# AN ALLIANCE OF BIODIVERSITY, AGRICULTURE, HEALTH, AND BUSINESS INTERESTS FOR IMPROVED ALIEN SPECIES MANAGEMENT IN HAWAII

Alan Holt, The Nature Conservancy of Hawaii
1116 Smith Street, Suite 201
Honolulu, Hawaii 96817

**Abstract:**

Hawaii is in the midst of an invasive species crisis affecting the archipelago's highly-endemic biota, overall environmental and human health, and the viability of its tourism- and agriculture-based economy. Each year, an average of 20 alien invertebrates become newly established in the islands, compared to an estimated natural colonization rate of one new invertebrate every 50-100,000 years. Half of these alien invertebrates are known pests. More than one third of the threatened and endangered plants and birds in the United States live only in Hawaii. The primary threat to these taxa is from invasive species. The islands remain free of venomous snakes, most biting insects, and many diseases because of a long-established quarantine program, but this status is threatened by potential invasions of the brown tree snake, biting midges, mosquitoes and other pests via the large and expanding international traffic utilizing Hawaiian ports.

A special alliance of biodiversity, agriculture, health, and business interests is emerging which has the potential to address this pest crisis. The Hawaii alliance has focused on the early formation of partnerships among parties regarded as key to any successful pest management program and on assessing the full cost of the impact of alien pests on the Hawaiian economy. The group is conducting a major public awareness campaign to build political support for new tools needed to stem the flow of new invasives and more effectively control those that enter the islands. The most serious need is for tools which help target problem species, especially in the form of pest risk assessment to identify potential pests, sampling systems to identify and monitor "leaks" in port-of-entry inspections, and surveillance to detect newly-established pests while eradication or containment is still possible. The Hawaii program may serve as a useful test of these or other elements of any proposed global strategy for invasive species management.

## Introduction

The Hawaiian Islands are in the midst of an invasive species crisis affecting the archipelago's highly-endemic biota, overall environmental and human health, and the viability of its tourism- and agriculture-based economy. This crisis is occurring in spite of the fact that Hawaii has one of the world's longest-standing and most comprehensive quarantine systems. This paper briefly describes the nature and extent of the alien species threat in Hawaii, the strategy currently underway to address it, and some of the main improvements needed in the Hawaiian pest prevention and control systems.

## The Impact of Alien Species in Hawaii

Two major factors have combined to bring about Hawaii's alien species crisis.

First, the archipelago offers an extraordinarily wide range of environments to potential invaders, as well as relatively mild competition for these habitats from native organisms. Before the arrival of humans some 1500 years ago, Hawaii's isolation in the middle of the Pacific Ocean severely limited the rate of colonization by plants and animals, as well as the kind of colonists that could cross 2000 miles (3200 km) of salt water. As a result, Hawaii's native biota is famous both for its unequaled levels of endemism, and for its complete lack of terrestrial reptiles, amphibians, many major invertebrate groups including social Hymenoptera (e.g., ants and wasps), and virtual absence of terrestrial mammals (certainly one and possibly two species of bats are the only native land mammals). These native taxa once occupied and, in about one quarter of the archipelago's land area, still occupy habitats ranging in elevation from sea level to nearly 14,000 feet (4270 m), in rainfall from 10 inches (25 cm) per year to over 500 inches (1270 cm), and in substrates from newly erupted lava and cinders to highly-weathered wet clays (HDLNR [1], USFWS and TNCH 1992). Any colonizing species that survived the ocean crossing to become established in Hawaii found a range of climates, fertile soils, relatively few competitors, and fewer diseases or predators than in most continental settings. Today, invading alien species benefit from the same favorable conditions.

The second major factor in Hawaii's alien species crisis is the breakdown of the extreme isolation once provided by the Pacific Ocean. Hawaii is the primary shipping link between North American, Asian, and other Pacific Rim ports, handling nearly 19 million tons of shipped cargo each year (HDOT 1994). Honolulu International is the 17th busiest airport in the world, averaging one arriving flight every 1.3 minutes, and carrying 7 million tourists to the islands each year. Hawaii itself is reliant on these links; over 80% of the goods consumed in Hawaii are imported. Inevitably, however, cargo shipments, passenger flights, military transports, mail, and other traffic entering Hawaii bring with them living plants, animals, and microbes that would have been unable to reach the islands on their own. Figure 1 summarizes data for alien invertebrates intercepted at Hawaii ports of entry in 1994.

