

**Implementation Of The
Maui Invasive Species Committee
(MISC)
Action Plan For Fiscal Year 2000
(July 1, 1999-June 30, 2000)**

[graphic of Island of Maui here]

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Submitted by:
Maui Invasive Species Committee

PROPOSAL ABSTRACT

We propose to use funds from federal, state, county, and private sources to proactively eradicate and/or contain several major incipient invasive plant and vertebrate animal species which threaten ecosystems, agriculture, economy, or quality of life on Maui, which is the location of many of the most intact federal, state, and private conservation lands in the State of Hawaii and habitat essential for survival of nearly 100 federally-listed endangered plant species. MISC is a partnership of government, private, and nonprofit organizations aimed at eradicating newly established pests and preventing them from spreading. MISC is envisioned as a much-needed model that in the near future can obtain significant county, state, federal and private agency funding and

expand to other islands, enhancing conservation efforts statewide.

EXECUTIVE SUMMARY

More native species have been eliminated in Hawaii than anywhere else in the United States. The introduction of alien species has contributed in a major way to biological impoverishment in the past and is now the predominant cause of biodiversity loss in this state. Federal, state, and private managers of protected areas on the island of Maui are struggling, with some success within their narrow jurisdictions, to cope with reducing the impacts of alien species on the native biota in order to prevent further biodiversity loss and ecosystem degradation, but managers are spread thin and successes are recognized as being only temporary, given continued invasion from beyond reserve boundaries. Because of the vulnerability of isolated oceanic islands to invasion, it is apparent that aggressive plant and vertebrate animal species, if freely introduced and given free reign once they arrive, will exploit and modify habitats and inundate all but the most resistant native ecosystems in protected areas of Maui. The Maui Invasive Species Committee (MISC), an informal private-state-federal partnership, has coalesced to bring about joint action to prevent, eradicate, and contain the most serious alien species invasions, using the 728 square-mile island of Maui as an Invasive Species Management Area. Although MISC formed in December 1997, the organizations involved in MISC have been working together successfully against alien species invasions since 1991, though with a narrower focus. MISC is envisioned as a much-needed model that can in the near future obtain significant county, state, federal and private funding and expand to other islands, enhancing conservation efforts statewide. Partners include the Maui Pineapple Company (MPC), The Nature Conservancy of Hawaii (TNC), the University of Hawaii (UH), the Hawaii Department of Land and Natural Resources (DLNR), the Hawaii Department of Agriculture (DOA), Maui County's Office of Economic Development (MC-OED), the Tri-Isle Resource Conservation and Development Council (RC&D), the USDA Forest Service (USFS), Haleakala National Park (HALE), the Biological Resources Division of the U.S. Geological Survey (USGS-BRD), the U.S. Fish and Wildlife Service (USFWS), and the Hawaii Army National Guard (HI-ARNG).

This project will proactively eradicate and/or contain several major incipient invasive plant and animal species which threaten ecosystems of Maui; including Haleakala National Park, the most biologically intact summit-to-sea reserve in the Hawaiian Islands and among the most important reserve sites in the United States for conservation of biodiversity. Other important federal conservation lands include the Kanaio National Guard Training Area and the Kealia National Wildlife Refuge. Survival of nearly 100 endangered plant species and important state and private conservation lands (TNC's Waikamoi and Kapunakea Preserves, Maui Pineapple Company's Pu`u Kukui Preserve, several state Natural Area Reserves, and many other as yet undesignated natural areas) will ultimately be jeopardized unless the invasive plant and animal species being addressed by MISC are contained or eradicated. Several of

these species also threaten economic activity and/or the quality of life on Maui. The major species being combated are Miconia (*Miconia calvescens*), Pampas grass (*Cortaderia jubata*), Fountain grass (*Pennisetum setaceum*), Ivy gourd (*Coccinia grandis*), and Caribbean frogs. The project will additionally assess the status of incipient invasions by parrots, snakes, and other vertebrate animals. MISC members will also have their sights on ten additional species for survey, mapping, and possible eventual targeting by MISC crews in future years. USGS-BRD will be concurrently involved in assessing current and future alien plant problems on Maui. The project will have a substantial education component and will make use of volunteers in community plant control efforts when feasible.

PROPOSAL BACKGROUND AND PROJECT NEED

ALIEN SPECIES ARE A WORLDWIDE PROBLEM, BUT ONE WHICH IS MUCH MORE SEVERE IN HAWAI`I

Alien species are becoming increasingly recognized as a threat to biological diversity and human welfare worldwide, not just on islands. However, oceanic island ecosystems in general and the Hawaiian Islands in particular are exceptionally vulnerable to damages caused by humans and the alien plants and animals they bring with them. Because of their evolution in relative isolation and in the absence of many forces shaping continental organisms, ecosystems of the Hawaiian Islands are highly susceptible to invasion by alien species from continents. In the Pacific islands, there is a gradient of increasing susceptibility to invasion from west to east (with increasing distance from Asia, the primary source area for the original colonizations by plants and animals). The Hawaiian islands, the easternmost islands in northern Polynesia and exceptionally isolated from all other island groups, are perhaps an order of magnitude more vulnerable than most ecosystems of continental U.S. More native species have been eliminated in Hawaii than anywhere else in the United States. Although habitat destruction has been an important cause of extinction and endangerment, the introduction of alien species has contributed in a major way in the past and is now the predominant cause of biodiversity loss in Hawaii. The island of Maui alone has almost 100 federally listed and candidate plant species and as many additional species classified as "species of concern" by FWS.

The story of how Hawaii's biota came to be is astonishingly simple, yet profound, and relates to the special vulnerability of the islands to pests. Prior to human influence, the relatively few animals and plants that reached Hawaii over thousands of miles of open ocean on the winds, floating, or attached to storm-driven birds arrived in remarkably diverse potential habitat. Approximately 10,000-12,000 species of land-dwelling animals and plants of Hawaii, most of them endemic, evolved from approximately 2,000 original ancestors that arrived on the islands by chance over the past 70 million years. It follows that the rate of successful colonization over geologic time was about once every 35,000 years.

Some of Hawaii's successful ancestral colonizing species are the sources of the most spectacular evolutionary adaptive radiations known in the world -- for example, the Hawaiian honeycreepers, the vinegar flies, and the silversword alliance. The Galapagos Islands have gained considerable fame from Charles Darwin's observations of classic radiations among the island group's animals during his 1832 visit -- observations which led to the birth of Darwin's theory of evolution through natural selection. Native animals and plants of the Hawaiian Islands, however, have evolved in isolation for much longer, had a

greater variety of habitats to occupy and evolved into a far greater diversity of species. The animals and plants of these islands are an important part of Hawaii's, America's, and the world's natural heritage, and comprise an extremely valuable natural resource. They are inseparable from the beauty and wonder of Hawaii. They hold back the soil from washing into the sea, provide for gradual release of runoff water, and provide numerous other utilitarian functions.

Improved global transportation, increased international trade, and the continued quest for novelty is resulting in the acceleration of purposeful and inadvertent exchange of organisms among biogeographic regions of the world. The once slow, erratic, and small-scale intentional transfer of species has shifted to a rapid and large-scale translocation of vast numbers of species. Pathways for inadvertent transfer of species have also multiplied. There is now a massive movement of nonnative species around the globe, and Hawaii is woefully vulnerable to these migrants/aliens.

To illustrate just one example of the problem's magnitude; alien vascular plants are a group for which much is known - most intentional plant introductions into Hawaii have been in horticulture. North American seed and nursery catalogues currently offer more than 59,000 plant species and varieties for sale to national and international markets and the number is continually growing. A total of about 13,000 species and varieties have already been introduced to Hawaii. Already, over 900 naturalized alien plant species are established somewhere in Hawaii and more than 100 of these are recognized as posing serious threats to natural areas.

