Non-native Plant Species in Hawaii: The Effects of Seed Dispersal Methods on the Likelihood of a Plant Becoming Invasive and its Relevance to Prevention Efforts

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Fall 2013

Hokule 'a National Environmental Issues

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Abstract

While many plant species are often unintentionally introduced by humans into an area where they did not naturally evolve, many non-native species become interwoven into agriculture and horticulture. When these plants escape cultivation they have the potential to become invasive, which can result in both serious environmental and economic consequences. Federal and State initiatives have been put in place to hinder the introduction and spread of invasive species; however the programs have loopholes and are underfunded. Therefore, it would be beneficial to identify a way that requires fewer resources to distinguish which species pose higher risks of becoming invasive. In a case study in Hawaii, this paper investigates whether there is a connection between the method of seed dispersal and the plant's likelihood of becoming invasive. Each method of seed dispersal (wind, water, gravity, mechanical/ballistic methods, and animals/birds) has its own niche for reproduction, but human intervention has allowed these methods to surpass previous limits and added another dimension to the invasive species issue. The results found that there is not a connection between the method of seed dispersal and the plant's likelihood of becoming invasive. However, if other factors were explored in the future and a key indicators were identified, that would be a significant step in combating the invasive species issue.

Introduction

A non-native plant, also known as an alien or exotic plant, is a species that was introduced by humans into an area where it did not naturally evolve. If this species is able to naturalize, meaning it can sustain itself without cultivation, it then has the potential of becoming invasive and poses a threat to the integrity of its plant community. While many non-

native plant species are often unintentionally introduced, many species are economically vital to agriculture and horticulture (Singeo, et al). Therefore, their introductions and cultivation are continued. When these non-native plants escape cultivation there can be both serious environmental and economic consequences. This research paper aims to expand on these consequences and investigate whether a plant's method of seed dispersal could be used to identify which species are more likely to become invasive. Additionally, this paper explores how that information could improve current invasive species policies.

Background: Costs and Benefits of Invasive Plants

The introduction of invasive plant species into an ecosystem can severely alter its natural habitat and biodiversity. Invasive species are listed by The Convention on Biological Diversity as one of the leading pressures of biodiversity loss (CBD). Invasive species crowd a habitat and can out-compete native species. This leads to a decline in the number of native plant individuals in that habitat and potentially the extinction of native plant species. While invasive species can thrive in the same locations as native species, they do not always fill the same niches as the native plants that they are driving out. Therefore, there will be missing members of water, nutrient, and energy cycles, causing the ecosystem to be fundamentally altered (GEG Project). In Hawaii, the spread of invasive strawberry guava, *Psidium cattleianum,* exemplifies these impacts. Strawberry guava plants have been shown to lose almost a third more water during evapotranspiration than native Hawaiian plants. As a result, in areas where strawberry guava is present, less freshwater is stored in aquifers and there are increased levels of erosion (Leveling the Playing Field).

The alteration of an ecosystem can result in both direct and indirect economic costs. Direct costs would include money spent controlling invasive species in order to hinder or attempt to reverse the environmental impacts of invasive species introductions. There are a variety of methods to achieve this, such as spraying herbicides, hand removing the species, or introducing a competitor. However, these methods have varying degrees of success and can be enormously expensive. It is estimated that the direct costs of invasive species (including both plant and animal species) is between 3.5 and 5 billion dollars annually for the United States alone (From Urban Landscapes). In comparison, the federal government provides Hawaii with just 2 billion dollars to cover all of its federally funded programs (Civil Beat).

In addition to those direct costs, 7.4 billion dollars is spent annually on indirect costs of invasive species in the United States (From Urban Landscapes). Indirect costs encompass the ecosystem services lost due to the introduction of invasive species. This money is spent replicating the services that the native species freely provided, such as water filtration, flood control, and erosion control. For example, funds will not only be needed to facilitate the

removal and control of the strawberry guava plants in Hawaii, but they will also be required to curb the resulting erosion and manually produce freshwater.

