KISC
KAUAI INVASIVE SPECIES COMMITTEE

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Kauai Invasive Species Committee's Plant Early Detection Program

A Summary of Developments, Findings and Prioritization of Species for Control from 2015 to 2017

Prepared for the Kauai Invasive Species Committee (KISC),
a project of the Pacific Cooperative Studies Unit at the University of Hawaii-Manoa, 2018.

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Introduction

The environmental, economic and cultural impacts of invasive plant species are well established, and effective ways to control spread and minimize impacts are being researched and integrated into management programs (Pysek and Richardson 2010, Simberloff et al. 2013). Hawaii's Interagency Biosecurity Plan outlines three strategies to manage invasive species statewide, including: 1) "Pre-Border", where policies and practices prevent invasive species from arriving in Hawaii, 2) "Border", where incoming items are inspected and controlled at Hawaii's state border, and 3) "Post-Border", where invasive species are identified and controlled after the opportunity to prevent their entry has passed (HIBP 2016). Although preventative measures included in "Pre-Border" and "Border" programs are often favored for their cost-effectiveness and minimization of risk, the diversity and prevalence of alien plants already present in Hawaii requires particular emphasis on "Post-Border" efforts in invasive plant management programs (Traveset et al. 2014). Currently, known naturalized plants comprise over 50% of Hawaii's plant species and occupy approximately 63% its land area (Price et al. 2012, Imada 2012), and more than 10,000 species of cultivated plants have been recorded. Moreover, Hawaii is home to many "rare invaders" (plants which are invasive in Hawaii and nowhere else), and the magnitude of invasive impacts for many species is not well studied (Simberloff et al. 2013, Traveset et al. 2014). This makes the detection and identification of potentially harmful plants difficult and requires a detailed understanding of species distributions and an assessment of their potential invasive impacts to be integrated into control efforts.

"Post-Border" programs can be further categorized into 1) Eradication, 2) Management and 3) Restoration efforts, as represented in Figure 1 (Sakai et al. 2001, Blackburn et al. 2011, KISC 2017). The aim of Kauai Invasive Species Committee's (KISC) Plant Early Detection Program is to identify invasive alien plant species that can be functionally eradicated from Kauai. This is accomplished by identifying invasive plants that have not yet spread from cultivation, detecting plants in nurseries before they are distributed through sale, and detecting naturalized populations that have not surpassed the eradication phase (**Figure 1**).

