivated plants
Status unknown plants
Current estimated distribution beyond surveys
1000 ft. contours
Areas surveyed



5 0 5 10 Miles

USGS-BRD Haleakala Field Station (May 2003)

Macaranga tanarius

Ulumalu, Haiku



SITE INFORMATION -- *Macaranga tanarius*

-- Maluna Pl., off of Ulumalu Rd., Ha'iku, East Maui.

A single large tree located in yard of first house on right, near corner. Tree is on left hand side of driveway under kukui nut trees.







Macaranga tanarius

Parasol leaf tree

Euphorbiaceae

Forest Starr, Kim Starr, and Lloyd Loope
United States Geological Survey--Biological Resources Division
Haleakala Field Station, Maui, Hawai'i

January, 2003

OVERVIEW

Macaranga tanarius, native to Malaysia, is a medium size tree that is cultivated for ornament and reforestation in Hawai'i and other tropical regions of the world. In Hawai'i, *M. tanarius* is naturalized in disturbed mesic valleys on Kaua'i, O'ahu, and Maui (Oppenheimer et al. 1999, Wagner et al. 1999). On Maui, *M. tanarius* is widely naturalized in the Waikapu area of West Maui where it forms dense thickets in mesic valleys and streams from near sea level up to about 4,400 ft (1,341 m) elevation. On East Maui, only a single cultivated tree is currently known from a residential planting in Ha'iku. On West Maui, the infestation may not be feasible to control due to the vast area that it covers in steep and difficult terrain. On East Maui, there will always be the potential of re-invasion from the west side of the island, but control of the lone tree now may prevent a large infestation from occurring in the future.

TAXONOMY

Family: Euphorbiaceae (spurge family) (Wagner et al. 1999).

Latin name: *Macaranga tanarius* (L.) Mull. Arg. (Wagner et al. 1999).

Synonyms: *Ricinus tanarius* L. (Wagner et al. 1999), *Macaranga molliuscula* Kurz, *Macaranga tomentosa* Druce, *Mappa tanarius* Blume (World Agroforestry Centre 2002).

Common names: Parasol leaf tree (Randall 2002), *Macaranga* (Neal 1965).

Taxonomic notes: The genus, *Macaranga*, is made up of 250-280 species from tropical Africa, Madagascar, and Malesia to Australia and some parts of the Pacific, though none are native to Hawai'i (Wagner et al. 1999).

Nomenclature: The name refers to the native Madagascar name for these plants (Wagner et al. 1999).

Related species in Hawai'i: Another species also known from Hawai'i is *Macaranga mappa* (L.) Mull. Arg. and is distinguished by it's larger leaves (60-100 cm) and bracts and calyx pink (Wagner et al. 1999). A third as yet unidentified *Macaranga* species was recently observed on Maui.

DESCRIPTION

"Dioecious trees 4-10(-20) m tall. Leaves peltate, ovate to oblong-ovate, 8-30 cm long, petioles 6-25 cm long, stipules oblong to narrowly ovate, 1-3 cm long, quickly deciduous. Staminate flowers in open panicles 13-35 cm long, bracts and calyx pale green to yellowish green, stamens (3)4-6(-10), anthers tetrathecal; pistillate flowers in panicles 8-30 cm long, ovary 2-3 celled, styles 5-8 mm long. Capsules 2-3-valved, 10-12 mm long,

covered with pale waxy glands and soft, scattered, elongate, spine-like processes." (Wagner et al. 1999).

BIOLOGY & ECOLOGY

Cultivation: *Macaranga tanarius* is cultivated for a variety of uses. This small tree is grown as an ornamental tree in landscaping and for reforestation projects in Hawai'i and other warm tropical regions of the world. The following uses for *M. tanarius* are listed by World Agroforestry Centre (2002). In Sumatra, the fruit of *M. tanarius* are added to palm juice and boiled to produce sugar for use in foods. In Indonesia and the Philippines, the gum from the bark is used as a glue. *M. tanarius* is used for firewood, its fibers can be used to make particle boards, it is also grown for timber, and promoted as a shade tree for other crops. Other uses include dyes made from its leaves and fermented drinks made from the leaves and bark.

Invasiveness: *M. tanarius* is naturalized in Hawai'i in disturbed mesic valleys, 0-220 m (721 ft) on Kaua'i and O'ahu (Wagner et al. 1999), and also on Maui (Oppenheimer et al. 1999), where it is found from near sea level to over 4,400 ft (1,341 m) (Fern Duvall pers comm.). *M. tanarius* is naturalized on West Maui in the Waikapu area where it forms dense thickets in streams, valleys, and moist areas. These dense thickets crowd out desirable vegetation and can form deep shade in streams and valleys. This prolific tree also invades roadsides, fencelines, and disturbed areas nearby major infestation sites.

Pollination: *M. tanarius* is wind pollinated with flowering and fruiting occurring several times a year (World Agroforestry Centre 2002).

Propagation: *M. tanarius* is propagated from seeds, with an average germination rate of 50% if the pulp is left on the seeds (World Agroforestry Centre 2002).

Dispersal: Uncertain, *M. tanarius* is possibly dispersed by wind, water, and birds. The plant on East Maui was cultivated in a yard and did not appear that it had dispersed from West Maui, but was more likely planted by the homeowner or came as a contaminant in soil. Trees on West Maui do germinate some distance away from the original infestation (less than 5 miles) but so far long distance spread further than that has not been documented.

Pests and Diseases: Unknown.

DISTRIBUTION

Native range: *M. tanarius* is native to the following regions: Australia, Brunei, Cambodia, China, Indonesia, Japan, Laos, Malaysia, Myanmar, Papua New Guinea, Philippines, Taiwan, Province of China, Thailand, and Vietnam (World Agroforestry Centre 2002). Average annual rainfalls in these areas varies from 40-over 80 in (100-over 200 cm) with average temperatures ranging from 50-over 68 F (10-over 20 C) in January to over 86 F (over 30 C) in July (Hammond 1986). In these regions, *M. tanarius* grows up to an elevation of 1,500 m (4,921 ft) and is common in secondary forests, especially in logging areas and also is found in thickets, brushwood, village groves, and

beach vegetation (World Agroforestry Centre 2002). *M. tanarius* grows in a variety of soil types including clay, loam, and sand and is usually found in the lowlands (World Agroforestry Centre 2002).

Global distribution: *M. tanarius* is cultivated in tropical regions throughout the world.

State of Hawai'i distribution: In Hawai'i, forestry records for *M. tanarius* report that in Lihue-Koloa, Kaua'i a total of 30 trees were planted in 1927, in Honolulu, O'ahu a total of 6 trees were planted in 1926, and in Hilo, Hawai'i a total of 237 trees were planted in 1926 (Skolmen 1960). *M. tanarius* is now naturalized in Hawai'i in disturbed mesic valleys, 0-220 m (721 ft) on Kaua'i and O'ahu (Wagner et al. 1999), and also on Maui (Oppenheimer et al. 1999), where it is found from near sea level to over 4,400 ft (1,341 m) (Fern Duvall pers comm.). The current status of the Hilo, Hawai'i planting is uncertain and needs further investigation.

Island of Maui distribution: On Maui, the major *M. tanarius* infestation occurs on West Maui, in the Waikapu area. Here, *M. tanarius* fill valleys, streams, and disturbed areas up to an elevation of 4,426 ft (1,349 m), the summit of Kapilau. Average annual rainfall in these areas ranges from about 15 in (38 cm) near the dry coastal areas and up to 100 in (254 cm) at higher elevations on West Maui (Juvik and Juvik 1998). Trees become less dense away from the main infestation, but can be found to the south along the Mokulele Highway towards Kihei germinating in roadside hedges, along irrigation lines, and cane roads. The infestation is large and would probably require vast resources and time to control. In addition, much of the terrain is inaccessible sheer cliffs, further complicating control and mapping. On East Maui, only a single specimen was located during island wide surveys in 2000. The tree appeared to be cultivated at a residence in Ulumalu, Ha'iku. The elevation here is about 1,000 ft (305 m) with an average annual rainfall about 100 in (254 cm) (Juvik and Juvik 1998).

CONTROL METHODS

Control methodology for *M. tanarius* has yet to be refined for Hawai'i. It is uncertain whether cutting at the base would completely control this tree or if application of herbicides are necessary. Further testing is necessary to be sure.

Physical control: Most likely, seedlings and small plants can be dug up. In ornamental situations if the stand is of a reasonable size, digging the plant up may be the preferred method.

Chemical control: In large wild stands, perhaps a cut stump or basal bark herbicide method would be effective. Foliar spray on this tall tree may not be effective and is not advised in areas where non-target plants were present.

Biological control: None known.

Cultural control: The public could be discouraged from planting *Macaranga* species, including *M. tanarius*, especially near natural areas or wet areas.

Noxious weed acts: None known.

MANAGEMENT RECOMMENDATIONS

On West Maui, the infested areas were not mapped in full accuracy due to inaccessible terrain. This species may be best mapped from a helicopter to refine the current boundaries of the infestation. The infestation here seems too large and difficult to eradicate. Perhaps containment would be the best strategy. The single specimen on East Maui should be controlled to prevent a larger infestation in the future. Monitoring should continue on both East and West Maui to detect new locations and these could be controlled if deemed appropriate and feasible.

REFERENCES

- Hammond Incorporated. 1986. *Hammond Citation World Atlas*. Hammond Incorporated, Maplewood, NJ.
- Juvik, S.P and J.O. Juvik. 1998. *Atlas of Hawai'i*. 3rd ed. Department of Geography, University of Hawai'i press, Honolulu, HI.
- Neal, M.C. 1965. *In Gardens of Hawai'i*. Bernice P. Bishop Museum Special Publication 40, Bishop Museum Press, Honolulu, HI.
- Oppenheimer, H.L., J.S. Meidell, and R.T. Bartlett. 1999. New plant records for Maui and Moloka'i. *Bishop Museum Occasional Papers* 59(2): 7-11.
- Randall, R. 2002. Global Compendium of Weeds. Department of Agriculture - Western Australia. Available: <http://www.hear.org/gcw> (Accessed: August 22, 2002).
- Skolmen, R.G. 1960. *Plantings on the Forest Reserves of Hawai'i: 1910-1960*. Institute of Pacific Islands Forestry, Pacific Southwest Forest and Range Experiment Station, United States Forest Service, Honolulu, HI.
- Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1999. *Manual of the Flowering Plants of Hawai'i*. 2 vols. Bishop Museum Special Publication 83, University of Hawai'i and Bishop Museum Press, Honolulu, HI.
- World Agroforestry Centre. 2002. Botanic Nomenclature to Agroforestry trees: *Macaranga tanarius*. World Agroforestry Centre. Available: <http://www.worldagroforestrycentre.org> (Accessed: August 22, 2002).

Maclura pomifera

(Osage orange)

Maclura pomifera

Osage orange -- Moraceae

Overview: *Maclura pomifera* (osage orange) is a thorny tree native to a narrow band near Texas and Arkansas, and widely planted throughout North America and southern Canada for windbreaks and fence posts. *Maclura pomifera* has become naturalized in areas where it has been planted. Recently, a single hedge of *Maclura pomifera* was discovered in Ha'iku, Maui.

Description: "Osage orange is dioecious. The simple, green, four-part flowers appear soon after the leaves on the same spurs. Male flowers are long peduncled axillary racemes 2.5 to 3.8 cm (1 to 1.5 in) long on the terminal leaf spur of the previous season; female flowers are in dense globose heads, axillary to the leaves, about 2.5 cm (1 in) in diameter. The female flowers in ripening becomes very fleshy, forming a large multiple fruit or syncarp composed of 1-seeded drupelets. The ripe fruit, 7.6 to 15 cm (3-6 in) in diameter, yellowish-green, resembles an orange and exudes a bitter milky juice when bruised." (Bailey 1935, Burns and Honkala 1990).

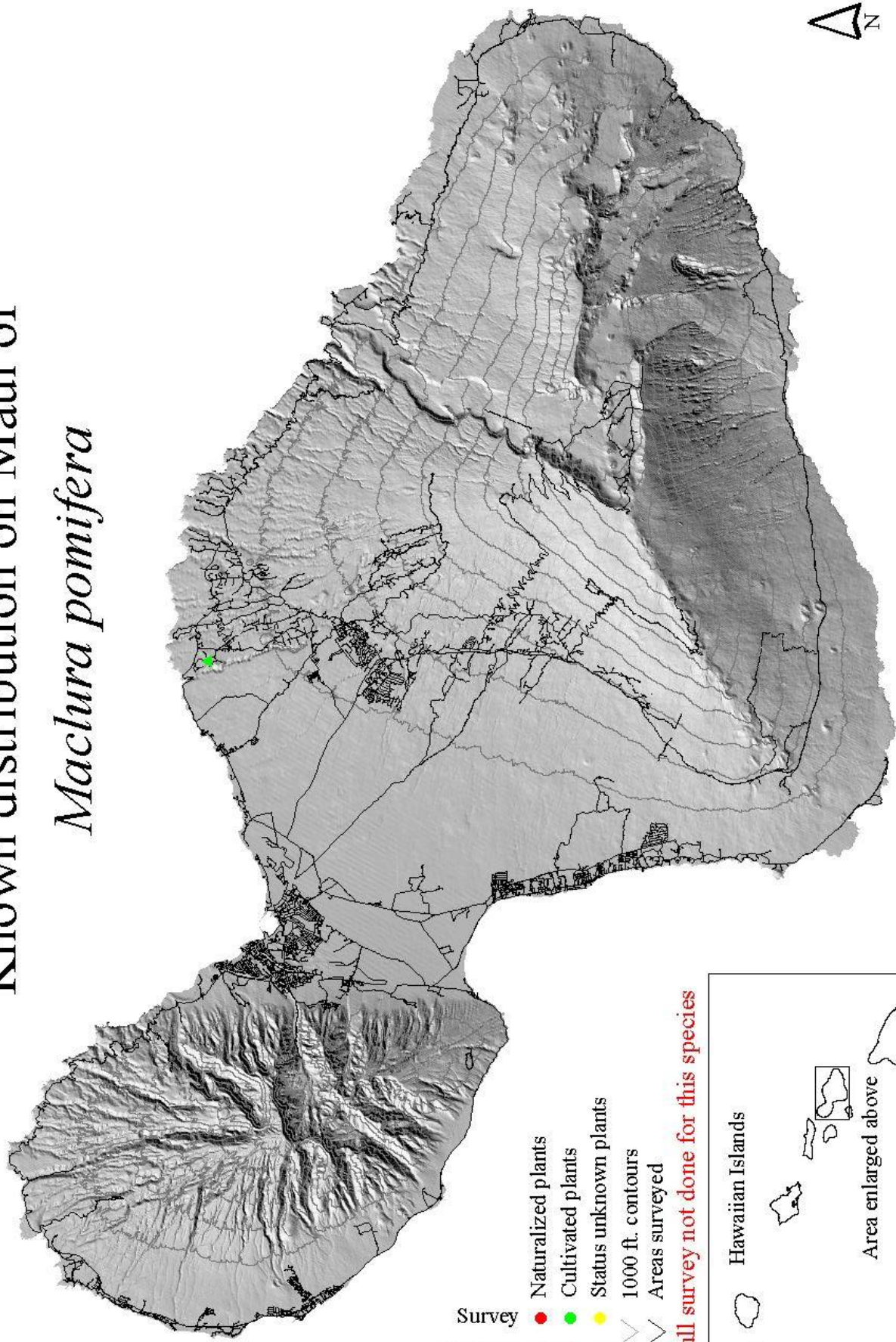
Impact: *Maclura pomifera* is extremely thorny and can create dense thickets in degraded pastures, along fences, ditches, ravines, and abandoned farms (Burns and Honkala 1990). *M. pomifera* readily escapes from cultivation and invades disturbed areas (Burns and Honkala 1990). Seeds are dispersed further by livestock, mammals, and birds.



Distribution: On Maui, a single cultivated hedge is currently known from a residential planting in Ha'iku. No regeneration has been observed yet.

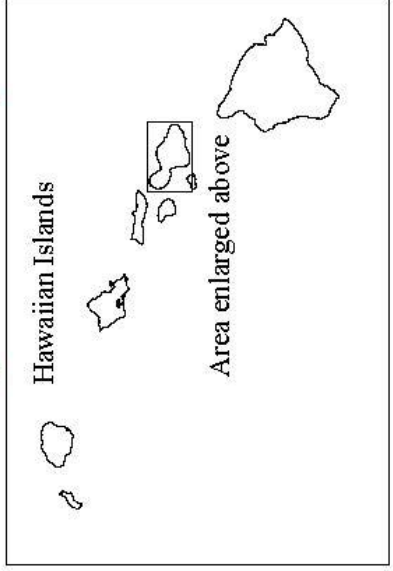
Control Methods: *M. pomifera* plants may be cut to the ground and the roots dug up. Hamel (1981) reports effective control using triclopyr or picloram applied with a chainsaw girdling treatment.

Known distribution on Maui of *Machura pomifera*



- | | | |
|-----------|---|-----------------------|
| Survey | ● | Naturalized plants |
| Interview | ▲ | Cultivated plants |
| | ● | Status unknown plants |
| | ▲ | 1000 ft. contours |
| | ▲ | Areas surveyed |

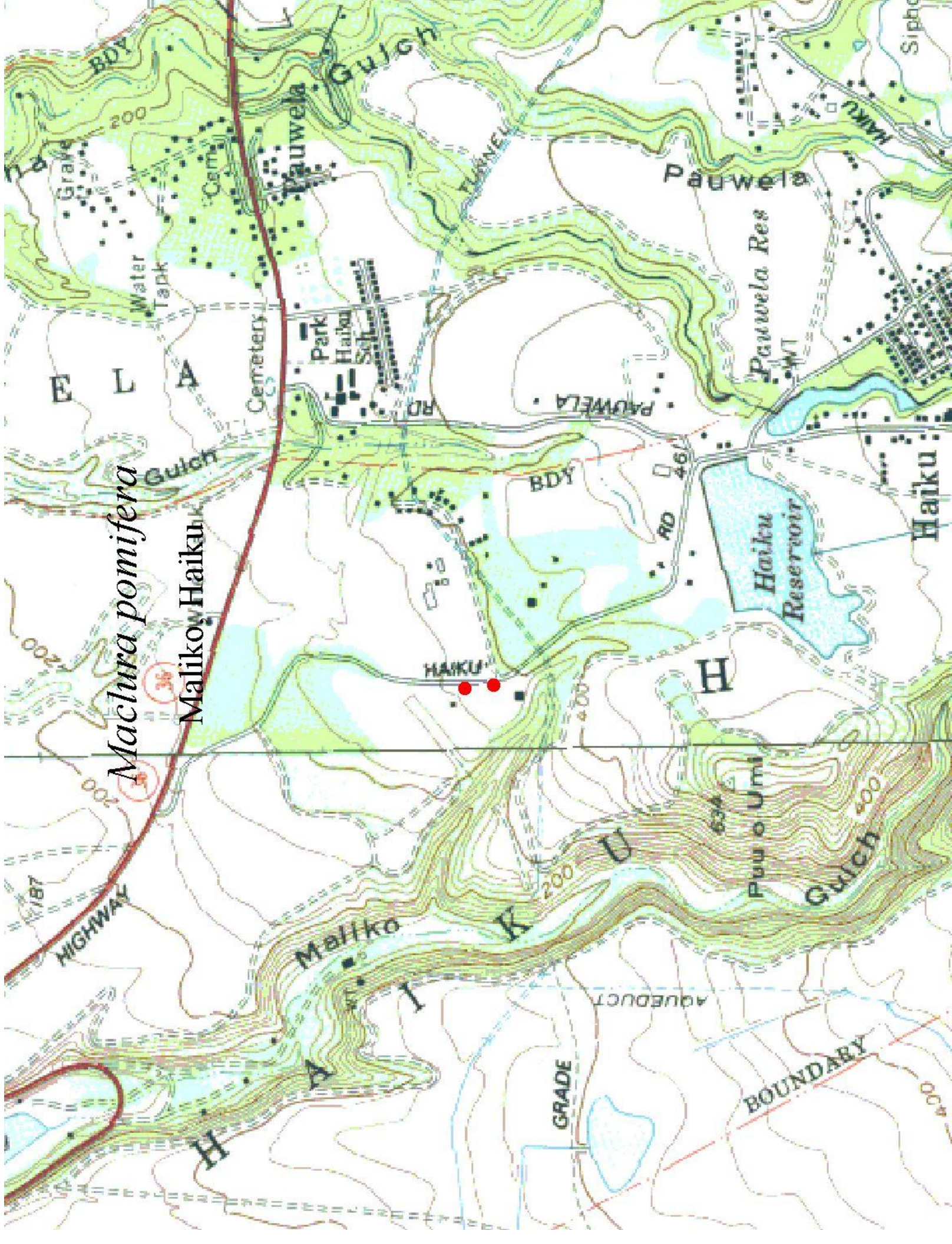
Full survey not done for this species



USGS-BRD Haleakala Field Station (May 2003)

Maclura pomifera

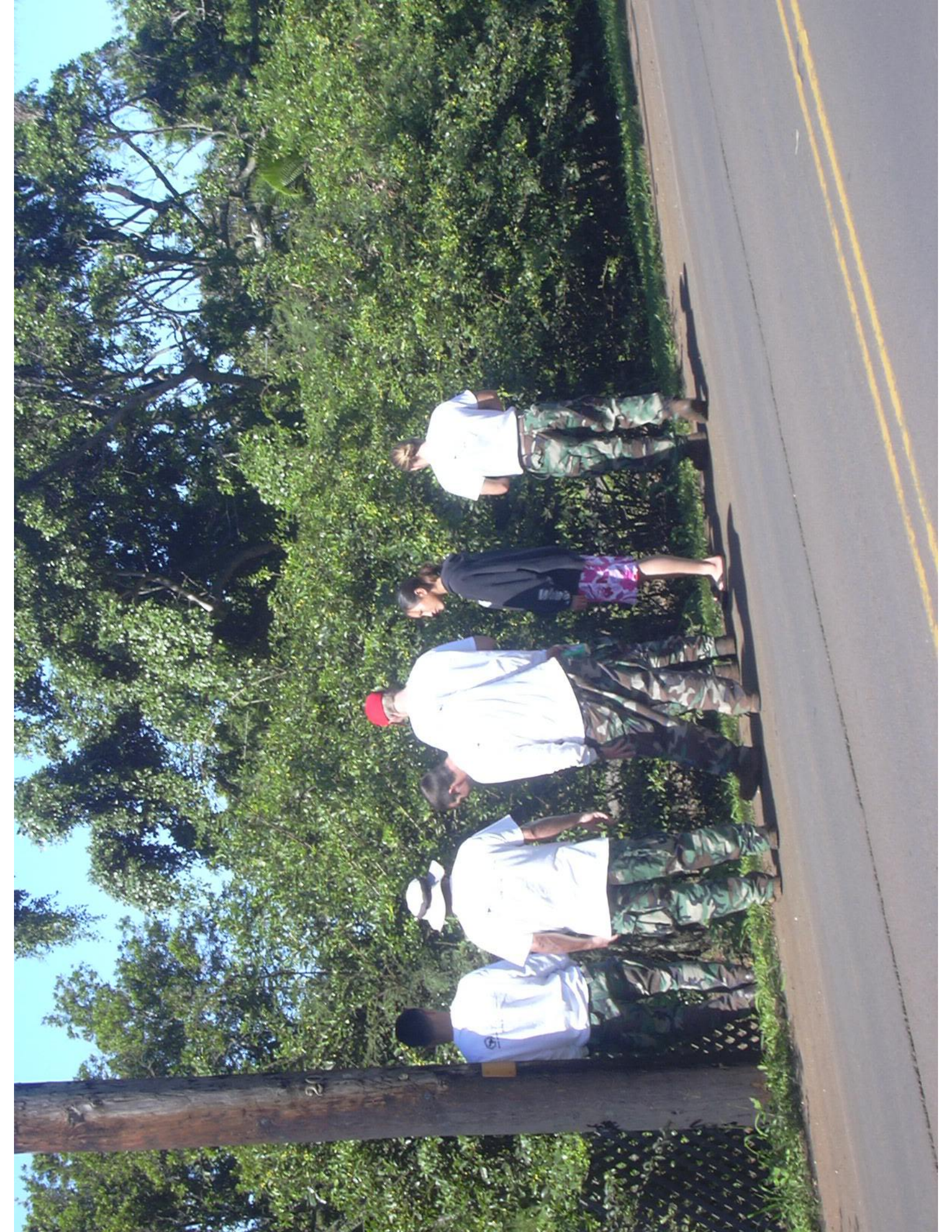
Maliko, Haiku



SITE INFORMATION -- *Maclura pomifera*

-- Ha'iku Rd., Ha'iku.

