

EPA WETLANDS PROGRAM DEVELOPMENT GRANT – PROPOSAL

Project Period: 2001-2002

1. Project Title: Building a Protective Layer for Hawaii's Wetlands: Measures to Prevent Invasion by the Red-imported Fire Ant (*Solenopsis invicta*).

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3. Project location: State of Hawaii

4. Project purpose, objectives, and final product:

The purpose of this project is to strengthen Hawaii's proactive wetland protection efforts by refining Hawaii's red imported fire ant (RIFA) prevention/quick response plan, and allowing for the building of a strong protective matrix against invasion by this ant. The objectives of this project are to refine Hawaii's RIFA prevention/rapid response plan by conducting the following tasks: 1) expand and coordinate public education efforts to include various community groups, public agencies, legislative bodies, and the private sector (businesses, business associations, and various industry related groups) in an effort to expand awareness and early detection, and foster support of the community for prevention/quick response activities; 2) conduct an economic assessment of a RIFA invasion in Hawaii (for establishment of prevention as priority within the political arena); 3) identify temperature-dependant RIFA range limits for the State of Hawaii with an adjusted computer model originally established for analysis of RIFA range limits for the mainland United States, using climate data obtained from the NOAA database network (in order to best prioritize regions during quick response activities), and 4) analyze the State and federal policy framework within which Hawaii's RIFA prevention/quick response plan will be initiated, and provide subsequent recommendations of alternative policy initiatives where deemed needed to obtain a high degree of success of an implemented plan. These efforts will include a public participation component that will extend to various community groups (farmers, ranchers, humane society, landscape professionals, garden clubs).

The final products of this project will include: 1) outreach materials with content developed specifically for each of several key community groups, and including programs for broad public involvement in an early detection system; 2) an economic assessment, for use by educators and lawmakers; 3) a map of range limits for the RIFA within Hawaii (including predicted likelihood of invasion in different areas), for use by land managers and policy makers in prioritization of locations for early-detection monitoring and quick response activities; and 4) a final policy analysis, with recommendations for initiatives to be introduced to legislative branches.

5. Background and need:

The red imported fire ant (RIFA) is very likely the most serious impending threat to Hawaii's wetland ecosystems. Without cooperative and creative efforts that will sufficiently strengthen, refine, and thus pave the way for successful implementation of a state-wide prevention/rapid response plan (currently being developed with EPA FY00, WPDG funds), there is little doubt that the RIFA will become established in Hawaii. This years wetland grant funds are crucial to this project. No other funding is currently available, and the threat of invasion by the RIFA is immediate. If Hawaii's RIFA prevention/rapid response plan is not sufficiently strengthened, we may be too late in preventing its establishment in Hawaii. This would have disastrous ecological impacts on Hawaii's wetlands. Not only would the RIFA cause serious impacts on wetland wildlife, but insecticide treatments for control of this harmful pest could cause degradation to overall wetland ecosystem health. Although

wetland ecosystems are not the only ones which will suffer if the RIFA were to establish in Hawaii, Hawaii's wetlands are especially vulnerable to infestation by this ant. The RIFA is especially adapted to establishing in disturbed habitats, and in areas with a high water table and seasonal flooding. The latter is a factor that eliminates most other ants from an area and favors RIFA establishment due to lack of competition with other ants, and has allowed the RIFA to invade even undisturbed wetland areas. These ants will thrive in most of Hawaii's climates, but especially in low elevation climates where most of Hawaii's major wetland areas occur. This is of particular concern because wetlands are among the few areas at low elevations in Hawaii to harbor native species.