***HAWAI`I'S BIOLOGICAL DIVERSITY CRISIS:
EFFORTS TO COPE WITH IT AND WHAT IS SPECIAL ABOUT THE ISLAND OF MAUI***

Managers of Hawaii's protected areas for ecosystem conservation (primarily National Parks and Wildlife Refuges, State Natural Area Reserves, and private reserves) are now realizing that although active on-site vigilance and management are essential, long-term protection of these areas may depend more than anything else on the success of keeping new alien plant and animal species from becoming established and spreading on an island-wide level. It is apparent that many aggressive plant and animal species not yet established in Hawaii can, if introduced, exploit and modify habitats not yet threatened by any well-established alien species. There is a realization that unless combated with ingenuity and commitment, the insidious threat of alien species can be expected to proliferate and inundate all but the most resistant native ecosystems in protected areas of Hawaii. And in view of the difficulty and expense of controlling invasive species after they are well-established, preventing establishment and spread of new introductions appears not only cost-effective, but essential.

There has been substantial movement statewide toward addressing alien species issues. The Honolulu-based interagency Coordinating Group on Alien Pest Species (CGAPS) is an alliance of biodiversity, agriculture, health, and business interests which has been working since 1995 to address the alien pest crises in Hawaii. A major public-relations campaign was launched in late-1996 to increase public awareness in the State of alien species problems. CGAPS is focussing on increasing awareness and mobilizing agency efforts statewide, with emphasis on prevention and rapid response to incipient invaders.

By any standard, however, efforts to protect biodiversity and ecosystem integrity are progressing far better on Maui than on any other major Hawaiian island. Reasons for this are complex, but important factors include fortuitous survival of outstanding resources until the present (partly due to limited penetration of high-altitude sites by roads and human-habitation), a highly supportive public (including the Polynesian community) and press, excellent effort exerted by key landowners/managers, and exceptional interagency cooperation.

Unlike at most locations in the U. S., the term "alien species" is a household word on Maui. Recent community-supported efforts involving alien species on Maui include (1) eradication in 1990-91 of a rabbit population which had exploded from pet releases within Haleakala National Park, accompanied and followed by citizen surveillance (in the form of citizen phone calls from all over the island) for incipient rabbit outbreaks; (2) the fight against the aggressive weed tree *Miconia calvescens* (with funding from Maui County, with support from the County Council and Mayor); (3) removal of feral pigs from remote areas to protect watersheds and biological diversity; (4) community support, especially by commercial sugar workers, in efforts to monitor for the presence of illegally released snakes and to prevent them from becoming established. A plan being developed by the local tourism industry devotes much more than token attention to support of anti-alien species efforts. Informal community action, while commendable, obviously has its limits in stemming the tide of invasions. However, in conjunction with coordinated action of local, state, and federal governments and major landowners, success may be achievable.

Higher elevation ecosystems (above 2,500-3,000 ft elevation) of both East and West Maui are increasingly receiving active ecosystem management and provide important reservoirs for biodiversity. Haleakala National Park (HALE) is among the most important reserve sites in the United States for conservation of biodiversity and is one of the world's premier reserves for protection of insular biota. Its 44 square-mile area, from sea level to over 10,000 ft elevation, represents a very important slice of the most intact remaining native ecosystems in Hawaii. The Park has made impressive advances in conservation over the past 15 years. State and private reserves (e.g., Waikamoi, Hanawi, Kapunakea, Pu`u Kukui) on East and West Maui are of comparable biological importance and complement the Park's role in ecosystem

protection. As a result of Maui's surviving diverse, relatively intact ecosystems, it has more to lose from proliferation of alien species than some other islands. The table below summarizes the rare, threatened and proposed endangered species that are currently under threat by the species proposed for eradication and/or control in this project:

**TABLE OF THREATENED, PROPOSED ENDANGERED AND ENDANGERED SPECIES
BENEFITED BY MISC ACTION PLAN**

The table lists the 79 current federally endangered and threatened plant species of Maui and indicates which will have their survival negatively affected by uncontrolled spread of the four primary target weed species.

Legend: T = threatened; E = endangered; M = present on Maui; MX = once present on Maui, no populations currently known, but reintroduction from other islands possible and/or possibility still exists for discovery of unknown populations

THREATS SPECIES	FEDERAL STATUS	STATUS ON MAUI	Fountain grass	Pampas grass	Ivy gourd	Miconia
<i>Abutilon menziesii</i>	E	M	Yes	No	Yes	No
<i>Acaena exigua</i>	E	M	No	Yes	No	Yes
<i>Alectryon macrococcus</i> var. <i>auwahiensis</i>	E	M	Yes	No	Yes	No
<i>Alectryon macrococcus</i> var. <i>macrococcus</i>	E	M	No	Yes	Yes	Yes
<i>Argyroxiphium sandwicense</i> ssp. <i>macrocephalum</i>	T	M	Yes?	No?	No	No
<i>Asplenium fragile</i> var. <i>insulare</i>	E	MX	No	Yes	No	No
<i>Bidens micrantha</i> ssp. <i>kalealaha</i>	E	M	Yes	Yes	No	No
<i>Bonamia menziesii</i>	E	M	Yes	No?	Yes	No
<i>Brighamia rockii</i>	E	MX	?	?	?	?
<i>Caesalpinia kavaiensis</i>	E	MX	Yes	Yes	Yes	Yes
<i>Cenchrus agrimonoides</i> var. <i>agrimonoides</i>	E	M	Yes	No?	Yes	No
<i>Centaurium sebaeoides</i>	E	M	Yes	No	Yes	Yes
<i>Clermontia lindseyana</i>	E	M	No	Yes	No	Yes?
<i>Clermontia oblongifolia</i> ssp. <i>mauiensis</i>	E	M	No	Yes	No	Yes
<i>Clermontia peleana</i> ssp. <i>singuliflora</i>	ra	E	MX	No	Yes	No

Yes							
<i>Clermontia samuelii</i> ssp. <i>hanaensis</i>	PE	M	No	Yes	No	Yes	
<i>Clermontia samuelii</i> ssp. <i>samuelii</i>	PE	M	No	Yes	No	Yes	
<i>Colubrina oppositifolia</i>	E	M	Yes	Yes	No	Yes	
<i>Ctenitis squamigera</i>	E	M	Yes	Yes	No?	Yes	
<i>Cyanea copelandii</i> ssp. <i>haleakalaeensis</i>	PE	M	No	Yes	No	Yes	
<i>Cyanea glabra</i>	PE	M	No	Yes	No	Yes	
<i>Cyanea grimesiana</i> ssp. <i>grimesiana</i>	E	M	No	Yes	No	Yes	
<i>Cyanea hamatiflora</i> ssp. <i>hamatiflora</i>	PE	M	No	Yes	No	Yes	
<i>Cyanea lobata</i>	E	M	No	Yes	No	Yes	
<i>Cyanea mceldowneyi</i>	E	M	No	Yes	No	Yes	
<i>Cyrtandra munroi</i>	E	M	No	Yes	No	Yes	
<i>Delissea undulata</i> ssp. <i>undulata</i>	E	MX	Yes?	No?	Yes?	No?	
<i>Diellia erecta</i>	E	M	No	Yes	No	Yes	
<i>Diplazium molokaiense</i>	E	M	No	Yes	No	Yes	
<i>Dubautia plantaginea</i> ssp. <i>humilis</i>	PE	M	Yes	Yes	Yes	Yes	
<i>Flueggea neowawraea</i>	E	M	Yes	No	Yes	No	
<i>Gardenia brighamii</i>	E	MX	Yes	Yes?	Yes	No	
<i>Geranium arboreum</i>		E	M	No	Yes	No	