Despite these negative environmental and economic impacts, the large-scale horticultural and agricultural industries are dependent on the income from introduction of non-native species. The United States' seed trade industry has a commercial market value around 12 billion dollars annually (Key Issues in International Seed Trade). The agriculture industry seeks new seeds that will result in the highest yield. Characteristics that would attribute to this include: accelerated growth and maturity, drought resistance, frost tolerance, abundant seed production, and great vegetative spread. Horticulturists look for seeds that will grow plants with attractive features, such as large flowers and fruits. However, the attributes that these industries find beneficial have a large overlap with the traits that lead to invasiveness of plants. Invaders are often hardy plants that can easily spread and produce large numbers of seeds.

Seed Dispersal Mechanisms

Plants rely on a variety of different seed dispersal methods including wind, water, gravity, mechanical/ballistic methods, and animals/birds; however, humans have added a new dimension to seed dispersal and the invasive species issue. While plants once relied on their natural methods for seed dispersal, now humans' assistance has allowed species to significantly broaden their territory. With ongoing globalization, the international seed exchange is expanding. Once a seed is planted in a new, viable ecosystem, the plant can then rely on its natural dispersal methods to spread into the new, local area. Each method of seed dispersal has its own niche for reproduction, allows invasive species to surpass previous limits of dispersal.

Wind: Plants that use wind as their primary method of seed dispersal usually have smaller seeds with feathered or fanned structures surrounding them. These structures are adept at catching the wind or breeze so that they can be carried to a new location where they can germinate. An example of a plant that uses wind dispersal would be dandelions; their seeds appear white and fluffy, and they release from the flower when wind (or a person) blows them. In Hawaii, a popular example would be Plumeria seeds (Plumeria Culture). These seeds can travel outside of the vicinity of the parent plant.

Water: Plants that use water as their primary method of seed dispersal usually have harder seeds that are able to float. Oftentimes, these are plants that are found near bodies of water, and when the seeds fall they are carried by the water to a new location. An example of a plant that uses water dispersal in Hawaii would be a coconut tree. The distant these seeds can travel is limited by the size of the body of water it is carried by, which has a large range depending on whether the carrier is a small stream or an ocean.

Gravity: Plants that use gravity as their primary method of dispersal oftentimes have fruit that drops to the ground when ripe. An example of a plant that uses gravity would be an apple tree; the fruit drops to the ground when ripe and decomposes. These seeds remain in the vicinity of the parent plant.

Mechanical/ Ballistic: Plants that use mechanical methods as their primary method of dispersal have a way of flinging their seeds away from the plant with a considerable force. An example of a plant that uses this method would be a rubber tree, which has pods that expel seeds. In Hawaii and example of this would be the Sandbox tree (Encyclopedia Britannica). These seeds remain in the vicinity of the parent plant.

Animals/ Birds: Plants that use animals/birds as their primary methods of dispersal can achieve this in a variety of ways. They can produce a seed that is covered in a burr that attaches itself to an animal. The animal would carry the seed a distance before it was rubbed off. The plants can also produce a seed that is able to survive going through an animal's digestive tract. An example of this would be a blackberry bush or the invasive *Miconia calvescens* in Hawaii. Birds eat the plants' berries and later deposit the seeds (Global Invasive Species Database). These seeds are limited to the range of the species that spreads them.

The success rate of a plant efficiently spreading its seeds to an environment where they will be able to survive on their own is lower as the distance increases (Dennis, 240). However, humans have increased the success rate by transporting the seeds themselves. This is particularly significant in Hawaii, the most isolated, populated piece of land in the world. Before humans first inhabited the islands around 1,500 years ago, one new species established itself on the islands every 35,000 years. Now, that has increased to at least 20-30 new species annually (Hawaii's Most Invasive Horticultural Plants). The opportunity for non-native plants to establish themselves in Hawaii has increased exponentially; as a result, the likelihood of the introduction of potentially invasive species has increased as well. Therefore, it is vitally important to have a system in place to monitor the plant species being introduced to the islands and to have a method to identify which species pose the greatest risk of becoming invasive once they have reached the islands.

Honolulu Botanical Garden Case Study

For my case study, I was interested to see if a plant's method of seed dispersal had an impact on its likelihood of becoming invasive. Most studies that look at seed dispersal have looked at trends in dispersal methods for species that naturalized without intentional human introduction. However, I was interested in looking at trends in seed dispersal methods and their rates of becoming invasive for those species that were introduced by humans. This information

could be relevant to industries and organizations doing significant plant importation and exportation and could affect their policies regarding those introduction practices.

