

Weed Risk Assessment and Prevention in Hawaii: Status and Practicalities

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ABSTRACT

Few efforts at weed risk assessment in Hawaii have been undertaken; several of those efforts are described here, and their degrees of success discussed. A number of federal, state, private, and multi-agency organizations have interests in the negative effects of alien species invasions in Hawaii, and may benefit from better weed risk assessment protocols. Weed risk assessment is discussed with respect to its applicability in Hawaii. Economic, political, and other practical aspects of alien species problems are addressed. Finally, issues are addressed which are deemed necessary to progress in the battle against problems caused by invasive alien species in Hawaii.

WEEDS AND HAWAII

When one thinks of Hawaii, the ideas that may come to mind include a tropical vacation paradise, a world-renowned center for endemism, "the extinction capital of the U.S.", or a mecca (or potential mecca) for nearly every weed on earth. Hawaii fits all these descriptions; the reasons for Hawaii fitting into each of these categories are interrelated, and relevant to Hawaii's alien species concerns.

The Hawaiian Islands (USA) are much more vulnerable to invasive alien species than most locations within continental United States. Hawaii is one of the most geographically isolated island groups in the world, the main islands being over 3000 kilometers (approximately 2000 miles) distant in any direction from a continental landmass, and about as far from any other high island group. Hawaii's topography and climate combine to form a landscape where almost all the major climate zones of the world occur within a few dozen kilometers of each other, including extensive areas of fairly mild climate. Therefore, virtually any species with any invasive potential at all is likely to find a place to thrive in Hawaii. Furthermore, upon its arrival into Hawaii, such a species' "ideal location" will not be far from its port of entry. This means that Hawaii should be wary of any species that has exhibited invasive qualities anywhere else in the world: the set of species that are potentially harmful to Hawaii is a superset of all the world's weeds! Some species exhibit invasive behavior in Hawaii that has not been observed anywhere else.

With only two-tenths of one percent (0.2%) of the land mass of the United States, Hawaii has 35% of the endangered species in the U.S., and invasive alien species pose the primary threats to most of them. Hawaii also has large near-pristine natural areas, mostly at high elevation, and much potential for restoration of

degraded areas, all of which are potentially at risk from IAS. Alien species such as Koster's curse (*Clidemia hirta* D. Don [*Melastomataceae*]), strawberry guava (*Psidium cattleianum* Sabine [*Myrtaceae*]), and gingers (e.g. *Hedychium gardnerianum* J. König [*Zingiberaceae*]) have drastically affected Hawaii's natural areas, and will continue to do so. Others, such as miconia (*Miconia calvescens* DC [*Melastomataceae*]), threaten to do so as well, but have barely even begun to demonstrate their destructive potential. Introduced fruit flies have had severe economic impacts on Hawaii, eliminating the domestic and international export markets for most fresh produce from Hawaii due to sanctions against Hawaii because of these introduced pests. As a result of the potential of contaminating mainland agricultural interests with problem species from Hawaii, Hawaii is the only state subject to a federal agricultural quarantine that includes comprehensive federal inspection activities. Some alien species currently not present in Hawaii--such as biting sandflies and brown tree snakes--have implications on economic, health, and quality-of-life issues, as well as threatening native Hawaiian ecosystems. Because so much is at stake, there is momentum in Hawaii by a developing alliance of biodiversity, agriculture, health, and business interests to address invasive alien species problems.

WEED RISK ASSESSMENT IN HAWAII: STATUS

There has been very little done regarding weed risk assessment in Hawaii. In the past few years, however, there has been increased interest in this area. There are substantial research budget requests pending from at least one federal agency in Hawaii for fiscal year 2000.

Dr. Sarah Reichard has done some work regarding the potential invasiveness of certain woody plants in Hawaii. Although we have not yet seen the final report from that project, our understanding is that the results indicate that there is no better set of indicators of potential invasiveness of the species examined than can be predicted by asking the question, "Has this species shown invasive qualities elsewhere?"