Yes?						
<i>Geranium</i>	E	M	No	Yes	No	No?
<i>multifloru</i>						
<i>m</i>						
<i>Gouania</i>	E	M	Yes	No	Yes	No
<i>hillebrand</i>						
<i>ii</i>						

THREATS SPECIES	FEDERAL STATUS	STATUS ON MAUI	Fountain grass	Pampas grass	Ivy gourd	Miconia
<i>Gouania vitifolia</i>	E	MX	Yes	No	Yes	No
<i>Haplostachys haplostachya</i>	E	MX	Yes	No?	Yes	No
<i>Hedyotis coriacea</i>	E	M	Yes	No	Yes	No
<i>Hedyotis manni</i>	E	M	Yes	Yes	Yes	Yes
<i>Hesperomania arborescens</i>	E	M	No	No	No	Yes
<i>Hesperomania arbuscula</i>	E	M	No	Yes	No	Yes
<i>Hibiscus brackenridgei</i> ssp. <i>brackenridgei</i>	E	M	Yes	No	Yes	No
<i>Ischaemum byrone</i>	E	M	Yes?	No	No	No
<i>Isodendron pyrifolium</i>	E	MX	Yes?	No	Yes?	No
<i>Lipochaeta kamolensis</i>	E	M	Yes	No	Yes	No
<i>Lysimachia lydgatei</i>	E	M	Yes	Yes	No	Yes
<i>Mariscus pennatifolius</i> ssp. <i>pennatifolius</i>	E	M	Yes	Yes	Yes	Yes
<i>Melicope adscendens</i>	E	M	Yes	Yes	No	No
<i>Melicope balloui</i>	E	M	No	No?	No	Yes
<i>Melicope knudsenii</i>	E	M	Yes	No	Yes	No
<i>Melicope mucronulata</i>	E	MX	Yes	No	Yes	No
<i>Melicope ovalis</i>	E	M	No	No	No	Yes
<i>Neraudia sericea</i>	E	M	Yes	Yes	Yes	Yes
<i>Nototrichium humile</i>	E	M	Yes	No	Yes	No
<i>Panicum fauriei</i>		var.	<i>carteri</i>	E	M	Yes?

No	No?	No	Yes?	No?	Yes?	No?
<i>Peucedanum sandwicense</i>	T	M	Yes?	No?	Yes?	No?
<i>Phlegmarium mannii</i>	E	M	Yes?	Yes	No	Yes?
<i>Phyllostegia mannii</i>	E	MX	No	No	No	Yes
<i>Phyllostegia mollis</i>	E	M	No	Yes	No	Yes
<i>Phyllostegia parviflora</i> var.	E	MX	Yes?	No	Yes?	Yes?
<i>Plantago princeps</i> var.	E	M	Yes?	Yes	No	Yes
<i>Plantago laxiflora</i>	E	M	No?	Yes	No	Yes
<i>Pteris lidgatei</i>	E	M	No	Yes	No	Yes
<i>Remya mauiensis</i>	E	M	Yes	Yes	Yes	Yes
<i>Sanicula purpurea</i>	E	M	No	No?	No	No?
<i>Santalum freycinetianum</i> var.	E	M	Yes	Yes	No	No
<i>Santalum lanaiense</i>	E	M	Yes	No	Yes	No
<i>Schiedea haleakalensis</i>	E	M	Yes	Yes	No	No
<i>Schiedea hookeri</i>	E	MX	Yes	Yes	Yes	Yes
<i>Sesbania tomentosa</i>	E	M	Yes	No	Yes	No
<i>Solanum incompletum</i>	E	MX	Yes	No	Yes?	No
<i>Spermolepis hawaiiensis</i>	E	M	Yes	No?	Yes	No
<i>Stenogyne angustifolia</i>	E	MX	Yes	Yes?	Yes?	No?
<i>Tetramolopium arenarium</i> var.	arenarium	E	MX	Yes	Yes	No
<i>Tetramolopium arenarium</i> ssp.	arenarium					

Yes							
<i>Tetramolopium arenarium</i> ssp. <i>laxum</i>	E	MX	Yes	Yes	No	Yes	
<i>Tetramolopium capillare</i>	E	M	Yes	Yes	No	No	
<i>Tetramolopium remyi</i>	E	MX	Yes	No?	Yes	No	
<i>Vigna owahuensis</i>	E	M	Yes	No	Yes	No	
<i>Zanthoxylum hawaiiense</i>	E	M	Yes?	No?	No	No?	

WHAT IS THE MAUI INVASIVE SPECIES COMMITTEE (MISC)?

Interior Secretary Bruce Babbitt contends in his forward to Robert Devine's new book, *Alien Invasion* (1998, National Geographic Society, Washington, D.C., 280 p.), that we have the means to cope with the invasion of alien species if we act quickly and in concert with others. Devine's last chapter gives the anti-alien species networking efforts on Maui a prominent place in a discussion of "choosing our future, saving our past." Indeed, grassroots efforts on the island of Maui are resulting in effective cooperation from a wide variety of interests toward dealing with alien threats. Whether this approach will succeed in stemming the alien species tide remains to be seen, but participants in the Maui Invasive Species Committee are excited over the prospects.

The idea of working together on Maui to address the perceived threat of invasion was stimulated by the threat to conservation lands from *Miconia calvescens*, *Tibouchina herbacea*, and *Clidemia hirta* -- three aggressively invasive species in the plant family Melastomataceae. A Melastome Action Committee (MAC) was formed in August 1991 through the initiative of R. Bartlett, watershed supervisor of the Maui Pineapple Company, Ltd., and E. Robello, the project director (recently retired) of the Tri-Isle (Maui County) Resource Conservation and Development Office of USDA. They and the following additional state, private and federal entities have met regularly since 1991: Hawaii Department of Land and Natural Resources, Hawaii Department of Agriculture, The Nature Conservancy of Hawaii, Maui County's Office of Economic Development, the University of Hawaii, the National Park Service (NPS), the U.S. Forest Service, and the Biological Resources Division of the U.S. Geological Survey. The U.S. Fish and Wildlife Service (FWS) and the Hawaii Army National Guard (HI-ARNG) have recently become active participants. Activities of the Committee have included public education, providing information to the Hawaii legislature and Maui County, and planning, coordinating, and facilitating cooperative chemical, mechanical and

biological control programs.

The invasive tree *Miconia calvescens* has been the primary target of action to date. This species, native to neotropical forests at 1000-6000 ft elevation, is now known to be an unusually aggressive invader of moist tropical island habitats. Introduced to Tahiti in 1937, dense thickets of miconia had by the 1980s replaced the native forest over most of the island, with dramatic reduction of biological diversity. A 1997 paper by J.-Y. Meyer and J. Florence (*Journal of Biogeography* 23:775-781) states that 40-50 species endemic to Tahiti are on the verge of extinction primarily because of the invasion of *Miconia*. After the late botanist F. R. Fosberg saw this species in Tahiti in 1971, he reported that "it is the one plant that could really destroy the native Hawaiian forest." Yet because of its attractive purple and green foliage, it had already been brought to Hawaii as an ornamental in the 1960s, and no sustained efforts were made to control it until it was well established on Hawaii island. After its detection on Maui by conservation agencies in 1990, an alarm was raised; it seemed to be an especially severe threat to the until-now largely intact high-elevation rainforest habitat of many endemic forest birds and plant species. Now miconia has become something of a household word on Maui and progress is being made to eradicate it. Since June 1996, a full-time 5-man crew funded by Maui County and supervised by DLNR staff has been combating miconia in the primary infestation area near Hana, Maui. TNC is taking the lead in dealing with outlying populations. USGS-BRD teamed with the University of Hawaii to locate potential biocontrol fungi with assistance from collaborators in Brazil. DOA is testing the fungi; one has already been released and has recently been found to be established.