Study Site

My study was based at the Honolulu Botanical Gardens (HBG) on the island of Oahu in Hawaii. While there is now awareness surrounding the negative environmental and economic effects invasive plant species can have, just 100 years ago, exotic plant introductions were widely celebrated and were part of the mission of botanical gardens around the world. Like most botanical gardens, HBG historically had unregulated plant introductions. This was an ideal study site because the majority of the plants in the gardens were largely non-native and intentionally introduced. I focused in on two of the five gardens of HBG, Koko Crater and Wahiawa. Koko Crater has a hot, dry climate, whereas Wahiawa is tropical and receives significant rainfall.

Procedure

The goals of my study were to look at 1) What proportion of botanical garden plant introductions have been naturalized in Hawaii? 2) Were there any patterns in methods of seed dispersal for the naturalized species?

To answer the first question, I examined reports from the O'ahu Early Detection Program (OED) which outlined the newly naturalized plant species in the gardens as well as island-wide. I cross-referenced these naturalized species, as well as additional naturalized taxa from other surveys and published references, with the inventories of Koko Crater and Wahiawa. I found that 5% of the total species in Wahiawa Garden and 4.45% in Koko Crater had become naturalized.

To address the second question, I determined the primary methods of seed dispersal for the species that I identified that had become naturalized. I used information given on the Hawaii Pacific Weed Risk Assessment (HPWRA) reports as well as other published sources. I then randomly chose species in the gardens that had not naturalized, but were from the same families as those that had become naturalized. I used an equal number of naturalized and non-naturalized species for my analysis, with a minimum of three non-naturalized species per family. Therefore, if there were four naturalized species in Family A, I chose four non-naturalized species from that family. However, if only two species naturalized from Family B, I still chose three non-naturalized species from Family B to work with. I then determined the methods of seed dispersal for those non-naturalize species, and compared the results shown in the table below to those of the naturalized species. Refer to Appendix 1 for the full list of naturalized and selected non-naturalized species used in the analysis.

Results

	Naturalized Species		Non-Naturalized Species	
Method of Seed Dispersal	**Koko Crater**	**Wahiawa**	**Koko Crater**	**Wahiawa**
bird/animal	70%	67%	68%	68%
mechanical/ballistic	3%	2%	0%	3%
water	6%	0%	2.5%	3%
wind	21%	31%	27%	26%
gravity	0%	0%	2.5%	0%

The study shows similar results for both naturalized and non-naturalized species across both of the gardens. Bird/animal dispersal consistently had the highest frequency. Wind was moderately frequent. Mechanical, water, and gravity methods appeared to be infrequent. The different climates between the two gardens, one arid and one tropical, did not appear to affect the frequencies. The consistency between the naturalized and non-naturalized data implies that there is not a connection between the method of seed dispersal and the plant's likelihood of becoming invasive. If there had proven to be a connection, that information could have been used to design a method of intervention that would add to current prevention initiatives.

Prevention Measures

There are groups, both at the Federal and State level, which are responsible for the management of invasive species and the prevention of the introduction of non-native species. While the movement of seeds by human initiative is very common, there are already some restrictions in place that aim to reduce this activity.

Federal Initiatives

The National Invasive Species Council was established in 1999 under the Executive Order 13112. The primary responsibility of the Council is to recommend "performance-oriented goals and objectives and specific measures of success for Federal agency efforts concerning invasive species" (The National Invasive Species Council). The Council, a multi-agency body, includes the Secretary of State, Treasury, Defense, Interior, Agriculture, Commerce, Transportation, and the Administrator of the Environmental Protection Agency.

The US Fish and Wildlife Service is in charge of all of the importations and exportations of wild plants in and out of the United States. The Plant Protection Act was enacted in 2000 to revise dated legislative statutes regarding the movement of plants within the United States. The

statute gives the Department of Agriculture the authority to issue regulation on "the introduction of plant pests into the United States or the dissemination of plant pests within the United States" 7 U. S. C. §7711(a). There is an established list of Noxious Weeds, for which a permit is required to relocate those species.

The federal invasive species programs are effective at identifying the greatest threats to the country. However, they do not have the depth to provide coverage at more local levels. Also, they do not require the labeling of plant species, so there can be confusion over what species are being transported and what their risks are.