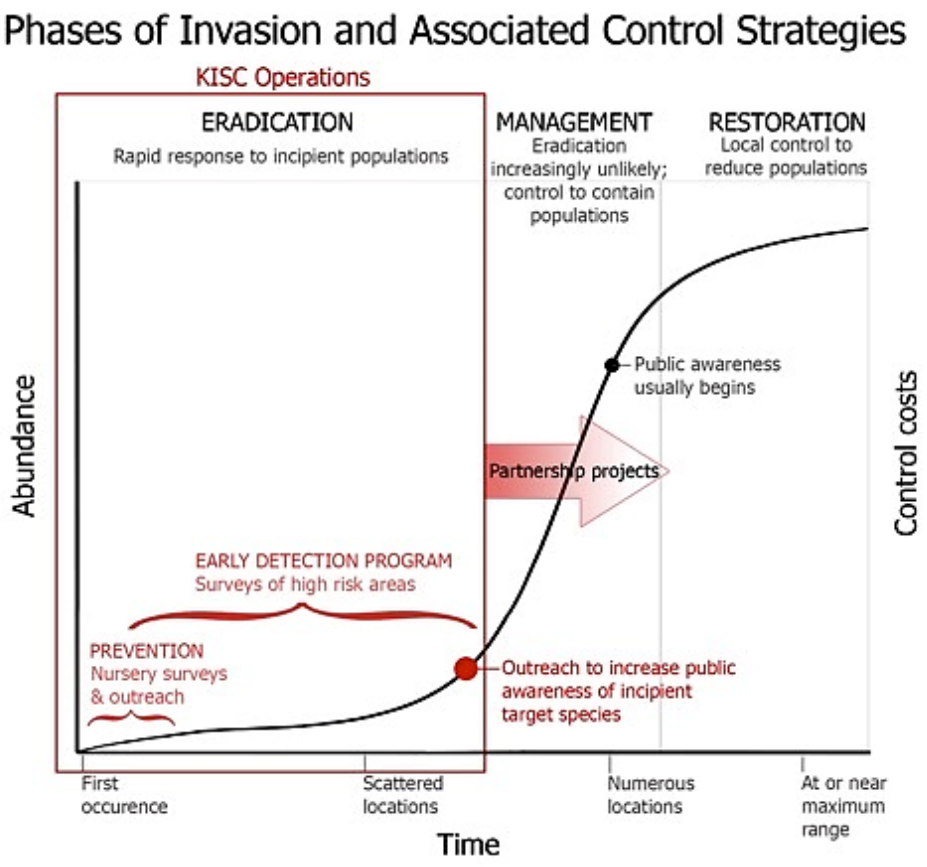

Figure 1. (Left)
An overview of KISC's efforts (represented in red) in the context of a species invasion curve, where the majority of focus is placed on preventing selected species from becoming widespread.

Although a few organizations on Kauai control invaders in high-value natural or cultural areas, KISC's Plant Early Detection Program is the only program currently identifying species that can be eradicated from the entire island of Kauai. This makes KISC's Plant Early Detection Program an important gap-filling program that systematically inventories, maps and evaluates potential impacts of early invaders island-wide. Importantly, KISC partners with other conservation agencies, which increases our ability to utilize available resources and direct management actions to Kauai's most needed areas. Notably, the herbarium and staff at the National Tropical Botanical Garden (NTBG) have provided vital scientific support, via plant identification and long-term data curation, expertise regarding invasiveness and distributions, as well as field surveys; the Hawaii State Department of Lands and Natural Resources Division of Forestry and Wildlife (DOFAW) and Kokee Resource Conservation Program (KRCP) have provided valuable reports of incipient species and general local knowledge as well as assistance with field surveys.

The History of KISC's Plant Early Detection Program (2002-2015)

This section highlights the methods and outcomes of KISC's early detection program prior to April 2015, when an Early Detection Botanist was hired to build upon the existing program. Due to lack of a full-time staff member, plant specialists were contracted to perform early detection surveys of roads, nurseries and other high-risk sites. Additionally, emphasis was previously placed on outreach efforts to increase reports of invasive plants by members of the public and partnering conservation organizations.

A summary of major activities of KISC's Plant Early Detection Program prior to 2015 are listed below:

- 2007: Island-wide survey contracted to NTBG Staff (surveys completed by specialists Clay Trauernicht and Natalia Tangalin).
- 2010: Island-wide survey contracted to Oahu Invasive Species Committee (OISC) Early Detection Botanists (surveys completed by specialists Alex Lau and Danielle Frohlich).
- 2014: State road survey contracted to OISC Early Detection Botanists (Alex Lau and Danielle Frohlich) in fulfillment of the Hawaii Department of Transportation's Statewide Noxious Invasive Pest Program (SNIPP).
- 2010 and 2014: Production of a plant prevention field guide containing information on plants with a high potential of arriving on Kauai from neighboring islands (outreach-based early detection).
- Beginning in 2010: Long-term storage for Early Detection survey data on a GIS platform.

Previous KISC Target species were selected via a combination of methods. Most commonly, Targets were selected when partnering agencies detected a plant with a well-known invasive reputation. KISC has currently designated thirteen species as Targets for eradication, which have been adopted from 2001 onwards. These species, alongside the method used to select them for eradication and a summary of effort expenditures, are presented in **Table 1**. These data highlight the commitment required in previous KISC control efforts. Twenty-seven additional species have been worked on by KISC during early detection surveys, species evaluation, or joint control with partnering agencies. The history of KISC Targets and notable early detection species are described in more detail in KISC's 2017-2022 Strategic Plan (2017).

Table 1. List of plant Target species and associated control efforts as of Feb 2018. Asterisks indicate that Target status requires evaluation due to eradication feasibility.