Work against miconia is progressing well, though the battle is far from won. However, other new invasive species continue to appear with alarming frequency. How to get ahead of the problem? After-the-fact analyses of species and ecosystem attributes to identify predictors of species likely to become invasive have concluded that the best predictor is the invasive behavior of introduced organisms in other parts of the world with similar environments. Within Hawaii, it can be safely assumed that a species which invades on another Hawaiian island is very likely to reach and eventually invade Maui unless effective preventive measures are in place. Range expansion of many introduced organisms has often been observed to follow a pattern of slow initial spread for at least several decades, followed by explosive growth. Reasons for this "lag phase" phenomenon are poorly understood but may involve difficulty of detection, temporary confinement to suboptimal habitat, exponential growth, local adaptation (genetic?), increased availability of "safe sites," restrictions due to life history attributes (e.g. dioecy or requirement for cross-pollination), or lagged introduction of a mutualist (such as a pollinator or a disperser). The importance of management intervention while a species is still in the lag phase, before it passes far into the phase of exponential growth, is becoming obvious.

In 1997, USGS-BRD began gathering detailed baseline data (distribution, population structure, dispersal) for selected alien plant species already present on Maui which are suspected of posing eventual threats to biodiversity of Haleakala National Park and other reserves of Maui, based on behavior in the Hawaiian Islands or elsewhere. Preliminary distribution maps for each species are being circulated to knowledgeable partners and members of the public, continually refining and updating the collective knowledge.

In December of 1997, members of the Melastome Action Committee decided to form a group that would address Maui County's invasive pest species problems beyond the family Melastomataceae. This group, the Maui Invasive Species Committee (MISC), is a voluntary partnership of private, government and nonprofit organizations to prevent new pest species from becoming established in Maui County and to stop newly established pests from spreading wherever possible. The MISC works to enhance the effectiveness of pest prevention and control through communication and coordinated planning. The group measures progress in terms of pest infestations prevented, contained, or eradicated, and avoids the creation of new bureaucratic processes. Its concerns extend to all pests threatening native ecosystems, agriculture and industry, human health or the quality of life within the county. In this way, the MISC serves as a coordinating body and advisor for other organizations seeking assistance in prioritizing and implementing effective pest-prevention measures.

Since December 1997, MISC has identified its task as that of developing priorities for pest prevention/eradication/containment, and developing plans and personnel/funding sources to achieve the highest priorities. There is the recognition that rather than focusing exclusively on threats to biodiversity, a broader range of threats (agriculture, health, quality of life) must be addressed in order to elicit a broader base of support. The MISC seeks to establish relations with and encourages the participation in MISC meetings of the Maui Association of Landscape Professionals, Maui Chamber of Commerce, Maui Farm Bureau, Maui Hotel Association, Maui Visitors Bureau and similar industry associations, businesses or trade groups in order to facilitate the distribution of information to members of these groups and to request their support of MISC goals and projects.

Information gathering is an important part of the effort. All MISC members are contributing information, but USGS-BRD has taken on responsibility for compiling and archiving information of alien plants, as well as conducting active exploration, mapping and research.

The greatest challenge appears to involve obtaining funding and

personnel to do the control work in an era of shrinking government. Is success possible? All agree that public education is a crucial ingredient of the anti-alien species strategy, to gain broad public support. Direct public involvement in selected eradication efforts is an important means of achieving this goal. Achieving and publicizing success stories is assumed to be an effective strategy. Maui's successes and failures could guide efforts statewide and even influence approaches taken elsewhere in the world. MISC is envisioned as a much-needed model for alien species rapid-response programs that can be exported to other islands, enhancing conservation efforts statewide.

PROJECT OBJECTIVES

PRIORITY INVASIVE PLANTS

1. MICONIA (*MICONIA CALVESCENS*):

Remove all *Miconia* plants over 18 inches in height should be removed from the 300-acre core area by June 1999. Completely survey the surrounding peripheral area and all other known *Miconia* sites and have all plants treated by June 30, 2000, carefully recording notes on what was removed and locations of fruiting trees. Record and eliminate any regrowth and/or reproduction. Continue aerial surveys and solicitation of information from pig hunters and other residents. Eliminate isolated trees/populations as needed.

2. PAMPAS GRASS (*CORTADERIA JUBATA*):

Treat all known populations (wild, as well as those in yards) and thoroughly survey potential habitat for additional populations.

3. FOUNTAIN GRASS (*PENNISETUM SETACEUM*):

Treat all individuals of all known populations and conduct comprehensive survey of potential habitat for additional populations.

4. IVY GOURD (*COCCINIA GRANDIS*):

Treat all individuals of all known populations and conduct comprehensive surveys of areas near known infestations.

5. GIANT REED (*ARUNDO DONAX*):

Remove (by mowing) and treat all known populations.

6. RUBBER VINE (*CRYPTOSTEGIA GRANDIFLORA*):

Treat all known populations and thoroughly survey potential habitat for additional populations.

7. OTHER:

MISC intends to assess an additional ten invasive plant species for potential future control. Although the crew will not devote significant time to these species this first year of MISC plan implementation, MISC will survey each species and seek systematic reporting of observations by others. These species are:

CAT'S CLAW (*CAESALPINIA DECAPETALA*)

GERMAN IVY (*DELAIRIA ODORATA* = "*SENECIO MIKANIOIDES*")

MALABAR MELASTOME (*MELASTOMA CANDIDUM*)

ALLSPICE (*PIMENTA DIOICA*)

VICTORIAN LAUREL (*PITTOSPORUM UNDULATUM*)

KUDZU (*PUERARIA LOBATA*)

DOWNY ROSE MYRTLE (*RHODOMYRTUS TOMENTOSA*)

RASPBERRY (*RUBUS DISCOLOR*)

HIMALAYAN RASPBERRY (*RUBUS ELLIPTICUS*)

MULLEIN (VERBASCUM THAPSUS)

METHODOLOGY

1. MICONIA (MICONIA CALVESCENS)

The strategy against *Miconia*, first presented at a public meeting in Hana, Maui, in December 1993, involves the following basic elements:

A. HELICOPTER SPRAYING OF HERBICIDE AS A HOLDING ACTION TO LIMIT SEED PRODUCTION, ESPECIALLY IN INACCESSIBLE SITES:

Helicopter spraying of herbicide has been implemented as a holding action to limit seed production by mature individuals, beginning in early 1994. The release device for spot-spraying, attached below a Hughes 500-D helicopter by a cable, had been developed for use by local law-enforcement authorities in controlling marijuana cultivation in remote mountain areas. The herbicide (Garlon 4, ester formulation of triclopyr) is applied with surfactant and blue dye (Turfmark). The dye assists the pilot in judging application rate and aerial extent and in identifying treated plants. As of late-1998, this strategy is still viewed as an important tool, especially in relatively inaccessible sites on cliff faces and steep slopes. Monitoring of effects of helicopter spraying of *Miconia* trees (n = 110 trees) in the Hana population with Garlon 4 in 1994 showed 72% of the trees killed and the remaining 28% of the trees with 69% defoliation and reduced fruiting after one year (Medeiros and Chimera, USGS-BRD, unpublished). Spraying of fruiting trees has proved effective as a holding action, but by opening the canopy, typically leads to abundant germination of soil seed banks of *Miconia*, and requires follow-up. Nevertheless, in spite of needed follow-up and the high cost of helicopter charter (ca. \$850 per hour), this method continues to be regarded as an important tool. As of late-1998, about 700 acres of the 2500-acre infestation have been treated at least once by spraying; the most densely-infested areas within this 700 acres have been sprayed repeatedly. Helicopter spraying has been and will continue to be used as a tool for attacking individual outlier *Miconia* trees, detected within the forest canopy by monitoring from a helicopter, before they set seed.