A long hedge lining the front of the property.







Maclura pomifera

Osage orange

Moraceae

Forest Starr, Kim Starr, and Lloyd Loope
United States Geological Survey--Biological Resources Division
Haleakala Field Station, Maui, Hawai'i

October, 2003

OVERVIEW

Maclura pomifera (osage orange) is a thorny, dioecious tree, native to a narrow band near Texas and Arkansas, and widely planted throughout North America and southern Canada for windbreaks and fence posts. *Maclura pomifera* has become naturalized in areas where it has been planted. *Maclura pomifera* is considered a pest plant in Italy and is being monitored for invasive potential in Spain where it is cultivated (Dana et al. 2001). Recently, a single hedge of *Maclura pomifera* was discovered in Ha'iku, Maui. In addition, Skolmen (1960) reports that *Maclura pomifera* was used as a forestry tree and was planted on Moloka'i, Hawai'i, and Maui. The status of these forestry plantings is not known and needs further investigation. The hedge in Ha'iku appears to show no sign of regeneration yet and only un-ripened female fruits have been observed. With an invasive history and limited distribution on Maui, this species is a good candidate for eradication before it becomes naturalized. It should also be prevented from further use in plantings through education and, or by adding it to the state noxious weed list.

TAXONOMY

Family: Moraceae (Mulberry family) (Wagner et al. 1999).

Latin name: *Maclura pomifera* (Raf.) Schneid. (PLANTS 2003).

Synonyms: *Ioxylon pomiferum* Raf., *Toxylon pomiferum* Raf. ex Sarg (PLANTS 2003).

Common names: Osage orange (PLANTS 2003), hedge apple, bois d'arc (Carey 1994).

Taxonomic notes: The genus, *Maclura*, is comprised of a single dioecious species, *Maclura pomifera*.

Nomenclature: The genus, *Maclura*, is named in honor of William Maclure, American geologist. The species name, *pomifera*, refers to bearing pomes or apples, for the fruit.

Related species in Hawai'i: None known.

DESCRIPTION

Small deciduous tree that averages 30 ft (9 m) in height. Though, in some sites, trees are may grow as tall as 21 m (70 ft) (Burns and Honkala 1990). It has a short trunk and rounded crown. Shade-killed lower branches remain on the tree for years, forming a dense thicket. Branches growing in full sun have sharp, stout thorns 0.5 to 1 in (1.3-2.5 cm) long. Osage orange has a large, round multiple fruit composed of many fleshy calyces, each containing one seed. Osage orange generally has a well-developed taproot; a tree in Oklahoma had roots more than 27 ft (8.2 m) deep. On shallow soils, roots spread laterally. (Burton 1990, Godfrey 1988, Wasser 1982).

"Osage orange is dioecious. The simple, green, four-part flowers appear soon after the leaves on the same spurs. Male flowers are long peduncled axillary racemes 2.5 to 3.8 cm (1 to 1.5 in) long on the terminal leaf spur of the previous season; female flowers are in dense globose heads, axillary to the leaves, about 2.5 cm (1 in) in diameter. The female flowers in ripening becomes very fleshy, forming a large multiple fruit or syncarp composed of 1-seeded drupelets. The ripe fruit, 7.6 to 15 cm (3-6 in) in diameter, yellowish-green, resembles an orange and exudes a bitter milky juice when bruised." (Bailey 1935, Burns and Honkala 1990).

BIOLOGY & ECOLOGY

Cultivation: *Maclura pomifera* has been planted in North America in greater numbers than any other tree species (Burns and Honkala 1990). Known for its hardiness, tolerance to drought, extremely hard wood, resistance to termites, and ability to grow in most types of soils, *Maclura pomifera* were valued and widely planted as windbreaks, then harvested for fence posts (Burns and Honkala 1990). *Maclura pomifera* is said to have led to the invention of barbed wire and was used for the posts when most of the west was fenced for cattle ranching. Native American Indians used the wood for making hunting bows. It has also been used in furniture making, for erosion control, as a landscape plant, and in strip mine reclamation (Burns and Honkala 1990).

Invasiveness: *Maclura pomifera* readily escapes from cultivation and invades disturbed areas (Burns and Honkala 1990). Abundant seeds are produced and seedlings readily germinate near parent plants. Seeds are also dispersed further by livestock, mammals, and birds that eat the fruit. In the United States, thickets occur in degraded pastures, along fences, ditches, ravines, and abandoned farms (Burns and Honkala 1990). Due to its invasiveness, *Maclura pomifera* is prohibited from planting in the village of Elburn, Illinois (Village of Elburn website 2003). *Maclura pomifera* was also recently detected in Spain where it is cultivated and is not yet known to be invasive, but is being monitored because of its invasiveness elsewhere in Europe (Italy) (Dana et al. 2003).

Pollination: *Maclura pomifera* is wind pollinated (Burns and Honkala 1990).

Propagation: When both sexes are present, *Maclura pomifera* propagates by seeds. Female plants that occur without male plants produce seedless fruits (Burns and Honkala 1990). Seeds have a slight dormancy that may be overcome by a 48 hour soak in water (Burns and Honkala 1990). Thornless male clones are often propagated by cuttings or grafts. Plants begin producing viable seed by about the 10th year, reach optimum seed bearing by years 25 through 75, and may live up to 100 years (USDA 1974).

Dispersal: *Maclura pomifera* seeds are dispersed by livestock, mammals, and birds that feed on the fruits (Burns and Honkala 1990). Seeds are also dispersed by gravity and water (Carey 1994).

Pests and diseases: Though considered extremely hardy and less susceptible to damage than any other trees planted in the Prairie States Forestry programs, a few pests are known to attack *Maclura pomifera*. It is susceptible to cotton root rot and at least four

stem borers including the mulberry borers (*Doraschema wildii* and *D. alternatum*), the painted hickory borer (*Meacyllene caryae*), and the red-shouldered hickory borer (*Xylobiops basilaris*) (Burns and Honkala 1990). Several scale insects attack *Maclura pomifera* including the European fruit lecanium (*Parthenolecanium cornii*), the walnut scale (*Quadraspidiotus juglansregiae*), the cottony maple scale (*Pulvinaria innumerabilis*), the terrapin scale (*Mesolecanium nigrofasciatum*), and the San Jose scale (*Quadraspidiotus perniciosus*) (Burns and Honkala 1990). Mice have been known to girdle younger trees in Illinois (Burns and Honkala 1990).

DISTRIBUTION

Native range: According to Burns and Honkala (1990), "The natural range of osage orange is in the Red River drainage of Oklahoma, Texas, and Arkansas; and in the Blackland Prairies, Post Oak Savannas, and Chisos Mountains of Texas." According to some authors, the original range included most of eastern Oklahoma, portions of Missouri, and perhaps northwestern Louisiana. In these areas, *Maclura pomifera* occurs in bottom lands that are often inundated with water, mixed with other hardwoods, and interspersed with prairie (Burns and Honkala 1990). In its native range, *Maclura pomifera* occurs in areas that receive an average annual rainfall of 1,020-1,140 mm (40-45 in) and average temperatures that range from 27 C (80 F) in July to 6-7 C (43-45 F) in January, with an extreme of -23 C (-10 F) (Burns and Honkala 1990).

Global distribution: *Maclura pomifera* has been planted in all the 48 conterminous States as well as in southeastern Canada (Burns and Honkala 1990). Dana et al. (2001) include *Maclura pomifera* in a list of "aliens which have showed to be highly invasive in other European Countries and which may represent a potential threat for Spanish ecosystems". It was detected in Spain but is not yet invasive there yet, though it is considered invasive in Italy.

State of Hawai'i distribution: *Maclura pomifera* was recently collected from a cultivated hedge in the Ha'iku area of Maui. This was thought to be the only known occurrence of this species in the state, until recently when it was found to be listed by Skolmen (1960) as planted in reforestation efforts on Moloka'i, Hawai'i, and Maui. On Moloka'i, 217 trees were planted in 1952. On Hawai'i, 12 trees were planted in the Ola'a area in 1922. On Maui, 8 trees were planted in the Waihou Springs area in 1931. The current status of these plantings is not known and needs further investigation.

Island of Maui distribution: On Maui, a single cultivated hedge is currently known from a planting in Ha'iku. The area is located at approximately 350 ft (107 m) elevation in a moist lowland disturbed residential setting. The area receives approximately 40-60 in (102-152 cm) average rainfall annually (Juvik and Juvik 1998). The *Maclura pomifera* hedge fronts a residential property and is adjacent to the road. The hedge is extremely thorny and could be comprised of female plants as only immature fruits have been observed to date. No regeneration has been observed yet. *Maclura pomifera* displays aggressive vegetative growth and occasionally road crews have to cut the plant back from the roadway. The 8 plants listed in Skolmen (1960) that were planted in 1931 in Waihou Springs needs further investigation. Former state forester, Robert Hobdy, does not know

of these trees in the area and it is uncertain if they are present or not. If found, these could also be controlled to prevent future spread.

CONTROL METHODS

Physical control: The plants may be cut to the ground and the roots dug up. Care must be taken when handling the plant because of its sharp thorns.

Chemical control: The plants probably can be cut to ground level with a proper application of herbicide. Plants will re-sprout if cut without herbicide. Hamel (1981) reports effective control using triclopyr or picloram applied with a chainsaw girdling treatment.

Biological control: None known.

Cultural control: The public could be informed of the invasive tendencies of *Maclura pomifera* and asked not to plant it.

Noxious weed acts: *Maclura pomifera* is prohibited from planting in the town of Elburn, Illinois (Village of Elburn website 2003).

MANAGEMENT RECOMMENDATIONS

Maclura pomifera is an extremely thorny dioecious tree native to a narrow area near Texas and Arkansas. It has been widely planted and naturalized throughout North America and is used mainly for fence posts and wind breaks. *Maclura pomifera* is cultivated and naturalized in Italy and was recently detected in Spain where it is now being monitored for spread. In Hawai'i, a single cultivated hedge of *Maclura pomifera* was recently detected in Ha'iku, Maui. It is also listed as planted in several forest reserves on the islands of Moloka'i, Hawai'i, and Maui (Skolmen 1960). For Maui, only 8 plants were listed as planted in the Waihou Springs area in 1931. The current status of this planting is not known and needs further investigation. Control of all known *Maclura pomifera* plants on Maui now may help prevent its eventual naturalization and spread in the future. Measures to prevent this species from being further planted are also needed, through education and, or noxious weed laws. Searches for new locations on Maui and other Hawaiian Islands is also recommended.

REFERENCES

Burton, J.D. 1990. *Maclura pomifera* (Raf.) Schneid. Osage-orange. In: Burns, R.M., Honkala, B.H., technical coordinators. *Silvics of North America: Volume 2. Hardwoods*. Agriculture Handbook 654. U.S. Department of Agriculture, Forest Service, Washington, DC.

Bailey, L.H. 1935. *The Standard Cyclopaedia of Horticulture*. Macmillan, NY.

Carey, J.H. 1994. *Maclura pomifera*. In: U.S. Department of Agriculture, Forest Service, Rocky Mountain Research Station, Sciences Laboratory. *Fire Effects*

Information System. Available: <http://www.fs.fed.us/database/feis> (Accessed: May 1, 2003).

Dana, E.D., M. Sanz-Elorza, and E. Sobrino. 2001. Plant invaders in Spain, the unwanted citizens. *Lazaroa* 22: 121-131.

Godfrey, R.K. 1988. *Trees, Shrubs, and Woody Vines of Northern Florida and Adjacent Georgia and Alabama*. The University of Georgia Press, Athens, GA.

Hamel, D.R. 1981. Forest Management Chemicals: *A Guide to Use When Considering Pesticides for Forest Management*. Agriculture Handbook 585. U.S. Department of Agriculture, Forest Service, Washington, DC.

Juvik, S.P and J.O. Juvik. 1998. *Atlas of Hawai'i*. 3rd ed. Department of Geography, University of Hawai'i press, Honolulu, HI.

PLANTS (National Plants Database). 2003. Online database. United States Department of Agriculture, Natural Resources Conservation Services, National Plant Data Center, Baton Rouge, LA. Available: <http://plants.usda.gov> (Accessed: May 1, 2003).

Skolmen, R.G. 1960. *Plantings on the Forest Reserves of Hawai'i: 1910-1960*. Institute of Pacific Islands Forestry, Pacific Southwest Forest and Range Experiment Station, United States Forest Service, Honolulu, HI.

U.S. Department of Agriculture, Forest Service. 1974. *Seeds of Woody Plants in the United States*. In: C.S. Schopmeyer, tech. coord. U.S. Department of Agriculture, Forest Service, Washington, DC.

Village of Elburn website. 2003. Shade Tree Ordinance 99-26. Available: <http://www.elburn.il.us/treecity/prohibitedtrees.html> (Accessed: May 1, 2003).

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1999. *Manual of the Flowering Plants of Hawai'i*. 2 vols. Bishop Museum Special Publication 83, University of Hawai'i and Bishop Museum Press, Honolulu, HI.

Wasser, C.H. 1982. *Ecology and Culture of Selected Species Useful in Revegetating Disturbed Lands in the West*. FWS/OBS - 82/56. U.S. Department of the Interior, Fish and Wildlife Service, Washington, DC.

Melastoma spp.

(Melastome)

Melastoma spp.

Melastoma -- Melastomataceae

Overview: *Melastoma* (*Melastoma* spp.) is cultivated in Hawai'i and other tropical areas where it has escaped from cultivation. In Hawai'i, it is locally abundant and invasive in mesic to wet areas, windward areas, and bog margins on Kaua'i, O'ahu, and Hawai'i (Conant 1996, Wagner et al. 1999). On Maui, very few plants are known from cultivation.

Description: "Erect shrubs or small slender trees, rarely herbs. Leaves 3-7 nerved. Flowers in usually terminal, simple or compound, bracteolate cymes or solitary: hypanthium campanulate to ovoid or urceolate, strigose to bristly or rarely spreading glandular pubescent; calyx lobes (4)5(-7), deciduous, often alternate with as many subulate or needle-like deciduous teeth; petals 5(-7), white, pink, or purple, usually obovate; stamens twice as many as petals, dimorphic; anthers subulate, connective of larger anthers prolonged ventrally, modified at the filament insertion into a 2-lobed or bituberculate appendage, connective of the smaller anthers not prolonged but also modified ventrally into a bituberculate appendage; ovary distinct at apex but adnate to the inner hypanthial wall by (4)5(-7) septa, 5-7 celled. Fruit a coriaceous or somewhat fleshy, irregularly dehiscent berry. Seeds cochleate, 0.5-1 mm long, minutely punctate (Wagner et al. 1999).

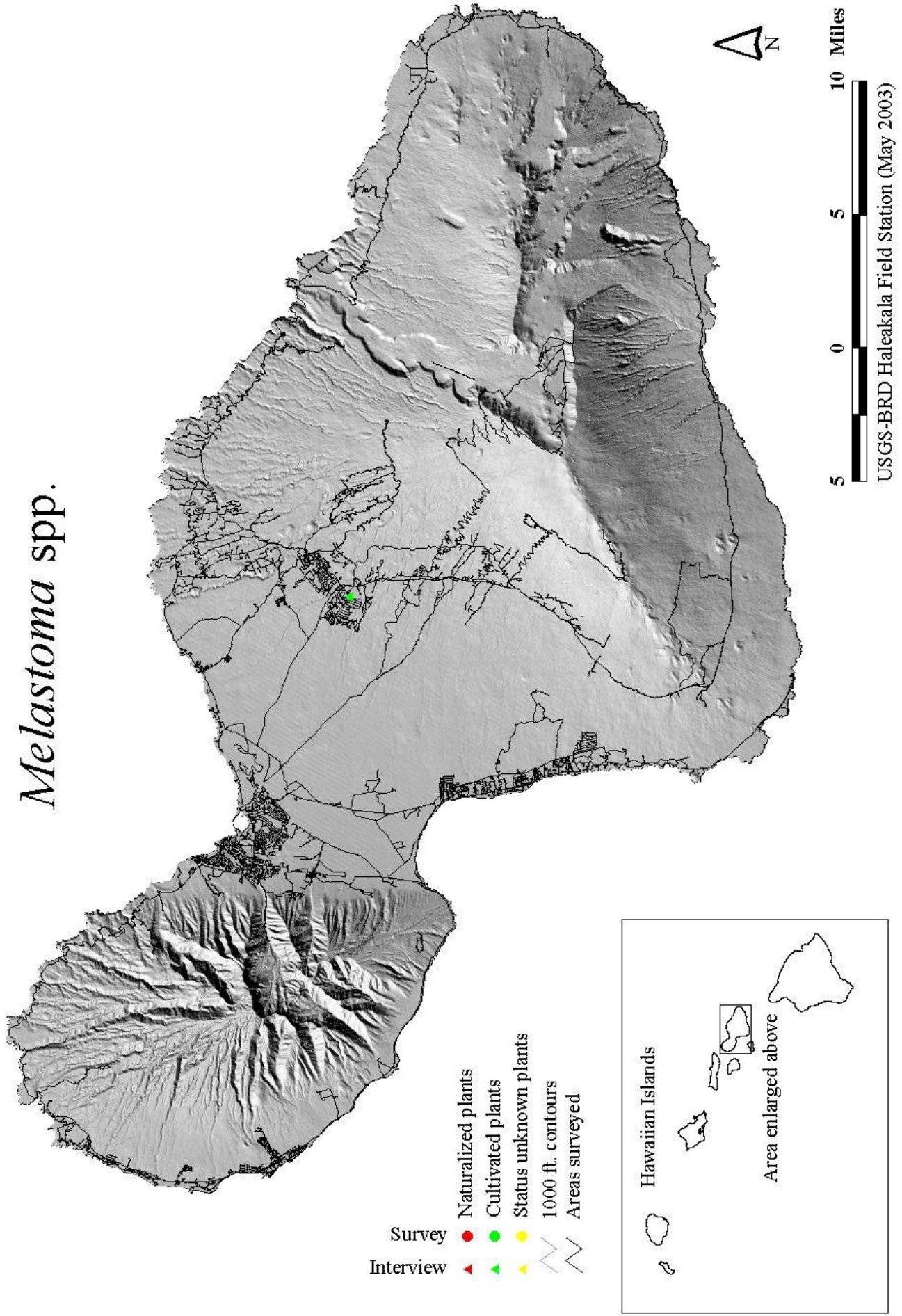
Impact: "Spread by birds, melastoma forms dense stands in wetter pastures and forests, shading out understory" (Motooka et al. 2002).



Distribution: On Maui, melastoma is currently known from a single cultivated location in Pukalani.

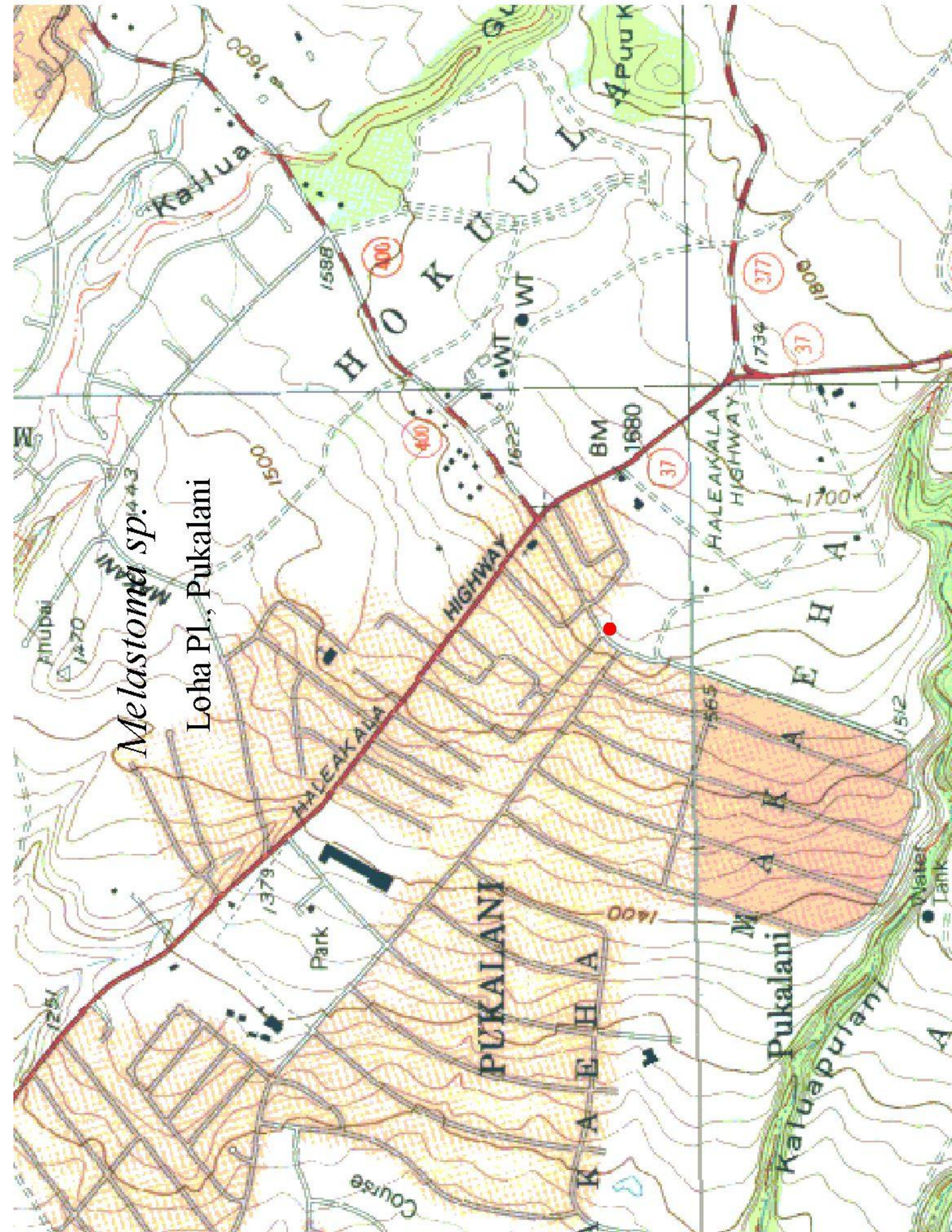
Control Methods: "Sensitive to hormone-type herbicides 2,4-D, dicamba, and triclopyr at 1 lb./acre, and to metsulfuron at 0.45 oz/acre. Sensitive to basal bark and stump bark applications of 2,4-D and triclopyr at 4% product in diesel." (Motooka et al. 2002).

Known distribution on Maui of *Melastoma* spp.



Melastoma sp.

Loha Pl., Pukalani



SITE INFORMATION -- *Melastoma* spp

Melastoma sanguineum

-- Loha Pl., Pukalani.

A single plant cultivated in yard near house. Mauka side of road.