Scientific Name	Common Name	Year	Target Selection Method	KISC Crew Work Hours	Total Hours Including Volunteers	Number of Watersheds
*Angiopteris evecta**	mule's foot fern	2010-present	Response to Partner Agency Report	571	614	6
Arundo donax	giant reed grass	2002-present	KISC Evaluated Target/ 2007 Action Plan	3,961	4,143	16
*Cenchrus setaceus**	fountain grass	2003-present	Response to Partner Agency Report/ HDOA 2003 Action Plan	444	704	6
Clerodendrum macrostegium	velvet leaf glory bower	2011-present	Expert Recommend-ation from 2010 Early Detection Surveys	208	208	2
Coccinia grandis	ivy gourd	2002-present	Response to Partner Agency Report/ HDOA 2003 Action Plan	5,861	6,009	15
Juncus effusus	common mat rush	2015-present	Response to Partner Agency Report + Semi-quantitative Prioritization Assessment	6	6	1
Macaranga mappa	bingabing	2011-present	KISC Evaluated Target/ 2017-2022 Action Plan	435	507	5
Miconia calvescens	miconia	2001-present	Consensus-Based committee, December 2001	8,018	9,855	2
Pereskia aculeata	Barbados gooseberry	2011-present	Expert Recommend-ation from 2010 Early Detection Surveys	126	129	7
Piper auritum	false kava	2002-present	Response to Partner Agency Report/ DoFAW 2003 Action Plan	2,780	2,826	15
Prosopis juliflora	long thorn kiawe	2001-present	KISC Evaluated Target/ 2003 Action Plan	10,437	11,745	14
*Rubus sieboldii**	Molucca raspberry	2009-present	KISC Evaluated Target/ 2017-2022 Action Plan	643	693	3
Solanum torvum	turkey berry	2014-present	Response to Partner Agency Report/ HDOA 2017-2022 Action Plan	247	308	5

The Future of KISC's Plant Early Detection Program (2015-Onwards)

The primary goal of KISC's Plant Early Detection Program is to focus on incipient plant eradications, so that invasive impacts can be prevented before it becomes infeasible to do so. However, a procedure for selecting species for eradication has been lacking in previous years, and a prioritization methodology is critical due to the vast number of alien species present on the island. So far, Kauai is thought to have approximately 720 alien plant species that have naturalized from over 2700 recorded in cultivation (BPBM 2018, NTBG 2018, Brock *in prep,* Imada 2012). Furthermore, a large proportion of these plants are deemed "High Risk" by the Hawaii-Pacific Weed Risk Assessment, and attempts to track distributions for important invasive species are sporadic and incomplete (HPWRA 2018). Thus, thorough early detection surveys readily produce a very long list of potentially incipient taxa that are clearly displaying invasive behavior or are deemed "High Risk" by the Hawaii-Pacific Weed Risk Assessment (Daehler et al. 2004). A systematic process to prioritize eradicable species with the largest invasive impact potential is necessary because the small staff/budget of KISC is incapable of controlling all potentially invasive plants detected. Major contributions to KISC's 2017-2022 Strategic Plan include the development of a systematic work flow allowing KISC to survey, track, and conduct science-based assessment of selected species. Ultimately, Target species will be chosen based on a semi-quantitative valuation of the magnitude of their potential invasive impacts and eradication feasibility. This work flow both utilizes and contributes to an increased understanding of alien plant biodiversity on Kauai, enabling KISC to adapt to dynamic ecological and economic scenarios and consider the relative threat and challenges of each species. This work flow is outlined in Figure 2.