B. DEVELOPMENT OF ACCESS ROUTES TO ALLOW ON-THE-GROUND CONTROL:

Access routes were developed and will be maintained through rough lava terrain, overgrown with dense secondary vegetation, to allow on-the-ground control at the Hana *Miconia* population. A contracted bulldozer operator, supervised by Robert Hobdy of DLNR, opened the first road in early 1996. Within 18 months, 6 miles of 4-wheel-drive roads were in place, subdividing the 2500-acre site into management units and allowing efficient access.

C. MECHANICAL/CHEMICAL REMOVAL BY WORKERS ON THE GROUND:

A Hana-based 5-man crew hired in June 1996 with County of Maui funding has been working full time to remove *Miconia* at the Hana population ever since. The motivation and effectiveness of this highly-motivated crew,

supervised by Robert Hobdy of DLNR, has been excellent. They are pulling up saplings, cutting trees too large to pull up, and applying Garlon 4 herbicide to cut stumps. As of late-1998, it is foreseen that they will have systematically covered the entire 2500-acre *Miconia*-infested area once by December 1999. (See accompanying map for accomplishments to date.)

D. CONTINUING PUBLIC INFORMATION AND SURVEILLANCE FOR NEW LOCATIONS:

USGS-BRD maintains a map of Maui *Miconia* locations. Pat Bily of The Nature Conservancy of Hawaii has been successfully using public outreach/education within the East Maui communities of Keanae, Nahiku, and Huelo as a monitoring strategy to locate plants within known populations and to locate previously unknown invaded sites. Helicopter survey has been used successfully in 1997-98 to locate new trees/populations. A number of isolated single trees have been located on East Maui, either the result of bird dispersal or of inadvertent (on boots?) human dispersal. Such isolated *Miconia* plants have been found as high as 2000 ft elevation and as much as 1.5 miles from the nearest known population. These "outliers" provide cause for much concern; they are treated, either by aerial spraying or by crews on the ground as soon as they are located.

E. MEASURES TO PREVENT SEED DISPERSAL BY MICONIA WORKERS:

No obvious problems have been noted in transfer to other sites of *Miconia* seeds in soil on the boots and equipment of crews engaged in control and assessment efforts. However, at this still early point in our efforts, it is difficult to assess the effectiveness of measures to prevent seed dispersal by *Miconia* workers. Those working with *Miconia* are required to wear conspicuously-marked footwear and other gear which are "dedicated," i.e. used only for work involving *Miconia*. Whenever bulldozers and other vehicles are used in *Miconia* areas, they are to be pressure washed immediately afterwards. The seed-dispersal problem greatly complicates the issue of using volunteers. Whenever *Miconia* control is undertaken, a supervisor must be responsible for seeing that safeguards are faithfully followed.

F. SUPPORT FOR BIOLOGICAL CONTROL:

Biological control is regarded as a highly welcome adjunct to mechanical/chemical efforts, to reduce recovery potential through reduction in leaf growth and reproduction. In mid-November 1997, the fungus *Colletotrichum gloeosporoides* f. sp. *miconiae*, which may prove to reduce vegetative growth of *Miconia*, was released by DOA's Dr. Eloise Killgore within the East Maui Hana population. Efforts are planned for the near future to bring a carposinid moth species, *Carposina bullata*, already tested and approved for release in Hawaii, but not yet established in favorable habitats in Hawaii, to the East Maui area (P. Conant, DOA, pers. comm.). The moth was originally investigated as a promising biocontrol agent for *Clidemia hirta*, upon whose flowers and fruits larvae feed; however, it was found to also attack many *Miconia* species in Trinidad, where *Miconia calvescens* is not present. We are

hopeful that it will prove to attack *Miconia calvescens* as well. *Clidemia*, which is locally abundant on East Maui, not far from the *Miconia* populations, could serve as a primary host for the biocontrol agent even after *Miconia* populations have been largely eliminated. Establishment of insect biocontrol agents in Hawaii has become notoriously difficult because of the accumulated establishment of a large diversity of alien generalist parasitoids. However, observations of the life history of the two moths in the field (R. Burkhart, pers. comm.) indicate that this larval moth should be protected from parasitism and predation through its feeding on the interior of reproductive parts of host plants.

G. MONITORING OF PROGRESS:

To date, helicopter survey provides the best method of assuring the absence of fruiting trees. This method will be supplemented by on-the-ground transects through the Hana population once the 5-man crew has systematically covered the entire 2500-acre *Miconia*-infested area (December 1999). The well-documented dynamics of *Miconia* re-establishment after removal within plots on Raiatea, French Polynesia (Meyer and Malet 1997), suggests a minimum of 4-5 years from seed germination to fruit production; dynamics of East Maui *Miconia* populations closely resemble those found for Raiatea. Meanwhile, a feasibility study, by Oahu-based TerraSystems, Inc., and the USDA Natural Resources and Conservation Service, is exploring the effectiveness of spectral-sensitive aerial photography in detecting and mapping individual canopy trees of *Miconia*. The work began in early-1998 and is near completion.

Note: Individuals of various agencies have stepped in to fill essential niches in the control effort. Major commitments are being made by DLNR (overseeing aerial herbicide application, development of access roads, and supervision of ground crews within the largest population, all by Robert Hobdy), TNCH (eradication within peripheral populations), DOA (biocontrol testing and logistical assistance with aerial herbicide application), and USGS-BRD (population mapping, aerial surveys, and biocontrol exploration).

2. ANDEAN PAMPAS GRASS (*CORTADERIA JUBATA*)

This species is recognized as one of the worst invasive weeds in natural areas of California and is also invasive in New Zealand and South Africa. It was discovered on Maui by Haleakala/ USGS-BRD in 1989; some control/monitoring has been done since in the Kula area of East Maui. It was added to the Hawaii Noxious Weed List in 1993. Now it has been found to have invaded numerous areas of rain forest/bog on East and West Maui, as well as a substantial area of private land just above the end of Olinda Road. Andean Pampas grass (Cj) seems to have the potential to invade Haleakala Crater and shrubland of HALE on a large scale. The situation is complicated by the extensive planting of *Cortaderia selloana* (Cs), especially in upcountry Maui. Cs is sparsely invasive on

Maui to date, but is known to be seriously invasive in New Zealand and elsewhere. Cs is very similar in appearance to Cj; in fact, though they are quite distinct in floral characteristics, even "experts" have a difficult time distinguishing them on a practical level. It has therefore been suggested that Cs be added to the Hawaii Noxious Weed List and that effort be made at eliminating both species. For the time being, however, it is perceived that the overwhelming priority is to keep Cj from going into a phase of geometric spread in wild lands. Relatively few private landowners (less than 5% of landowners with "Pampas grass") have Cj on their property. *Cortaderia jubata* is already on the Hawaii Noxious Weed list, so control authority should not be a problem. Roundup Pro (glyphosate) herbicide will be used in Pampas grass control. These activities will require about 400 person days and 25 hours of helicopter time (treatment and survey). DLNR/DOA will be the lead agencies, supervising the crew. All MISC members will keep eyes open for additional populations and report them to USGS-BRD (572-4418) for mapping and control referral.