The RIFA is a notoriously destructive invasive pest. The species Latin name, "invicta" appropriately means "invincible". Colonies are extremely productive compared to other ant species, and grow rapidly. Individual colonies consist of hundreds of thousands of ants, and colonies occur in high densities. Individual worker ant densities are consequently also high, averaging 1500-3000 ants/square meter. The RIFA's extremely aggressive territorial and predatory nature, coupled with its powerful sting, renders it a danger to most animals, including humans. Thousands of these ants will swarm on, and relentlessly sting, anything that is unfortunate enough to disturb their colony. One researcher was stung over 250 times on one leg within 10 seconds of inadvertently disturbing a nest (Weaver-Missick 1999). The ants are quick, each individual ant can sting repeatedly, and the sting is exceptionally severe. Though two other species of fire ant, *Solenopsis geminata* and *S. papuana* already occur in Hawaii (and are considered aggressive and destructive invasive species), the RIFA is a much more aggressive invader. For instance, in areas where RIFA has invaded it has totally replaced *S.geminata* colonies. On the mainland, *S. geminata* populations were generally low (with less than 8 mounds (i.e. nests)/hectare). RIFA infested areas, on the other hand, have up to 250 mounds/hectare (with occasional reports of up to 1000 mounds/ha). *S.geminata* and *S. papuana* are generally restricted in habitat requirements (dry coastal areas and mesic-wet forest, respectively) and inflict only a few stings when disturbed. The RIFA is found in any environment, including wetlands, and inflicts many stings when disturbed. Compared to other invasive ants, the sheer numbers in which RIFA occur and their severe aggressiveness render them a much more serious, dangerous, and devastating invader. RIFA are opportunistic in their feeding habits and actively prey on invertebrates, vertebrates and plants (Vinson 1994). Animals susceptible to predatory attack by foraging RIFA include anything that is relatively immobile and unable to run away from attacking ants. The eggs and young of most vertebrate species are hence extremely vulnerable to attack by RIFA. Animals reported in the scientific literature to be killed by RIFA include: birds, lizards, and turtles, especially nestlings and pipped eggs; small mammals; invertebrates; and humans (those hypersensitive to their venom; and bed-ridden immobile individuals) (Vinson 1994, Environment News Service 1999). In general, as the RIFA invades an area, the diversity and abundance of native arthropods and vertebrates plummets (Tschinkel 1993).

Eight native species of waterbirds breed (and reside year round) in Hawaii's wetlands. Five of these, the Hawaiian coot, Hawaiian Gallinule (moorhen), Hawaiian stilt, Hawaiian Duck and Laysan Duck are endangered endemic species. The other three include the Pied-billed Grebe, Fulvous Whistling-Duck and Black-crowned Night-heron. Hawaii's wetlands also provide foraging habitat for several species of migratory waterbirds. The wetland bird species most threatened by RIFA are the endangered endemic species, due to their small populations and the fact that they evolved in the absence of ants. There are no ants native to Hawaii, and Hawaii's biota is notoriously vulnerable to predation by alien ants (Gillespie and Reimer 1993). Hawaii's birds have not evolved the defenses (such as avoidance behaviors) necessary to protect themselves from ants and thus will be exceptionally vulnerable to RIFA attacks. In addition, all five of the endangered wetland birds nest at ground level and are hence especially likely to be encountered by foraging and colony-defending RIFA. Wetland habitat in Hawaii is extremely rare and comprises only about 3% of Hawaii's total land area. One of the primary factors contributing to the threatened and endangered status of wetland species is habitat loss and degradation. Infestation by RIFA will undoubtedly constitute additional loss of suitable habitat for Hawaii's endangered wetland birds, a loss that these species cannot afford.

The RIFA is native to the seasonally-flooded Pantanal region of southern Brazil and is able to thrive in seasonally flooded habitats where other ant species are absent. This alien ant has

severe impacts on wildlife in wetland areas of southeastern U.S. Evidence for the potential impacts of RIFA on Hawaii's wetland birds includes reports of RIFA impacts on wetland/water birds elsewhere. Drees (1994) studied breeding success of waterbirds in Texas. He found that RIFA attack and predate the pipped eggs and nestlings of several species of colonial ground and shrub nesting waterbirds, including egrets, herons, spoonbills, cormorants, and gulls. Drees's study showed a 92% overall reduction of waterbird reproduction during part of the breeding season in RIFA infested areas (compared to non-infested areas). During one month, hatchling waterbird mortality was 100% in RIFA infested areas, compared to 0% in non-infested areas. Lockly (1995) reported a 27% increase in mortality in chicks of the ground nesting endangered least tern in RIFA infested areas (compared to non-infested areas). The RIFA is also known to attack the nestlings of wood duck and is speculated to exclude wood ducks from natural cavity nest sites. In one study RIFA destroyed 15% of clutches in wood duck nest boxes (Ridleyhuber 1982). The current populations of Hawaii's endangered wetland birds range from a few hundred (Laysan duck) to a few thousand (Hawaiian coot) individuals. An added mortality factor of the magnitude that RIFA exerts on several bird species (and other vertebrates) would likely have extremely serious consequences for these small populations.