Melastoma spp.

Asian Melastome

Melastomataceae

Forest Starr, Kim Starr, and Lloyd Loope
United States Geological Survey--Biological Resources Division
Haleakala Field Station, Maui, Hawai'i

October, 2003

OVERVIEW

Melastoma candidum, native to Southeast Asia, is cultivated in Hawai'i and other tropical areas as an ornamental shrub. In Hawai'i, *M. candidum* has escaped from cultivation and is now locally abundant and invasive in mesic to wet areas, windward areas, and bog margins on Kaua'i, O'ahu, and Hawai'i from sea level up to about 900 m (2,952 ft) (Conant 1996, Wagner et al. 1999). The genus *Melastoma* is taxonomically difficult and there has been confusion with several species. *M. candidum* was previously called *M. malabathricum* (Malabar melastome, Indian rhododendron), a related species, by Hawaiian botanists and appears as this in past literature (Wagner et al. 1999). Some sources list *M. candidum* as a synonym of *M. septemnerium* (Kartesz 1996). In addition, a related species with similar appearance, *M. sanguineum* (fox-tongued melastoma, red melastome), is cultivated and naturalized on the island of Hawai'i (Wagner et al. 1999), and is also known from a single cultivated location on Maui. Furthermore, some *Tibouchina* species may also be confused as *Melastoma* species. On Maui, there has also been some confusion in identifying *Melastoma* spp. Previously not known to be present on Maui, what was thought to be *M. candidum* was recently found to be sparingly cultivated in a few locations on East Maui. After closer examination, it is now thought that species present represent both *M. candidum* and *M. sanguineum*. *M. candidum* is currently a target species for eradication by the Maui Invasive Species Committee (MISC) and so far, two locations have been controlled. *M. sanguineum* is now also being included in plans for control. All species in the genus, *Melastoma*, are listed as Hawai'i state noxious weeds, making it illegal to possess, sell, and propagate *Melastoma* species in Hawai'i. On Maui, eradication of the few known *Melastoma* spp. plants now could save large amounts of time, money, and resources in the future. Even with a notoriously weedy history and noxious weed status, plants such as *Melastoma* spp. are still cultivated in Hawai'i and elsewhere. There seems to be little awareness as to which plants are actually on the noxious weed list. Education on the subject may help the general public in choosing which plants to grow in their yards.

TAXONOMY

Family: Melastomataceae (Melastoma family) (Wagner et al. 1999).

Latin name: *Melastoma candidum* D. Don (Wagner et al. 1999), *Melastoma sanguineum* Sims (Wagner et al. 1999).

Synonyms: *M. candidum*: *Melastoma septemnerium* Lour. (Meyer 2000). Previously known as *M. malabathricum* sensu Hawaiian botanists, non L. which is a related species

(Wagner et al. 1999). *M. sanguineum*: *M. decemfidum* Roxb. ex W. Jack (Wagner et al. 1999).

Common names: *M. candidum*: Asian melastome (Kartesz 1996). In Hawai'i, previously called and sometimes still referred to as Malabar melastome and Indian rhododendron, which are common names for *M. malabathricum*. *M. sanguineum*: Fox-tongued melastoma (Wagner et al. 1999).

Taxonomic notes: The genus *Melastoma* is a difficult one taxonomically. It is currently comprised of about 50-70 species from India through southeastern Asia, north to Japan and south to Pacific islands and Australia (Wagner et al. 1999). The number of species will most likely be reduced once a revision is completed.

Nomenclature: The name is derived from the Greek *melas*, meaning black, and *stoma*, meaning mouth, in reference to the color left in the mouth when the berries of some species are eaten (Wagner et al. 1999).

Related species in Hawai'i: In Hawai'i, many plants in the family Melastomataceae are present and invasive, including well known weeds such as *Miconia calvescens*, *Clidemia hirta*, *Tibouchina herbacea*, and others. Within the genus, *Melastoma*, there is one other species, *Melastoma sanguineum* Sims [syn. *M. decemfidum* Roxb. ex W. Jack], known from Hawai'i island and now also known from cultivated plants on Maui, and is roughly distinguished by having petals 6, with branches and petioles sparsely covered with spreading, smooth hairs 5-15 mm long, rather than petals 5, with branches and petioles densely covered with a mixture of appressed, short, laciniate scales 0.5-1 mm long in *M. candidum* (Wagner et al. 1999). Wagner et al. (1999) add, "The assemblage of genera treated here makes it difficult to key out *Melastoma* without resorting to the use of fruit type. Because fruit type is not always readily apparent in dried material, *Tibouchina urvilleana* may be confused with our 2 naturalized species of *Melastoma*, both of which differ in having yellow staminal appendages and hypanthial pubescence that consists of basally flattened, incurved hairs of overlapping lanceolate scales."

DESCRIPTION

M. candidum: "Erect shrubs or small trees 1.5-5 m tall, branches and petioles are densely covered with a mixture of short, appressed, laciniate scales 0.5-1 mm long and longer lanceolate scales 1.5-5 mm long. Leaves elliptic to elliptic-ovate, 4-11 cm long, 1.3-4 cm wide, 5(-7) nerved, upper surface strigose to scabrous, lower surface sericeous but with a mixture of scales on the nerves like those of the young branches, margins entire, apex acute, base obtuse to rounded, petioles 5-12 mm long. Inflorescences 2-7 flowered, pedicels 10-12 mm long in fruit, bracts and bracteoles elliptic, lanceolate, or ovate, 1-2.2 cm long, 0.5-1.3 cm wide, early deciduous; hypanthium densely covered with imbricate, lanceolate, ciliolate scales; calyx 5-lobed, triangular-lanceolate, 0.7-2 cm long; petals usually 5, pink, 2.5-3.2 cm long, 1.5-2.3 cm wide; anthers of larger stamens 10-11 mm long, anthers of smaller stamens 8.5-10 mm long. Berries 5-celled, 10-15 mm long." (Wagner et al. 1999).

M. sanguineum: "Erect shrubs or small trees 2-4(-8) m tall, branches and petioles sparsely covered with spreading, smooth hairs 5-15 mm long, but often intermixed with or replaced by appressed, smooth, subulate hairs usually 1 mm or less long. Leaves ovate-lanceolate, (8-)10-20 cm long, 2-4..5(-6.5) cm wide, 5(-7)-nerved, upper surface

moderately covered with hairs that are adnate to the epidermis for most of their length, lower surface strigillose with scattered appressed lanceolate scales on the elevated nerves, margins entire, apex acuminate to attenuate, base obtuse to rounded, petioles 10-20(-30) mm long. Inflorescences 2-7-flowered, pedicels 10-15 mm long in fruit, bracts and bracteoles elliptic to lanceolate, 7-15 mm long, 3-9 mm wide, early deciduous; hypanthium covered with spreading or incurved, smooth, \pm basally flattened hairs; calyx 6-lobed, ovate to triangular, 6-12 mm long, apex acuminate; petals 6, purplish pink, 2.5-4.7 cm long, 2.7-3.5 cm wide; anthers of larger stamens 12-15 mm long, connective prolonged 12-16 mm with an appendage ca. 2 mm long, anthers of smaller stamens 9-11 mm long. Berries 6-celled, 15-17 mm long." (Wagner et al. 1999).

BIOLOGY & ECOLOGY

Cultivation: In Hawai'i, *M. candidum* and *M. sanguineum* are grown as ornamentals for their showy pinkish to purplish flowers, shrubby habit, and attractive foliage. *M. candidum* was first introduced as an ornamental from Florida to the island of Kaua'i in 1916 (Hasselwood and Motter 1983, Jacobi and Warshauer 1992, Wester 1992). *M. sanguineum* was first collected from the island of Hawai'i in 1957 (Wagner et al. 1999).

Invasiveness: *Melastoma candidum* escapes from cultivation and is now naturalized on Kaua'i, O'ahu, and Hawai'i in mesic to wet areas and bog margins (Conant 1996, Wagner et al. 1999). *M. sanguineum* also escapes cultivation and naturalizes in mesic sites on the island of Hawai'i in the Keaukaha area and along the highway between Volcano and Hilo (Wagner et al. 1999). Both species form dense monotypic thickets up to 2 m tall and can crowd out native vegetation. Degener (1973) shows photos of the Kilohana Crater area over run with *M. candidum*. In one of the photos, *M. candidum* was completely monotypic and was almost as tall as the person in the middle of the thicket. The invasive nature of *M. candidum* is further described by Degener (1973).

"The Malabar melastome, introduced as an ornamental of Kaua'i, has become naturalized within the last few decades. It has already replaced nearly all other vegetation in Kilohana Crater and is rapidly spreading from that locality into neighboring regions, smothering to death the more interesting native plants that stand in its way. The crater is now a devastated thicket of worthless shrubs through which neither man nor beast can penetrate for any distance. The introduction of the Melastome and its ultimate spread over the lowlands of Kaua'i, and of probably all Islands unless these are carefully guarded, will be as great a misfortune as was the introduction of the gorse, the Lantana, and the Eupatorium."

Pollination: Many plants in the family Melastomataceae are buzz pollinated by bees (Meyer 2000).

Propagation: *Melastoma* spp. can be propagated from seeds.

Dispersal: *Melastoma* spp. are spread long distance by humans in the horticulture trade. From gardens, plants readily escape and are further spread by fruit eating birds and

possibly other mammals (Smith 1999). Dispersal from inter-island horticulture exchange is also a threat as several species of Melastomataceae and other invasive weeds have been observed moving inter-island on hapu'u fern (*Cibotium* spp.) stumps and parts.

Pests and Diseases: None known, except for the biological control agents.

DISTRIBUTION

Native range: *M. candidum* is native to Vietnam, southern China, Philippine Islands, Taiwan, Ryukyu Islands, and southern Japan (Wagner et al. 1999). Meyer (2000) describes the native distribution of *M. candidum* as Japan, South China, Taiwan, and northern Vietnam, growing in light forests, clearings, and grass lands, or on rocky slopes from sea level to 1,500 m (4,921 ft) elevation. *M. sanguineum* is native to the Malay Peninsula, Java, Sumatra, Vietnam, and southeastern China (Wagner et al. 1999). Meyer (2000) describes the native distribution of *M. sanguineum* as Burma, Thailand, Malaysian Peninsula, Sumatra, Borneo, Moluccas, South China, and Indochina, growing in disturbed forests, along streams and roads, in open places and savannas up to 2,300 m (7,546 ft) elevation.

Global distribution: *M. candidum* and *M. sanguineum* are cultivated in Hawai'i and other tropical regions of the world. *M. malabathricum* is apparently invasive in Florida and North Carolina (USDA-ARS 1998).

State of Hawai'i distribution: Heavy infestations of *M. candidum* can be found on Kaua'i and the Puna and Hamakua Districts from sea level to 700 m (2,297 ft) (Smith 1999). On Kaua'i in some places such as the Kilohana Crater, this species is being replaced by *Rhodomyrtus tomentosa* (Smith 1999). *M. sanguineum* is naturalized in mesic sites in the Keaukaha area and along the highway between Volcano and Hilo (Wagner et al. 1999). Both species are known from a few cultivated individuals on Maui with no signs of spread yet.

Island of Maui distribution: On Maui, *M. candidum* is currently known only from 3 locations: Makawao, Pukalani, and Kula. All 3 are garden type plantings of a single plant each. These sites are all relatively dry located from 1,600 ft to 3,000 (488-914 m), with Makawao being the moister of the 3 locations. 2 of these locations, Kula and Makawao, have already been controlled by MISC. After closer inspection of flowers, it is now thought that the Pukalani plant is actually *M. sanguineum*. A suspected 4th plant was recently detected, also in Pukalani, but it has since been re-identified as *Tibouchina granulosa*.

CONTROL METHODS

Physical control: Plants on Maui are all small, cultivated specimens and it is probably feasible to dig up the plants if so desired.

Chemical control: Plants can probably be cut at the base and treated with an herbicide. Cut material should be disposed of properly. This method is useful to remove the plant with a small amount of non-target effects. Basal bark methods would probably work as

well, but may not be desirable in a garden setting. It is uncertain whether foliar spray applications would work, and this would have the most non-target effects and may be unsitely in a garden situation.

Biological control: Several moth species (Lepidoptera) have been purposely introduced as biological control agents for *M. candidum* (as *M. malabathricum* in Teramoto and Heu 2000). Two moths in the family Pyralidae have been released. *Bocchoris adipalis* Zell., native to Malaysia, was released in 1964 (Teramoto and Heu 2000). Another, *Bocchoris fatualis* (Lederer), native to the Philippines, was released in 1958 and is now established on Kaua'i (Teramoto and Heu 2000). A moth in the Arctiidae family, *Selca brunella* Hampson, native to Malaysia, was released in 1964 and is now established on the island of Hawai'i (Teramoto and Heu 2000).

Cultural control: The public could be discouraged from planting any plants in the family Melastomataceae. The public could also be discouraged from planting hapu'u ferns (*Cibotium* spp.) or use hapu'u mulch that is harvested from the wild forests of Hawai'i Island as they often harbor noxious weed species such as *Melastoma* spp.

Noxious weed acts: All species in the genus *Melastoma* are Hawai'i state noxious weeds. *Melastoma malabathricum* is listed as a noxious weed in Florida and North Carolina (USDA-ARS 1998).

MANAGEMENT RECOMMENDATIONS

All species of *Melastoma* are considered noxious in the state of Hawai'i. Their invasiveness is readily observed on the islands of Hawai'i and Kaua'i. On Maui, there are only a few plantings of *Melastoma* spp., and most of these have already been controlled. MISC should continue to target *Melastoma candidum*, as well as other *Melastoma* species. Maui is fortunate that there are no large infestations of *Melastoma* spp. and continued efforts are advised to detect and control plants before they become out of control. The public should be educated to not possess, propagate, or sell noxious weeds and other harmful non-native plants. There needs to be better prevention of inter-island dispersal from Kaua'i and Hawai'i to other islands. This includes plants in the horticulture trade as well as plants that may disperse accidentally as contaminants on hapu'u ferns.

REFERENCES

Degener, O. 1973. Plants of Hawai'i National Parks. Braun-Brumfield, Inc., Ann Arbor, Michigan.

Haselwood, E.L. and G.G. Motter, eds. 1983. *Handbook of Hawaiian Weeds*. 2nd ed., revised and expanded by R.T. Hirano. Harold L. Lyon Arboretum, University of Hawai'i, Honolulu, HI.

Jacobi, J.D. and F.R. Warshauer, 1992. Distribution of Six Alien Plant Species in Upland Habitats on the Island of Hawai'i. In: *Alien Plant Invasions in Native*

Ecosystems of Hawai'i, C.P. Stone, C.W. Smith, and J.T. Tunison, eds. University of Hawai'i Press, Honolulu, HI.

Kartesz, J.T. 1996. A Synonymized Checklist of the Vascular Flora of the United States, Canada, and Greenland. The Biota of North America Program or the North Carolina Botanical Garden. Available: <http://www.csd.tamu.edu/FLORA/bonapfams/-bonzzmls.htm> (Accessed: August 28, 2002).

Meyer, K. 2000. Phylogeny and systematics of the genus *Melastoma* (Melastomataceae). The Melastomaceae HomePage. Available: <http://www.uni-mainz.de/FB/Biologie/Botanikspeziell/Melastomataceae/Melasoma1.html> (Accessed: August 28, 2002).

Smith, C.W. 1999. Alien Plants of Hawai'i. *Melastoma candidum*. University of Hawai'i Botany Web page. Available: http://www.botany.hawaii.edu/faculty/cw_smith/mel_can.htm (Accessed: March 21, 1998).

USDA-ARS (United States Department of Agriculture, Agricultural Research Service). 1998. Invaders Database System, Noxious Weeds Summary. Available: http://www.invader.dbs.umd.edu/Noxious_Weeds/noxlist.asp (Accessed: March 21, 1998).

Teramoto, K.K. and R.A. Heu. 2000. *List of Beneficial Organisms Purposely Released for Biological Control in Hawai'i*. State of Hawai'i, Department of Agriculture, Honolulu, HI.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1999. *Manual of the Flowering Plants of Hawai'i*. 2 vols. Bishop Museum Special Publication 83, University of Hawai'i and Bishop Museum Press, Honolulu, HI.

Wester, L. 1992. Origin and distribution of adventive alien flowering plants in Hawai'i. In: *Alien Plant Invasions in Native Ecosystems of Hawai'i*. C.P. Stone, C.W. Smith, and J.T. Tunison, eds. University of Hawai'i Press, Honolulu, HI.

Morella cerifera

(Wax myrtle)

Morella cerifera

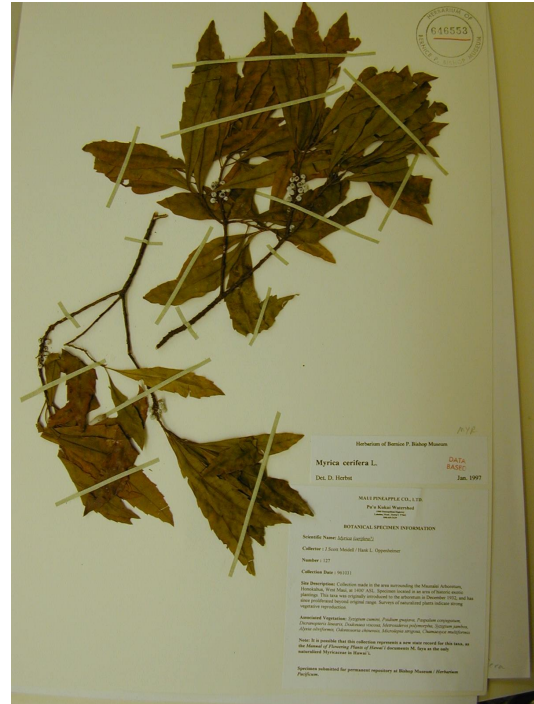
Wax myrtle -- Myricaceae

Overview: *Morella cerifera* (wax myrtle) is an evergreen shrub to small tree native to the coastal southeastern United States from Maryland to Texas (Dehgan 1998). On Maui, *M. cerifera* is sparingly cultivated and was recently reported as naturalized in mesic to wet forests on West Maui (Meidell et al. 1997).

Description: "Shrub or tree to 10 m tall. Leaf tips acute, the sides forming an angle under 65 degrees. Leaves evergreen, sometimes dropping in severe winters; the surfaces with abundant waxy granules, especially the underside. Fruits 2.0-3.5 mm long, without hairs, with an irregular surface heavily coated with waxy granules." (Duncan and Duncan 1987).

Impact: *M. cerifera* is native to Florida, but is considered a major woody pest plant of pastures there (Kalmbacher et al. 1993). Dehgan (1998) describes *M. cerifera* as a very tough plant that is easy to grow, but may become weedy with rapid growth and frequent suckering from trunk bases and roots. *M. cerifera* has rapid growth, production of numerous bird dispersed fruits, nitrogen-fixing capabilities, and can colonize and dominate disturbed areas in a variety of habitats.

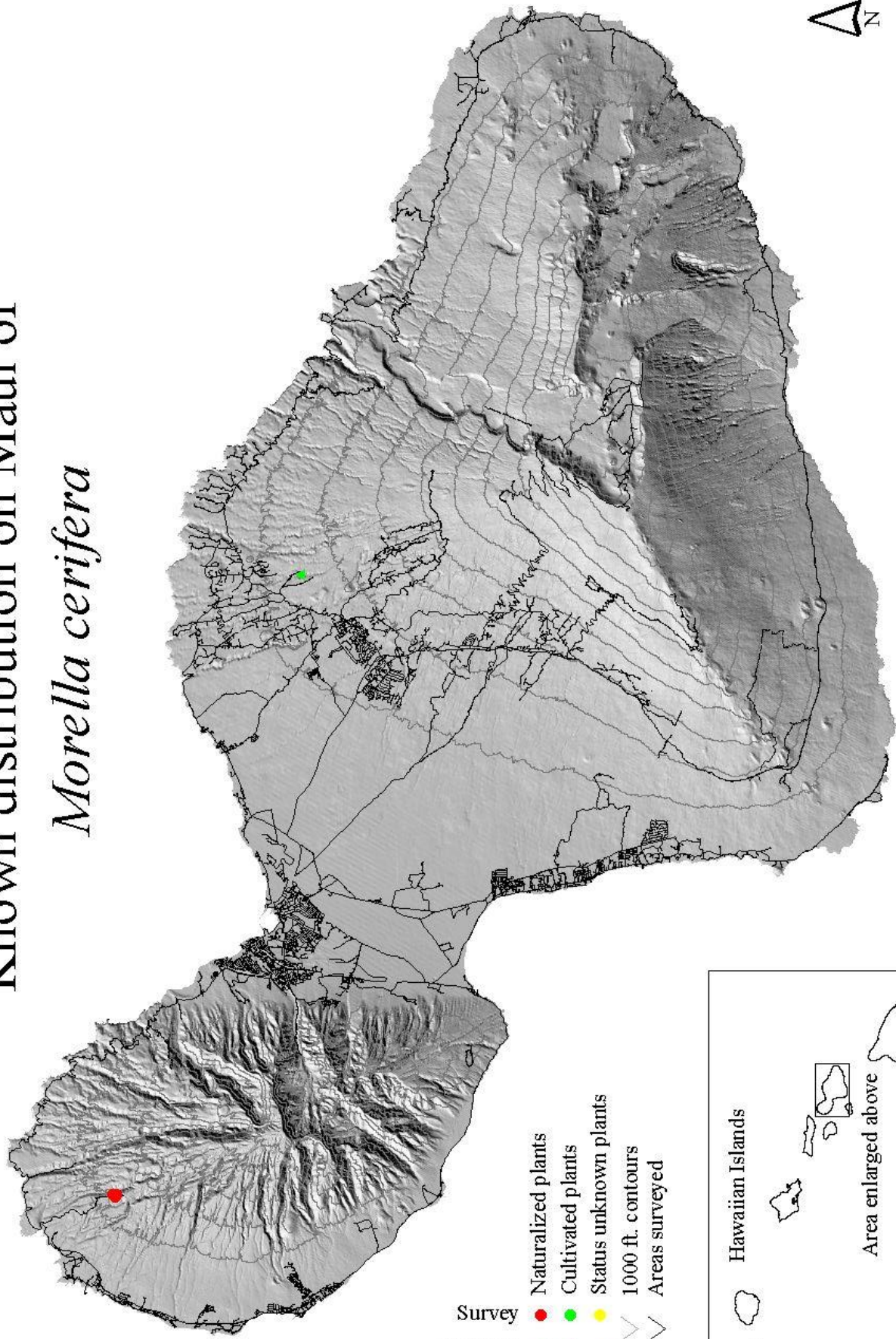
Distribution: On Maui, *M. cerifera* was first documented as naturalized on West Maui by Meidell et al. (1997). Meidell et al. (1997) found that the species had proliferated well beyond the original planting site. They estimated that 200+



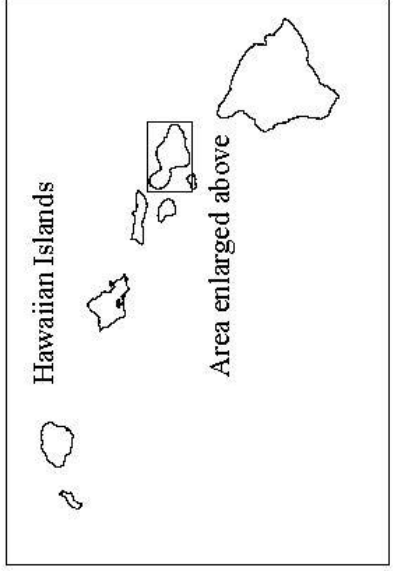
individuals were in an area between Honolua and Honkahua Valleys. On East Maui, there has been a siting in Ha'iku where it was being cultivated as a hedge.