In 1996, the Hawaiian Ecosystems at Risk project (HEAR) organized an interagency "Alien Plants Working Group" with the intention of creating a compendium of information of plant species already in the state to be used to prioritize control and/or eradication strategies within the state. This wide-ranging group, comprising experts on the flora of each Hawaiian islands, used a "seat-of-the-pants" approach, calling on the unpublished personal knowledge of the experts, in addition to information available in published sources. The group, working within a framework of somewhat-subjectively defined terms of reference, met several times to develop and refine ideas relating to the topic at hand. The consensus of the group was that the majority of cases an island-based approach made the most sense (i.e. prioritization of actions should occur on an island-by-island basis, depending on which species occurred on each island, and the relative degree of infestation of each species on each island). If a species was considered eradicable on all islands on which it was known to occur, this fact would contribute to "high priority" consideration for action, since a one-time effort could eliminate the need for long-term future control efforts. It was hoped that the list could be used for statewide priority-setting, as well as at the individual island level. The final product of the group was the HEAR "Island Matrix". A species was selected for inclusion in the exercise if it was considered to be "controllable" on at least one island by at least one knowledgeable person in the group. The Island Matrix is a database with a spreadsheet-like grid as one major output, showing the status--controllable, uncontrollable, not known to be present--of each selected species on each major island (based on "conservative" expert opinion). (Island Matrix data and documentation is available online at <http://www.hear.org/matrix>.) A comprehensive prioritization rationale was never actually agreed upon.

Some computer-based modelling approaches were considered by the HEAR Alien Plants Working Group (e.g. using reproductive, habitat, and other characteristics as factors) to attempt to help prioritize actions,

particularly for species about which little was known. (Note that these models were NOT meant to be used for screening of species not yet in the state, but for prioritization of actions for already-established species.) It was decided that any such model--in order to be considered valid--should be able to produce results that seemed reasonable to the group (i.e. to show that the species that were already known to be "very bad" fell into this category based on the model's results). Additionally, in order for the model to be robust enough to be useful, it would have to be able to work with a fairly small amount of reasonably-obtainable data, realizing that in some cases complete information would be unavailable. No model presented to the group--nor other models which were considered later by HEAR--met these criteria adequately so as to be considered particularly useful for the intended purpose.

HEAR recently produced a document entitled "Prototype tools for risk assessment of alien plant invasions in Hawaii". Notably, this report includes a draft version of what is known locally as the "HEAR climate model". This model incorporates climatic information and worldwide occurrence data for plant species to be analyzed in a map-based geographic information system (GIS). The climate zones in Hawaii were classified based on "Holdridge life zones" in order to be able to use global occurrence data (since the entire world has been mapped into "Holdridge life zones"). Documentation for this model is available online (<http://www.hear.org/climatemodel>), and the complete software system is available on request from HEAR. Additional work needs to be done with this model--e.g. case studies--in order to validate the model and potentially enhance its usefulness.

In September 1998, the Maui Invasive Species Committee (MISC; described later in this paper) sponsored a 2-day workshop to create lists of top-priority species (plants and vertebrates) which the committee would like to see targeted for eradication (on one or more islands in Maui County). This was, again, an "expert-based" selection process (versus a process using a specific multifactored set of criteria). The group was quite satisfied with the results of this approach. It seems that it would be difficult to create any other system of prioritization which would make results quite so achievable, or for that matter, any more relevant. (It is acknowledged that the set of species considered was somewhat self-limiting, because one of the criteria considered was that the species must have been considered eradicable [not just "controllable"] on the island in question. This is a fairly small set of species, since most species which are present and known/thought to be invasive have already spread past the point of being considered feasibly eradicable.) This approach, though perhaps far from "scientific", seems to have produced the most useful results of any weed risk assessment technique used in Hawaii to date.

Regarding prediction of invasive potential of plants in Hawaii, the general consensus among interested parties in the state seems to be that if a species has exhibited an invasive or otherwise character anywhere else in the world, it should be viewed a potential problem in Hawaii. Additionally, it is realized that there are many other plant species which could prove to be problematic in Hawaii (e.g. particularly species related to known "problem species"), even though they may not be known to be invasive or harmful elsewhere (e.g. there are approximately 1000 neotropical species in the genus *Miconia*; many of them have weedy tendencies in their native habitats, invading disturbed areas). However, there is not (yet?) any commonly-accepted objective protocol which justifies this stance as it may be practically applied at a species-by-species level.