The likely devastating impacts of RIFA on Hawaii's wetland birds is also supported by evidence of the impacts this ant has on fauna in other ecosystems, which evolved in the presence of a formidable ant fauna, including *S.geminata*. Birds reported in the literature as predated by RIFA include the eggs/nestlings of cliff swallows, where an increase in RIFA densities were associated with a 34% decrease in cliff swallow nesting success (Sikes and Arnold 1986), crested caracara (Dickenson 1995), and bobwhite quail (Allen et al 1995). Also negatively affected by this species are the threatened loggerhead sea turtle (Moulis 1996) and the endangered green sea turtle (Weaver-Missick 1999) whose nests and nestlings are attacked by RIFA in coastal areas of Georgia and Florida, respectively (hence, the threatened pacific green sea turtle, which nests in coastal habitats of Hawaii that border coastal wetlands, are also at risk). RIFA is also known to have negative impacts on small mammals. It is believed to have caused deaths of several species of rodents (Masser and Grant 1986, Flickiinger 1989), and is reported to negatively effect small mammal densities (Smith et al 1990, Stoker 1992, Killion and Grant 1993). Authors have also reported substantial differences in small mammal foraging ecology and behavior in the absence versus the presence of RIFA, including avoidance of areas infested with RIFA. RIFA also prey heavily on invertebrates. Scientists have shown a significant reduction of the abundance of several types of invertebrates at RIFA infested sites, with a total arthropod species richness of 40% less than at sites without the RIFA (Porter and Savignano 1990).

In the event of RIFA establishment in Hawaii, last-ditch efforts to protect wetland wildlife, as well as humans, would require large-scale use of insecticides. USDA entomologists already work with many environmental and conservation groups in the southern U. S. to keep fire ants from harming endangered species (i.e. Stock Island tree snails, gopher tortoises, Florida grasshopper sparrows, saltmarsh rabbits, and sea turtles) (Weaver-Missick 1999). These efforts usually involve chemically treating large areas to reduce RIFA populations. And, because the RIFA is currently impossible to eradicate once established, continued pesticide treatments are needed to maintain reduced ant numbers. In addition, pesticides currently used against RIFA (hydramethylnon, fenoxycarb, diazinon, and others) are not species specific. Therefore, some wetland invertebrate populations would no doubt be severely impacted by the use of these pesticides. Invertebrates typically represent a major portion of the fauna biomass in any ecosystem and are indispensable in maintaining ecosystem health.

Large-scale use of insecticides to control RIFA has threatened water supplies and ecosystems elsewhere (Associated Press 1998, Texas A&M Univ.), and would pose a significant threat to Hawaii's water and overall wetland ecosystem health. The potential for drastic increases in pesticide use in Hawaii is huge. Hawaii's climate and large tourist industry result in a situation with extensive outdoor recreation and industry. The nursery and tourism industry, both very large in Hawaii, would require regular RIFA control to protect their businesses and to protect against the threat of liability. Extensive use, not to mention misuse and overuse, of pesticides to protect Hawaii's homeowners, residents, industries, and wildlife would no doubt drastically increase

pesticide loads in soils and runoff. If the RIFA is allowed to become established in Hawaii, there is no doubt that that it will cause disastrous economic and ecological impacts (of at least equal magnitude to the much-feared and -publicized Brown Tree Snake) involving many sectors (human health, tourism, biodiversity, agriculture, quality-of-life), including wetlands.

