

Plant Biocontrol Quarantine Facility At Hawaii Volcanoes

By Donald E. Gardner and Clifford W. Smith

Hawaii, perhaps the showcase of the effects of geographic isolation on evolution, has a native terrestrial flora and fauna, 95 percent of which is unique. Since the arrival of man, these unique plants and animals have been subjected to an array of pressures that they rarely, if ever, experienced previously, e.g. fire, habitat disturbance, mammalian herbivores, parasites and parasitoids, and weeds. Because of these pressures, Hawaii has the ignoble distinction of having the largest number of extinct and/or endangered animals and plants in the world after corrections for area and original numbers of species are considered.

Legal controls over importation of plants are weak. Imported plants are inspected for nematodes, insects, and diseases which may affect principal agricultural products, but not necessarily for their potential weediness.

The weed problem in native Hawaiian ecosystems is enormous. Approximately 6,000 seed plants presently are known from the Hawaiian Islands, but only 1,400 (23%) of these are native. A large percentage of the alien flora consists of horticultural plants. Another significant element is small herbaceous weeds. Many are cosmopolitan, and most are thought to have a very minor impact on ecosystems. But approximately 100 species are significant weeds in native ecosystems and, once established, may dominate the area. Some are capable of invading undisturbed habitat, but the majority require some change in the native ecological process before they can take hold. Most of the disturbances are themselves alien influences, but natural events, such as high winds and landslides, are common enough to provide footholds even in pristine environments.

Most of these weeds are beyond conventional control techniques. Handpulling, extremely labor intensive, is useful only in small areas for cosmetic or critical ecosystem management. The activity of the weeders themselves can have a detrimental effect.

Herbicide use is not favored for various reasons, some of them specific to Hawaii, where highly porous soils and frequently low microbial activity levels allow chemicals to percolate rapidly down to the water table.

The serious weed problems are not isolated. Many are the result of complex interactions between alien plants and vertebrates. Others create environmental situations that exacerbate previously inconsequential phenomena such as fire. Some change the status of soil-related factors or nutrients in the ecosystem. Most of these ancillary factors are not controllable for practical or political reasons. The plants themselves, therefore, become the primary focus of alien control strategies.

One of the most widely appealing solutions is the concept of biological control (biocontrol), the use of natural predators or parasites that were not introduced with the alien plant. This procedure, however, necessitates adding to the number of alien organisms by introducing biocontrol agents. It is imperative, therefore, to determine that these organisms will serve their intended purpose and not themselves become future problems.

The aggressiveness of an invading plant species in the new habitat is frequently uncharacteristic of its

behavior under native conditions. The goal of biocontrol is therefore to restore the mitigating agents – natural predators, parasites, and competitors – to the environment of the alien species. Although spectacular results, such as severe reduction or complete elimination of target species are sometimes obtained, biocontrol more frequently results in just a subtle reduction of the competitive edge of the target plants in favor of native species.

The modern practice of biocontrol of weeds in the U.S., and perhaps in the world, originated in Hawaii in 1902. Twenty-three species of insects were imported from Mexico by the Hawaii Board of Agriculture and Forestry to control lantana, an introduced ornamental that had escaped cultivation. Since that time, several additional plants and insect pests, which have threatened economic concerns, have been designated for biocontrol efforts in Hawaii. Biocontrol research of alien plants in natural systems conducted by NPS is a relatively recent expansion of the original agriculture-oriented concept. Whereas the screening process in the past has generally been limited to agricultural crops or ornamentals, the NPS program must also include native species.

The concept of biocontrol in natural areas remains controversial. Importation of organisms to Hawaii is under the legal jurisdiction of the State Department of Agriculture. Perhaps because there is not a significant forest industry in the islands (koa timber is marginal), the state has until recently given little attention to forest weeds.

Some of the most serious alien plant infestations in Hawaii's national parks, however, have become of concern not only to NPS managers, but also to other federal and state land managing agencies. Because of the wide variety of land management interests, a cooperative effort among five concerned agencies was established. The agreement delineates the five agencies' roles and responsibilities as follows:

NPS – construction and maintenance of the quarantine facility and provision of a research plant pathologist.

U.S. Forest Service – Provision of a research entomologist and furnishing certain facility equipment.

State Department of Land and Natural Resources – Foreign biocontrol exploratory work and steering committee chair.

State Department of Agriculture – Permit facilitation and coordination with other state programs.

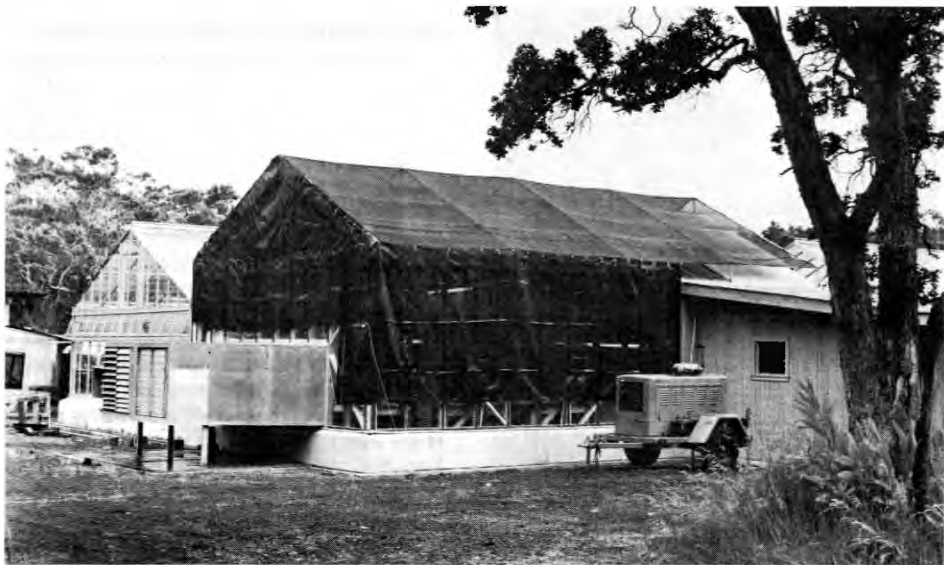
University of Hawaii – Post-release evaluations and use of library, laboratory, and similar facilities.