Control Methods: In pastures of Florida, *M. cerifera* is mechanically controlled through prescribed burns and mowing. Small seedlings and root suckers may be difficult to pull or dig up. Trials of foliar applications of triclopyr showed that control was effective, especially when concentrated at higher rates (Kalmbacher et al. 1993).

Known distribution on Maui of *Morella cerifera*

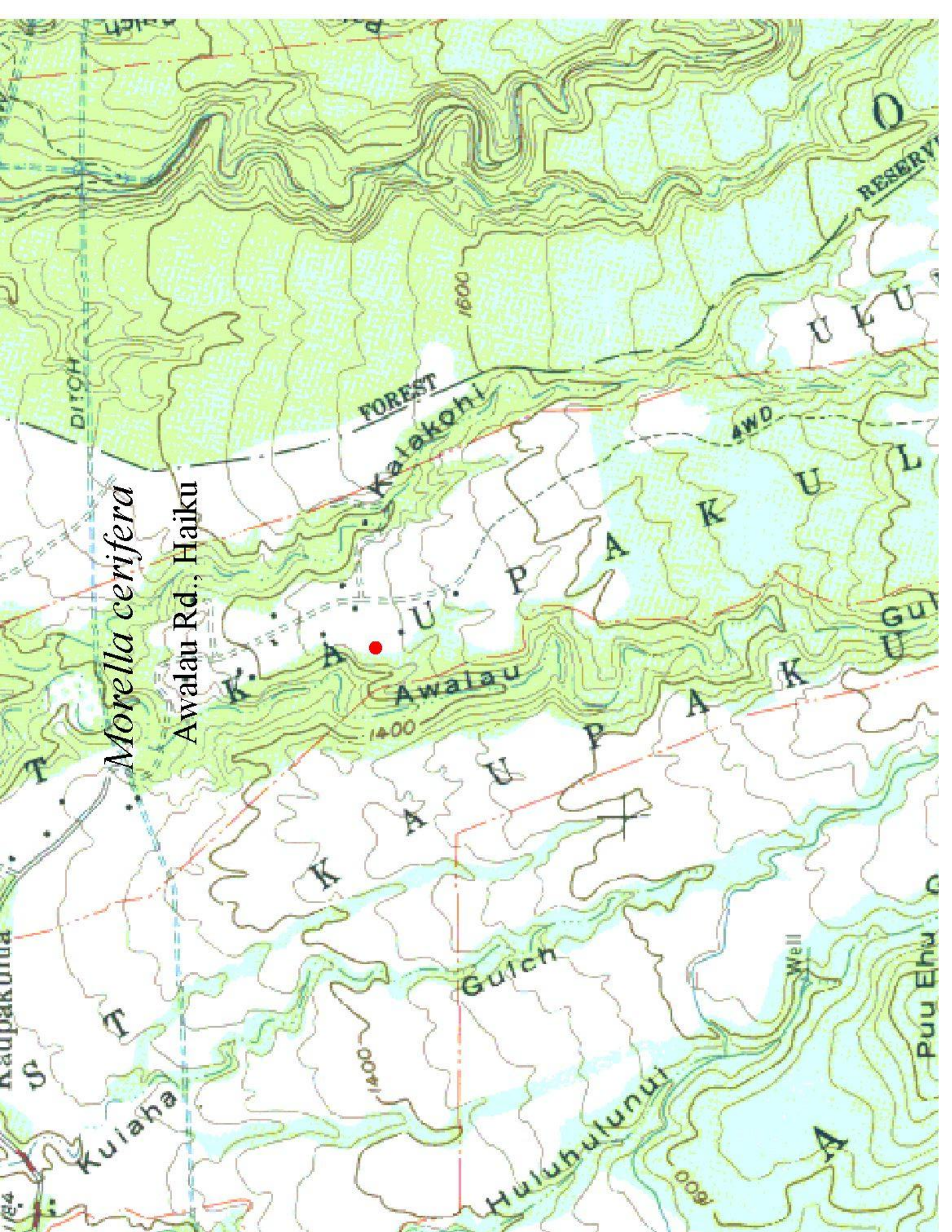


- | | | |
|-----------|---|-----------------------|
| Survey | ● | Naturalized plants |
| Interview | ▲ | Cultivated plants |
| | ● | Status unknown plants |
| | — | 1000 ft. contours |
| | — | Areas surveyed |



5 0 5 10 Miles

USGS-BRD Haleakala Field Station (May 2003)



Morella cerifera

Awalau Rd., Haiku

FOREST

Kalakohi

Awalau

DITCH

AWD

Gulch

Well

Huluhulunui

RESERV

Naupakuiua

Kulaha

Puu Ehw

Morella cerifera
Fleming Arboretum



SITE INFORMATION -- *Morella cerifera*

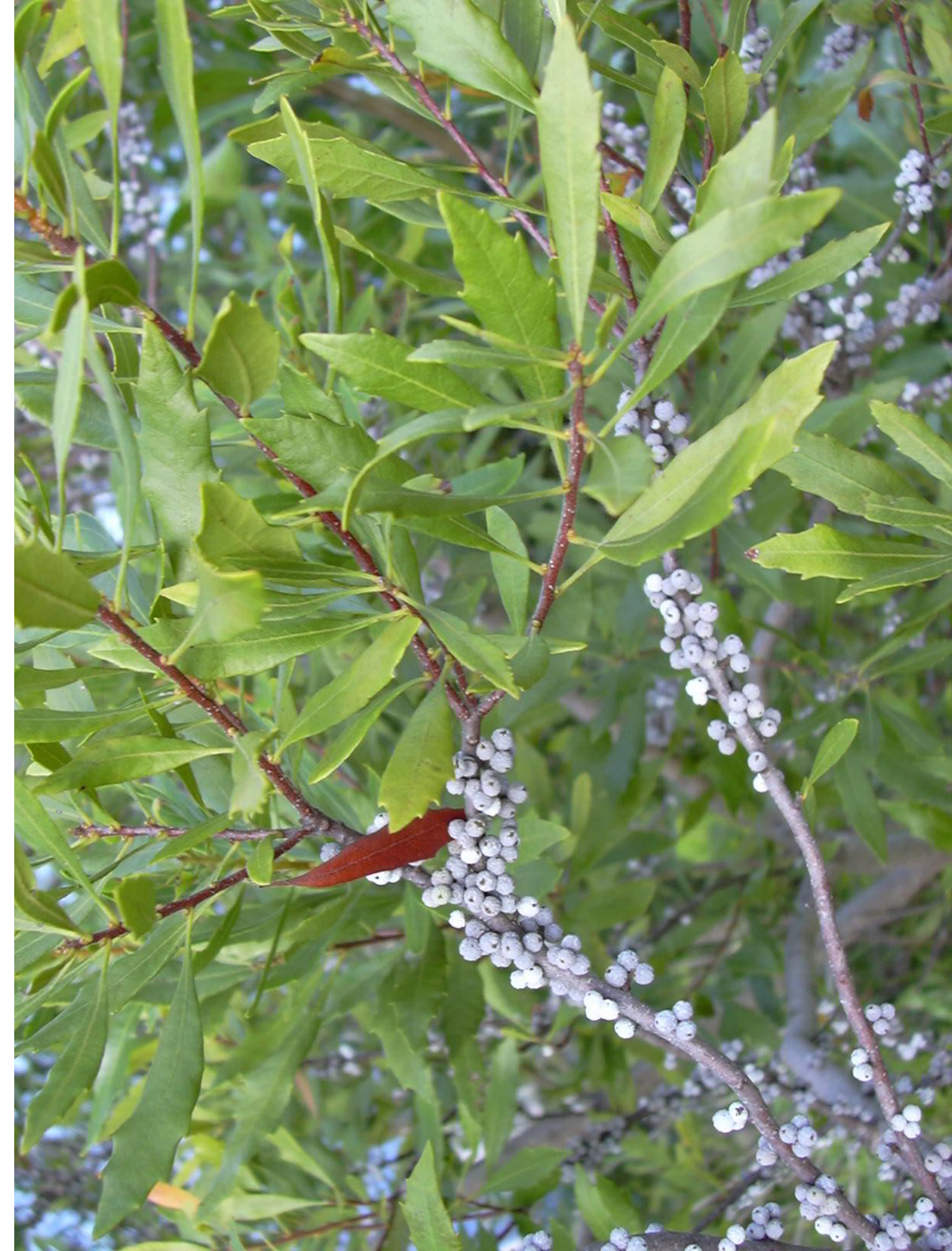
-- Fleming Arboretum, West Maui.

Spreading from plantings in Fleming Arboretum. Being controlled by Pu'u Kukui Watershed staff.

-- Awalau Rd., Ha'iku, East Maui.

A single long hedge planted in yard





Morella cerifera

Wax myrtle

Myricaceae

Forest Starr, Kim Starr, and Lloyd Loope
United States Geological Survey--Biological Resources Division
Haleakala Field Station, Maui, Hawai'i

August, 2003

OVERVIEW

Morella cerifera (wax myrtle) is an evergreen shrub to small tree that is native to the coastal southeastern United States from Maryland to Texas (Dehgan 1998). In its native range, *Morella cerifera* grows in sand dunes, edges of marshes and ponds, and woods (Duncan and Duncan 1987). *Morella cerifera* has attributes similar to *Morella faya*, a related species that has become invasive in Hawai'i. Both are evergreen nitrogen fixing pioneer trees in their native ranges and often become dominants in their ecosystems. Both spread rapidly through aggressive growth and production of numerous bird dispersed fruits. On Maui, *Morella faya* is widely naturalized, especially in the Kula area where it occupies large acreages of pastures, roadsides, open forests and shrubland. *Morella cerifera* is sparingly cultivated and was recently reported as naturalized in mesic to wet forests on West Maui escaping from Maunalei Arboretum where it was originally planted by D. T. Fleming in December 1932 (Meidell et al. 1997). Over 200+ individuals located between Honolua and Honokahua Valleys at an elevation of 395-490 m (1,296-1,608 ft) have been located and controlled by Pu'u Kukui Watershed staff in attempts to eradicate the species from the area (Meidell et al. 1997). Recently, what appeared to be *M. cerifera* was observed being cultivated as a hedge in Ha'iku, East Maui. On Maui, *M. cerifera* is not nearly as widespread as *M. faya*, though it poses a similar threat. Eradication on Maui seems feasible at this time. Locating other individuals in cultivation and elsewhere throughout the state may help determine how much is currently present and help prioritize control efforts.

TAXONOMY

Family: Myricaceae (Bayberry family) (PLANTS 2003).

Latin name: *Morella cerifera* (L.) Small (PLANTS 2003).

Synonyms: *Cerothamnus ceriferus* (L.) Small, *Cerothamnus pumilus* (Michx.) Small, *Myrica cerifera* L., *Myrica cerifera* L. var. *pumila* Michx., *Myrica pusilla* Raf. (PLANTS 2003).

Common names: Southern wax myrtle, wax-myrtle, wax myrtle (PLANTS 2003, Dehgan 1998, Brickell and Zuk 1997, Duncan and Duncan 1987).

Taxonomic notes: The family Myricaceae is made up of 3 genera and possibly up to 50 species that are widespread in the Old and New World, mostly in temperate and subtropical regions and are represented in Hawai'i by two naturalized species, *Morella cerifera* and *Morella faya* (Wagner et al. 1999, Meidell et al. 1997).

Nomenclature: The genus *Myrica* was recently split into 3 genera after a review by Wilbur (1994) resulting in a name change from *Myrica faya* to *Morella faya* as well as a

name change from *Myrica cerifera* to *Morella cerifera* (Wagner et al. 1999, Staples et al. 2002, PLANTS 2003).

Related species in Hawai'i: A second naturalized species in Hawai'i is *Morella faya* (firetree) (Wagner et al. 1999). Other *Morella* species known in the United States include *M. californica* (Cham. & Schlecht.) Wilbur (California wax myrtle), *M. gale* L. (sweet-gale, bog myrtle), *M. holdridgeana* (Lundell) Kartesz, comb. nov. ined. (Palo de cera), *M. inodora* (Bartr.) Small (scentless bayberry), *M. x macfarlanei* (youngken) Kartesz, comb. nov. ined. [*cerifera* x *pensylvanica*], and *M. pensylvanica* (Mirbel) Kartesz, comb. nov. ined. (northern bayberry) (PLANTS 2003, Duncan and Duncan 1987).

DESCRIPTION

"Monoecious, large, evergreen shrub or small tree, clumping, irregular, rounded, densely foliated and medium-textured. Reaches a height and spread of 35 ft, but is usually seen in the 15-20 ft range. Growth rate is rapid. Leaves simple, alternate, oblanceolate, to 4 in long, often undulate. The thin, olive green leaves are often coarsely serrate along apical margins and dotted with tiny rusty glands on both sides. Aromatic. Multiple crooked trunks are covered with smooth, grayish-white bark. Young stems light green to gray, pubescent. Suckers frequently from trunk bases and roots. Plants dioecious; flowers inconspicuous, small axillary catkins appear in March. Fruit grayish-blue, 0.25 in wide, in dense clusters along the twigs in fall. The fruit are heavily coated with wax." (Dehgan 1998).

"Shrub or tree to 10 m tall. Leaf tips acute, the sides forming an angle under 65 degrees. Leaves evergreen, sometimes dropping in severe winters; the surfaces with abundant waxy granules, especially the underside. Fruits 2.0-3.5 mm long, without hairs, with an irregular surface heavily coated with waxy granules." (Duncan and Duncan 1987).

BIOLOGY & ECOLOGY

Cultivation: The waxy surfaces of *M. cerifera* and other species is removed by boiling in water and used as a source of candle wax (Duncan and Duncan 1987). It is cultivated as a hedge, screen, or enclosure plant as well as a background shrub. Lower branches can be trimmed to make an excellent small tree for roadside or park plantings (Dehgan 1998). *M. cerifera* grows in full sun or partial shade on almost any soil type. It can tolerate salty conditions and flooding, but does not withstand excessive drought (Dehgan 1998).

Invasiveness: *M. cerifera* is native to Florida, but it is considered the major woody pest plant of pastures there (Kalmbacher et al. 1993). Landscapers warn of the invasiveness of *M. cerifera* and other *Morella* species. Dehgan (1998) describes *M. cerifera* as a very tough plant that is easy to grow, but may become weedy with rapid growth and frequent suckering from trunk bases and roots. *M. cerifera* shares similar attributes with *M. faya*. These attributes include rapid growth, production of numerous bird dispersed fruits, a history of cultivation in the Hawaiian Islands, nitrogen-fixing capabilities, and ability to colonize and dominate disturbed areas in a variety of habitat. In Hawai'i, *M. faya* has invaded large areas in numerous habitats and it is suspected *M. cerifera* could potentially do the same if left uncontrolled. On Maui, *M. cerifera* was originally planted in 1932

(Meidell et al. 1997). It has since spread and is now considered a control priority by Pu'u Kukui Watershed staff.

Pollination: *Morella faya*, a related species, is wind pollinated (Siebold 2001) and it is likely that *M. cerifera* is as well.

Propagation: *M. cerifera* is easily and rapidly propagated from seed and can also be propagated from tip cuttings (Dehgan 1998).

Dispersal: *M. cerifera* is dispersed over long distances by humans who cultivate the plant. The major method of seed dispersal is by birds (Fordham 1983). *M. cerifera* fruits are main food sources for tree swallows (*Iridoprocne bicolor*) that spend the winters in Florida and the Gulf coast (Halls 1977).

Pests and diseases: In Florida, a leaf beetle *Colaspis pseudofavosa* Riley is known to feed on leaves of *M. cerifera*. Dehgan (1998) reports that *M. cerifera* is generally pest free, but can be damaged by chewing insects and is sometimes killed by a canker disease.

DISTRIBUTION

Native range: *M. cerifera* is native to the coastal plains from Maryland to Texas (Dehgan 1998). It is described as ubiquitous in Florida (Dehgan 1998). *M. cerifera* is a common coastal plant that is found scattered in primary dunes, and frequent in stable dune areas, edges of marshes and ponds, and woods (Duncan and Duncan 1987). On some Virginia barrier islands, *M. cerifera* is the most abundant woody species, occurring in swales behind dunes, and can occupy up to 12% of total vegetation (Young 1992).

Global distribution: *M. cerifera* is cultivated in moist, warm areas, such as the southeast coastal United States, where it is native (Brickell and Zuk 1997).

State of Hawai'i distribution: In Hawai'i, *M. cerifera* was first documented as naturalized on West Maui (see below). Status on other islands is uncertain, though Skolmen (1960) reports that 50 *M. cerifera* trees were planted in 1932 during reforestation efforts in Honolulu, O'ahu. The current status of this planting is not known.

Island of Maui distribution: *M. cerifera* was first documented as naturalized on West Maui by Meidell et al. (1997). It was originally introduced by D.T. Fleming in December 1932 as part of the Maunalei Arboretum project. Meidell et al. (1997) found that the species had proliferated well beyond the original planting site. They estimated that 200+ individuals were in an area between Honolua and Honkahua Valleys, 395-490 m (1,296-1,608 ft). They also add that there were likely more naturalized plants that would be found in follow up surveys and that an aggressive eradication effort was underway. On East Maui, there has been an unconfirmed *M. cerifera* siting in Ha'iku where it was being cultivated as a hedge in a backyard.

CONTROL METHODS

Physical control: In pastures of Florida where *M. cerifera* is considered invasive, it is mechanically controlled through prescribed burns and mowing. Small seedlings and root suckers may be difficult to pull or dig up.

Chemical control: Trials of foliar applications of triclopyr showed that control was effective, especially when concentrated at higher rates (Kalmbacher et al. 1993). Other methods including basal bark and cut stump treatments are potentially effective.

Biological control: None known.

Cultural control: The public could be encouraged not to grow this or other harmful plant species.

Noxious weed acts: *M. cerifera* is not currently on any noxious weed lists. However, the related species *Morella faya* is listed as a Hawai'i state noxious weed by the Department of Agriculture (HDOA 1992). It may be useful to add *M. cerifera* to the noxious weed list to assist with control efforts on Maui and to help prevent reintroduction.

MANAGEMENT RECOMMENDATIONS

M. cerifera is sparingly cultivated in Hawai'i and was recently reported as naturalized on West Maui (Meidell 1997). Approximately 200+ individual plants have been located and controlled by Pu'u Kukui Watershed staff. It is feared that this species will pose similar threats as that of its weedy relative *Morella faya* as it is similar in growth habits and dispersal mechanisms. A planting of *M. cerifera* was recently observed on East Maui and there are records of *M. cerifera* being planted for forestry efforts on O'ahu (Skolmen 1960). It is likely that there are other places in the Hawaiian Islands where *M. cerifera* is cultivated and naturalized. This and other *Morella* species should be looked for in forestry plantations, arboretums, and yards. If feasible, *M. cerifera* should be added to the Hawai'i noxious weed list to help assist eradication efforts on Maui. In addition, other *Morella* species could be evaluated and restricted depending on their potential to become invasive.

REFERENCES

Brickell, C. and J.D. Zuk. 1997. *The American Horticultural Society A-Z Encyclopedia of Garden Plants*. DK Publishing, Inc., NY.

Dehgan, B. 1998. *Landscape Plants for Subtropical Climates*. University Press of Florida, Gainesville, FL.

Duncan, W.H. and M.B. Duncan. 1987. *The Smithsonian Guide to Seaside Plants of the Gulf and Atlantic Coasts*. Smithsonian Institution Press, Washington, DC.

Fordham, A.J. 1983. Of birds and bayberries: seed dispersal and propagation of three *Myrica* species. *Arnoldia* 43: 20-23.

Halls, L.K. 1977. Southern bayberry *Myrica cerifera* L. [Woody plants as wildlife food, species]. USDA-Forest Serv. Tech. Rep. Southern For. Exp. Stn. 16: 57-58.

HDOA (Hawai'i Department of Agriculture). 1992. *List of Plant Species Designated as Noxious Weeds for Eradication or Control Purposes* (June 18, 1992). Hawaii Department of Agriculture. Available: <http://www.botany.hawaii.edu/cpsu/-strawgua/other/noxious/noxious.html> (Accessed: February 26, 2003).

Kalmbacher, R.S., J.E. Eger, Jr., and A.J. Rowland-Bamford. 1993. Response of Southern wax myrtle (*Myrica cerifera*) to herbicides in Florida. *Weed Technology* 7: 84-91.

Meidell, J.S., H.L. Oppenheimer, and R.T. Bartlett. 1997. New plant records from Pu'u Kukui Watershed and adjacent areas, Maui. *Bishop Mus. Occas. Pap.* 49(2): 17-19.

PLANTS (National Plants Database). 2003. Online database. United States Department of Agriculture, Natural Resources Conservation Services, National Plant Data Center, Baton Rouge, LA. Available: <http://plants.usda.gov> (Accessed: February 27, 2003).

Siebold, R. 2001. Controlling Fire Tree (*Myrica faya*) in Hawai'i. Restoration and Reclamation Review Student On-line Journal, Volume 6. Dept. of Horticultural Science, University of Minnesota, St. Paul. Available: <http://www.hort.agri.umn.edu/hort5015/00papers/siebold.htm> (Accessed: February 26, 2003).

Skolmen, R.G. 1960. *Plantings on the Forest Reserves of Hawai'i: 1910-1960*. Institute of Pacific Islands Forestry, Pacific Southwest Forest and Range Experiment Station, United States Forest Service, Honolulu, HI.

Staples, G.W., C.T. Imada, and D.R. Herbst. 2002. New Hawaiian plant records for 2000. *Bishop Mus. Occas. Pap.* 68(1): 3-18.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1999. *Manual of the Flowering Plants of Hawai'i*. 2 vols. Bishop Museum Special Publication 83, University of Hawai'i and Bishop Museum Press, Honolulu, HI.

Wilbur, R.L. 1994. The Myricaceae of the United States and Canada: genera, subgenera, and seies. *Sida* 16(1): 93-107.

Young, D.R. 1992. Photosynthetic characteristics and potential moisture stress for the Actinorhizal shrub, *Myrica cerifera* (Myricaceae), on a Virginia barrier island. *American Journal of Botany* 79(1): 2-7.

Morella faya

(Firetree)

Morella faya

Firetree -- Myricaceae

Overview: *Morella faya*, native to the Atlantic Isles of the Canaries, Azores, and Madeira, is a fast growing, quick spreading tree that invades a variety of habitats from disturbed pasture and ranchland to native mesic and wet open forests on the islands of Hawai'i, Maui, Lana'i, O'ahu, and Kaua'i (Oppenheimer et al. 1999, Wagner et al. 1999). *M. faya* was originally introduced to Hawai'i in the late 1800's and was used in forestry plantations.

Description: "Evergreen shrubs or small trees up to 8 m tall; branches with reddish peltate hairs. Leaves coriaceous, oblanceolate, 4-11 cm long, 1-2.5 cm wide, glabrous, glandular dots inconspicuous, margins somewhat revolute, remotely serrulate or serrate in upper 1/2, apex rounded to acute. Flowers in usually branched catkins borne among leaves of the current year's growth. Fruit drupaceous, dark red or blackish when mature, slightly fleshy." (Wagner et al. 1999).