3. FOUNTAIN GRASS (*PENNISETUM SETACEUM*)

Highly flammable fountain grass (on Hawaii's Noxious Weed List) has been recognized since the 1960s as a threat to agriculture and natural areas of Maui. MISC proposes in the first year to treat all individuals of all known populations, using Velpar (hexazinone) herbicide. Search and destroy missions will be conducted in areas of one mile radius around known populations (ground and aerial survey); follow-up evaluations will be conducted biannually (2x per year) in the 6-8 Maui sites known to have ever had fountain grass. A one-time comprehensive jeep survey of lower Ulupalakua Ranch (UR) lands will be done in the vicinity of Pu`u Nao, a large, arid area, infrequently visited and closed to the public (the most likely large tract of land where fountain grass could establish and proliferate for years without being noticed). Annual aerial survey of western leeward Haleakala and lower UR lands will be made. Color wanted posters will be distributed to likely sources (National Guard people, garden shops, botanical gardens, Kanaio and other leeward land owners, cowboys, golf course managers, strategic landowners in proximity to known populations, hunters that UR allows on their lands, DLNR employees, Hawaiian settlement people at Kahikinui, etc.). These activities will require 200 person days and 10 hours of helicopter time. All MISC members will keep eyes open for additional populations and report them to USGS-BRD (572-4418) for mapping and control referral.

4. IVY GOURD (*COCCINIA GRANDIS*)

This species (on Hawaii Noxious Weed List) exploded in the 1980s on Oahu and in the Kona area of the Big Island, creating huge problems for agriculture and conservation of lowland sites. It was first found and removed on Maui in 1992, and is probably still eradicatable, because of its dioecious condition (both male & female plants generally necessary for pollination and seed set). Problems: 1) Once seeds are set, seed bank persists for at least 3-4 years, and 2) More and more plants are

being found on Maui, but no one is really looking as part of their job (response is passive). MISC proposes to devote 40 person days for initial eradication and follow-up on known populations and 72 person days (2 days per month for 3-person crew) to survey new areas. Stems will be treated with Garlon (triclopyr). All MISC members will keep eyes open for additional populations and report them to USGS-BRD (572-4418) for mapping and control referral.

5. GIANT REED (*ARUNDO DONAX*)

Whereas this species is extremely invasive and damaging in riparian areas of southwestern U.S., there is yet little or no sign of extreme invasiveness on Maui (and apparently no seed set yet), even though it has been here for at least 100 years. About 12 small populations are known on Maui (mapped by BRD). Yet habitat vulnerable to invasion seems to exist (riparian areas, beaches?), and caution seems prudent in view of many examples in the literature of a "lag phase" for invasive plants. MISC hopes to devote 40 person days to treat known populations, using a heavy-duty "mower," and following up with treatment with Roundup Pro (glyphosate) herbicide. All MISC members will keep eyes open for additional populations and report them to USGS-BRD (572-4418) for mapping and control referral.

6. RUBBER VINE (*CRYPTOSTEGIA GRANDIFLORA*)

Notorious for its invasiveness in Australia and elsewhere, MISC will lobby to get this species placed on the Hawaii Noxious Weed list ASAP. The situation is complicated by its similarity to *C. madagascariensis*, so that it may be necessary to get both species placed on the noxious list. MISC hopes to devote 10 person days to treat/eradicate known populations and 20 person days to survey for new populations. Stems will be treated with Garlon (triclopyr) herbicide. All MISC members will keep eyes open for additional populations and report them to USGS-BRD (572-4418) for mapping and control referral.

7. OTHER:

MISC also has its sights on 10 additional invasive plant species. Although the crew will not devote significant time to them this first year of MISC plan implementation, these species will nevertheless receive attention from MISC, especially through surveys by BRD and systematic reporting of observations by MISC members. The MISC coordinator/ education specialist will make an effort to get the word out to the green industry, agencies, and the public to be on the lookout for these species (in addition to the eight target species above):

HIMALAYAN RASPBERRY (*RUBUS ELLIPTICUS*)

On Hawaii Noxious Weed List. Based on its extreme invasiveness and impacts in the Ola`a-Kilauea area of the Big Island, it is recognized by USGS-BRD as second only to *Miconia* in invasiveness in the State. It has recently (early 1998) been determined that it is continually being inadvertently brought from the Big Island to Maui

and other islands via the hapu`u (tree fern) trade. Education and information should be passed on to the green industry, agencies, and the public. If a population is found to be establishing, BRD will contact Steve Anderson of HALE, who has expressed willingness to deal with such populations.

MALABAR MELASTOME (MELASTOMA CANDIDUM)

On Hawaii Noxious Weed List. Situation identical to Himalayan raspberry, above. It is continually being brought from the Big Island to Maui and other islands via the hapu`u (tree fern) trade. The plan is the same as for Himalayan raspberry, above.

VICTORIAN LAUREL (PITTOSPORUM UNDULATUM)

On the Hawaii Noxious Weed List. This species is notorious for its invasiveness in cloud forests of Jamaica, Madeira, and elsewhere. All MISC members will keep eyes open for the presence of this species and report to USGS-BRD (572-4418) for mapping and control referral. BRD plans to investigate status of this species on Lanai and the Big Island, where it is said to be escaping from cultivation.

MULLEIN (VERBASCUM THAPSUS)

On Hawaii Noxious Weed List. A serious invader at high elevations on Mauna Kea as well as elsewhere in the world. Detected and eliminated on Maui at multiple sites in 1986-1992. Was being propagated (as an herb) in Makawao and sold by a store in Pukalani; however, they were highly cooperative when alarm was raised. All MISC members will keep eyes open for the presence of this species and report to USGS-BRD (572-4418) for mapping and control referral.

DOWNY ROSE MYRTLE (RHODOMYRTUS TOMENTOSA)

On Hawaii Noxious Weed List and a serious invader on Kauai and Oahu. Recently found to be present in at least one botanical collection on Maui. All MISC members will keep eyes open for the presence of this species and report to USGS-BRD (572-4418) for mapping and control referral.

RUBUS DISCOLOR [A SPECIES OF RASPBERRY AS YET RARE IN HAWAII]

Proposed because of the importance of keeping another problematic *Rubus* species out of Maui County. Maui Pineapple Company's Pu`u Kukui Watershed staff and R. Hobdy, DLNR, to work to get definitive identification and will survey/treat/eradicate.

CAT'S CLAW (CAESALPINIA DECAPETALA)

This deciduous, sprawling, leguminous shrub from India has vicious spines and forms impenetrable thickets on the Hawaiian island of Kauai, where it has invaded extensively, centered on the northeastern portion of that island. On one occasion on Kauai,

forester Robert Hobdy observed that a cow had become entangled above ground and died in a *Caesalpinia* thicket. It is believed that seeds are spread primarily by heavy road equipment (R. Hobdy, DLNR, pers. comm.). It could be a highly problematic species, especially along irrigation ditches and roadsides. On Maui, this species seems to be confined to the area of 20-30 acres (extent needs verification) in Kakipi Gulch near Haiku. It may or may not be a feasible target for eradication. Helicopter spraying should be evaluated for feasibility/ tested. Aerial wires in the area may create problems. However, through delineation of the area and education, it may be possible to keep it confined to its current area of infestation. USGS-BRD will map distribution more precisely; BRD/DLNR to conduct herbicide tests and work with NRCS-EQIP program and landowner to develop proposal for testing of helicopter spraying.

ALLSPICE (*PIMENTA DIOICA*)

A serious invader of forests on Oahu. Although widely planted on Maui, there may still be only a few sites where it is naturalizing (e.g. Rainbow Park on Baldwin Ave. below Makawao, nursery near Waikapu), because of its dioecious condition (both male and female plants generally necessary for pollination and seed set). MISC will work toward achieving voluntary compliance for not selling, distributing, growing it and toward getting it on a state prohibited list. Additional exploration and mapping needed; also documentation of status and impacts on Oahu and elsewhere (USGS-BRD to take lead).

KUDZU (*PUERARIA LOBATA*)

Tropical kudzu (*Pueraria phaseoloides*), but not *P. lobata*, is on Hawaii Noxious Weed List. *Pueraria lobata* is an aggressively spreading vine from North Asia which has a well-known track record of invasiveness in southeastern U.S., where it has invaded 5 million acres; also said to be invasive in South Africa and New Guinea. It occurs sparingly in the Keanae/Wailua to Nahiku area of the East Maui watershed. USGS-BRD will continue surveys on Maui.