There are several organizations in Hawaii which seem to be particularly interested in the problem of weed risk assessment in the state. These organizations include the Pacific Islands Ecosystem Research Center (U.S. Geological Survey, Biological Resources Division: USGS/BRD/PIERC), under whose auspices falls HEAR; certain factions of the Hawaii Department of Land and Natural Resources and the Hawaii Department of Agriculture [HDOA]; the National Park Service; The Nature Conservancy of Hawaii; and several interagency groups, including the Coordinating Group on Alien Pest Species (CGAPS) and the Maui Invasive Species

Committee (MISC). Future commitment to further research into the issue of weed risk assessment in Hawaii is evident, particularly in the case of USGS/BRD/PIERC.

The Coordinating Group on Alien Pest Species (CGAPS) is a multi-agency partnership to coordinate more effective protection for Hawaii's economy, environment, health, and way of life from harmful alien pests. The purpose of the formation of CGAPS (1995) was to improve communication, coordination, and cooperation among top-level officials of various agencies with legal and/or land-care authority whose jurisdictions or charges could affect or be affected by alien species issues in the state. CGAPS meets regularly and addresses issues of concern to the member agencies, in addition to supporting other multi-agency groups in the state (such as MISC/MAC [see below]) and providing educational materials (such as their high-quality booklet "The Silent Invasion"). (A membership list and contact information are available online at <http://www.hear.org/cgaps>.)

There are several other interagency groups in Hawaii addressing alien species issues with more "grass-roots" origins (so to speak). All these groups are modelled, to some extent, after the Melastome Action Committee (MAC), formed on Maui in 1991 in an effort to coordinate efforts against the spread on that island of miconia (*Miconia calvescens*) and other melastomes. MAC has had amazing success at getting funding from local (county), state, and federal sources, and using this funding in a highly successful campaign to reduce the threat of miconia to Maui.

In late 1997, MAC members decided to expand the scope of concern to include efforts against other incipient species on Maui, and created the Maui Invasive Species Committee (MISC) (of which MAC is now a subcommittee). MISC is the best-developed committee of its type in the state. MISC is a voluntary partnership of over a dozen private, government, and nonprofit organizations to prevent new pest species from becoming established in Maui County (the islands of Maui, Molokai, and Lanai), and to stop newly established pests from spreading whenever possible. MISC works to enhance the effectiveness of pest prevention and control through communication and coordinated planning. 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, MISC serves as a coordinating body and advisor for other organizations seeking assistance in prioritizing and implementing effective pest prevention measures. Any successes of MISC can be directly attributed to the interest and activities of the individuals who choose to participate.

Efforts at effecting commitments from MISC member agencies for on-the-ground personnel to attack important infestations have been fairly unsuccessful. However, this is largely because the nature of the problem is such that such activities are usually outside the area of responsibility of any single member organization (often because of land ownership issues and/or jurisdictional limitations). It is recognized that there needs to be a separate group whose sole mission and responsibility is to pursue eradication of MISC's priority species (i.e. those species selected at the September 1998 workshop). MISC's greatest success to date is its members' cooperative production of several funding proposals to create such a group. These proposals are currently being submitted to various potential funding sources. (Additional information about MISC/MAC is available online at <http://www.hear.org/misc>.)

Other similar groups in Hawaii include the Big Island Melastome Action Committee (BIMAC; <http://www.hear.org/bimac>), and a group on Oahu whose initial target is fountaingrass (*Pennisetum setaceum* (Forssk.) Chiov. [*Poaceae*]). Both these groups have expressed interest in eventually expanding their scopes and are interested in MISC as a model organization.

Persistent strong interest in alien species risk assessment in Hawaii is evidenced by three of the top four priority USGS/BRD/PIERC budget requests for fiscal year 2000 being related to alien species impacts. Over \$1.5

million (U.S. dollars) are being requested for these proposed projects: "Assessment and prediction of alien plant invasions in Hawaii"; "Prediction of invasions of non-indigenous vertebrates into Pacific ecosystems and regional economics"; and "Development of decision support systems for the control of alien invertebrates in Hawaii".