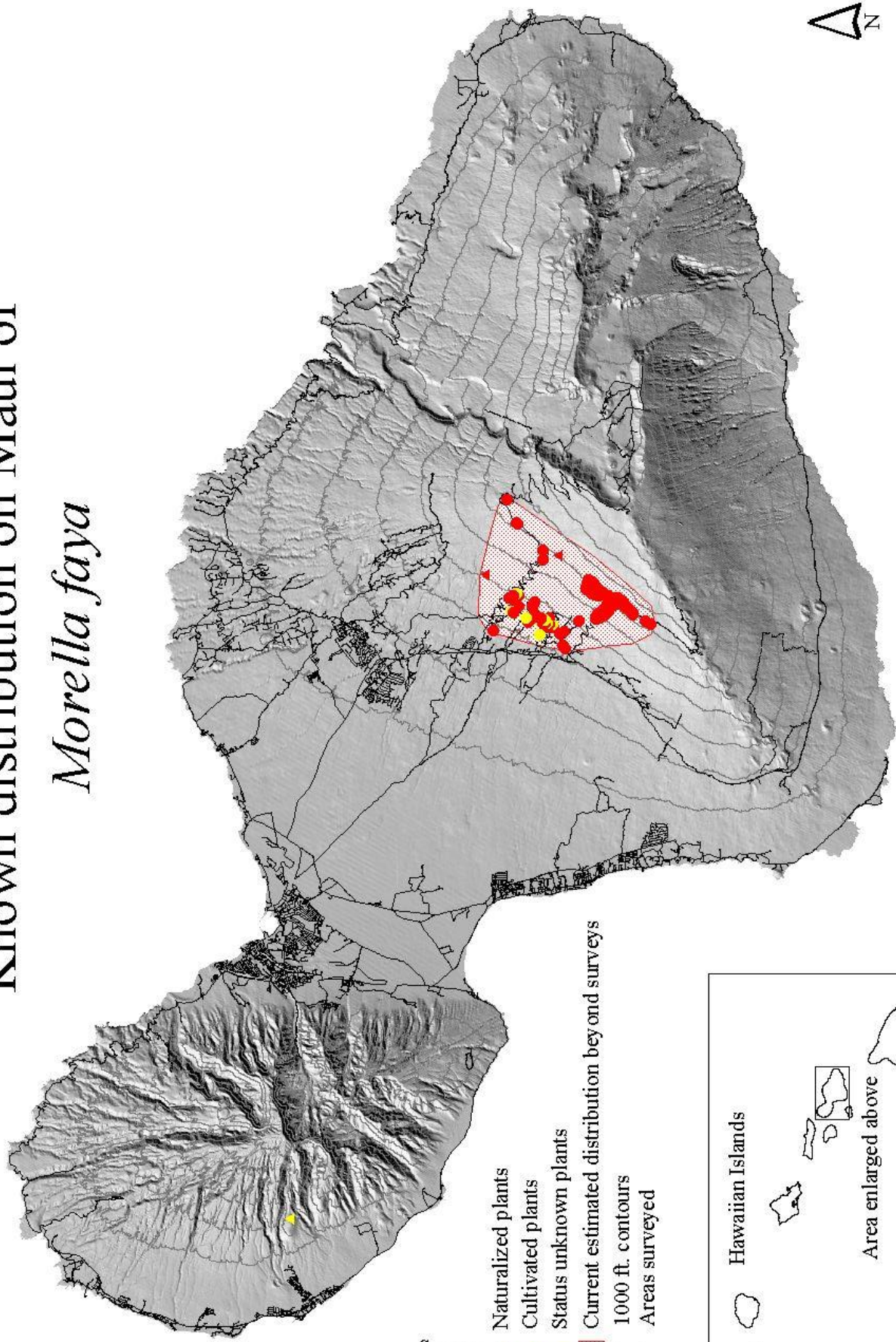
Invasiveness: *Morella faya* spreads rapidly and forms a thick monotypic cover that can crowd out desirable vegetation and alter ecosystem dynamics. In addition, the leaf litter of *M. faya* is allelopathic and is known to prevent germination of native *Metrosideros polymorpha* ('ohia) (Binggeli 1998). *M. faya* produces numerous seeds that are spread by fruit eating birds and animals such as pigs (Whiteaker and Gardner 1992).



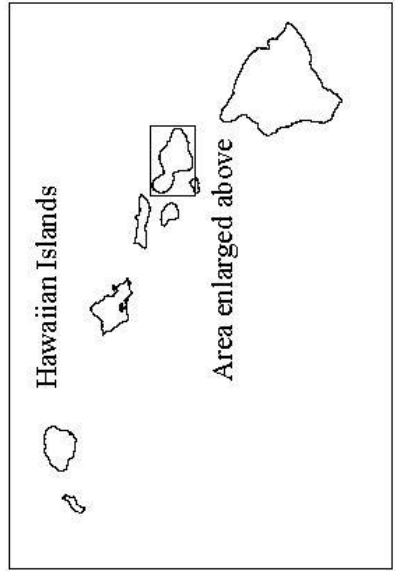
Distribution: On Maui, the main *M. faya* infestation occurs on the windward slope of Haleakala. In addition, there were a couple plants that were located and controlled above Lahaina on West Maui (H. Oppenheimer pers. comm.).

Control Methods: Small seedlings and saplings of *M. faya* can be hand pulled or dug up. Foliar applications of herbicide will work. Susceptible to cut-stump treatments of 10% triclopyr, and 100% glyphosate, and frill application of 50% triclopyr (Motooka et al. 2002). Gardner and Kageler (1982) tested several different methods for application in sensitive areas and found that the method that worked best was to inject undiluted Roundup (5-10 ml) per tree.

Known distribution on Maui of *Morella faya*



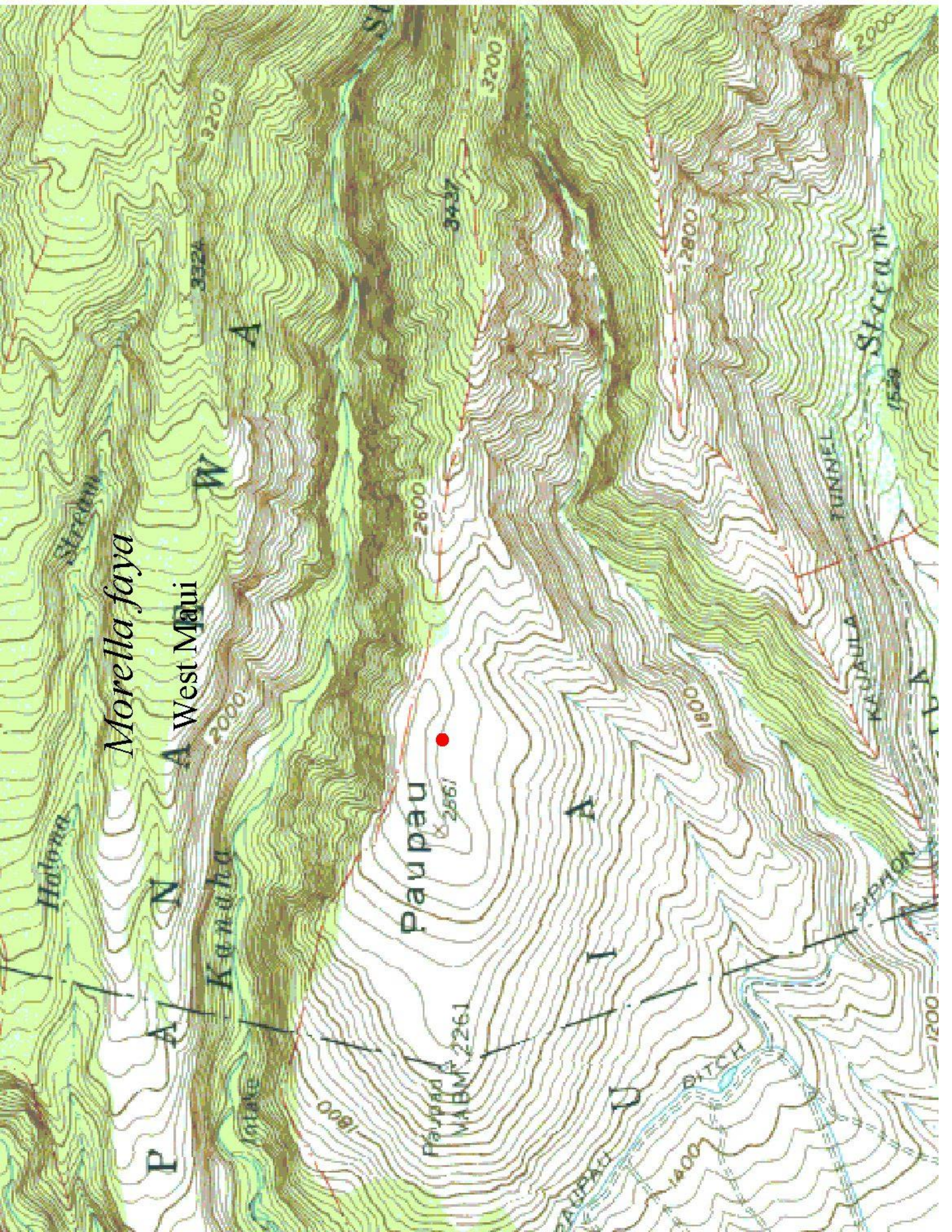
- | | | |
|-----------|---|---|
| Survey | ● | Naturalized plants |
| Interview | ▲ | Cultivated plants |
| | ● | Status unknown plants |
| | ▲ | Current estimated distribution beyond surveys |
| | ■ | 1000 ft. contours |
| | — | Areas surveyed |



5 0 5 10 Miles



USGS-BRD Haleakala Field Station (May 2003)



Morella faya

PAUPAU West Maui

Paupau

2861

Paupau
M.B.M.
2261

3437

2600

2800

1800

1400

3200

3324

3000

2000

1800

2000

1500

1200

Halona Stream

Kanaha

Kauaia Tunnel

Kauaia Stream

PAUPAU BLITCH

PAUPAU

PAUPAU

PAUPAU

SITE INFORMATION -- *Morella faya*

-- Lahaina, West Maui.

A few trees found and controlled by Pu'u Kukui Watershed staff.







Morella faya

Firetree
Myricaceae

Forest Starr, Kim Starr, and Lloyd Loope
United States Geological Survey--Biological Resources Division
Haleakala Field Station, Maui, Hawai'i

March, 2003

OVERVIEW

Morella faya is a fast growing, quick spreading tree that invades a variety of habitats from disturbed pasture and ranchland to native mesic and wet open forests on the islands of Hawai'i, Maui, Lana'i, O'ahu, and Kaua'i. *M. faya* was originally introduced to Hawai'i in the late 1800's and was used in forestry plantations in the late 1920's. By 1944, *M. faya* was rapidly spreading and was being recognized as a pest plant (Neal 1965). Today, *M. faya* is a declared noxious weed in the state of Hawai'i (HDOA 1992) and it continues to spread and cover large areas. On Maui, *M. faya* covers vast acreage in the 3,000-6,000 ft (914-1,829 m) elevation area on the slopes of Haleakala, but has been found as high as 7,000 ft (2,134 m). Eradication at this time does not seem feasible. This species poses a serious risk to areas in and near the current infestation. In December 2001, a small seedling was found and pulled in Haleakala National Park on Pu'u Nianiau, 7,000 ft (2,134 m) elevation. In addition, Park staff have controlled outlier plants that are approaching the wet forest boundaries. Early detection and containment of *M. faya* in and near natural areas will be key to preventing large infestations and costly removal programs in the future.

TAXONOMY

Family: Myricaceae (Bayberry family) (Wagner et al. 1999).

Latin name: *Morella faya* (Aiton) Wilbur (Wagner et al. 1999, Staples et al. 2002).

Synonyms: *Myrica faya* Aiton (Wagner et al. 1999, Staples et al. 2002).

Common names: Firetree (Neal 1965).

Taxonomic notes: The family Myricaceae is made up of 3 genera and possibly up to 50 species that are widespread in the Old and New World, mostly in temperate and subtropical regions and are represented in Hawai'i by two naturalized species (Wagner et al. 1999, Meidell et al. 1997).

Nomenclature: The genus *Myrica* was recently split into 3 genera after a review by Wilbur (1994) resulting in a name change from *Myrica faya* to *Morella faya* as well as a name change from *Myrica cerifera* to *Morella cerifera* (Wagner et al. 1999, Staples et al. 2002, PLANTS 2003).

Related species in Hawai'i: A second naturalized species in Hawai'i is *Morella cerifera* (wax myrtle). *Morella cerifera* is native to eastern and southern coastal United States and grows in sand dunes, edges of marshes and ponds, and woods (Duncan and Duncan 1987). In Hawai'i, *Morella cerifera* is sparingly cultivated and was recently reported as naturalized on West Maui escaping from Maunalei Arboretum where it was originally planted in 1932 (Meidell et al. 1997). Over 200+ individuals located between Honolua

and Honokahua Valleys at an elevation of 395-490 m (1,296-1,608 ft) have been located and controlled by Pu'u Kukui Watershed staff in attempts to eradicate the species from the area (Meidell et al. 1997). Recently, what appeared to be *M. cerifera* was observed being cultivated as a hedge in Ha'iku, East Maui.

DESCRIPTION

"Evergreen shrubs or small trees up to 8 m tall; branches with reddish peltate hairs. Leaves coriaceous, oblanceolate, 4-11 cm long, 1-2.5 cm wide, glabrous, glandular dots inconspicuous, margins somewhat revolute, remotely serrulate or serrate in upper 1/2, apex rounded to acute. Flowers in usually branched catkins borne among leaves of the current year's growth. Fruit drupaceous, dark red or blackish when mature, slightly fleshy." (Wagner et al. 1999).

BIOLOGY & ECOLOGY

Cultivation: *Morella faya* was introduced to Hawai'i in the late 1800's presumably by Portuguese laborers for ornamental purposes and for making wine out of the fruits (Little and Skolmen 1989). It was then cultivated and planted throughout the Hawaiian Islands for in reforestation efforts in the early 1920's (Skolmen and Little 1989). *Morella faya* is also observed in yards and gardens of Maui as an ornamental tree.

Invasiveness: *Morella faya* began spreading in the Hawaiian Islands shortly after it was planted in reforestation efforts in the 1920's and was considered a noxious weed by the Hawai'i Department of Agriculture by 1944 (Neal 1965). *M. faya* is naturalized and considered a serious pest, becoming dominant in many areas, occurring in mesic to wet forest, 150-1,310 m (492-4,298 ft), on Kaua'i, O'ahu, Lana'i, Maui, and Hawai'i (Wagner et al. 1999). In addition, it has been recorded as high as 7,000 ft (2,134 m) on Maui. *Morella faya* spreads rapidly and forms a thick monotypic cover that can crowd out desirable vegetation and alter ecosystem dynamics. In addition, the leaf litter of *M. faya* is allelopathic and is known to prevent germination of native *Metrosideros polymorpha* ('ohia) (Binggeli 1998). *M. faya* produces numerous seeds (ranging from 40,000 to 400,000 fruits/year) (Siebold 2001). The seeds are spread by fruit eating birds and animals such as pigs (Whiteaker and Gardner 1992). *M. faya* is vigorous in a wide variety of habitats. It is a nitrogen fixing tree and readily invades recent nutrient poor volcanic sites much quicker than native plants resulting in a disruption of natural succession (Benton 2002). On Maui, *M. faya* is rapidly invading pasture, light gaps in mesic to wet forests, and degraded shrubland from 3,000-6,000 ft (914-1,829 m) on East Maui from Haleakala Ranch west to Polipoli.

Pollination: *Morella faya* is wind pollinated (Siebold 2001). In Hawai'i, it is visited by the non-native *Apis mellifera* (honey bee) (Binggeli 1998).

Propagation: *Morella faya* reproduces from seed. *M. faya* is a dioecious species, however male plants often produce some fruits and female individuals sometimes produce a few male inflorescences (Binggeli 1998). In Hawai'i, fruits ripen mainly between August and November but may be produced throughout the year (Binggeli 1998). Germination occurs at all light levels but is highest under 55% and 63% of shade

(Binggeli 1998). On Maui, *M. faya* is less dense under the shade of Eucalyptus and pine plantations and tends to come up in light gaps, margins, and openings in the forest.

Dispersal: *Morella faya* was first introduced to Hawai'i presumably by Portuguese settlers for ornament, firewood, and making wine out of the fruits. It was then spread throughout the islands in forestry plantings. According to Vitousek and Walker (1989), *Metrosideros* sp. open canopied sites are especially susceptible to invasion by *M. faya* as they are good perch trees for birds which are the primary dispersal agents. Seeds of *M. faya* are primarily spread by *Zosterops japonica* (Japanese white-eye) resulting in population growth by nucleation (Siebold 2001). Other birds associated with the spread of *M. faya* include non-natives such as *Acridotheres tristis* (common mynah) and *Leiothrix lutea* (red-billed leiothrix), and natives such as *Phaeornis obscurus* ('oma'o) (Clarke 1978, Smathers and Gardner 1979, Gardner and Davis 1982, LaRosa et al. 1985). In addition, *Sus scrofa* (feral pigs) have been implicated as dispersal agents for *M. faya* (Clarke 1978).

Pests and diseases: The seeds of *Morella faya* are sometimes eaten by rats (Binggeli 1998). In Hawai'i, *M. faya* was a host for *Sophonia rufostachia* (two-spotted leafhopper). However, populations of the leafhopper have since dropped, and little damage is evident now. Brickell and Zuk (1997) report that species of *Morella* [*Myrica*] are susceptible to leaf spots, stem rots, root rots, dieback, and rust.

DISTRIBUTION

Native range: *Morella faya* is native to the Canary Islands, Madeira, and the Azores (Wagner et al. 1999). The Climate in its native range in the Canary Islands is typically mediterranean with wet winters and dry summers. The average temperatures in the Azores is 21 C (84 F) in the summer and 14.5 C (58 F) in the winter. The climate on Madeira is intermediate. Rainfall in this region increases with altitude, similar to Hawai'i, and varies between 750 and 2,500 mm (30-98 in) and highlands are usually covered in clouds and mist (Binggeli 1998). In the Azores, *M. faya* is the main species in the lowlands to regenerate on old lava flows. Near 600 m (1,968 ft) in the Azores, *M. faya* is a codominant in the canopy and is distributed up to 900 m (2,953 ft) with poor regeneration under canopy (Binggeli 1998). In its native range, *M. faya* is being displaced by *Pittosporum undulatum*, native to eastern Australia (Binggeli 1998).

Global distribution: *Morella faya* is cultivated elsewhere including Australia and New Zealand (PIER 2003). It is apparently naturalized on Chatham Island, New Zealand, but not yet on the mainland (PIER 2003). *M. faya* is cultivated and naturalized in Hawai'i.

State of Hawai'i distribution: *Morella faya* was originally introduced in the late 1800's presumably by Portuguese immigrants who brought the plant for ornament and other uses such as making wine from the fruits (Fosberg 1937, Little and Skolmen 1989). Shortly thereafter, the Hawaiian Sugar Planters' Association obtained seeds from the island of Hawai'i for use in reforestation attempts (Fosberg 1937). In the late 1920's, several hundred *M. faya* trees were planted on the islands of Kaua'i, O'ahu, and Hawai'i (Skolmen 1960). Planting records report 30 trees planted on Kaua'i, 112 trees planted on

O'ahu, and 548 trees planted on Hawai'i (Skolmen 1960). The plantings succeeded too well and by 1944 *M. faya* was declared a noxious weed by the HDOA and efforts began to eradicate the plant (Neal 1965). Despite efforts by the HDOA, State, and National Park Service to control the tree, *M. faya* continues to spread. Today, *M. faya* is now known from Kaua'i, O'ahu, Lana'i, Maui, and Hawai'i (Oppenheimer et al. 1999, Wagner et al. 1999). *M. faya* occurs as low as 1,400 ft (425 m) on Lana'i to as high as 7,000 ft (2,134 m) on Maui. In the Hawaiian Islands, *M. faya* invades a wide variety of habitats from mesic to wet forests, urban areas, pastures, and shrubland. Juvik and Juvik (1992) made the following estimates of total infested area: All islands, 85,912 a (34,365 ha); Hawai'i, 72,265 a (28,906 ha); Maui, 4,770 a (1,908 ha); O'ahu, 435 a (174 ha); Kaua'i, 5,925 a (2,370 ha); and Lana'i, 2,518 a (1,020 ha).

Hawai'i: On the island of Hawai'i, *M. faya* is found in the Hamakua district between Laupahoehoe and Honoka'a from 2,000-4,400 ft (610-1,341 m) elevation of mostly ranchland and pastures (Whiteaker and Gardner 1992). A second infestation site occurs in the Volcano area, including a large portion of Hawai'i Volcanoes National Park, at elevations ranging between 1,800-4,000 ft (549-1,219 m), consisting of a wide range of habitats including montane 'ohia rain forest, submontane seasonal forest, montane seasonal forest converted to pasture, and dry scrubland (Whiteaker and Gardner 1992). There are also infestations on Kapapala Ranch in pastures between 3,500 and 3,760 ft (1,067-1,146 m) and on Hualalai in ranchland between 4,850 and 6,040 ft (1,470-1,830 m) elevation (Whiteaker and Gardner 1992).

Maui: See below.

Lana'i: *M. faya* occurs in the mountainous areas of Lana'i Hale from 1,400 ft (425 m) to 3,370 ft (1,020 m) at the summit on narrow ridges, steep slopes, and protected gullies (Whiteaker and Gardner 1992).

O'ahu: *M. faya* occurs in the Wai'anae mountains, O'ahu at 2,000-3,127 ft (610-948 m) elevation in rough mountainous terrain with narrow ridges and steep slopes (Whiteaker and Gardner 1992).

Kaua'i: *M. faya* occurs in a variety of habitats on Kaua'i from montane rain forest to dry open steep slopes in the Koke'e State Park area at 4,200 ft (1,280 m) elevation and on the northwestern slopes of the Island at 1,800 ft (549 m) elevation (Whiteaker and Gardner 1992).

Island of Maui distribution: On Maui, the main *M. faya* infestation occurs on the windward slope of Haleakala from 3,000-7,000 ft (914-2,134 m) elevation from Pu'u Nianiau on the east to Polipoli State Park on the west. In addition, there were a couple plants that were located and controlled above Lahaina on West Maui (H. Oppenheimer pers. comm.). The infestation on East Maui is especially dense in areas nearby forestry plantations and residential sites along Crater Rd. and Kula west to Polipoli. Average annual rainfall in these areas ranges from 30-80 in (76-203 cm) (Juvik and Juvik 1998). Scattered plants can be observed in pastures and degraded shrubland areas just below

Haleakala National Park. In the Polipoli area, where *M. faya* was likely planted in forestry efforts, the infestation is especially dense in some nearby areas where it is becoming a co-dominant with other weedy plants including *Pinus radiata* (Monterey pine), *Acacia mearnsii* (black wattle), and *Passiflora mollissima* (banana poka) in degraded shrubland, mesic forest, pastures, and abandoned pastures. Numerous fruit eating birds in the area as well as feral pigs are likely dispersing seeds of *M. faya*. Under dense plantations of *Pinus* spp. and *Eucalyptus* spp., *M. faya* is not as aggressive and only occupies areas where there are light gaps and openings in the forest. The furthest east that *M. faya* has been found is Pu'u Nianiau, Haleakala National Park (HNP), elevation 7,000 ft (2,134 m) where 1 small plant found and pulled in December, 2001 by Betsy Gagne and Forest Starr. The National Park Service's -Exotic Plant Management Team has done control on plants at the leading edge of the invasion in Haleakala Ranch land located directly adjacent to and below HNP. Currently, locating and controlling *M. faya* in the open ranchland is relatively easy. Park staff is concerned that once *M. faya* reaches the wet forest, it will be extremely difficult to locate and control. *M. faya* seems to not have reached its full potential distribution on Maui and continued early detection in natural areas along with control of outliers will be key to preventing future infestations and costly control.

CONTROL METHODS

Physical control: Small seedlings and saplings of *M. faya* can be hand pulled or dug up.