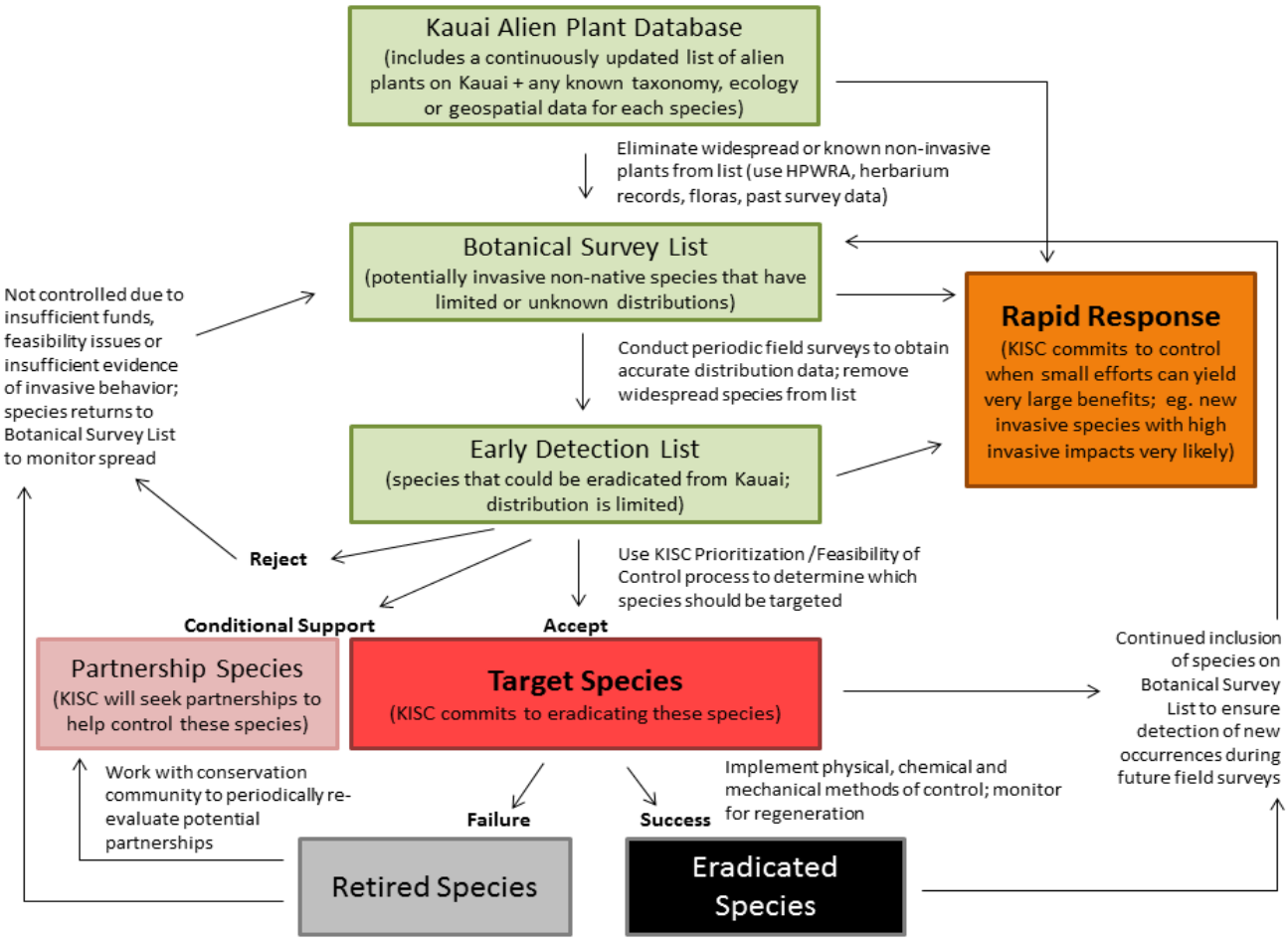

Figure 2. Flow Chart of KISC's Plant Early Detection Program.

Species considered by KISC are assigned a status according to the workflow outlined in **Figure 2**, allowing KISC to track species and keep a record of decision making. A list of status designations is shown in Table 2.

Table 2. List of terms and definitions used in Figure 2 and throughout this report