WEED RISK ASSESSMENT IN HAWAII: PRACTICALITIES

It seems that there are two major subtopics under "weed risk assessment": assessment of risk of introduction of species that are not already present in an area, and prioritization of efforts regarding species which are already present in an area. Assessment techniques may be different for these two situations, because the goals of each process are different. The goal of risk assessment of a species not already present would be to predict what threats introduction of that species would have with respect to the perceived value of that introduction (i.e. in terms of the effects on economics, human health, quality of life, native ecosystems, etc.). Risk assessment of species that are already present could be done with respect to the cost effectiveness and/or feasibility of either control or eradication of that species from a specified geographic area.

Because of the presence of abrupt terrestrial boundaries, in island systems--particularly remote systems, such as Hawaii--the definition of "already present" is less vague than in continental areas. Populations in continental systems often have much less well-defined geographic barriers than island systems--particularly remote island systems like Hawaii. Transport of propagules between adjacent (or distant) areas in continental system is often much easier to achieve and more difficult to prevent (e.g. via overland vehicular travel).

In Hawaii, for practical purposes, the "already present" concept is broken down into "already present in the state" and "already present on a particular island". Strategies could effectively be developed for control or eradication not only at the state level (which might be more effective than the same strategies in continental areas), but also on an island-by-island basis, or even a regional basis (e.g. East Maui vs. West Maui). Of course, this is in addition to the possibility of targeting control of one or more invasive species in special ecological areas (plot-based rather than species-based approach).

The reason for pointing out the differences in the uses of weed risk assessment is to remind us to take note of our objectives when attempting to design weed risk assessment techniques or models. A risk assessment protocol designed to exclude species not already present in an area (state, island, country) may require different information for input and create a very different type of information than a risk assessment designed to help prioritize actions regarding species which are already present. Screening systems, such as those used by Australia and New Zealand for assessment of importation of "new" species, are good for that purpose, but may not contain adequate information to aid in "best use of resources" decisions to combat species already present. As obvious as this distinction sounds, it seems that the difference may not always have been recognized when grappling with these issues in Hawaii. It seems that useful screening protocols are perhaps easier to design, and seem to be more prevalent, than (useful) prioritization models. The "word of warning" is that using one type of model for purposes other than those for which it was intended is probably not a good idea.

Even if Hawaii had ideal weed risk assessment protocols in place, the potential for enforcement of decisions based on these protocols is extremely limited at this point. Currently, state regulations regarding importation of plant materials into Hawaii (domestic flights) are virtually all agriculture-based. With very few exceptions, these addressed by Hawaii's inadequate "noxious weed" laws, wildland weeds have been ignored from a regulatory standpoint. There is, therefore, basically an "open door" policy for importation of plants. Historically, this situation was probably created in part due to lack of awareness of the importance of the issue of

the effect of alien species on the natural environment. Recently, although there is increased awareness of these issues, the general political climate in Hawaii seems to be shifting to "economy first" (i.e. short-term economic growth), and thus everything else (e.g. and especially the environment) has lower (to no) priority. Financial support has been dwindling for those programs which already exist to protect even agricultural interests, i.e. staffing and funding for quarantine inspectors and other areas of the state Department of Agriculture. The inspection staff and facilities of the state are severely restricted, even compared to the federal inspection facilities (for outgoing domestic traffic), and inspection procedures and policies are woefully inadequate. To paraphrase an HDOA professional (who would prefer to remain anonymous), "It's amazing that anything gets caught at all [by the quarantine system]." Due to Americans' (over?)zealous belief in the sanctity of personal privacy, first class domestic mail cannot be reasonably inspected (e.g. x-rayed), so that is a wide-open loophole for anyone wanting to import illegal items (plant or animal), even if there were adequate state laws in place regarding imports. (State laws regarding importation of animals are much more restrictive than those regarding plants.) Obviously, development of weed risk assessment techniques would have to go hand-in-hand with political and legal reform in Hawaii before results would be very useful on a wide scale in the state. Perhaps the results of weed risk assessment protocols (regarding importation of plant species) could be the impetus for change in these policies.