[1] Acronyms, see attached list.

The negative impact of alien pests has increased continually since first European contact with the islands in 1778, and is very serious today.

Alien species are the chief threat to Hawaii's native biota, including an estimated 10,000 endemic life forms. Native habitats are threatened by alien ungulates such as pigs, goats, and deer that destroy vegetation, accelerate soil erosion, and facilitate the spread of alien weeds and insects. Our native birds suffer from introduced predators, loss of habitat to feral ungulates, and alien diseases spread by alien mosquitoes. Hawaii is now home to 38% of the United States' threatened and endangered plants and 41% of its endangered birds, in spite of the fact that these islands make up only 0.2% of the nation's land area (HDLNR, USFWS and TNCH 1992). For more than 95% of these 282 imperiled Hawaiian species, alien competitors, diseases, or predators are a primary threat.

Hawaii's agricultural sector, the third largest revenue producer behind tourism and military spending, estimates it is losing $300 million per year in revenue from potential markets that now refuse Hawaii exports because of alien fruit flies that infest many island crops. Sugarcane and pineapple, the long-standing forces of Hawaiian plantation agriculture, are rapidly scaling down, creating an opportunity and a need for crop diversification. Many of Hawaii's most promising crops, however, are struggling under a siege of alien pests. In recent years these have included the papaya ringspot virus, banana bunchytop disease, bacterial blight of anthuriums and others. Each year, an average of 20 new alien invertebrates become established in the islands (Beardsley 1979). This is a rate of one successful colonization every 18 days, compared to the estimated natural rate of once every 25-100,000 years (Zimmerman 1970). Moreover, in the average year, half of the newly established invertebrates are taxa with known pest potential.

A single alien pest that entered the islands in the early 1800's--the Formosan subterranean termite--now causes nearly $150 million in treatment and damage repair costs annually, most of which is paid by private homeowners (Tamashiro et al. 1990). By comparison, the combined budget of all government pest prevention programs in Hawaii is only $25 million (TNCH and NRDC 1992).

Hawaii's $18.9 billion visitor industry and island residents are increasingly concerned about new pests which threaten to invade. Hawaii has no snakes (except the harmless blind snake, introduced from the orient), no malaria, rabies, or dengue fever, and few biting insects; these facts are a large part of what makes Hawaii such a pleasant place to live or visit. The interception of brown tree snakes (*Boiga irregularis*) in Hawaii on six occasions since 1971, however, has made Hawaii's people extremely concerned (see Table 1). Brown tree snakes intercepted in Hawaii have been on aircraft or in cargo from Guam. Experts do not believe this snake is established in Hawaii at the present time. However, the risk of snake invasion, as well as recent interceptions of imported piranhas (*Serrasalmus* spp.), red fire ants (*Solenopsis invicta*), and emperor scorpions (*Heterometrus* sp.) in mail parcels have created increasing concerns regarding the threat of alien species to human health and safety and the overall quality of life in Hawaii.

| Table 1 - Impacts of the Brown Tree Snake on Guam |
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| · Over 200 snakebite victims, 84% bitten while sleeping |
| · Power outages average once every four days |
| · Virtually all birdlife destroyed |
| · 9 endemic birds extinct in the wild |

(Source: Fritts et al. 1995)

## Current Pest Prevention Systems

Hawaii has been actively involved in alien pest prevention since 1888, when King David Kalakaua declared a quarantine on imported coffee to prevent the introduction of coffee rust and other diseases. Today, more than 20 state, federal, and private organizations and a number of volunteer groups dedicate a major part of their resources to designing, implementing, and improving alien pest prevention and control programs (TNCH and NRDC 1992). The primary prevention agencies are the state and federal departments of agriculture. In general, federal agencies in Hawaii are concerned with preventing the introduction of noxious pests into the U.S. from foreign sources and preventing pests established in Hawaii from reaching the U.S. mainland. The primary task of the U.S. Department of Agriculture's inspection branch in Hawaii is to prevent the spread of Mediterranean and other fruit flies to major U.S. agricultural areas by inspecting passengers and flights leaving Hawaii for mainland destinations. The State Department of Agriculture, meanwhile, is mandated to protect Hawaii against pests from both domestic U.S. and foreign sources. Although state and federal agencies support each other to some extent in these inspections, the lists of restricted pests for which each agency has the authority to inspect differ dramatically, placing major limits on the sharing of inspection duties. Hawaii's list of prohibited or restricted taxa is longer than the federal list and includes vertebrates for which USDA has no inspection authority. State resources for inspection, however, do not reflect this broader inspection mandate. In 1992, federal agricultural inspection staff was double the size of the state's counterpart agency (TNCH and NRDC 1992).