Term	Definition
Survey List	Refers to a status in KISC databases given to alien plants that are mapped during botanical surveys. In most cases, all incidences encountered will be mapped using GPS and photographs to inform prioritization assessments. However, surveys may exclude cultivated or naturalized instances if the collection of specific data is necessary to confirm the invasive status of certain species (e.g. widely cultivated, so not a feasible for eradication, but data needed to establish naturalized status).
Pono Phase Out List	Refers to a list used by KISC's Pono Endorsement Program, which is designed to phase certain plants out of the sale stock of endorsed nurseries over two years. A status of "Pono Phase Out List" may be held concurrently with other statuses in KISC databases.
Early Detection	Refers to a species that is considered limited in distribution, and may be feasible to eradicate from Kauai. A status of "Early Detection" in KISC databases supersedes the "Survey List" status in KISC databases.
Rapid Response	Refers to easily eradicable species that KISC removes immediately upon detection without completing a prioritization assessment. The potential to cause large invasive impacts quickly are well-known.
Target	Refers to species that KISC intends to eradicate from Kauai. A status of "Target" supersedes "Early Detection" in KISC databases.
Partnership	Refers to a species KISC is controlling alongside partnering agency. A status of "Partnership" supersedes "Target" in KISC databases.
Retired	Refers to a species KISC considers infeasible to eradicate, ending control efforts indefinitely
Eradicated	Refers to a species KISC has removed from all known sites on Kauai. KISC control data and scientific literature are reviewed to determine if delimiting survey efforts are sufficient and if seed banks have expired.

Methods

Creating a Survey List

A list was developed for use during 2015-2017 surveys for which GPS and other data were collected for each listed species encountered. A data informatics strategy was used to create this list in order to increase the probability that eradicable species with the highest invasive impacts were detected amongst numerous alien plants cultivated and naturalized on Kauai. Firstly, three types of data (taxonomic, ecological and geospatial) were amassed into a database because a synthesis of these data was hypothesized to minimize the risk of recommending non-eradicable species, non-invasive species, or incorrect (misidentified or undetected) species as KISC Targets (**Figure 3**).

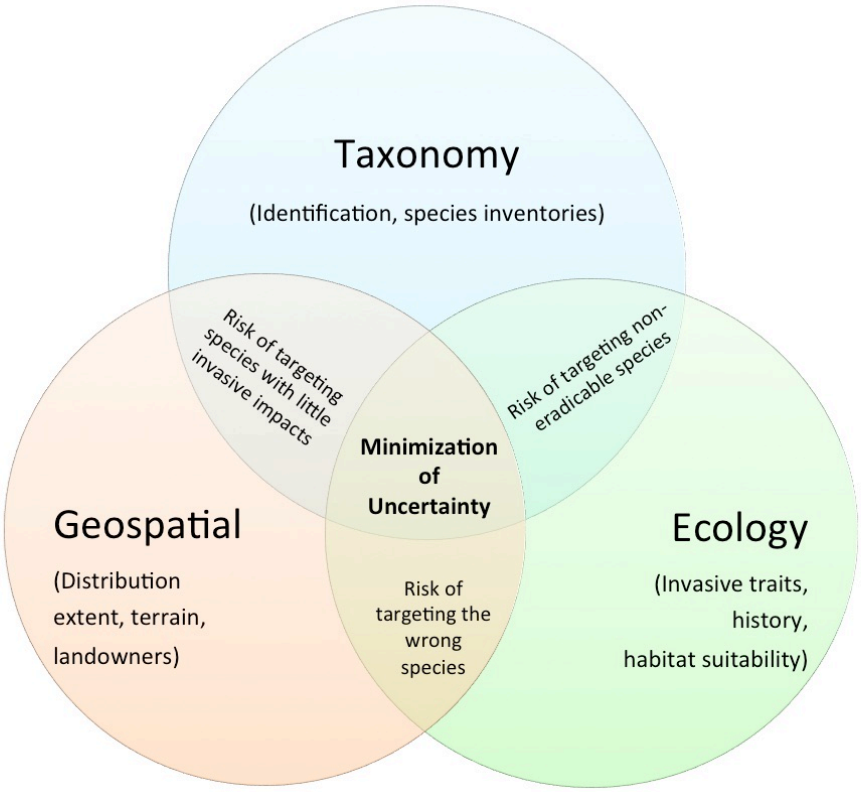

Figure 3. A conceptual diagram presenting the importance of collecting and synthesizing taxonomic, ecological and geospatial data when making management decisions about eradicating species.

A species inventory for Kauai was compiled using digitized data from National Tropical Botanical Garden's herbarium (letter code = PTBG), the Bishop Museum's Herbarium Pacificum (letter code = BISH) as well as previous early detection data in KISC's database. This list of species was then cross-referenced with geospatial data or expert opinion to eliminate species with broad distributions, which in turn was compared to resources summarizing invasiveness for each species (e.g. Hawaii-Pacific Weed Risk Assessment, Naturalization Lists, "worst weed" lists, etc.) to form the final survey list. Local botanists and land managers were contacted for their input, and the list was updated as field surveys uncovered additional species of interest. A list of taxonomic, ecological and geospatial resources used during this process, as well as during prioritization assessments (See Prioritizing Species for Control Section below), is shown in **Table 3**.