State initiatives

Each state has its own programs for the prevention of invasive species. Hawaii, the home to one-third of the endangered species in the country, has a variety of invasive species prevention programs. Hawaii's Department of Agriculture has multiple branches to restrict what plant species come onto and leave the islands. "HDOA's Plant Quarantine Branch conducts inspections at air and sea ports to help prevent the introduction of plant pests and diseases that threaten Hawaii's unique agriculture and precious environment" (Protecting Hawaii from Invasive Species). In addition, the Plant Pest Control Branch is responsible for eradicating noxious weeds that make it onto the islands (Ikuma, et al).

In Hawaii, the invasive species programing is specialized for each island. On the island of Oahu, The Oahu Invasive Species Committee (OISC) serves a similar purpose to its federal level counterpart. The committee "is a voluntary partnership between state, federal, and private agencies. The committee combats invasive species, works to control pests both on public and private lands, and does community education on the threats of invasive species on our environment, economy, and human health" (Oahu Invasive Species Committee). One of the committee's projects is the Oahu Early Detection Program (OED), which is in collaboration with the Honolulu-based Bishop Museum. The program aims to detect invasive species on Oahu. These island programs are very active in identifying and preventing the dispersal of invasive species; however, they are restricted by their limited funding. The estimated cost of financing all potential invasive species programs in Hawaii for one year is approximately 50 million dollars (Ikuma, et al). That amount of money is not available, so many projects do not receive funding at all, and the ones that do oftentimes do not get enough.

Current Initiative and Resource Limitations

All of the preventative legislation and programs listed above have common themes. If a plant is known to be invasive, the programs try to prevent its introduction. Additionally, the programs try to keep the list of invasive species as up to date as possible. However, they do not

try to identify patterns of which plant species become invasive. If this were possible, this information could be put to use to help the prevention of the introduction of invasive species. The closest thing Hawaii has is the HPWRA, which is a program that relies on evidence of the behavior of a plant species in a similar environment outside of Hawaii to help predict the likelihood that the species will become invasive if brought to Hawaii. The assessment is 49 questions and results in the species either being accepted for introduction, rejected, or recommended for further analysis. When applied to Hawaii, the HPWRA rejected 99% of the invasive species sought for introduction (Krivanek, et al). However, it takes six hours and a lot of resources to complete an assessment for each species. I was interested in looking into if there was an easier and cheaper way to identify which introduced species would pose the greatest threat of becoming invasive.

Future work

Continued work on this study would help determine the conclusiveness of these findings. In the future, the study could be expanded to more study sites at different locations on Oahu. Additionally, data on the seed dispersal methods for all of the non-native species in the gardens, not just a random selection, would increase the data's accuracy. If the conclusions hold true, and that method of seed dispersal does not affect plant species' likelihood of becoming invasive, then it would be constructive to investigate the numerous other possible factors that would determine whether a non-native plant will become invasive. It would be beneficial to investigate whether a plant utilizing rhizomes and other methods rather than seeds to spread has an impact on invasiveness. Ginger is a highly invasive plant that has utilized rhizomes to spread across Hawaii.

While the dangers and costs of invasive species are understood, at this point in time the prevention methods put in place at the federal and state levels are not adequate. It is important for those policies to continue to develop, but the issue of underfunding will likely remain. A partial solution would be for private consumers to commit to avoiding the acquisition of seeds and plants that have high weed risk assessments. In order for this to happen, they would need to commit to fighting invasive species and be willing to give up the benefits they sought from those plants. During my time at HBG, I assisted in writing an invasive species policy for the gardens (see Appendix 2), which could be used as a template for similar institutions (Singeo, et al). Additionally, the risk assessments would have to expand, and there would have to be an obligatory labeling system with that information in order for people to understand the potential risks of buying certain plants. As of now, the human transportation of seeds continues in full strength. Therefore, it is vitally important to identify a way that requires few resources to distinguish which species pose higher risks of becoming invasive. Even if the distinction is a broad rule that has exceptions, such as plants with certain methods of dispersal pose a higher

risk, it would be a beneficial guideline for distributers and consumers to follow and a significant step in combating the invasive species issue. Then, we will truly begin to make innovative progress when fighting invasive species.