Chemical control: Foliar applications of herbicide will work to control *M. faya* and is best done in easily accessible areas where native plants are not nearby, such as in pastures and ranchland. Gardner and Kageler (1982) tested several different methods for application in sensitive areas and found that the method that worked best was to inject undiluted Roundup (5-10 ml) per tree. This method allows for quick absorption and least amount of non-target effects. Other methods that likely control *M. faya* include basal bark and cut stump applications of Garlon 4 and Garlon 3A.

Biological control: The agent *Botrytis cinerea* is a locally established pathogen (fungus) in Hawai'i that has been found to diminish *M. faya* populations. The fungus causes fruit rot and is known to diminish seed viability from 66% to 16.8% in Hawai'i Volcanoes National Park (Siebold 2001). The infected fruit also is less attractive to birds which lessens their dispersal rate (Siebold 2001). The fungus *B. cinerea* is spread by several fruit eating insects including *Amorbia emigratella* and *Cryptoblabes gnidiella* which act as vectors for the fungus (Siebold 2001). Two spotted leaf hopper (*Sophonia rufostachia*) has also been documented on *M. faya* in Hawai'i resulting in yellowing of leaves and affecting the health of plants.

Cultural control: *M. faya* seems to be somewhat shade tolerant and has difficulty invading closed intact forests. Limiting disturbances, damage caused by feral animals, and fragmentation of forests may help prevent infestations of *M. faya* (Whiteaker and Gardner 1992).

Noxious weed acts: *Morella faya* is listed as a Hawai'i State noxious weed (HDOA 1992).

MANAGEMENT RECOMMENDATIONS

Morella faya was introduced to Hawai'i in the late 1800's and was widely planted throughout the state in the 1920's. By 1944, the tree was considered a pest species and is now on the Hawai'i State noxious weed list. Despite control programs, *M. faya* continues to spread today and covers vast acreage on most of the main Hawaiian Islands. On Maui, *M. faya* is established in the Kula and Polipoli areas of East Maui where it is rapidly spreading in pastures, residential areas, along roads, shrublands, and mesic forests. On West Maui, there is only a small population of *M. faya* and these have already been controlled. *M. faya* may have some trouble invading dense intact native forests, but will opportunistically colonize disturbances, light gaps, and openings in the forest. Early detection and control of outliers in and nearby natural areas will need to continue in order to fend off the invasion of *M. faya*.

REFERENCES

- Benton, N. 2002. Firetree (*Myrica faya*). Plant Conservation Alliance, Alien Plant Working Group and The Nature Conservancy, Arlington, VA. Available: <http://www.nps.gov/plants/alien/fact/myfa1.htm> (Accessed: February 26, 2003).
- Binggeli, P. 1998. *An Overview of Invasive Woody Plants in the Tropics*. School of Agricultural and Forest Sciences Publication Number 13, University of Wales, Bangor, UK.
- Brickell, C. and J.D. Zuk. 1997. *The American Horticultural Society A-Z Encyclopedia of Garden Plants*. DK Publishing, Inc., NY.
- Clarke, G. 1978. The distribution of *Myrica faya* and other selected problem exotics within Hawaii Volcanoes National Park. Pres. 2nd Conf. Nat. Sci., Hawaii Volcanoes Natl. Park, June 1-3, 1978. Abstract, *Proc. 2nd Conf. Nat. Sci., Hawaii Volcanoes Natl. Park*, 51. Univ. Hawaii Coop. Natl. Park Resour. Stud. Unit, Honolulu, HI
- Duncan, W.H. and M.B. Duncan. 1987. *The Smithsonian Guide to Seaside Plants of the Gulf and Atlantic Coasts*. Smithsonian Institution Press, Washington, DC.
- Fosberg, F.R. 1937. Immigrant plants in the Hawaiian Islands. I. *Univ. Hawaii Occas. Paper* No. 32, University of Hawai'i, Honolulu, HI.
- Gardner, D.E. and C.J. Davis. 1982. The projects for biological control of nonnative plants in Hawaiian national parks. *Tech. Rep.* 45, Univ. Hawaii Coop. Natl. Park Resour. Stud. Unit, Honolulu, HI.
- Gardner, D.E. and V.A.D. Kageler. 1982. Herbicidal control of firetree in Hawaii Volcanoes National Park: a new approach. *Natl. Park Serv. Ecol. Serv. Bull.* 7. U.S. Dep. Interior, Washington, DC.

HDOA (Hawai'i Department of Agriculture). 1992. *List of Plant Species Designated as Noxious Weeds for Eradication or Control Purposes* (June 18, 1992). Hawaii Department of Agriculture. Available: <http://www.botany.hawaii.edu/cpsu/-strawgua/other/noxious/noxious.html> (Accessed: February 26, 2003).

Juvik, S.P and J.O. Juvik. 1998. *Atlas of Hawai'i*. 3rd ed. Department of Geography, University of Hawai'i press, Honolulu, HI.

LaRosa, A.M., C.W. Smith, and D.E. Gardner. 1985. Role of alien and native birds in the dissemination of firetree (*Myrica faya* Ait. - Myricaceae) and associated plant in Hawaii. *Pac. Sci.* 39: 372-378.

Little, E.L. and R.G. Skolmen. 1989. *Common Forest Trees of Hawai'i*. Agriculture Handbook No. 679. United States Department of Agriculture, Washington, DC.

Meidell, J.S., H.L. Oppenheimer, and R.T. Bartlett. 1997. New plant records from Pu'u Kukui Watershed and adjacent areas, Maui. *Bishop Mus. Occas. Pap.* 49(2): 17-19.

Neal, M.C. 1965. *In Gardens of Hawai'i*. Bernice P. Bishop Museum Special Publication 40, Bishop Museum Press, Honolulu, HI.

Oppenheimer, H.L., J.S. Meidell, and R.T. Bartlett. 1999. New plant records for Maui and Moloka'i. *Bishop Mus. Occas. Pap.* 59(2): 7-11.

PLANTS (National Plants Database). 2003. Online database. United States Department of Agriculture, Natural Resources Conservation Services, National Plant Data Center, Baton Rouge, LA. Available: <http://plants.usda.gov> (Accessed: February 26, 2003).

Siebold, R. 2001. Controlling Fire Tree (*Myrica faya*) in Hawai'i. Restoration and Reclamation Review Student On-line Journal, Volume 6. Dept. of Horticultural Science, University of Minnesota, St. Paul. Available: <http://www.hort.agri.umn.edu/hort5015/00papers/siebold.htm> (Accessed: February 26, 2003).

Skolmen, R.G. 1960. *Plantings on the Forest Reserves of Hawai'i: 1910-1960*. Institute of Pacific Islands Forestry, Pacific Southwest Forest and Range Experiment Station, United States Forest Service, Honolulu, HI.

Smathers, G.A. and D.E. Gardner. 1979. Stand analysis of an invading firetree (*Myrica faya* Aiton) population, Hawai'i. *Pac Sci.* 33(3): 239-255.

Staples, G.W., C.T. Imada, and D.R. Herbst. 2002. New Hawaiian plant records for 2000. *Bishop Mus. Occas. Pap.* 68(1): 3-18.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1999. *Manual of the Flowering Plants of Hawai'i*. 2 vols. Bishop Museum Special Publication 83, University of Hawai'i and Bishop Museum Press, Honolulu, HI.

Whiteaker, L.D. and D.E. Gardner. 1992. Firetree (*Myrica faya*) Distribution in Hawai'i. In: *Alien Plant Invasions in Native Ecosystems of Hawai'i*, C.P. Stone, C.W. Smith, and J.T. Tunison, eds. University of Hawai'i Press, Honolulu, HI.

Wilbur, R.L. 1994. The Myricaceae of the United States and Canada: genera, subgenera, and series. *Sida* 16(1): 93-107.

Pittosporum viridiflorum

(Cape pittosporum)

Pittosporum viridiflorum

Cape pittosporum -- Pittosporaceae

Overview: *Pittosporum viridiflorum* (Cape pittosporum), native to South Africa, is cultivated in Hawai'i as an ornamental plant (Wagner et al. 1999). In Hawai'i, *P. viridiflorum* was first collected in 1954. It has spread from plantings via bird dispersed seeds and is now naturalized on the islands of Hawai'i, Lana'i, and Maui (Starr et al. 1999, Wagner et al. 1999).



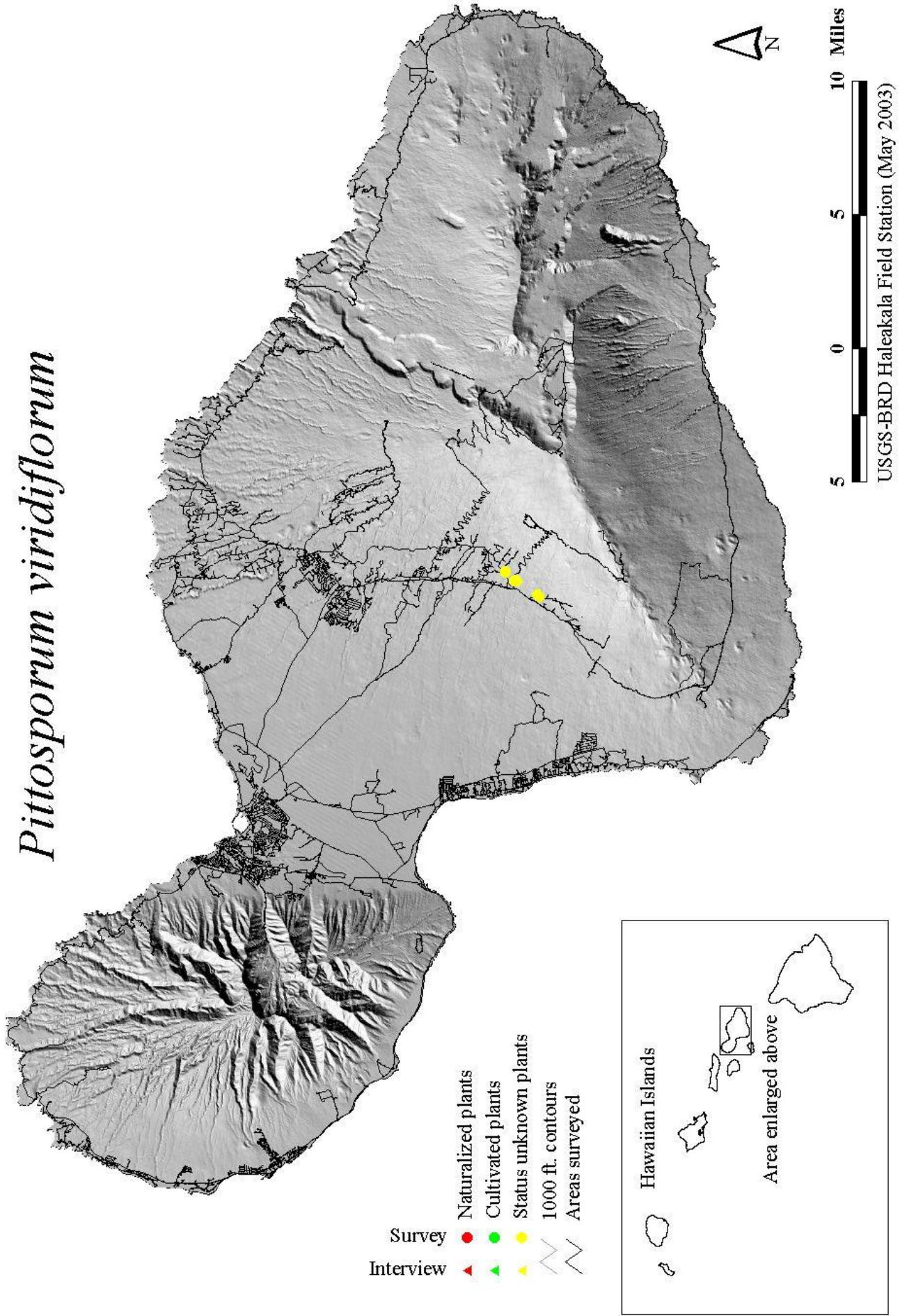
Description: "Small trees 3-6 m tall, young parts and inflorescences sparsely puberulent; branches glabrous. Leaves leathery, 6-15 cm long, 2.2-4 cm wide, glabrous, margins minutely revolute, apex bluntly acuminate to rounded, base attenuate, petioles 0.6-1.5 cm long. Flowers perfect, numerous in terminal, branched, corymbose inflorescences, peduncles 0-8 mm long, pedicels slender, 5-7 mm long; sepals elliptic, ca. 1.5 mm long, margins scarious; petals yellowish green, 5-6 mm long, margins slightly revolute and erose; ovary 2-carpellate. Capsules depressed-subglobose, slightly compressed, 4-5 mm long, the valves with thin exocarp, the surface minutely rugulose. Seeds 4-6, reddish black, subreniform, somewhat compressed, ca. 3.5-4 mm long." (Wagner et al. 1999).

to pinpoint the exact extent of the infestation.

Control Methods: No information was found for control, but standard practices for control of large trees would likely work.

Distribution: *P. viridiflorum* is locally spreading in Kula. Plants can be observed spreading here and there in yards and waste areas. The infestation does not seem very dense or very large in these areas, yet. Recent surveys indicate more refined mapping is needed

Known distribution on Maui of *Pittosporum viridiflorum*





Pittosporum viridiflorum

Polipoli Rd., Kula

WAIOHULI-KEOKEA
HOMESTEADS

Kaipalo

Waiohuli

KEOKEA

A D S

Water Tank
3344

Corral

PIPE LINE

ROAD

WT 2983

BM 3225

BM 3000

WT 3236

WT 3000

WT 3500

WT 3900

WT 2700

WT 2600

WT 3400

WT 3100

WT 3000

WT 2900

WT 2800

WT 4000

WT 3500

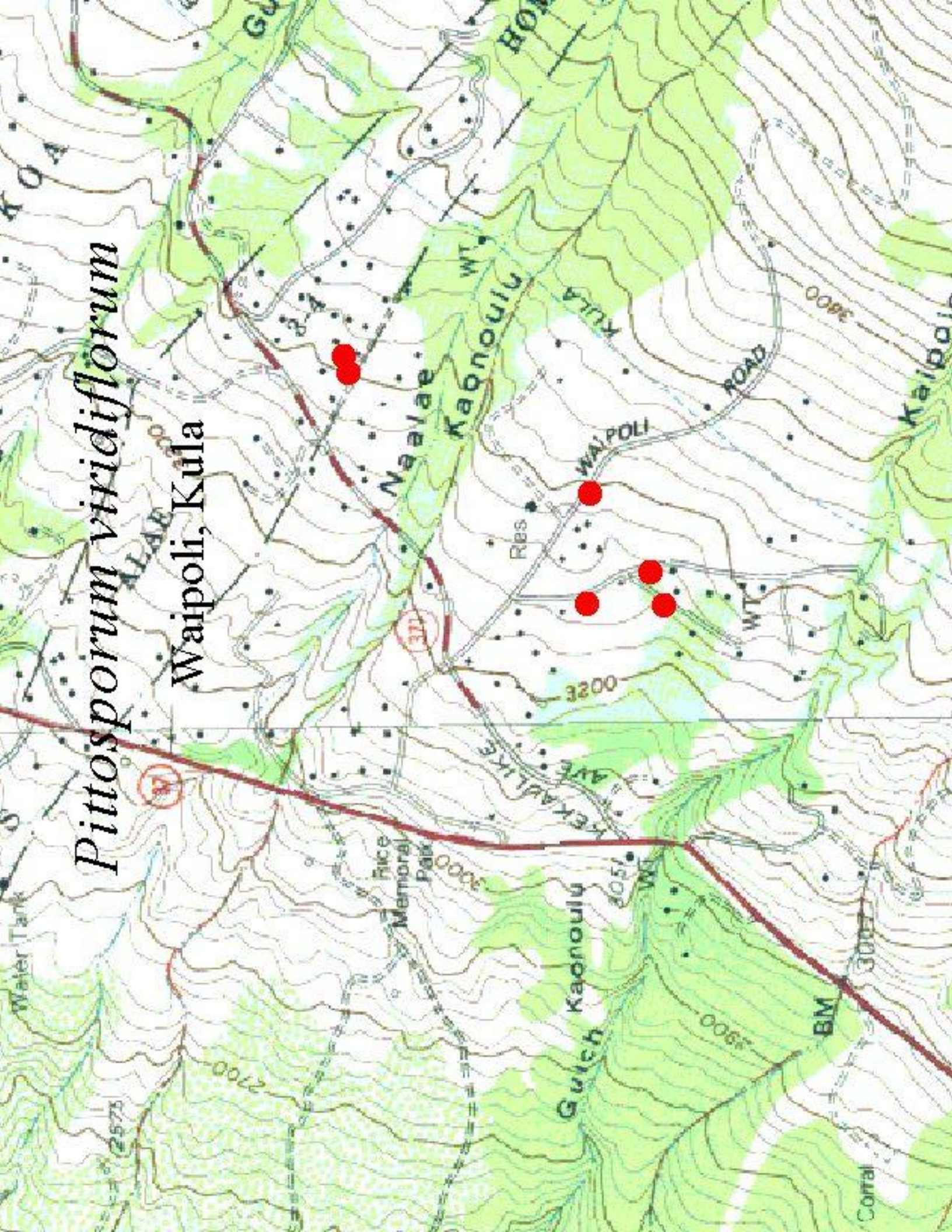
WT 3000

WT 2900

WT 2800

Pittosporum viridiflorum

Waipoli, Kula



SITE INFORMATION -- *Pittosporum viridiflorum*

-- Scattered trees from Polipoli Rd. to Waipoli Rd.Kula.





Pittosporum viridiflorum

Cape pittosporum

Pittosporaceae

Forest Starr, Kim Starr, and Lloyd Loope
United States Geological Survey--Biological Resources Division
Haleakala Field Station, Maui, Hawai'i

May, 2003

OVERVIEW

Pittosporum viridiflorum (Cape pittosporum), native to South Africa, is cultivated in Hawai'i as an ornamental plant (Wagner et al. 1999). In Hawai'i, *P. viridiflorum* was first collected in 1954. It has spread from plantings via bird dispersed seeds and is now naturalized on the islands of Hawai'i, Lana'i, and Maui (Starr et al. 1999, Wagner et al. 1999). Due to its relative small distribution and potential threat, *P. viridiflorum* is targeted for control by the Big Island Invasive Committee (BIISC) on Hawai'i and is a potential future target for control by the Maui Invasive Species Committee (MISC) on Maui. The Lana'i population could also be evaluated for control.

TAXONOMY

Family: Pittosporaceae (Pittosporum family) (Wagner et al. 1999).

Latin name: *Pittosporum viridiflorum* Sims (Wagner et al. 1999).

Synonyms: None known.

Common names: Cape pittosporum, cheesewood (Wagner et al. 1999, Matshinyalo and Reynolds 2002).

Taxonomic notes: Pittosporaceae is a family made up of 9 genera and about 200 species from tropical and warm temperate areas of the Old World, being best developed in Australia (Wagner et al. 1999). The genus *Pittosporum* is made up of about 150 species of tropical and subtropical Africa, Asia, Australia, New Zealand, and some Pacific Islands (Wagner et al. 1999).

Nomenclature: The genus name, *Pittosporum*, is derived from the Greek word, *pittos*, meaning pitch, and *sporos*, meaning seeds, in reference to the black seeds covered with viscid resin (Wagner et al. 1999).

Related species in Hawai'i: In Hawai'i, *Pittosporum* is represented by 10 endemic species and 3 naturalized species which include *P. pentandrum*, *P. undulatum*, and *P. viridiflorum* (Herbarium Pacificum staff 1999, Starr et al. 1999, Wagner et al. 1999). In addition, *P. tobira* is cultivated in Hawai'i.

DESCRIPTION

"Small trees 3-6 m tall, young parts and inflorescences sparsely puberulent; branches glabrous. Leaves leathery, 6-15 cm long, 2.2-4 cm wide, glabrous, margins minutely revolute, apex bluntly acuminate to rounded, base attenuate, petioles 0.6-1.5 cm long. Flowers perfect, numerous in terminal, branched, corymbose inflorescences, peduncles 0-8 mm long, pedicels slender, 5-7 mm long; sepals elliptic, ca. 1.5 mm long, margins scarios; petals yellowish green, 5-6 mm long, margins slightly revolute and erose; ovary

2-carpellate. Capsules depressed-subglobose, slightly compressed, 4-5 mm long, the valves with thin exocarp, the surface minutely rugulose. Seeds 4-6, reddish black, subreniform, somewhat compressed, ca. 3.5-4 mm long." (Wagner et al. 1999).

BIOLOGY & ECOLOGY

Cultivation: *P. viridiflorum* is cultivated in various regions of the world as an ornamental tree with fragrant flowers. In addition, the stem and bark have been used medicinally (Matshinyalo and Reynolds 2002). Apparently, *P. viridiflorum* is cultivated in Europe and in St. Helena where it had been introduced by the Dutch in the 17th century (Matshinyalo and Reynolds 2002). In Hawai'i, *P. viridiflorum* was first collected from cultivated material on the island of Hawai'i in 1954 (Wagner et al. 1999).

Invasiveness: *P. viridiflorum* spreads via bird dispersed fruits and is locally established in a few areas of Hawai'i, Lana'i, and Maui in disturbed mesic areas up to 1,000 m (3,281 ft) elevation (Wagner et al. 1999).

Pollination: Other similar *Pittosporum* species with fragrant flowers, such as *P. undulatum*, are insect pollinated (Binggeli 1998).

Propagation: *Pittosporum viridiflorum* can be easily propagated from seeds as soon as they are ripe and often yield germination rates of 80-90%. Semi-ripe cuttings or air layers are also effective propagation methods (Brickell and Zuk 1997). Seedling recruitment for other *Pittosporum* species, such as *P. undulatum*, increases with higher light levels and disturbance (Binggeli 1998).

Dispersal: *P. viridiflorum* are spread long distances by humans who use the plant in landscaping. In its native range, *P. viridiflorum* fruits are dispersed by birds, including red-eyed doves and starlings (Matshinyalo and Reynolds 2002).

Pests and diseases: According to Brickell and Zuk (1997), *Pittosporum* spp. are susceptible to aphids, spider mites, mealybugs, scale insects, leaf spots, dieback, root knot nematode, galls, and cankers.

DISTRIBUTION

Native range: *P. viridiflorum* are native to South Africa (Wagner et al. 1999). It is widely distributed in the eastern half of South Africa, occurring from the Western Cape up into tropical Africa and beyond to Arabia and India (Matshinyalo and Reynolds 2002). It tolerates a wide range of elevations and grows in tall forests, in scrub on forest margins, and on stream banks (Matshinyalo and Reynolds 2002).

Global distribution: *P. viridiflorum* is cultivated in warm regions of the United States and naturalized in Hawai'i (Brickell and Zuk 1997, Wagner et al. 1999).

State of Hawai'i distribution: In Hawai'i, *P. viridiflorum* is naturalized on the islands of Maui, Lana'i, and Hawai'i (Starr et al. 1999, Wagner et al. 1999). On the island of Hawai'i, *P. viridiflorum* is known up to 1,000 m (3,281 ft) on Pu'uwa'awa'a and Waimea

(Wagner et al. 1999). It is currently being targeted for control by BIISC on Hawai'i. On Lana'i, it is apparently known from Kapano Gulch. We are currently unfamiliar with this population and further investigation is needed. On Maui, it is spreading in Kula and is being considered for control by MISC.

Island of Maui distribution: *P. viridiflorum* is locally spreading in the Kula vicinity, elevation ca. 3,200 ft (975 m), with a relatively cool and dry climate in disturbed residential, pasture, and agriculture land use. Plants can be observed spreading here and there in yards and waste areas. The infestation does not seem very dense or very large in these areas yet. More refined mapping is needed to pinpoint the exact extent of the infestation.

CONTROL METHODS

Physical control: Seedlings can likely be hand pulled. Small trees can probably be dug up. Cutting without herbicide treatment may result in re-growth.