Recently funded wetland projects in Hawaii include development of Hawaii's RIFA prevention/quick response plan (funded with EPA FY00 WPDG funds). The objective of this initial project (which is currently in progress) is to develop a RIFA prevention/rapid response plan. Specifically, this initial project was to: identify/determine potential pathways of introduction; develop quarantine strategies; develop survey/early detection strategies; develop/test RIFA school curriculum for education; and identify quick-response pesticides for early registration by the State. Due to the complex and interdisciplinary nature of this initial project, we did not foresee the need for the additional tasks outlined in the current proposal. However, it became apparent during the initial project that these tasks would be needed in order to insure the likelihood of community support and implementation of a strong RIFA prevention/quick response plan. For instance:

- Although the initial RIFA plan includes education of school kids (for awareness and early detection purposes), it has become apparent that much broader outreach activities are needed if Hawaii's RIFA plan is to gain the community-wide support needed for eventual implementation of the RIFA plan (including potentially novel prevention/quick response activities). It is therefore of primary importance to extend outreach to include a variety of community groups, public agencies, legislative bodies, and the private sector (businesses, business associations, and various industry related groups). It is also critical that part of this outreach effort include an economic assessment of a potential RIFA invasion in Hawaii. The title of an article in the Dec. 1 issue of Pacific Business News, "Fire ant inspection program stings shippers," (see attachment) forewarns of potential attitudes of the political and business communities toward future prevention/rapid response activities. Such attitudes are likely in the absence of an understanding of the economic risks posed by a RIFA invasion. An economic assessment is absolutely necessary for establishment of RIFA prevention as a priority within Hawaii's political arena and business community. (Tasks 1 and 2, Section 7)
- Early detection strategies (including using school kids to sample for ants), are being developed for inclusion in the initial RIFA plan. However, we currently lack the information needed to prioritize areas of the state on which to focus these early detection efforts. Hence, a critical need exists for information that can aid in determining which areas are more prone to RIFA establishment. A computer model (designed to predict RIFA range limits on the mainland U.S.) exists that can categorize areas, based on climate data and RIFA biological parameters, as "certain", "possible", or "improbable" to be able to support RIFA colony establishment. This information would be indispensable in directing detection efforts to appropriate areas and thus allow for much needed refinement of early detection strategies. (Task 3, Section 7)
- Implementation of various aspects of the developing RIFA plan (such as inspection of non-agricultural goods) would not be possible under current state and/or federal policy/statutes. Such constraints need to be evaluated to identify where, and specifically what type of, change is needed (and appropriate) to allow for effective prevention/rapid response measures. (Task 4, Section 7)

It is our belief that when we have addressed these needs, Hawaii's RIFA prevention/quick response plan will be ready for implementation, and will have a high chance of success. We also believe that, should any additional unforeseen refinements of the plan be required prior to implementation, we will have established the state-wide support necessary to obtain additional funding from local sources, if needed.

Recently funded wetland projects in Hawaii have also included those that focused on controlling alien species (predators, weeds) for the purpose of protecting wetland habitat and endangered wetland birds. For instance, projects have included control of alien predators of wetland birds in Kanaha Pond State Wildlife Refuge and weed removal at Kealia National Wildlife Refuge.

This project offers a new approach to reducing extinction risks to these birds by identifying a future threat and using proactive measures to reduce the risk of that threat. This project is designed to allow protection of wetland species from the RIFA threat without having to resort to large-scale on-the-ground "control" efforts. Such a proactive approach is an economically efficient and environmentally friendly alternative to traditional approaches to harmful alien species threats (i.e. chemical/mechanical control after establishment), and will offer a model for dealing with other identified threats to Hawaii's wetlands.

6. Definition of success: Success will be defined as completion, within the defined project period, of all final products (a final policy assessment, with recommendations for alternatives; outreach materials, including programs for public involvement, with content developed specifically for each of several community groups; an economic assessment, for use by educators and lawmakers; and a map of range limits for the RIFA within Hawaii [including predicted likelihood of invasion in different areas], for use by land managers and policy makers in prioritization of locations for early-detection monitoring and quick response activities). During the project period, success will be defined as completion of specific tasks throughout the project period, as outlined in the schedule.