GERMAN IVY (*DELAIRIA ODORATA* = "*SENECIO MIKANIOIDES*")

A serious invader of mamane forests and other habitats on the Big Island and of natural areas in California. USGS-BRD will continue surveys on Maui to determine feasibility of control and attempt to get better information on what this species is doing on the Big Island.

Note: Over the next five years, USGS-BRD plans to continue to gather detailed baseline data (on distribution, population structure, and dispersal) on alien plant species suspected of eventually posing threats to biodiversity on Maui. The above-named MISC targets will be surveyed, as well as other potentially invasive alien plant species known or suspected to be present on Maui. Selection is based on behavior in the

Hawaiian Islands or elsewhere. Species currently targeted by USGS-BRD include:

Archontophoenix alexandrae, *Bocconia frutescens*, *Cinchona* spp., *Citharexylum caudatum*, *C. spinosum*, *Clerodendrum macrostegia*, *Cortaderia selloana*, *Cotoneaster* spp., *Derris elliptica*, *Erigeron karvinskianus*, *Hiptage benghalensis*, *Hypericum* spp., *Hyperrhenia rufa*, *Leptospermum scoparium*, *Ligustrum* spp., *Lonicera japonica*, *Melochia umbellata*, *Myrica cerifera*, *Olea europea*, *Oxyspora paniculata*, *Paederia scandens*, *Paraserianthes falcataria*, *Passiflora laurifolia*, *P. ligularis*, *Phormium tenax*, *Pyracantha* spp., *Schizachyrium condensatum*, *Solanum robustum*, *S. torvum*, *Tetragonia tetragonioides*, *Thunbergia grandiflora* and other spp., *Tibouchina urvilleana*, *Washingtonia* spp.

Preliminary distribution maps for each species will be circulated to knowledgeable partners and members of the public, continually refining and updating the collective knowledge. USGS-BRD also plans to pursue research over the next 5 years to develop better scientific understanding of the invasion process, determining major pathways by which potentially invasive plant species get to the state of Hawaii. A comprehensive inventory of Maui's nurseries and botanical gardens is planned. The Maui Invasive Species Committee will be appraised monthly of findings for invasive species for which control is underway, planned, or contemplated.

PRIORITY INVASIVE VERTEBRATE ANIMALS

1. CARIBBEAN FROGS (GENUS *ELEUTHERODACTYLUS*)

Three species of small brown Caribbean frogs of the large Neotropical genus *Eleutherodactylus* have been introduced to Hawaii in the past 5-7 years. Two of these species (*E. coqui* and *E. martinicensis*) occur on Maui; the third (*E. planirostris*) occurs on Big Island and Oahu and could easily be transported to Maui as well. [Because the two species known from Maui call from perches from 0-3m high in vegetation at night, they have frequently been referred to as "tree frogs" locally. However, this name potentially provides some confusion because they are not related to the frogs known as "tree frogs" by scientists or by the general public on the mainland. Use of the names "coqui" for *E. coqui* and *E. martinicensis* (two very similar species from different islands in the Caribbean) and "greenhouse frog" for *E. planirostris* would avoid this confusion.] All three species of frogs have reached Hawaii and are being spread around the State in nursery materials used for landscaping purposes. The largest populations in Hawaii occur at nurseries and this is the well-documented means of spread of these and related species throughout the Caribbean region. *E. coqui* is well studied in its native Puerto Rico and from these studies we can readily deduce the problems this and related species could cause in Hawaii if they become well-established and widespread. Basic ecological information relevant to determining these effects include the following:

- 1) the frogs can occur at densities up to 8000/acre;
- 2) they consume on average 45,000 prey items/acre/night [approximately 16 million prey items/acre/year];
- 3) females can produce 4-6 clutches/year, each clutch consisting of 16-41 eggs;
- 4) the frogs reach sexual maturity 8 months after being laid as eggs; and
- 5) they can occur from sea level to at least mid-elevation rainforest and mesic forest.

As a result of these ecological attributes we may expect that if left unchecked these frogs will soon spread and establish numbers on Maui too large for control. If so, it is reasonable to expect that they will have the following negative effects on Maui's native species and ecosystems:

- 1) they will exert a tremendous predation pressure on a wide array of native nocturnal invertebrates, including insects, spiders, and snails, many of which are already stressed to the edge of extinction;
- 2) by removing a large percentage of the insect prey base, they will

have a large indirect effect on Maui's remaining native forest birds, most of which are partially or largely insectivorous;

- 3) they will serve as a food source for rats and mongooses, allowing these predators to reach even higher densities than occur now and thereby increasing the predation pressure these alien mammals exert on Maui's native birds, tree snails, and plants; and
- 4) they will serve as a potential food source for any snake species that may become established on Maui in the future, thereby making it easier for any such species to maintain artificially high population densities, as has occurred with the brown tree snake on Guam.

As well as this, there are other negative consequences of these frogs' establishment on Maui, the main one of which is that their loud calls (emitted at 90-100 decibels) prove very annoying and disturbing to the sleep of many locals and visitors alike. Visitors at several hotels on Maui have complained about the noise at night, and some residents have even threatened to leave Maui if the frogs could not be removed. And these complaints have come about frog populations having no more than 30-80 frogs, not the thousands the species are capable of attaining. It is also possible that the frogs may be capable of serving as vectors of plant nematode eggs by having them adhere to their skins, increasing an already significant problem for some sectors of the horticultural industry. Further, if states such as California discover that Hawaiian nurseries are contaminated by these frogs, they may refuse shipments of material not certified to be free of the pests, again increasing costs to the industry generally.

Funds are sought for two full-time employee (FTE) positions who will work to verify frog reports, survey localities to determine population sizes, educate nursery owners and landowners about the problem, and eradicate the populations before they spread further. First priority will be given to eradicating all known populations at nurseries so as to stop the establishment of new populations around Maui. Funding is also sought to initiate studies needed to register a detergent for use in killing the frogs. Frog populations may be successfully eradicated by hand-capturing all of the easily targeted calling males. However, eradication would be much more efficient if hand-capture were not necessary and a toxin could, instead be sprayed in the immediate location from which males are calling. It is known that weak detergent solutions (such as dishwashing detergents) are toxic to frogs. Several detergents are already registered by the U.S. Environmental Protection Agency (EPA) for field uses, and funds are sought to conduct the necessary trials to test the efficacy of these products against frogs and to get these products registered with EPA for such an application.

2. ESCAPED PARROTS AND PARROT-LIKE BIRDS

A variety of parrot species have been released by pet owners and have established populations in the wild on Maui and the other main Hawaiian Islands, in some cases for many years now. However, it is unknown exactly how many and which parrot species are established on Maui, what the population sizes are, where they roost, or how successfully they are breeding and increasing their numbers. Sightings of flocks of birds have been documented by DLNR Forestry and Wildlife staff for Mitred Conures, *Aratinga mitrata*, two Amazon parrots *Amazona* spp. (probably one species is the Blue-fronted Amazon), the Rose-ringed Parakeet *Psittacula krameri*, the Ring-necked Parakeet *P. alexandrinus*, Peach-faced Lovebirds or a hybrid-form, probably *Agapornis* spp., as well as a white cockatoo (*Cacatua* sp.). All of these previously listed forms probably represent species which are breeding in the wild on Maui and are persisting at least in small to moderate numbers. Furthermore DLNR DOFAW staff have observed at least three other taxa that may not represent breeding populations. A variety of parrot species are well-known agricultural pests elsewhere in the tropics, typically targeting fruit and grain crops, and they have reached sufficient numbers that control measures have been required on Kauai. They pose additional threats to native ecosystems in two ways. First, because of the long distances they frequently fly, they are efficient dispersers of seeds for a variety of invasive plant species. Furthermore, the fact that several parrots at loose in Hawaii are of much larger size than other alien bird species makes it likely that they will disperse seeds from alien plants having large fruits that are currently not a problem in the State. Second, introduced parrots are also effective seed predators of some tree species and eat the crowns of other trees, causing their death. This has resulted in the decimation of native palm trees in Palau, for example. It is possible that they could serve to inhibit reproduction in native tree species whose seeds they might eat, serving to reduce native plant populations. They are also a likely threat to Maui's native loulu palms, which are already endangered.