The control of established or newly escaped pests in Hawaii is primarily the responsibility of the state government, although federal agencies carry out pest control operations on federal lands, enforce endangered species laws, and carry out research to improve control methods. Private and non-governmental organizations are also actively involved in pest research and control. Hawaii has been a center for biological control research focused mostly on agriculture, and is actively engaged in the management of invasions for the protection of biodiversity. Over 75% of the management costs at Hawaii's national, state, and private nature reserves are for alien species control.

## Strategy for Improving Hawaii's Protection Against Harmful Alien Species

The current effort to strengthen Hawaii's quarantine systems has developed in three stages. During 1991 and 1992, two non-governmental organizations (The Nature Conservancy of Hawaii and the Natural Resources Defense Council) prepared a report entitled The Alien Pest Species Invasion in Hawaii: Background Study and Recommendations for Interagency Planning. This report describes the roles, legal mandates, and resources of each agency or organization involved in preventing pests from becoming established in Hawaii or in controlling established pests. It identifies at a general level the major problems in the current system, and recommends a process for developing plans to resolve these problems. The report highlighted two major needs above all others. First, it characterized the current system as "a set of programs that are generally effective within their own jurisdictions but which, together, leave many gaps and leaks for pest entry and establishment." The report called for a comprehensive pest management strategy linking the various players in a coordinated system. Second, it named strong public support and high-level political leadership as essential ingredients for success that, in 1992, did not exist. In preparing this report, the authors took special steps to work closely with the staff of the agencies whose work they were describing, in order to foster a constructive working relationship for future collaboration. For the public release of the document, key constituencies (e.g. the Hawaii Visitors Bureau, legislative leaders, agency heads) were briefed in advance and asked to prepare supporting statements for the media. The report was well received by the media and the community in general as a practical approach to an issue of real concern.

The 1992 background report set the stage for multi-agency development of an Alien Species Action Plan in 1993-94. This effort involved over 80 individuals from more than 40 government, non-profit, and private agencies, organizations, and businesses, who worked in professionally facilitated topic groups to prepare the plan. These topic groups submitted 34 more or less specific proposals for improvements to an oversight committee made up of leaders of key agencies and organizations. This committee then prepared the final plan, described as its commitment to "a first set of actions...to improve pest prevention and control for Hawaii." The Oversight Committee's first action was to re-form itself as a permanent Coordinating Group on Alien Pest Species (CGAPS). CGAPS' most important feature is the broad set of interests it represents beyond the expected state and federal quarantine agencies. These include the state transportation and health departments, the Hawaii Visitors Bureau, the Hawaii Farm Bureau Federation which also represents horticultural interests, the U.S. Postal Service, the military, and state, federal, and non-profit biodiversity conservation agencies. The group is "held together by the voluntary efforts and enlightened self-interest of its members rather than by any formal authority," although formal agreements may be desirable for certain joint programs. Its purpose is "to expedite communications, problem-solving, and decision-making for more effective implementation of pest prevention and control work." The group is administered by the Hawaii Department of Agriculture, with additional staff support from The Nature Conservancy, and has held half-day, quarterly meetings since January 1995.

During its first 18 months, CGAPS faced two significant challenges in becoming an effective, multi-agency team. First, the launch of CGAPS coincided with the sharpest cutbacks in government budgets since statehood. This heightened member interest in collaboration and

combining resources, but, more often, left key members with insufficient funding and personnel to pursue the desired alien species management actions. Second, many of the individuals sitting on CGAPS as agency representatives are unable to make major commitments for their agency. CGAPS can develop excellent strategies and resolve problems that require little new funding and no major legislative work. Major improvements, however, require political leadership of the highest level, and this depends upon widespread public support.