7. Description of project tasks:

Task 1: Public education efforts will be expanded and coordinated to include community groups, public agencies, legislative bodies, and the private sector. An outreach coordinator will be hired (with EPA funds) to work, under guidance of the Hawaii Ant Group (an interagency working group), on gathering appropriate facts, information, and support materials and developing outreach materials addressing general RIFA threats, concerns specific to particular groups, RIFA identification, protocols for reporting potential RIFA sightings. The outreach coordinator will serve as the primary staff contact for the public. Outreach materials developed will include slide shows, pamphlets, posters, and articles for newsletters/bulletins. The Outreach Coordinator will conduct and coordinate distribution and/or presentation of materials to agencies and community groups. Materials will be posted in electronic format on the Hawaii Ant Group website to facilitate sharing of materials and information with others.

Milestones: identification of all groups to be targeted for outreach activities; completion of outreach products; distribution and/or presentation of final materials to appropriate groups; posting of materials on the Hawaii Ant Group website.

Deliverable: Final outreach materials (including, but not limited to, slideshows, posters, pamphlets, and newsletter articles) designed specifically for different groups within the community.

Dates: July 1'01 – June 30'03 **Funds:** EPA = \$72,929; Matching = \$13,900

Task 2: An economic assessment of a potential RIFA invasion in Hawaii will be conducted by a post-doctoral Economist (hired with EPA funds), with input and assistance from the Hawaii Ant Group and project cooperators. The economist, with input from cooperators, will identify areas of potential economic impact, and outline a research plan and methodology. Data will then be collected and analyzed, and a final written assessment produced that identifies specific economic impacts to various sectors. A copy of the final assessment will be delivered to cooperators, and a copy posted in electronic format on the Hawaii Ant Group website to facilitate use of the information, and sharing of the information with others.

Milestones: Completion of list identifying all areas/sectors likely to suffer economic impacts if RIFA invades Hawaii; completion of a research plan and methodology; completion of data collection process; completion of data analysis; completion of final written assessment and posting on the Hawaii Ant Group website.

Deliverables: Final written economic assessment of a potential RIFA invasion in Hawaii.

Dates: Sept. 1'01- Aug. 31'02 **Funds:** EPA = \$50,000; Matching = \$12,300

Task 3: Potential RIFA range limits within Hawaii will be predicted using a temperature dependant computer model built for RIFA range prediction on the mainland. The information provided will identify high-risk areas within the state, and hence indicate where quarantine and early detection efforts are most needed. A system modeler familiar with the specific RIFA range prediction model to be used, and with RIFA biology, will be contracted (with EPA funds) to perform the analysis.

Hawaii soil temperature, air temperature, and rainfall data will be obtained from the NOAA database network, and from an independent University of Hawaii database. Data will be extracted from these datasets, corrected, and assembled into usable format. Missing data will be generated using standard formulas for converting air to soil temperatures. Data will then be generated through the model. The final product will consist of a GIS map representation of that shows potential range of RIFA throughout Hawaii, in addition to the relative likelihood of establishment within different areas of the predicted range. The final product will be posted on the Hawaii Ant Group website to facilitate sharing of the information with others.

Milestones: procurement of NOAA and University of Hawaii climate data; completion of all preliminary data processing; final generation of model results; completion of GIS map representation of results; posting of the map on the Hawaii Ant Group website.

Deliverables: A map showing predicted RIFA range, and likelihood of establishment, throughout Hawaii. (i.e. a GIS representation of model results).

Dates: July 1'01- Aug 30'01 **Funds:** EPA = \$6,000; Matching = \$800

Task 4: An assessment will be conducted (with in-kind contributions) of State and federal policy as it relates to Hawaii's RIFA prevention/quick response plan. All State and federal policy and statute constraints associated with the initial plan will be identified, with assistance and input from the Hawaii Ant Group. Possible options for easing these restraints will be outlined and evaluated. Subsequent recommendations will be made for potential alternative policy initiatives, where deemed appropriate for successful implementation of the RIFA plan. A summary of constraints, possible options, and recommendations for change will be written and delivered to Hawaii's Coordinating Group on Alien Pest Species (CGAPS) and appropriate State personnel, and posted on the Hawaii Ant Group website to facilitate sharing of the information with others.