Appendix 1

Koko Crater Naturalized Species:

Acacia auriculiformis

Acacia auriculiformis

Acacia robusta ssp. clavigera

Acokanthera schimperi

Caesalpinia bonduc

Cereus uruguayanus

Cissus quadrangularis

Cordia alliodora

Cordia glabra

Cordia monoica

Cryptostegia madagascariensis

Cryptostegia madagascariensis

Cynanchum gerardii

Eragrostis variabilis

Euphorbia ingens

Euphorbia tirucalli

Grewia micrantha

Grewia truncata

Guaiacum sanctum

Hura crepitans

Jatropha curcas

Melia azedarach

Moringa stenopetala

Peniocereus hirschtianus

Pereskia aculeata

Pereskia bleo

Pereskia grandiflora

Pereskia lychniflora

Phormium tenax

Pilosocereus sp.

Prosopis pallida

Sansevieria cf. liberica

Sansevieria trifasciata

Vitex agnus-castus

Washingtonia robusta

Selected Koko Crater Non-Naturalized Species:

Acacia koa

Agave vilmoriniana

Angylocalyx braunii

Bauhinia tomentosa

Browningia microsperma

Caesalpinia gracilis

Callicarpa nudiflora

Carissa macrocarpa

Cephalocereus russelianus

Cereus peruvianus

Ceropegia stapeliaformis

Cissus cactiformis

Cissus rhombifolia

Codiaeum variegatum

Cordia africana

Cordia boissieri

Cordia lutea

Cynanchum marnerianum

Delonix adansonioides

Diphysa robinioides

Dracaena draco

Euphorbia haeleeleana

Folotsia grandiflorum

Furcraea macdougalii

Grewia calymmatosepala

Grewia forbsii

Heteropogon contortus

Moringa drouhardii

Nyctocereus serpentinus

Plumeria caracasana

Pritchardia schattaueri

Rathbunia alamosensis

Rauvolfia sandwicensis

Sabal uresana

Stenocereus thurberi

Synadenium grantii

Tetrastigma hookeri

Trichocereus peruvianus

Zombia antillarum

Wahiawa Naturalized Species:

Acacia confusa

Adenanthera pavonina cf. car microsperma

Alpinia purpurata

Angiopteris evecta

Anthurium sp.

Antigonon leptopus

Ardisia solanacea

Asparagus densiflorus

Bauhinia vahlii

Begonia glabra

Casuarina sp.

Cecropia peltata

Chrysophyllum oliviforme

Cinnamomum burmanni

Cinnamomum camphora

Cinnamomum verum

Cinnamomum verum

Clusia rosea

Coffea arabica

Costus scaber

Dianella atraxis

Dieffenbachia maculata

Dieffenbachia seguine

Dovyalis hebecarpa

Drynaria rigidula

Entada polystachya

Epipremnum pinnatum

Eugenia brasiliensis

Ficus rubiginosa

Hedychium coronarium

Hedychium coronarium

Hedychium gardnerianum

Hedychium gardnerianum

Heliconia psittacorum

Hibiscus makinoi

Jasminum fluminense

Leea indica

Lonicera japonica

Lophostemon confertus

Mallotus philippensis

Medinilla cumingii

Medinilla cumingii

Medinilla magnifica

Megaskepasma erythrochlamys

Metrosideros excelsa

Miconia calvescens

Olea europaea

Palisota sp.

Paraderris elliptica (Syn. Derris elliptica)

Pimenta dioica

Piper sp.

Platycerium bifurcatum

Platymiscium sp.

Psidium guineense

Pyracantha angustifolia

Pyrostegia venusta

Pyrrosia longifolia

Schefflera insularum

Solanum seaforthianum

Stachytarpheta mutabilis

Stachytarpheta mutabilis

Swietenia macrophylla

Swietenia mahagoni

Syngonium podophyllum

Tecoma stans

Tetrastigma voinieranum

Tetrastigma voinierianum

Toona ciliata

Selected Wahiawa Non-Naturalized Species:

Abelia x grandiflora

Acalypha wilkesiana

Aframomum zambesiacum

Aglaomorpha heraclea

Aglaonema commutatum

Alpinia calcarata

Amherstia nobilis

Angiopteris commutata

Aphelandra aurantiaca

Ardisia humilis

Artocarpus heterophyllus

Asparagus falcatus

Bambusa nutans

Bauhinia galpinii

Begonia acutifolia

Bobea elatior

Boerlagiodendron moluccanum

Brownea hybrida

Brunfelsia sp.