Alien species issues are often very political in Hawaii. An example of this is the recent conflict and uproar in the state regarding attempts to restrict the export of the originally illegally-imported--but now "naturalized"--Jackson's chameleon. Because of the implication that short-term economic opportunities may be lost by restriction of introduction of "new" species, it is possible (and likely?) that there would be strong objections raised by certain agricultural industries to proposed rules to that end. One possible approach to prevention of such resistance is early education of the nursery and landscape industry. Such an approach is being tried by HEAR on Maui, in that an active role in the local landscape industry association is being taken.

Prevention of alien species introduction is a hot topic on the island of Maui now because of the proposed lengthening of the runway of the main (Kahului) airport. Such action would "pave the way" for internationalization of that airport. The National Park Service (among others) has contended that there are inadequate quarantine facilities at the airport to prevent the introduction of alien species from direct international flights which could disastrously affect the natural resources protected by the island's Haleakala National Park. This issue has forced re-evaluation of the project's Environmental Impact Statement and the measures necessary to mitigate the risks of additional alien species introductions to the island. This issue has attracted national attention, and may (hopefully) result in Maui getting a "model airport" with respect to quarantine measures in the event that the proposed expansion actually takes place.

The Hawaii Department of Agriculture is reportedly in process of revising its import rules. When this is officially announced, there will be a public comment period. This will be an opportunity for interested parties to (hopefully) effect positive changes to these rules. When public comments are accepted, it is planned that the recently-revised draft of the "IUCN Guidelines for the Prevention of Biodiversity Loss due to Biological Invasion" (from The World Conservation Union) will be presented to HDOA, and HDOA asked that compliance with the recommendations of this document be incorporated into their rules. Weed risk assessment ("risk analysis", in the words of the draft IUCN report) should be part of the proposed procedures. Appropriate assessment methods need to be developed for Hawaii and endorsed by HDOA.

To most effectively deal with the problems of alien species invasions in Hawaii, we need to ensure that our goals are clear, and that appropriate actions are taken to address the relevant issues. What can and should be done about excluding potential weeds that aren't yet present in the state, or on a particular island? What can and should be done to prioritize work on weeds that are here already? Which weeds show the greatest potential to

create problems? What kind of problems can/should we address? How do we assess when control and/or eradication is feasible? How do we get the financial resources to address these problems? And, how best (if at all) can weed risk assessment contribute to the answers to these questions?

Hawaii has unique problems regarding alien species introduction compared to U.S. mainland areas because of its geography (isolated islands), climate (highly varied and more tropical), and consequent high rate of endemism of its native flora; and because of the fact that it is highly trafficked (domestic and international tourism, military activities). It shares with other states--as well as other countries--problems of limited awareness and support of issues regarding alien species prevention and control, and therefore inadequate legal protection against threats posed by alien species invasions. Hawaii has a few advantages in this arena compared to continental areas, including the islands' isolation from adjacent terrestrial sources of alien species infestation, its small physical area, and the possibility to some extent of addressing alien species infestations on an island-by-island approach.

Adequately forwarding the cause of harm prevention by alien species in Hawaii will require a number of concurrent actions, many of which are difficult, time-consuming, and/or expensive, and all of which will require dedication on the part of those seeking to implement progress. Appropriate risk assessment protocols are needed, both for prevention of introduction of "new" harmful alien species, and prioritization of actions for incipient and already-present species. Success will require education of the public and our politicians on national, state, and local levels. Public support for appropriate personal and political actions must be elicited; the appropriate use of communications media will be critical to this mission. Particularly in these times of budgetary concerns, interagency cooperation will be crucial in order to achieve common goals. (Fortunately, we have evidence that this can be achieved, to at least some extent, on local and state levels.) Above all, personal commitment of dedicated individuals will be necessary in order to develop protocols for, and act on the results of, weed risk assessment in Hawaii.