A steering committee, consisting of one representative from each agency, establishes priorities, monitors work progress, and coordinates the contributions of each agency. However, all importation and release permits continue exclusively under the control of the State Department of Agriculture, which establishes advisory committees to consider each permit request on an individual basis.

The current top-priority alien plant targeted for
(Continued on next page)



Inside the NPS quarantine facility, double thicknesses of 100-mesh stainless steel screen cover the panels on either end where air enters and exits the facility. All photos by Dina Kageler.



NPS quarantine facility at Hawaii Volcanoes National Park is designed as a greenhouse with natural sunlight and cooled by moving outside air through the secure area with large fans. The picture shadecloth is used in the summer to help control the inside temperature.

(Continued from previous page)

biocontrol is the banana poka vine (*Passiflora mollissima*), native to Columbia, Ecuador, and Peru and probably introduced to Hawaii as an ornamental. The plant produces large, showy pink flowers and juicy, yellow oblong fruit superficially resembling a banana. In Hawaii, feral pigs, themselves a serious alien problem, consume the fruit and carry the still-viable seeds in their digestive tracts throughout the forest. Alien fruit-eating birds also may aid in seed dispersal. Banana poka vines smother forest plants with dense mats of foliage in much the same manner as kudzu in forests of the southeastern U.S.

Exploration in the native countries of banana poka for potential control agents is currently underway through the cooperative agreement, with exploratory entomologists and plant pathologists from the University of Hawaii and the U.S. Department of Agriculture Biological Control of Weeds Laboratory in Albany, California. The U.S. Forest Service entomologist, duty stationed at the recently completed NPS quarantine facility in Hawaii Volcanoes National Park (HAVO), is designated as the quarantine officer. He is responsible for receiving and testing insects collected on banana poka and related plants in the countries of origin. The insects are tested for their effectiveness against target plants as well as for their host specificity. Insects that are destructive to plants of the target species but that may also attack other plants are not suitable, since they may become pests on desirable plant species. All host preference and other testing must be conducted under strict quarantine to prevent premature release of alien insects.



The banana poka vine, native to Columbia, Ecuador, and Peru, smothers Hawaii's native forest plants with dense mats of foliage, much as does kudzu in forests of the southeastern United States.

There are few laboratories in the U.S. certified by state departments of agriculture and the USDA Animal and Plant Health Inspection Service as adequately secure for introduction and maintenance of foreign insects. Many of the insect quarantine facilities which do exist are completely enclosed, artificially lighted and temperature-controlled. The HAVO facility is unusual in that it is designed as a greenhouse with natural sunlight and cooled by movement of large volumes of outside air with fans through the secure area. Double thicknesses of 100-mesh stainless steel screen cover the panels on either end where air enters and exits the facility. Means to suspend shade cloth above the surface also are provided to aid in cooling as needed.

The Hawaii State Department of Agriculture's quarantine facility is located at sea level in Honolulu, an elevation at which banana poka will not grow under natural conditions. Since the target plants mostly occur above 3,000 ft. (920 m), a lowland facility would not serve the intended purpose.

The HAVO quarantine greenhouse is constructed with transparent Lexan Margard polycarbonate, an extremely strong and durable material with the light transmittance qualities of clear glass. All joints and seams are caulked and sealed to be insect-proof, and the facility is provided with three heavy, refrigerator-type sealing doors in sequence, which open into two black anterooms through which one must pass to enter and exist the facility. Light traps in the anterooms attract any stray insects, and the doors are provided with warning mechanisms to prevent more than one door from being opened at once. A large steam sterilizer with a door at each end is mounted through the outside wall of the insect receiving room so that all biological and other material used in the facility may be passed through it prior to being removed from quarantine. The insects themselves are confined on plants in cages or in incubators within the larger greenhouse area. Any escaped insect is promptly retrieved. Non-secure conventional greenhouse sections adjacent to the quarantine structure itself provide space for cultivating plants used in the biocontrol program.

The design and operation of HAVO's facility had little precedent. It was decided that a section of an existing conventional greenhouse, measuring 31 x 22 ft., could more feasibly be converted into an insect-secure structure than an entirely new building could be constructed. Furthermore, it was desirable to maintain as nearly as possible natural, rather than artificial lighting and temperature conditions for host plant growth and insect activity typical of the environment where target plant infestations occur. Of major concern was the capability of fans alone to provide outside temperatures inside, and at the same time maintain insect-security. Our experience since completion and inspection of the facility indicates that satisfactory temperatures can be maintained, aided by the use of shade cloth.

Because of the ventilation system and the use of screens to prevent escape of insects, the facility is only suitable for biocontrol work with entomological agents rather than plant disease organisms. Testing of the latter agents, many of which are microscopic fungi that produce airborne spores, must be conducted in other facilities designed to contain these microorganisms.

Gardner is an NPS Research Scientist and Smith is an Associate Professor of Botany at the University of Hawaii; both are located at the University of Hawaii NPS CPSU, of which Smith is Director.