Chemical control: Cut stump, frill, and basal bark methods employing herbicides are likely effective means of control for *P. viridiflorum*.

Biological control: None known. With numerous endemic *Pittosporum* species in Hawai'i, any biological control should be done with extreme caution.

Cultural control: The public could be discouraged from planting *Pittosporum* species that are known to spread.

Noxious weed acts: None known. A related species, *P. undulatum* is a Hawai'i state noxious weed (HDOA 1992). *P. undulatum*, native to Australia, is listed as a Category 1 Invasive Plant in South Africa and can not be cultivated there.

MANAGEMENT RECOMMENDATIONS

Pittosporum viridiflorum is cultivated and naturalized in Hawai'i. *P. viridiflorum* spreads via bird dispersed fruits and is known from Hawai'i, Lana'i, and Maui. All populations seem to be somewhat limited in distribution. *P. viridiflorum* has been targeted for control by BIISC on the island of Hawai'i and may become a future target for MISC on the island of Maui. The Lana'i population should be evaluated for control and other islands may want to search for the presence of *P. viridiflorum*. Areas that seem threatened on Maui by invasion of *P. viridiflorum* include mid-elevation mesic forests, pastures, abandoned fields, and natural areas nearby planting sources.

REFERENCES

Binggeli, P. 1998. *An Overview of Invasive Woody Plants in the Tropics*. School of Agricultural and Forest Sciences Publication Number 13, University of Wales, Bangor, UK.

Brickell, C. and J.D. Zuk. 1997. *The American Horticultural Society A-Z Encyclopedia of Garden Plants*. DK Publishing, Inc., NY.

HDOA (Hawai'i Department of Agriculture). 1992. *List of Plant Species Designated as Noxious Weeds for Eradication or Control Purposes* (June 18, 1992). Hawai'i Department of Agriculture, Honolulu, HI. Available: <http://www.botany.hawaii.edu/cpsu/-strawgua/other/noxious/noxious.html> (Accessed: July 25, 2001).

Herbarium Pacificum Staff. 1999. New Hawaiian plant records for 1998. *Bishop Mus. Occas. Pap.* 58(1): 3-12.

Matshinyalo, T.T. and Y. Reynolds. 2002. *Pittosporum viridiflorum* Sims. Witwatersrand National Botanical Garden. Available: <http://www.plantzafrica.com> (Accessed: May 27, 2003).

PIER (Pacific Islands Ecosystems at Risk). 2003. Invasive Plant Species: *Pittosporum pentandrum*. Available: <http://www.hear.org/pier> (Accessed: May 27, 2003).

Starr, F., K. Martz, and L.L. Loope. 1999. New plant records from East Maui for 1998. *Bishop Mus. Occ. Pap.* 59(2):11-15.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1999. *Manual of the Flowering Plants of Hawai'i*. 2 vols. Bishop Museum Special Publication 83, University of Hawai'i and Bishop Museum Press, Honolulu, HI.

Sideroxylon persimile

(Bully tree)

Sideroxylon persimile

Bully tree -- Sapotaceae

Overview: *Sideroxylon persimile* is a large thorny tree native from Mexico through Central America to northern South America. On Maui, *S. persimile* is cultivated in the Mauna'olu area where it is locally common and spreading in nearby disturbed areas, open fields, along roads, scrub areas, and gulches. Recently a second smaller infestation was found in Ulupalakua.

Description: "Large trees, round-tipped to 20 m tall, trunk vertically fluted, 1 m thick, bark rough, sometimes armed with painful and irritating thorns (1-3 cm long), with obvious sticky white sap, and stems occasionally bearing red hairs. Leaves dark green, glossy ovate, entire (3-4 cm long). Flowers are sweetly fragrant, greenish. Fruit is round to subglobose, about 1 cm, and green turning black or deep blue with maturity during June-July." (Starr et al. 2002).

Impact: On Maui, this species is spreading from initial plantings. Trees produce numerous seeds which are likely bird dispersed. Plants are now found in gulches, pastures, open fields, and scrub areas from Hali'imaile to near Paia east to Giggle Hill. Trees are armed with painful and irritating thorns.

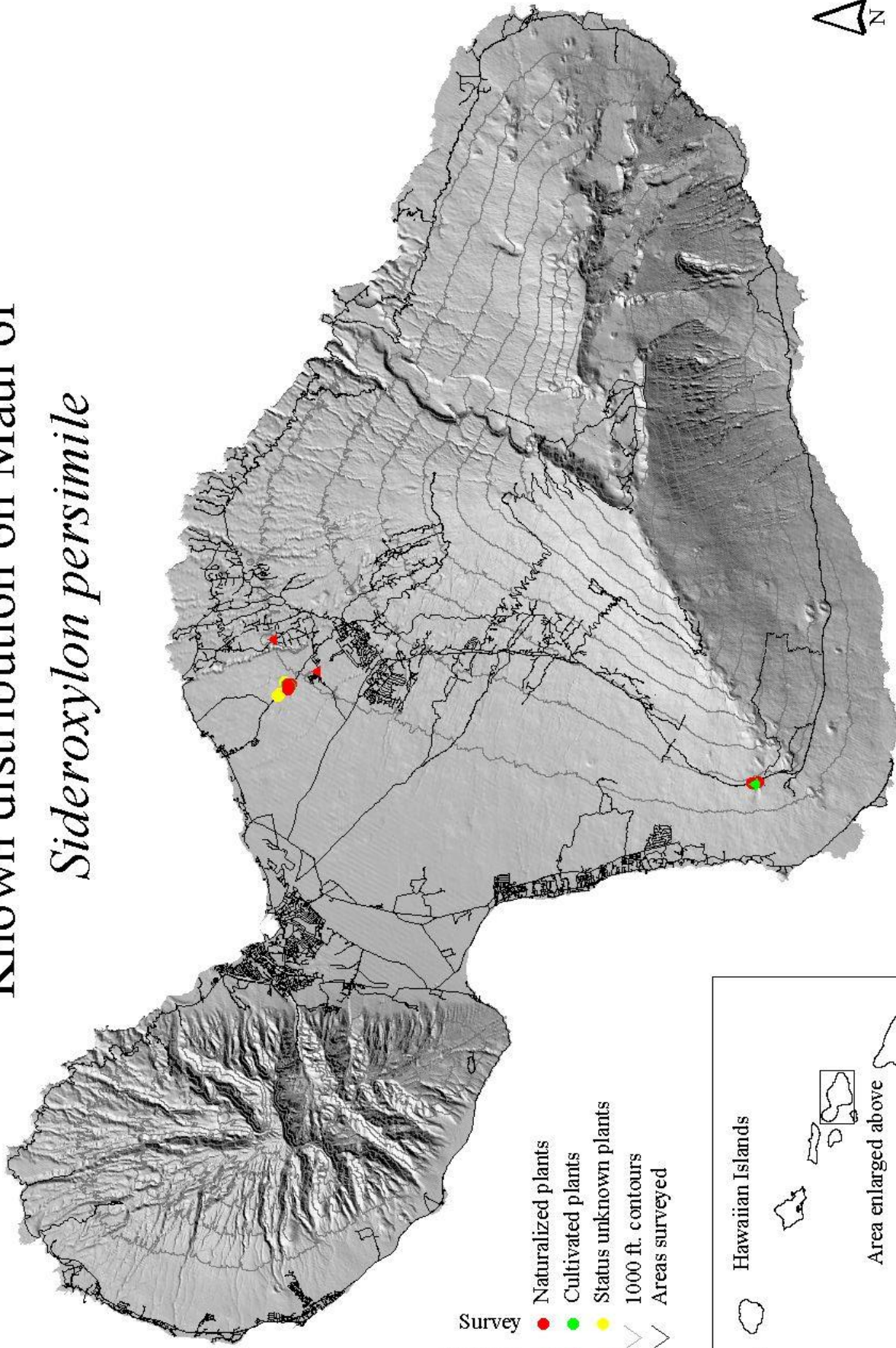
Distribution: Large trees of *Sideroxylon persimile* were apparently originally cultivated on Maui near the Mauna'olu Campus on Baldwin Avenue, where it was collected as early as 1967. Now this thorny species occurs in nearby gulches and roadsides. Recently, more



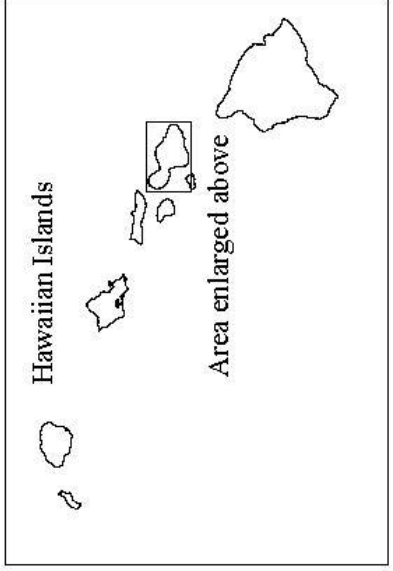
trees were located in Ulupalakua near the ranch headquarters.

Control Methods: No information was found for control, but standard practices for control of large trees would likely work.

Known distribution on Maui of *Sideroxylon persimile*

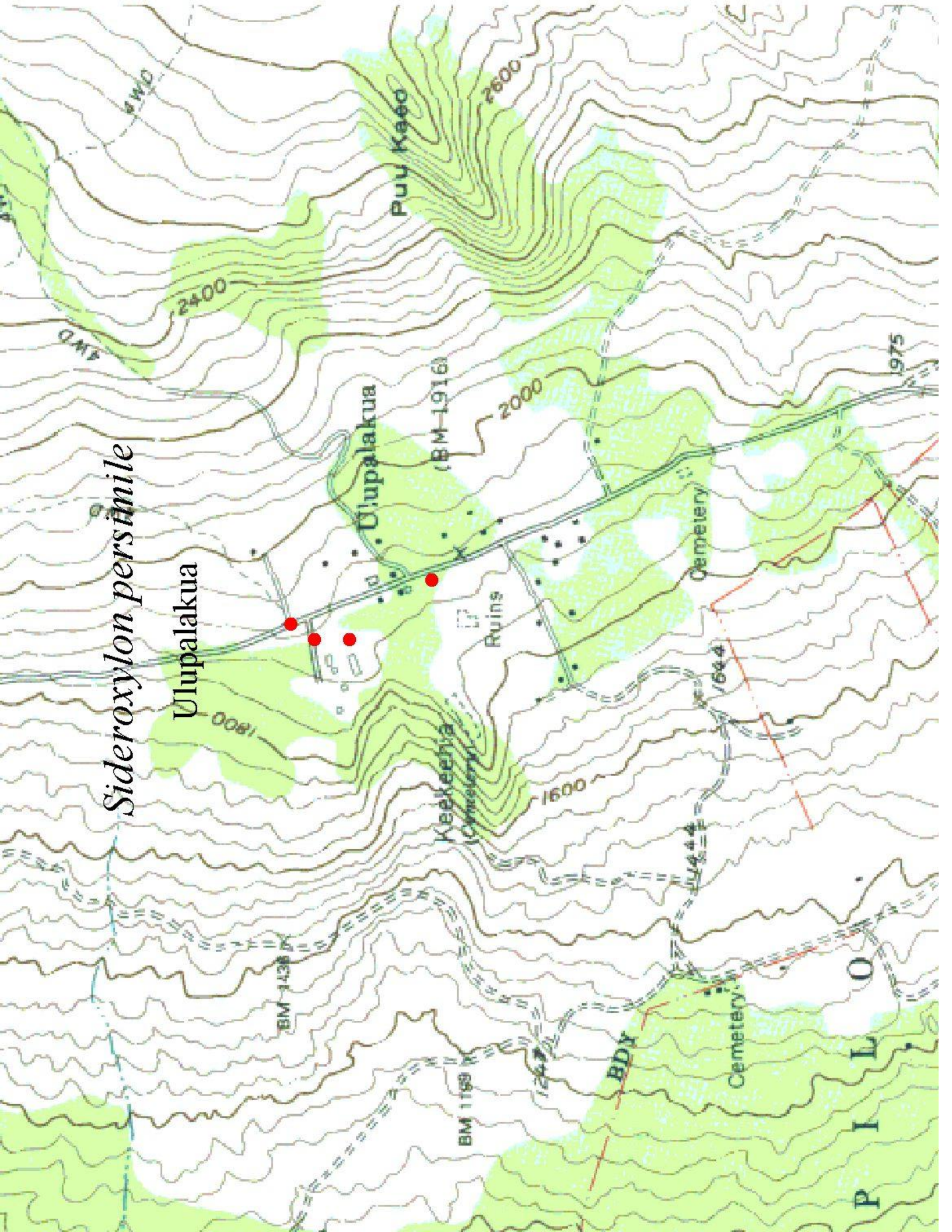


- | | | |
|-----------|---|-----------------------|
| Survey | ● | Naturalized plants |
| Interview | ▲ | Cultivated plants |
| | ● | Status unknown plants |
| | ▲ | 1000 ft. contours |
| | — | Areas surveyed |



5 0 5 10 Miles

USGS-BRD Haleakala Field Station (May 2003)



Sideroxylon persimile

Ulupalakua

Ulupalakua

Puu Keelo

Ruins

Keekeeana

Cemetery

Cemetery

BDY

PILLO

1975

2400

2000

1600

2600

BM 1438

(BM 1916)

BM 1758

AWD

SITE INFORMATION -- *Sideroxylon persimile*

-- Ulupalakua Ranch, Ulupalakua.

A single large tree located near the greenhouse. Small seedlings scattered along fences and road nearby







Sideroxylon persimile

Bully tree
Sapotaceae

Forest Starr, Kim Starr, and Lloyd Loope
United States Geological Survey--Biological Resources Division
Haleakala Field Station, Maui, Hawai'i

October, 2003

OVERVIEW

Sideroxylon persimile is a large thorny tree native from Mexico through Central America to northern South America. Not much is known about this tree but it was recently published as a new naturalized plant record for the State of Hawai'i (Starr et al. 2002). *S. persimile* occurs on the island of Maui and is cultivated in the Mauna'olu area, about 800 ft (244 m) elevation, where it is locally common and spreading from initial plantings to nearby disturbed areas in open fields, along roads, scrub areas, and gulches from Hali'imaile, 1,100 ft (335 m) elevation, to Paia, 500 ft (152 m) elevation. Recently a second site was found on leeward Maui in Ulupalakua, 1,800 ft (549 m) elevation, where a single large tree and a few small saplings occur. The Ulupalakua site is small enough that it could be controlled to prevent further spread in this area. The Mauna'olu infestation is more established and may not be feasible to control at this time. Further refined mapping is suggested. This species is planted as a street tree on O'ahu and as a forestry tree on other Hawaiian Islands. Updated information on the distribution and status of this species for the rest of the State is needed.

TAXONOMY

Family: Sapotaceae (Sapodilla family) (Wagner et al. 1999).

Latin name: *Sideroxylon persimile* (Hemsl.) T.D. Penn (Starr et al. 2002).

Synonyms: Previously known under the misapplied name *Bumelia buxifolia* Wild. ex. Hbk. (*sensu* Neal 1965), *Bumelia persilis* Hemsl. (Anon 2003).

Common names: Bully tree (Starr et al. 2002).

Taxonomic notes: Sapotaceae is a family comprised of about 900 species and 60 genera from humid tropical regions of the world (Wagner et al. 1999).

Nomenclature: Not known.

Related species in Hawai'i: There are possibly a few other species cultivated in Hawai'i.

DESCRIPTION

"Large trees, round-tipped to 20 m tall, trunk vertically fluted, 1 m thick, bark rough, sometimes armed with painful and irritating thorns (1-3 cm long), with obvious sticky white sap, and stems occasionally bearing red hairs. Leaves dark green, glossy ovate, entire (3-4 cm long). Flowers are sweetly fragrant, greenish. Fruit is round to subglobose, about 1 cm, and green turning black or deep blue with maturity during June-July." (Starr et al. 2002).

BIOLOGY & ECOLOGY

Cultivation: *S. persimile* has been used as a street tree in Honolulu and has been planted on other islands for reforestation (Starr et al. 2002). In its native range, the tree is used for firewood and the fruits are eaten. The wood is also used for making handles of tools such as axes (Anon 2003).

Invasiveness: On Maui, this species is spreading from initial plantings. Specimens on Maui at the Mauna'olu Campus location were collected as early as 1967. Trees produce numerous seeds which are likely bird dispersed. Plants are now found in gulches, pastures, open fields, and scrub areas from Hali'imaile to near Paia. Trees are armed with painful and irritating thorns.

Pollination: Not known. Flowers are sweetly fragrant and likely attract a number of insects.

Propagation: Plants are currently reproducing from seeds on Maui.

Dispersal: *Sideroxylon persimile* [*Bumelia*] seeds are dispersed by fruit eating birds (Neal 1965).

Pests and diseases: Not known.

DISTRIBUTION

Native range: *Sideroxylon persimile* is native from Mexico through Central America to northern South America (Pennington 1990). The Missouri Botanical Garden (2003) lists the following location information for collections of *S. persimile* from its native range in Central America. Belize: 100 ft (30 m); Costa Rica: 40-1900 m (131-6,234 ft); El Salvador: 250-1,600 m (820-5,249 ft); Mexico: 950-1,000 m (3,117-3,281 ft); Nicaragua: 1,200-1,400 m (3,937-4,593 ft); and Panama: 30 m (98 ft).

Global distribution: *S. persimile* is naturalized in at least Hawai'i (Starr et al. 2002). It does not seem to be widely cultivated. It is cultivated in Hawai'i as an ornamental street tree and as a forestry tree and may be cultivated elsewhere for similar purposes.

State of Hawai'i distribution: In Hawai'i, *Sideroxylon persimile* was recently reported as naturalized on the island of Maui (Starr et al. 2002). There are several records of *S. persimile* also being cultivated on other Hawaiian Islands. Bishop Museum herbarium records include the following collections from around the state of Hawai'i. O'ahu: Honolulu, Kilihi St., corner at Beckley St., collected in 1925; collected again at this location in 1941; Honolulu, Capitol grounds, near burial mound, collected in 1939; Makiki, at corner Makiki and Kina'u Sts., collected in 1946; Waiahole, Water Reserve, project for reforesting by O'ahu Sugar Co., collected 1962; Waimanalo, on private horse farm, collected 1990. Lana'i: north of Lana'i City, planted in forest reserve, collected in 1952. In addition, Skolmen (1960) lists 2,791 trees planted on the island of O'ahu for what is likely this tree under the misapplied name *Bumelia buxifolia*. There is also a

record of 1 tree planted in South Kona, Hawai'i for *Sideroxylon norae*, possibly a related species. Neal (1965) reports that there are at least two species in Hawai'i.

Island of Maui distribution: Large trees of *Sideroxylon persimile* were apparently originally cultivated on Maui near the Mauna'olu Campus (old Baldwin estate) on Baldwin Avenue, where it was collected as early as 1967. Now this thorny species occurs in gulches and along roadsides from Hali'imaile to near Pa'ia. This was the first naturalized record of this species in the state of Hawai'i. Recently, more trees were located in Ulupalakua near the ranch headquarters at about 1,800 ft (549 m) elevation. Upon brief investigation it is apparent that there is a single enormous tree that was likely planted some time ago. Nearby (within a 1/2 mile) a few small seedlings can be seen coming up along fences. No other locations are currently known on Maui. Places where it would likely be found in the future include older plantings around estates and gardens, forest reserves, and urban areas.

CONTROL METHODS

Physical control: *Sideroxylon persimile* has painful irritating thorns and a milky white sap. It should be handled with extreme care. Small trees could perhaps be dug out. Larger trees could be chain-sawed down to a stump then treated with an herbicide or dug up.

Chemical control: Uncertain, though herbicide methods such as frill and basal bark applications could be tested.

Biological control: None known.

Cultural control: The public could be discouraged from planting thorny plants that spread into the wild.

Noxious weed acts: None known.

MANAGEMENT RECOMMENDATIONS

Sideroxylon persimile was recently reported as a new naturalized species for the State of Hawai'i, where it has been planted on several islands as an ornamental street tree and as a forestry tree. On Maui, this thorny tree is spreading from initial plantings and is locally common in the Mauna'olu area. There is also a discrete population of a few trees located in Ulupalakua. While the Mauna'olu infestation is fairly well established and not likely to be easily controlled, the outlier Ulupalakua infestation on the leeward side of the island is restricted to just a few individuals and could potentially be controlled. Records show that it is likely planted on at least O'ahu, Lana'i, and possibly Hawai'i as well. The current status and distribution on other islands needs updating.

REFERENCES

Anon. 2003. Species With Uses in Tropical and Subtropical Forests. University Autonoma Metropolitana - Iztalpalana. Available:

http://www.semarnat.gob.mx/pfnm2/fichas/sideroxylon_persimile.htm (Accessed: March 25, 2003).

Missouri Botanical Garden. 2003. W3TROPICOS: Specimen database. Available: http://mobot.mobot.org/cgi_bin/search_vast (Accessed: October 12, 2003).

Neal, M.C. 1965. *In Gardens of Hawai'i*. Bernice P. Bishop Museum Special Publication 40, Bishop Museum Press, Honolulu, HI.

Pennington, T.D. 1990. Sapotaceae. *Flora Neotropica Mon.* 52.

Skolmen, R.G. 1960. *Plantings on the Forest Reserves of Hawai'i: 1910-1960*. Institute of Pacific Islands Forestry, Pacific Southwest Forest and Range Experiment Station, United States Forest Service, Honolulu, HI.

Starr, F., K. Martz, and L.L. Loope. 2002. New plant records for the Hawaiian Archipelago. *Bishop Mus. Occ. Pap.* 69(2): 16-27.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1999. *Manual of the Flowering Plants of Hawai'i*. 2 vols. Bishop Museum Special Publication 83, University of Hawai'i and Bishop Museum Press, Honolulu, HI.

Verbascum thapsus

(Common mullein)

Verbascum thapsus

Common mullein -- Scrophulariaceae

Overview: *Verbascum thapsus* is an herbaceous plant native to Europe that is cultivated and naturalized in temperate areas of the world. On Maui, a few *V. thapsus* plants were found and controlled in the 1980's. Recently, *V. thapsus* was again observed being cultivated in Kula.

Description: "Stout biennial herbs 3-20 dm tall in the second year, densely yellowish woolly tomentose throughout, the hairs stellate or dendritic. Basal leaves obovate to oblanceolate, 8-50 cm long, 2.5-14 cm wide, densely yellowish or whitish woolly tomentose, margins entire to shallowly crenate; cauline leaves becoming progressively smaller toward the inflorescence, oblanceolate, sessile and decurrent on stem. Flowers in compact, spike-like panicles, pedicels partly adnate to the stem; calyx (5-)8-12 mm long, the lobes lanceolate; corolla yellow, rarely white, 8-15 mm long, scurfy pubescent externally, sometimes also ciliate, the hairs stellate; upper 3 staminal filaments villous with yellow hairs, the lower 2 glabrous to sparsely villous. Capsules broadly ovoid to elliptic-ovoid, 0.7-1 cm long, densely tomentose with stellate or branched hairs." (Wagner et al. 1999).