With this in mind, CGAPS launched a major public awareness campaign in late 1996. The campaign's centerpiece is a report entitled "The Silent Invasion" co-authored by all 14 CGAPS member agencies. The report is intended for elected officials and other community leaders, the media, and schoolteachers, and takes a bold approach to show how much Hawaii stands to lose from further pest introductions. It leads with the potential impacts on tourism, by far the state's leading industry, and describes the impact of pest species on people's lives. It includes culture as a potential victim of alien species invasion, and addresses the reader as an ally against this threat. The report provides the reader with the facts about why Hawaii is so vulnerable to invasion, and describes the main shortcomings in the current prevention system. It lays out a generalized 10-point plan that will serve as a framework for the many specific tasks needed to address the invasion problem. A goal in the campaign is to give the public a sense of the magnitude of the problem without leaving them feeling hopeless in the face of its complexity. For this reason, the report concludes with a list of the 10 Most Unwanted Pests, and a list of actions that every individual can take to reduce the chances that they or their friends and family will introduce a damaging pest species.

The campaign also includes lesson plans on alien pests for use by primary school teachers, an advertising campaign directed primarily at travelers, and polling to measure the effectiveness of the campaign in altering public knowledge and behavior. We will continue the highly successful Operation Miconia, a statewide media campaign to engage the public in locating and controlling *Miconia calvescens* (Melastomacae), a neotropical weed that has already overwhelmed major portions of Tahiti's native forests and which is now established on four Hawaiian islands. Other projects modeled after Operation Miconia will expand the opportunities for direct public involvement.

CGAPS is using the increased public awareness from this campaign to support specific alien species management legislative measures.

## Priorities for Improvement

The beginning of a major public awareness campaign brings all of CGAPS' members face to face with the obvious question: "What--specifically--do we want the public and our elected officials to do once they become aware of the magnitude of the alien species problem?" Like any highly complex problem, some parts of the solution are apparent and relatively simple while others are not yet clear even to the experts. More precisely, for the more difficult parts of the solution, the desired end result is clear but we cannot yet describe a practical approach for achieving it. This is also reflected in the SCOPE draft *A Global Strategy for Alien Invasive Species*, with its heavy

focus on problem assessment in Phase I of the proposed planning project. In Hawaii's case, however, we have chosen to organize CGAPS and undertake some specific improvements before the problem assessment phase is fully completed. We recognized in 1992 that the relevant agencies had neither the necessary analytical capacity for full problem assessment nor the political support to develop it at that time. We also recognized a widespread sense of hopelessness in most agencies about being able to do anything to reduce significantly the alien species problem, and felt we had to get started with simple tasks, register some victories and public enthusiasm, and build our combined strength and commitment for the tougher challenges. Operation Miconia, for example, was carried out in 1996 to test CGAPS' ability to enlist the community in a pest containment effort. The overwhelming positive response from all sectors of the community not only accelerated *Miconia* control statewide but gave CGAPS members a strong boost to undertake additional projects.

CGAPS regards the following as the areas most in need of improvement:

**Self-sustaining public education program**--We are convinced that our greatest opportunity for improved pest prevention lies in educating the public. CGAPS' goal is to establish a dedicated funding source for continuous, high-quality public education messages delivered through a wide range of vehicles (e.g., tourist information, in-flight print and video materials, baggage claim area signage, school curricula, etc.). We are investigating the use of commercial advertising associated with alien species prevention messages in airports and other public facilities; the commercial ads are intended to pay for the public education program. State regulations currently prohibit commercial advertising in most areas of the airport, and there are other legal complications to overcome.

**Developing the ability to inspect all pest pathways**--A large proportion of the total passenger, cargo, and other traffic entering Hawaii is currently uninspected, including materials known to be significant sources of new alien species. Domestic U.S. arrivals are very lightly inspected, and the state relies on voluntary declaration in order to foster a friendly, welcoming atmosphere for visitors. There are significant logistical and financial constraints on instituting mandatory domestic inspection, which would probably require pre-clearance of Hawaii-bound traffic at ports of origin to avoid redesign of Hawaii airports. State inspections are further hampered by the lack of x-ray equipment, and by questions about the state's legal authority to use x-ray to inspect baggage without probable cause. Moreover, some known pest pathways are legally protected against inspection. The U.S. First Class and air mails are common vehicles for transport of illegal animals and plants (TNCH and NRDC 1992). Both California and Hawaii are working now with the U.S. Postal Service to find a way to stop these pests without violating the Fourth Amendment of the U.S. Constitution which protects these classes of mail. Until a remedy is found, an inspector must either have the permission of the sender or recipient to open the package, or a warrant from a federal magistrate for each package, and must complete the inspection without delaying the mail. The best hope for near-term improvement is probably through education reinforced by strict prosecution of violators.