Milestones: Completion of list of constraints; completion of recommendations; completion of task summary; delivery of task recommendations to CGAPS and posting of the summary on the Hawaii Ant Group website.

Deliverable: Completion of task summary, including alternative policy recommendations.

Dates: July 1'01 – June 30'03 **Funds:** EPA = \$0; Matching = \$25,000

8. Schedule:

July 1, 2001	outreach coordinator begins work; computer modeler begins work; Hawaii Dept of Agriculture personnel begin work on policy assessment
Jul 15	procurement of climate data for modeling RIFA range limits;
Jul 30	completion of preliminary climate data processing for modeling RIFA range limits
Aug 15	completion of RIFA range limit model results
Aug 31	completion of GIS map of RIFA range limit model results, and posting of map on web; identification of groups to be targeted for outreach activities
Sep 1	economist begins work
Oct 15	submit 1 st quarterly report; completion of list identifying all sectors/areas likely to suffer economic impacts if RIFA invades
Nov 15	completion of research plan and methodology for economic assessment
Jan 15, 2002	Submit 2 nd quarterly report
Apr 15	Submit 3 rd quarterly report; completion of economic assessment data collection
Jul 1	completion of list of policy constraints; completion of economic assessment data analysis
Jul 15	submit 4 th quarterly report
Aug 30	completion of final written economic assessment, and posting on the web
Oct 15	submit 5 th quarterly report
Jan 15, 2003	submit 6 th quarterly report
Apr 15	submit 7 th quarterly report
Jun 1	completion of policy recommendations
Jul 15	submit final quarterly report; completion of policy assessment task and posting of it on the web

9. Budget: (see attached table)

10. Readiness: Upon receipt of EPA funding, work will commence on most tasks: an outreach coordinator is clearly available, currently working on invasive ant research, planning and outreach in Hawaii; a professor of economics at University of Hawaii has agreed to solicit for a post-doctoral position (under his guidance) to begin work on the economic assessment in the beginning of the next academic year (fall 2001); a computer modeler (who is familiar with the RIFA range prediction model to be used) is available to initiate work on task 3; the Hawaii Department of Agriculture has personnel-time available to initiate the policy assessment; the Hawaii Ant Group (an interagency working group who will be involved in most tasks) is well established, meets regularly and will provide guidance in all tasks, and their web site - URL: hbs.bishopmuseum.org/ants/ - is available to offer public access to information.

11. Support for the project: This project has the support of the Hawaii Department of Agriculture (primary organization responsible for preventing establishment of new pests in Hawaii, and for regulation of pesticide use), Hawaii Department of Health, Hawaii Department of Transportation, Hawaii Department of Land and Natural Resources, U.S. Fish and Wildlife Service, National Park Service, Bishop Museum, The Nature Conservancy, University of Hawaii Social Science Research Institute, Maui Invasive Species Committee, the Hawaii Tourism Authority, the Hawaii Cattlemen's Council, the Hawaii Farm Bureau Federation, the Humane Society, and the State's Cooperative Group on Alien Pest Species (a multi-agency partnership to coordinate more effective protection for Hawaii's economy, environment, health, and way of life from harmful alien pests - see URL: www.hear.org/cgaps/cgaps.htm).

12. Relation to existing state wetland conservation plan: Although no State of Hawaii wetlands conservation or watershed plan has been completed, Hawaii's recently developed Wetland Management Policy states that improving wetland management can be achieved by improving public awareness and inter-agency coordination. A major component of this project consists of developing public awareness of the RIFA threat and participation in early detection, and developing and coordinating responsibilities amongst various state, federal, and private agencies/organizations to prevent RIFA from establishing in Hawaii and contributing to wetland habitat loss/degradation. Also, this project helps to achieve one of the policy's stated goals: to "promote the preservation, conservation, restoration, and creation of wetlands", in which "creation of methods to adequately prevent loss of wetlands" is included. This project offers to strengthen proactive methods (i.e. prevention/rapid response plan) to prevent loss of wetland habitat suitable for endangered wetland birds. In addition, expanding public education/awareness, and involvement in an early warning system, over the broader community helps to achieve another of the policies stated goals: to "improve public participation in the wetland management process."

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