Callisia fragrans

Callistemon polandii

Canthium barbatum

Cedrela odorata

Cestrum aurantiacum

Cinnamomum zeylanicum

Clerodendrum glabrum

Colocasia esculenta

Costus afer

Crescentia cujete

Curcuma zedoaria

Delarbrea lauterbachii

Delostoma lobbii

Dianella caerulea

Dichorisandra thyrsiflora

Dimerocostus strobilaceus

Eranthemum wattii

Erythrina sandwicensis

Eucalyptus deglupta

Eugenia similis

Ficus benjamina

Ficus samantosa

Flacourtia jangomas

Garcinia venulosa

Gardenia brighamii

Gigasiphon macrosiphon

Goethea strictiflora

Heliconia secunda

Hibiscadelphus distans

Hydnocarpus kurzii

Hypericum lanceolatum

Indet. piperaceae

Jacobinia carnea

Jasminum subhumile

Khaya nyasica

Kokia drynarioides

Macaranga grandifolia

Manilkara zapota

Marattia attenuata

Melastoma decemfidum

Memecylon caeruleum

Metrosideros macropus

Microgramma piloselloides

Monstera deliciosa

Montrouziera cauliflora

Munroidendron racemosum

Myrsine lessertiana

Noronhia emarginata

Osmanthus fragrans

Osteomeles anthyllidifolia

Peperomia obtusifolia

Persea americana

Phaeomeria speciosa

Philodendron andreanum

Platycerium bifurcatum

Pouteria campechiana

Prunus serrulata

Rhaphiolepis indica

Riedelia corallina

Schismatoglottis calyptrata

Selaginella willdenowii

Swietenia mahagoni

Syzygium aromaticum

Tapeinochilos ananassae

Tecomaria capensis

Tibouchina urvilliana

Vitex pinnata

Xylosma hawaiiense

Zebrina pendula

Appendix 2

Honolulu Botanical Gardens
Invasive Species Policy and Management Practices

The Honolulu Botanical Gardens (HBG) conservation mission promotes the preservation of plant diversity for Hawai`i and the world. The HBG plant collection represents 5,000 plant species from diverse geographical regions. It is a repository of valued genetic material utilized in taxonomic research throughout the world.

It is estimated that only a small percentage of plants have the potential to become invasive, however these species have the capability to cause devastating ecological damage and result in great economic cost. These negative effects are especially threatening to Hawai`i's highly endemic and endangered flora. For these reasons, the HBG has set forth the following invasive species policy and management practices to responsibly development of our plant collection.

HBG pledges institutional leadership and support of the International Agenda for Botanical Gardens in Conservation (BGCI) invasive alien plant targets of botanical gardens (Sections 2.9 and 2.11 and GSPC Target 10) requiring "all botanic gardens carry out invasive species risk assessments of their collections

and management practices and gardens contribute to best management practice for control programs for invasive species that threaten plants, plant communities, associated habitats, and ecosystems."

Invasive Plant Species Management Practices

Any plant found having the potential to threaten the genetic diversity of native Hawaiian plant populations through overly aggressive behavior or the ability to introduce pests or diseases will be thoughtfully evaluated and a course of action will be determined:

Remove - complete removal and controlled disposal of all accessions of the species within the collection.

Phase Out – species will be phased out as resources can be allotted. Propagation and distribution will cease and alternative plants will be sought and promoted.

Evaluate/Monitor – species will be maintained in the collection and monitored.

Contain/Suppress – species is beyond eradication and will be contained mechanically and/or suppressed through use of herbicide.

Species of lesser invasive risk or casually naturalized in disturbed areas may be maintained, but efforts may be made to phase out. HBG will work to reduce their promotion in the landscape industry.

Significant mature tree species which have naturalized throughout Hawai`i yet are providing significant contributions to the garden or are of Exceptional Tree status may be maintained.

Representative samples of highly invasive species may be maintained for educational or program purposes.