Impact: *V. thapsus* invades dry, rocky disturbed areas, and threatens to degrade native plant communities (Juvik and Juvik 1992). *V. thapsus* can thrive in a variety of habitats and quickly colonizes roadsides, pastures, and woodland margins. It spreads rapidly through numerous seeds, which can remain



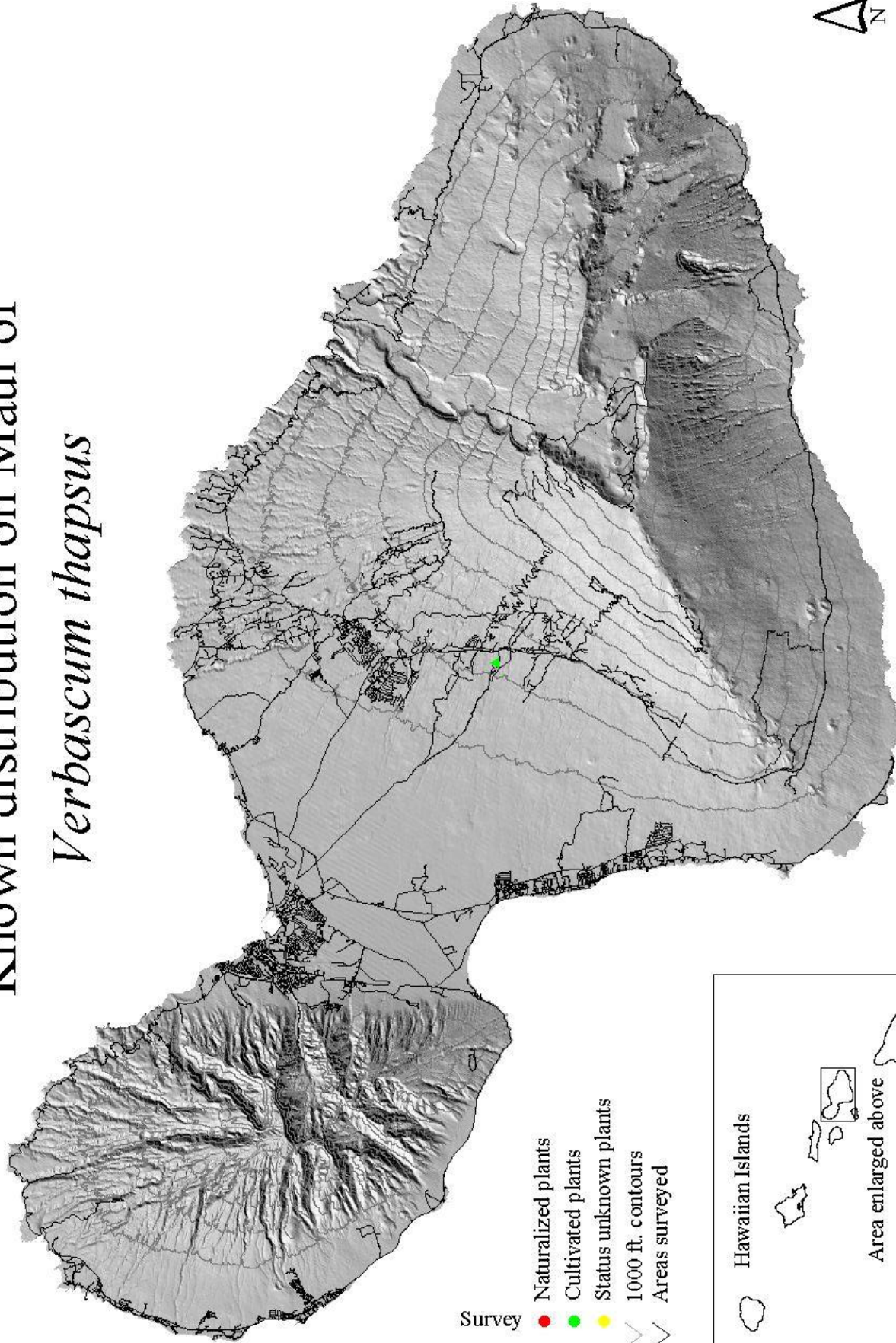
Photo by Phil Motooka.

dormant for >100 years (Gross and Werner 1982).

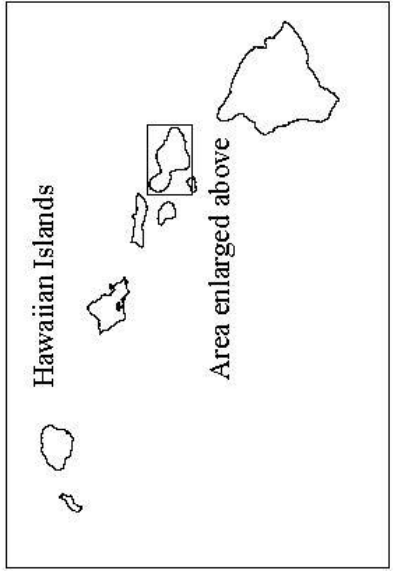
Distribution: Once thought to be eradicated on Maui, *V. thapsus* was recently observed being cultivated in Kula.

Control Methods: Management includes manual removal of plants before flowering, establishment of dense groundcover, and minimizing the availability of bare soil (Hoshovsky 1986). *V. thapsus*, especially seedlings, are easily hand pulled (Remaley 1998). Seeds should be bagged and thrown away. Foliar herbicides are used in dense infestations (Hoshovsky 1986). A 2% solution of glyphosate or triclopyr is suggested (Remaley 1998).

Known distribution on Maui of *Verbascum thapsus*



- | | | |
|-----------|---|-----------------------|
| Survey | ● | Naturalized plants |
| Interview | ▲ | Cultivated plants |
| | ▲ | Status unknown plants |
| | ▲ | 1000 ft. contours |
| | — | Areas surveyed |

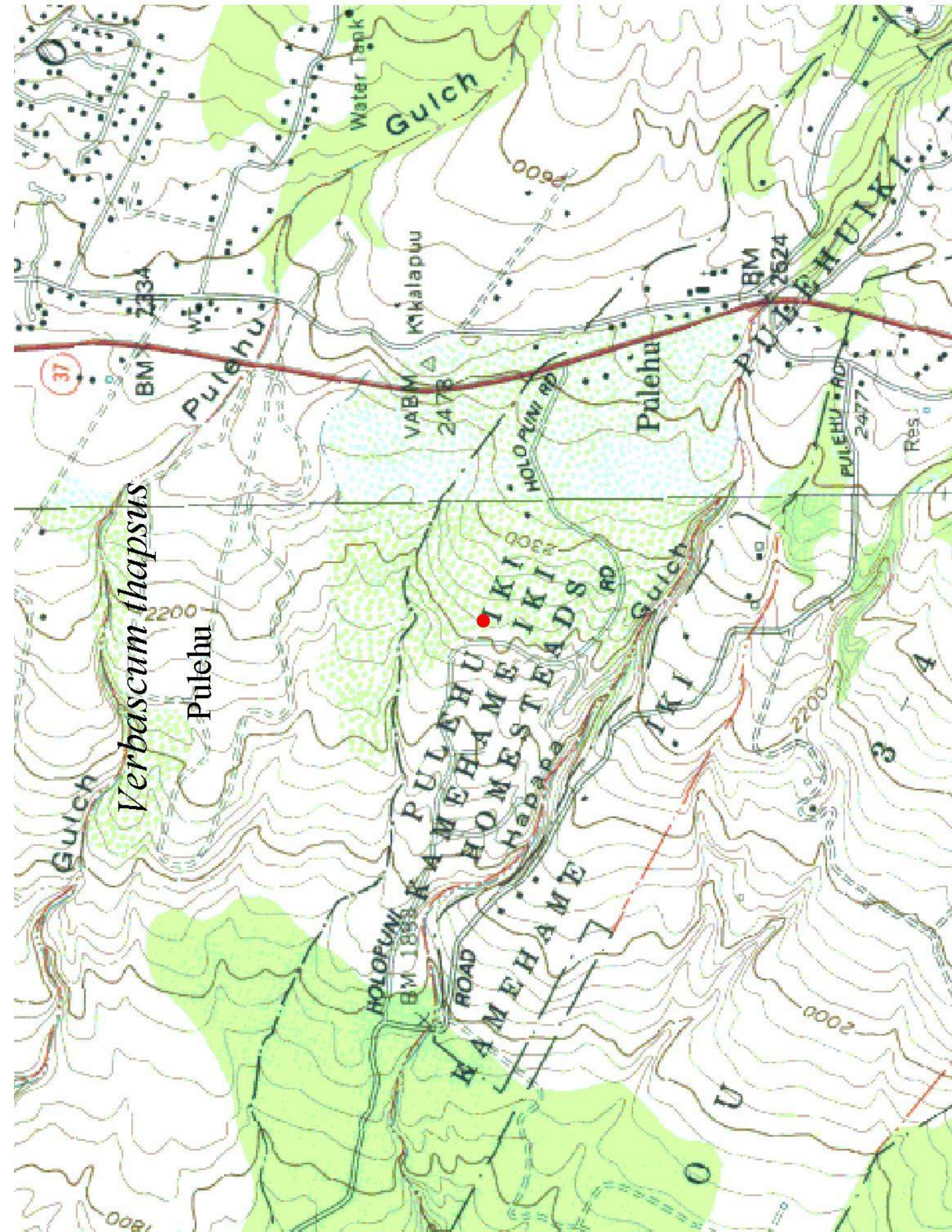


5 0 5 10 Miles

USGS-BRD Haleakala Field Station (May 2003)

Verbascum thapsus

Pulehu



SITE INFORMATION -- *Verbascum thapsus*

-- Holopuni, Kula Glenn, Kula.
Cultivated in herb garden







Verbascum thapsus

Common mullein

Scrophulariaceae

Forest Starr, Kim Starr, and Lloyd Loope
United States Geological Survey--Biological Resources Division
Haleakala Field Station, Maui, Hawai'i

March, 2003

OVERVIEW

Verbascum thapsus is an herbaceous plant native to Europe that is cultivated and naturalized in temperate areas of the world, including North America, Hawai'i, Reunion, Australia, and New Zealand. *Verbascum thapsus* can become invasive by quickly colonizing disturbed areas. *V. thapsus* plants produce numerous seeds that may remain dormant in the soil for over 100 years. *V. thapsus* is a state noxious weed in Colorado and Hawai'i (PLANTS 2003). In Hawai'i, *V. thapsus* is known from the Island of Hawai'i, where it infests roadsides at elevations from 5,000-10,000 ft (1,524-3,048 m) and is particularly dense around 6,562 ft (2,000 m) forming a monotypic cover that can out-compete native vegetation. It is feared that *V. thapsus* could do the same in similar native alpine ecosystems on Maui. In the 1980's, two plants were detected and eradicated in Haleakala National Park. In addition, plants were being cultivated by a plant grower in Kula. All plants have been destroyed. Recently (2003), *V. thapsus* was again observed being cultivated in Kula. Early detection and control in natural areas as well as public education on noxious weed species are both needed to help keep *V. thapsus* from invading on Maui.

TAXONOMY

Family: Scrophulariaceae (figwort family) (Wagner et al. 1999).

Latin name: *Verbascum thapsus* L. (Wagner et al. 1999).

Synonyms: None known.

Common names: Woolly or common mullein, flannel or velvet plant, Aaron's rod, Adam's flannel, beggar's blanket, beggar's flannel, beggar's stalk, big taper, blanket herb, blanket leaf, bullock's lungwort, and numerous others (Brickell and Zuk 1997, Wagner et al. 1999, OSU 2003).

Taxonomic notes: The genus *Verbascum* is comprised of 360 species found mostly on dry, stony hillsides, wastelands, and open woodlands of Europe, North Africa, and West and Central Asia (Brickell and Zuk 1997).

Nomenclature: The genus name, *Verbascum*, may be derived from the Latin word, *barbascum*, which means bearded plant. The common name, mullein, is derived from the Latin word, *mollis*, which means soft (OSU 2003).

Related species in Hawai'i: Two other *Verbascum* species are documented from Hawai'i, *Verbascum blattaria* and *Verbascum virgatum*. *V. blattaria* (moth mullein), native to Eurasia and widely naturalized in temperate areas, is known from a single collection made in 1955 from a pasture in Humu'ula, Hawai'i, 1,980 m (6,496 ft) elevation (Wagner et al. 1999). *V. virgatum* (virgate or wand mullein), native to western

Europe and occasionally naturalized in temperate areas, is known from near Hale Pohaku Ranger Station and near the David Douglas monument and Ka'u District, Hawai'i (Wagner et al. 1999). Numerous other *Verbascum* species are cultivated throughout the world and may likely be cultivated in Hawai'i as well.

DESCRIPTION

"Stout biennial herbs 3-20 dm tall in the second year, densely yellowish woolly tomentose throughout, the hairs stellate or dendritic. Basal leaves obovate to oblanceolate, 8-50 cm long, 2.5-14 cm wide, densely yellowish or whitish woolly tomentose, margins entire to shallowly crenate; cauline leaves becoming progressively smaller toward the inflorescence, oblanceolate, sessile and decurrent on stem. Flowers in compact, spike-like panicles, pedicels partly adnate to the stem; calyx (5-)8-12 mm long, the lobes lanceolate; corolla yellow, rarely white, 8-15 mm long, scurfy pubescent externally, sometimes also ciliate, the hairs stellate; upper 3 staminal filaments villous with yellow hairs, the lower 2 glabrous to sparsely villous. Capsules broadly ovoid to elliptic-ovoid, 0.7-1 cm long, densely tomentose with stellate or branched hairs." (Wagner et al. 1999).

The following description appears in Hovshovsky (1986) and is derived from Abrams (1951), Munz and Keck (1973), and Gross and Werner (1978). "Biennial, perennial or, rarely, an annual with a deep tap root. In its first year it produces a low vegetative rosette up to 60 cm in diameter which overwinters and is followed in the succeeding growing season by a stout flowering stem 5-18 dm tall. The basal leaves are oblong-obovate to obovate-lanceolate and 10-40 cm long including the petiole. The flower stem is longitudinally ridged by the bases of decurrent leaves and is densely woolly with branched hairs. Cauline leaves are elliptic-lanceolate, decurrent, and gradually reduced up the stem. The inflorescence is a spike-like raceme 20-50 cm long and approximately 3 cm in diameter. It is usually very dense; rare axillary racemes may arise from the upper leaves. The sessile flowers are usually one per axil with pedicels less than 2 mm and slightly irregular with rotate corollas. The calyx consists of 5 lanceolate or ovate sepals, 7-9 mm long with caudate tips. The corolla is 20-25 mm broad consisting of five yellow (rarely white) petals. Fruit is an ovoid, stellate-pubescent capsule 3-6 mm long, which splits into two valves at maturity. There are numerous brown seeds, 0.5-1.0 mm long which are six-sided and have angular lateral surfaces with rows of pits."

BIOLOGY & ECOLOGY

Cultivation: *Verbascum thapsus* has long been cultivated as a medicinal herb and for numerous other purposes. The leaves have been used as lamp wicks and Romans dipped the plants in fat to light as torches. Romans also extracted a yellow dye from the flowers to coloring women's hair (OSU 2003). *V. thapsus* has been cultivated as a remedy for coughs and diarrhea, to provide a stimulant when smoked, as a fish poison, for use in mosquito larvae control, and as an ornamental garden plant (Gross and Werner 1978).

Invasiveness: *V. thapsus* has become naturalized in North America and other temperate regions of the world, including Australia and New Zealand (Juvik and Juvik 1992). *V. thapsus* can thrive in a variety of habitats and is a pioneer species, quickly colonizing disturbed roadsides, pastures, and woodland margins. The plant spreads rapidly through

production of numerous seeds (up to 100,000-180,000) per plant, which are produced during the second or third year of growth, and can remain dormant for greater than 100 years (Gross and Werner 1982). In fact, viable seeds have been found in the soil samples archaeologically dated from 1300 A.D. (Gross and Werner 1982), pushing the potential seed dormancy to over several hundred years. *V. thapsus* is invasive in Hawai'i and Reunion Islands where it forms thick infestations in dry, rocky disturbed areas at elevations ranging from 5,000-10,000 ft (1,524-3,048 m), and threatens to degrade native plant communities in the alpine zone (Juvik and Juvik 1992).

Pollination: *V. thapsus* flowers are cross-pollinated by short and long tongued bees. Flowers are also autogamous, self-pollination occurring at the end of the day if cross-pollination has not occurred (Gross and Werner 1978).

Propagation: *Verbascum* species can be propagated from seeds, divisions, or root cuttings (Brickell and Zuk 1997).

Dispersal: *V. thapsus* plants are dispersed over long distances in horticulture trade. Seeds on established plants tend to fall nearby and secondary spread is usually not very far from parent plants. In Hawai'i, it has been speculated that seeds are dispersed in mud along roads by cars and along trails by hikers (Juvik and Juvik 1992, Stone and Pratt 1994).

Pests and diseases: Brickell and Zuk (1997) report that *V. thapsus* is susceptible to powdery mildew, a variety of fungal leaf spots, and caterpillars.

DISTRIBUTION

Native range: In their native range, *Verbascum* species are found mainly on dry, stony hillsides, wasteland, and open woodland in Europe, Africa and West and Central Asia (Brickell and Zuk 1997).

Global distribution: *V. thapsus* has become naturalized in North America and other temperate regions of the world, including Hawai'i, La Reunion, Australia, and New Zealand (Juvik and Juvik 1992, Stone and Pratt 1994). *V. thapsus* covers all of the United States and southern Canada (OSU 2003, PLANTS 2003). In states such as Ohio, *V. thapsus* is commonly abundant throughout the state occurring on roadsides railroads, fence rows, old fields, pastures, and agricultural fields (OSU 2003). *V. thapsus* was first introduced to North America as early as the 1700's to Virginia for use as a piscicide (fish poison). By the early 1800's, *V. thapsus* was so well established on the East Coast that it was erroneously described as native in 1818. By 1876, *V. thapsus* had spread across North America to the Pacific Coast (Brewer et al. 1876). In California *V. thapsus* occurs on The Nature Conservancy's Santa Cruz Island, Northern California Coast Range, and McCloud River Preserves (Hoshovsky 1986).

State of Hawai'i distribution: *V. thapsus* is established on the island of Hawai'i and has been sparingly found and controlled on the island of Maui. On Hawai'i, *V. thapsus* is most common on leeward uplands 3,940-9,840 ft (1,200-3,000 m) of Mauna Loa, Mauna

Kea, and Hualalai (Juvik and Juvik 1992). It occurs also occasionally occurs in areas outside these zones, including windward Mauna Loa and some coastal and arid western sites (Juvik and Juvik 1992).

Island of Maui distribution: On Maui, *V. thapsus* was first discovered in 1986 in Haleakala National Park at 9,150 ft (2,789 m) below Kalahaku lookout (Medeiros et al. 1999). It was found again in the Park in 1988 at 6,900 ft (2,103 m) below headquarters (Medeiros et al. 1999). Both plants were destroyed. Cultivated plants were then found in a Kula Nursery and were also destroyed. Recently, *V. thapsus* was observed being cultivated in Kula.

CONTROL METHODS

It is recommended that a combination of control efforts be used. Effective management of *V. thapsus* includes manual removal of plants before flowering, the establishment of a dense groundcover, and minimizing the availability of bare soil (Hoshovsky 1986).

Physical control: *V. thapsus* plants, especially seedlings, are easily hand pulled (Remaley 1998). Hand pulling does create disturbance and plants should be pulled prior to flowering if possible. Seeds should be bagged and thrown away.

Chemical control: Broadcast foliar herbicides are used in dense *V. thapsus* infestations where non-target effects are minimal (Hoshovsky 1986). It is also used in areas where access is limited, such as on steep slopes, or when hand pulling would cause too much disturbance (Remaley 1998). A 2% solution of glyphosate or triclopyr is suggested (Remaley 1998). Basal stem sprays are also effective.

Biological control: A curculionid weevil (*Gymnaetron tetrum*), specific to *V. thapsus*, was introduced as a biological control agent to North America from Europe before 1937. The larva mature in the seeds and can destroy up to 50% of the seeds (Hoshovsky 1986). A second agent is the mullein moth (*Cucullia verbasci*) which has been tested and is being considered for introduction to the United States (Remaley 1998). There are also numerous pathogens, including root rot and powdery mildew, that occur on *V. thapsus* in North America (Hoshovsky 1986).

Cultural control: Because *V. thapsus* is such a prolific seed setter and seeds have such long viability lives, an established population is extremely hard to eradicate (Remaley 1998/). On Maui, early detection, rapid control, and public education are crucial to keep *V. thapsus* from establishing on Maui. Establishing a cover after control is suggested to prevent germination of *V. thapsus*.

Noxious weed acts: *V. thapsus* is a declared noxious weed in Colorado and Hawai'i (PLANTS 2003). It is also a class C noxious weed in Washington (PLANTS 2003).

MANAGEMENT RECOMMENDATIONS

V. thapsus has long been cultivated as a medicinal herb. It has become weedy in temperate regions throughout the world where it has been introduced including the

United States, southern Canada, Hawai'i, La Reunion, Australia, and New Zealand. In Hawai'i, *V. thapsus* is a state noxious weed. It is well established on the island of Hawai'i. On Maui, it is not established, but has been previously detected in limited numbers and controlled. It was recently observed being cultivated in Kula and efforts are underway to control the plant. *V. thapsus* threatens pristine areas of Haleakala National Park's upper elevations and continued early detection and rapid control as well as public education will be crucial in preventing *V. thapsus* from establishing on Maui.

REFERENCES

- Abrams, L. 1951. *Illustrated Flora of the Pacific States*. Vol. III. Stanford University Press, Stanford, CA.
- Brickell, C. and J.D. Zuk. 1997. *The American Horticultural Society A-Z Encyclopedia of Garden Plants*. DK Publishing, Inc., NY.
- Gross, K.L. and P.A. Werner. 1978. The biology of Canadian weeds: *Verbascum thapsus* and *V. blatteria*. *Can. J. Plant Science* 58: 401-413.
- Gross, K.L. and P.A. Werner. 1982. Colonizing abilities of "biennial" plant species in relation to ground cover: implications for their distributions in a successional sere. *Ecology* 63(4): 921-931.
- Juvik, J.O. and S.P. Juvik. 1992. Mullein (*Verbascum thapsus*): The Spread and Adaptation of a Temperate Weed in the Montane Tropics. In: *Alien Plant Invasions in Native Ecosystems of Hawai'i*, C.P. Stone, C.W. Smith, and J.T. Tunison, eds. University of Hawai'i Press, Honolulu, HI.
- Munz, P.A. and D.D. Keck. 1973. *A California Flora and Supplement*. University of California Press, Berkeley, CA.
- Hovshovsky, M.C. 1986. Element Stewardship Abstract for *Verbascum thapsus* (common mullein). The Nature Conservancy, Arlington, VA.
- Medeiros, A.C., L.L. Loope, and C.G. Chimera. 1999. *Flowering Plants and Gymnosperms of Haleakala National Park*. Coop. Natl. Park Resources Studies Unit, University of Hawaii, Manoa, Dept. of Botany. Tech. Rept.
- OSU (Ohio State University). 2003. Ohio Perennial & Biennial Weed Guide. Ohio State University, OH. Available: <http://www.oardc.ohio-state.edu/weedguide/> (Accessed: March 13, 2003).
- PLANTS (National Plants Database). 2003. Online database. United States Department of Agriculture, Natural Resources Conservation Services, National Plant Data Center, Baton Rouge, LA. Available: <http://plants.usda.gov> (Accessed: March 13, 2003).

Remaley, T. 1998. Common mullein (*Verbascum thapsus*). Plant Conservation Alliance, Alien Plant Working Group, National Park Service. Available: <http://www.nps.gov/plants/alien/fact/veth1.htm> (Accessed: March 13, 2003).

Stone, C.P. and L.W. Pratt. 1994. *Hawai'i's Plants and Animals: Biological Sketches of Hawaii Volcanoes National Park*. University of Hawaii Press, Honolulu, HI.

Wagner, W.L., D.R. Herbst, and S.H. Sohmer. 1999. *Manual of the Flowering Plants of Hawai'i*. 2 vols. Bishop Museum Special Publication 83, University of Hawai'i and Bishop Museum Press, Honolulu, HI.