Funds are sought to conduct a one year intensive field-study of parrots on Maui to ascertain numbers, exact species composition(s) and breeding status, diets, and the foraging patterns of these birds on Maui and to gather all necessary information on activity patterns to design effective removal strategies for the future.

3. SNAKES, RABBITS, AND OTHER VERTEBRATES

A variety of other alien vertebrates that are not currently known to be established on Maui still show up on island at frequent intervals. These animals, which include snakes, lizards, turtles, frogs, and rabbits, are thought to be animals released by pet owners. Other vertebrate pests, such as bulbuls, may potentially arrive on Maui from neighboring islands. In order to avoid having these animals establish populations on Maui, it is imperative that reported sightings of any new vertebrate

pests be quickly responded to in order to capture the reported animal. Furthermore, the large number of reported sightings of snakes on Maui since August, 1997, and the clustering of these sightings in two geographically limited areas raises the concern that some species of moderately large snake may be in the process of establishing a population on Maui. Evaluation of this possibility is currently hampered by the lack of sufficient personnel to respond effectively to each sighting.

The two FTE's employed to conduct the frog survey and eradication program will be used to assist State DLNR personnel to respond to any and all such reports of new alien vertebrates so as to increase the likelihood that these species will be prevented from establishing on Maui.

PROJECT IMPLEMENTATION

The planned work is to be accomplished by a team comprised of a Project Coordinator, an Education/Public Relations Specialist, and field crew members. Whereas in the long run, coordination will involve long-range planning, and education outreach will attempt to reach a broad audience, we envision that during the first year of implementation the project leader and education specialist will both spend much time working closely with the field crew with outreach at specific sites, i.e., working with property owners in our target areas to assure access and minimal controversy. Streamlining this aspect of operations, in conjunction with the Hawaii Department of Agriculture, will be crucial.

MISC has requested through CGAPS that a cooperative arrangement with Hawaii Department of Agriculture be developed to provide office and storage space for the project coordinator, education specialist, and crew.

PROJECT SUPPORT

WHY SHOULD FEDERAL AGENCIES SUPPORT THIS PROJECT?

NATIONAL PARK SERVICE

Haleakala National Park (HALE) is the most biologically intact summit-to-sea reserve in the Hawaiian Islands and is among the most important reserve sites in the United States for conservation of biodiversity. It is currently free of *Miconia* and Pampas grass, but is extremely vulnerable to invasion by both these species. Pampas grass has the potential to invade approximately one-half the 28,400+ acres of HALE), and *Miconia* has the potential to invade most of the other half. HALE is also vulnerable to many of MISC's other target taxa - both plant and vertebrate - as well.

FISH AND WILDLIFE SERVICE

The island of Maui alone has almost 100 listed and candidate plant species and as many additional species classified as "species of concern" by FWS. Survival of virtually all those species will ultimately be jeopardized unless the weeds being addressed by MISC are eradicated or contained. Alien plant species being address by MISC are also a threat to Maui's Kealia National Wildlife Refuge.

DEPARTMENT OF DEFENSE

Travel by military personnel and transport of military equipment from other islands to Kanaio National Guard Training Area on Maui is a major potential source of dispersal for alien plant species, especially fountain grass (*Pennisetum setaceum*) and ivy gourd (*Coccoloba grandis*). Fountain grass is a dominant species at Pohakuloa Training Area and elsewhere on the island of Hawaii. Fountain grass fuels fire and would pose severe threats to the biodiversity of Haleakala National Park (especially Haleakala Crater to 9000 ft elevation) and to many sites on leeward Haleakala volcano outside the Park. Invasion of ivy gourd is rampant on Oahu and in the Kona area of the island of Hawaii. Both these species can be readily transported to Maui by military personnel and their equipment. Obviously, the threat is not just to military lands but to the entire area on the island vulnerable to invasion by fountain grass and ivy gourd.

WHY SHOULD STATE, COUNTY AND PRIVATE ENTITIES SUPPORT THIS PROJECT?

Miconia, Pampas grass, fountain grass, ivy gourd, Caribbean frogs, and the other species being addressed by MISC pose serious threats to state and private conservation reserves, to county watersheds, to agriculture,

to tourism, and/or to the quality of life of all Maui residents. The Maui tourism industry is proud of the fact that Maui has been chosen the "Best Island in the World" for five consecutive years by Conde Nast Traveler magazine. MISC's activities to stop incipient alien species are devoted to maintaining Maui's high-quality environment in spite of an onslaught of alien species invasions. MISC is soliciting federal funds for this project through the National Fish and Wildlife Foundation (which provides funds from a consortium of federal agencies) and the U.S. Forest Service. **To receive those funds, a minimum 1:1 non-federal match must be available.**

PROJECT BUDGET

**TOTAL PROPOSED COST OF YEAR 1
MISC ACTION PLAN IMPLEMENTATION**

Personnel (includes 28 % benefits, etc.)		
medical, employer tax contribution,		
Co-coordinator; 1 FTE @ \$46,000		46000
Public relations specialist; 1 FTE @ \$38,400		38400
Biocontrol research associates; 2 FTE @ \$40,000		80000
Field crew; 11 FTE @ \$30,600 (includes dedicated 5-man Miconia crew)		336600
Personnel/Labor Total		\$501,000
Other		
Cell phones/service (5 @ \$300/yr)		1500
Computer hardware and software (5 systems @ \$1500/ea)		7500
Contractual services (self-contained/equipped w/minimal staff - Parrot Survey - Snake Survey)	assistance)	50000 50000
Global Positioning System		6500
Helicopter (35 hrs @ \$700/hr)		24500
Herbicides (Plant Eradication Team)		7600
Night Vision equipment (Vertebrate Eradication Team)		1200
Misc. equipment (backpack sprayers, etc.)		4600
Office space, storage, telephone/fax/modem lines, equipment, supplies		25000
Personal protective equipment: gloves, rubber boots, goggles, rain gear, first aid		2000
Public Awareness/Education (PSAs, flyers, etc.)		10000
Snake Dog (Vertebrate Eradication Team)		700
Travel/Per Diem		3000
Vehicles (4 x 4WD @ \$600/month + insurance)		28800
Vehicle mileage/maintenance (20k/yr x .31/mi/ea)		30800
Other Total		\$253,700
	Project SubTotal	

	\$754,700
RCUH/PCSU overhead (2%)	15094
Grand Total Project Need	\$769,794

PROJECT NEED

Grand Total Project Need 769794

ESTIMATED NON-FEDERAL CHALLENGE FUNDS

Co-coordinator (Robert Hobdy, Dept. of Land and Natural Resources in- kind)	10000
State DLNR (in-kind)	75000
State Legislature	293594
Maui County	175000
The Nature Conservancy	10000
Grand Total Estimated Challenge Funds	\$ 563,594

FUNDS REQUESTED

NFWF Funds Requested (Federal Challenge Funds)	\$206,200
County of Maui Funds Requested (Non-Federal Matching Funds)	\$175,000
State of Hawaii Funds Requested (Non-Federal, Non-Departmental Match)	\$293,594