Acceptance of New Plant Species

Species known to be invasive in Hawai`i will not be added to the HBG collections. The potential for naturalization will be thoroughly researched by HBG staff prior to acceptance into collection.

The Hawai`i Weed Risk Assessment (HWRA) will be consulted prior to acceptance into the HBG collection. If an assessment has not been done the species will be submitted for evaluation and held in the nursery until an assessment is completed.

Plant Importation and Exportation

HBG will comply with all importation, exportation and quarantine laws across all political boundaries.

HBG will refrain from exporting species with documented invasive traits into geographic regions where a concern is known.

Early Detection of Invasive Species

As it has been determined that the best practice is to identify and control invasive species before they become wide-spread, HBG will routinely review all botanical surveys relating to new records of naturalization and early detection efforts conducted by partner agencies.

HBG will comply with recommendations set forth in surveys or attained from field observations by partner agencies to the extent that resources allow. We will communicate actions taken, methods used and status of targeted species to partner agencies as needed.

Monitoring Existing Collections

Recognizing that plants may not exhibit invasive characteristics until they have been in the collection for long periods, HBG collections will be monitored continually. New observations will be shared with partner agencies.

HBG will communicate new observations to peer gardens in Hawai`i who may have the same species and any parties to which we have distributed the species.

Plant Species Hybridization

If a significant risk of hybridization is determined between a native and an exotic species which serves to compromise the genetic integrity of the native plant, best management practice will be determined and enacted.

Invasive Species Research Resource

HBG plant collections will be made available to assist with research conducted by federal, state, and private non-profit agencies on invasive plants, insects, diseases and biological control programs.

HBG Staff and Volunteer Education

Garden staff and volunteers will be trained in the recognition and safe removal of targeted species.

Best management practices regarding the safe disposal of invasive plant material will be determined and enacted.

Grounds staff will be trained in recognition of early warning signs of naturalization.

HBG will provide regular training on new target species of concern and their method of control. Information will be gathered and shared with partner agencies regarding the extent of spread within gardens and the control actions taken.

All nurseries within HBG will adhere to best management practices for the control of weeds, insects and diseases.

Municipal Leadership

HBG will assist and advise on plant selection on all properties under the purview of the Department of Urban Forestry or belonging to the City and County of Honolulu to assure that invasive species are not planted or promoted.

Participate and Promote Green Industry Initiatives

HBG will contribute to and promote green industry initiatives advocating and promoting awareness of the invasive species issue.

General Public Awareness and Plant Distribution

Staff will review plants used in plant displays, crafts, gift shop and floral arrangements to assure that invasive species are not included, promoted or sold.

The gardens will act as an outreach advocate for all public programs working to combat invasive species.

Collection of plant material by the general public is forbidden by City Ordinance further promoting the controlled and recorded distribution of plant species from the HBG plant collections.

Definitions Summary

Native (Indigenous/endemic): A species that arrived in Hawaii without human introduction, both intentional and unintentional. The species was introduced by natural methods, such as dispersal by wind, water or birds, and adapted to grow naturally in Hawaii without human intervention.

Non-Native (Exotic, alien, introduced): A species introduced to Hawai`i by humans, whether intentionally or unintentionally.

Invasive: A species that poses a threat to the integrity of a plant community. This includes non-native species that adversely affect its introduced area, as well as indigenous species that begin to dominate their communities due to loss of natural controls.

Naturalized: A non-native species that established itself in Hawai`i, being able to sustain itself without cultivation.

Exceptional Tree: A tree that Honolulu's Arborist Advisory Committee has designated to be protected by the 1975 Exceptional Tree Act, due to its aesthetic and/or ecological value

Partner Recognition/Links

Botanical Gardens Conservation International (BGCI):
http://www.bgci.org/usa/

Coordinating Group on Alien Pest Species (CGAPS): http://www.hawaiiinvasivespecies.org/cgaps/

Hawaii Invasive Species Council (HISC):
http://www.hawaiiinvasivespecies.org/hisc/

Hawai`i Pacific Weed Risk Assessment (HPWRA):
https://sites.google.com/site/weedriskassessment/

Landscape Industry Coucil of Hawai`i (LICH)
Oahu Early Detection (OED)/Bishop Museum:
http://www.bishopmuseum.org/research/natsci/botany/products.html

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