**Systems to monitor total pest traffic**--Neither the federal nor state inspection agencies maintain consistent protocols to monitor the total pest traffic through a particular pathway as a gauge on the effectiveness of quarantine programs. Those data which are collected on pest interceptions are not fully utilized to improve inspection efficacy due to the lack of personnel dedicated to data analysis. In some cases (e.g., state monitoring of domestic U.S. pathways), the ability of agencies to conduct monitoring is constrained by the same laws which constrain inspection (above). Quarantine agencies do not currently have the resources to investigate newly detected pests to determine how they entered the state in order to detect leaks in the prevention system. Until greater monitoring capacity is developed, our appeal to the public and elected officials for quarantine improvements will be negated by our inability to tell them how well we are doing with present resources (i.e., what percentage of the estimated total alien species traffic are we intercepting). Or worse, our only gauge on the effectiveness of quarantine systems will be the number of newly established pest species, most of which are detected only after they have caused significant damage. The U.S. Department of Agriculture Animal and Plant Health Inspection Service initiated a sampling and data analysis program in 1997 to begin to fill this monitoring gap.

**Technical support and timely processing of import permit review decisions**--Although the Hawaii Department of Agriculture has the most comprehensive regulations in the U.S. for review of animal, plant, and microorganism imports (OTA 1993), the expert committees that recommend permit decisions to the Board of Agriculture lack ready access to information relevant to assessing the subject taxon's disruptive potential. Decision-making is an inconsistent and time-consuming process because of this, and is made worse by state legal requirements for multiple reviews and public hearings that bring the standard processing time for many permits to over 12 months.

**Early detection and eradication of new pest infestations**--This is the most neglected phase of the invasion process, in that virtually all pest management effort is directed at port-of-entry inspections and the control of widespread pests (TNCH and NRDC 1992). The U.S. Geological Survey's Biological Resource Division and others in Hawaii are now working on a prototype database to organize information from diverse sources on established pests. One application of these data will be to identify infestations that may be vulnerable to containment or eradication on a statewide, whole-island, or island region scale. These will be identified first for plants, and presented to weed control agencies in an attempt to organize range-wide containment or eradication projects. Remote sensing and other survey methods will have to be improved in order to support these projects and strengthen our ability to detect new pests.

In addition to range and biology data, eradication of incipient invasions requires better training for managers in pest control strategies to maximize the chances for success. Too often, the initial treatment of an infestation is intense but short-lived, and without precautions to prevent reinfestation or spread to other sites through contaminated equipment. Most projects also lack the long-term follow-up to ensure complete eradication. A commitment to better training and planning is expected to improve the rate at which these projects succeed. Some Hawaii managers have suggested establishing a statewide team of pest control experts as trainers and information sources for natural area managers, much as the Cooperative Extension Service does for farmers. The Cooperative Extension Service and associated field agents from other agricultural agencies are the only team in Hawaii currently dedicated to early detection of pests, compilation of pest information, and dissemination of the best available control methods to field practitioners. Their approach needs to be applied to natural areas.

## Acronyms

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| HDLNR | Hawaii Department of Land and Natural Resources |
| USFWS | United States Fish & Wildlife Service |
| TNCH | The Nature Conservancy of Hawaii |
| HDOT | Hawaii Department of Transportation |
| USDA-APHIS | United States Department of Agriculture - Animal and Plant Health Inspection Service |
| HDOA | Hawaii Department of Agriculture |
| NRDC | Natural Resources Defense Council |
| CGAPS | Coordinating Group on Alien Pest Species |
| OTA | U.S. Congress Office of Technology Assessment |

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## Curriculum Vitae for Alan Holt
## Prepared for the Norway/UN Conference on Alien Species, July 1-5, 1996

Alan Holt is Deputy Director for the Hawaii programs of The Nature Conservancy, a non-profit organization dedicated to biodiversity protection through direct habitat protection and innovative partnerships with private landowners and government. Mr. Holt has directed the design and management of the organization's 22,000-acre Hawaii nature reserve system, and since 1992 has worked with agriculture, health, tourism, and biodiversity interests to stem the flow of new alien pest species into the Hawaiian islands. Mr. Holt is involved with The Nature Conservancy's strategic planning at the international level, and is a member of the IUCN Invasive Species Specialist Group.