Table 3. Data resources used to inform the creation of a 2015-2017 survey list and prioritization assessments

Taxonomy	Ecology	Geospatial
• Physical use of on-island herbarium (PTBG), botanists, and library resources used to identify specimens at NTBG. • Digitized herbarium records from PTBG and BISH to generate Kauai-specific alien plant lists. • State Native/Naturalized checklist compiled by Bishop Museum used to inform which species are considered naturalized on Kauai and other islands (Imada 2012). • Forestry Planting Records to of species planted in large numbers on forest reserves (Skolmen 1980).	• Hawaii Pacific Weed Risk Assessment (HPWRA) to help predict the likelihood of naturalization and potential invasive impacts (Daehler et al. 2004, HPWRA 2018). • State Native/Naturalized checklist to inform which species have naturalized on which islands across the Hawaiian archipelago, which helps predict the likelihood of naturalization on Kauai (Imada 2012). • Digitized herbarium records to determine patterns in habitat use and predict which areas may be most impacted. • Data mined from numerous publications documenting invasive history to predict likelihood of invasive impacts on Kauai (e.g. Pacific island weed inventory, globally invasive plant databases, etc.).	• Previous early detection survey data are used to examine the distributions of incipient species. • Locations of rare plants as indicated by "popref" polygons are overlain with incipient invasive plant points to help predict future threats to endangered taxa. • GIS layer of Kauai TMKs (Tax Map Key) is used to determine the identity and number of landowners overlapping an infestation. • Aerial imagery and maps indicating topography and access for control crews are used to determine whether control efforts are safe and feasible. • GIS layers of districts, watersheds are used to assess management feasibility. • Digitized herbarium records listing specific locations are imported into ArcMap to supplement survey data.

Island-wide Surveys

Surveys were divided into five categories according to method or area surveyed: aerial (helicopter), boat (surveys of coasts, waterways), nursery, roadside, site (refers to all non-linear surveys other than nursery; e.g. a farm) and trail. A geographic point was marked using a handheld global positioning system (GPS) device and photographs were taken when alien plants of interest were encountered. Notes on the size, structure and maturity of populations were taken when possible. All unknown plants encountered in the field were recorded, and thus, many more GPS points were generated than were used in this report. All survey tracks and point data for species discussed in this report were uploaded into the KISC database. Vouchers of alien species including new island records and important range extensions were collected to ensure accurate taxonomic identifications and to contribute to a basic, long-term understanding of Kauai's flora. Vouchers were deposited at PTBG and duplicates were collected, when possible, to send on to other herbaria at the discretion of NTBG staff.

GPS data collected in the field or from partner organizations were mapped on Kauai according to house district, judicial district, and watershed GIS layers unless otherwise specified (**Figure 4**). House district polygons are used for KISC data reporting to the Hawaii Invasive Species Council (HISC) and are delineated politically, making them useful for management decisions. Judicial districts were used because they parse Kauai into more equal parts relative to other GIS layers, allowing for a large scale assessment of how broadly distributed species are throughout Kauai. Additionally, judiciary districts are used when collecting location information for voucher collections in the National Tropical Botanical Garden herbarium (PTBG) database; using consistent data collection techniques allows for easier data sharing between organizations. The watershed layer is used to inform more fine-scale management decisions, as watersheds are thought to represent biologically significant areas pertaining to seed dispersal and ecological/agricultural impacts (Chang et al. 1998, Muneepeerakul et al. 2007, Zhang et al. 2007). Where

applicable, species that overlap “pop ref” polygons containing Plant Extinction Prevention (PEP) species were also noted. Additionally, Tax Map Keys (TMKs) were used to evaluate how many landowners are included. Herbaria vouchers are used to supplement survey data and are referenced throughout this report in the following format: name of collector and collection number, 4 letter herbarium code (e.g.: J. Smith 170, HERB).

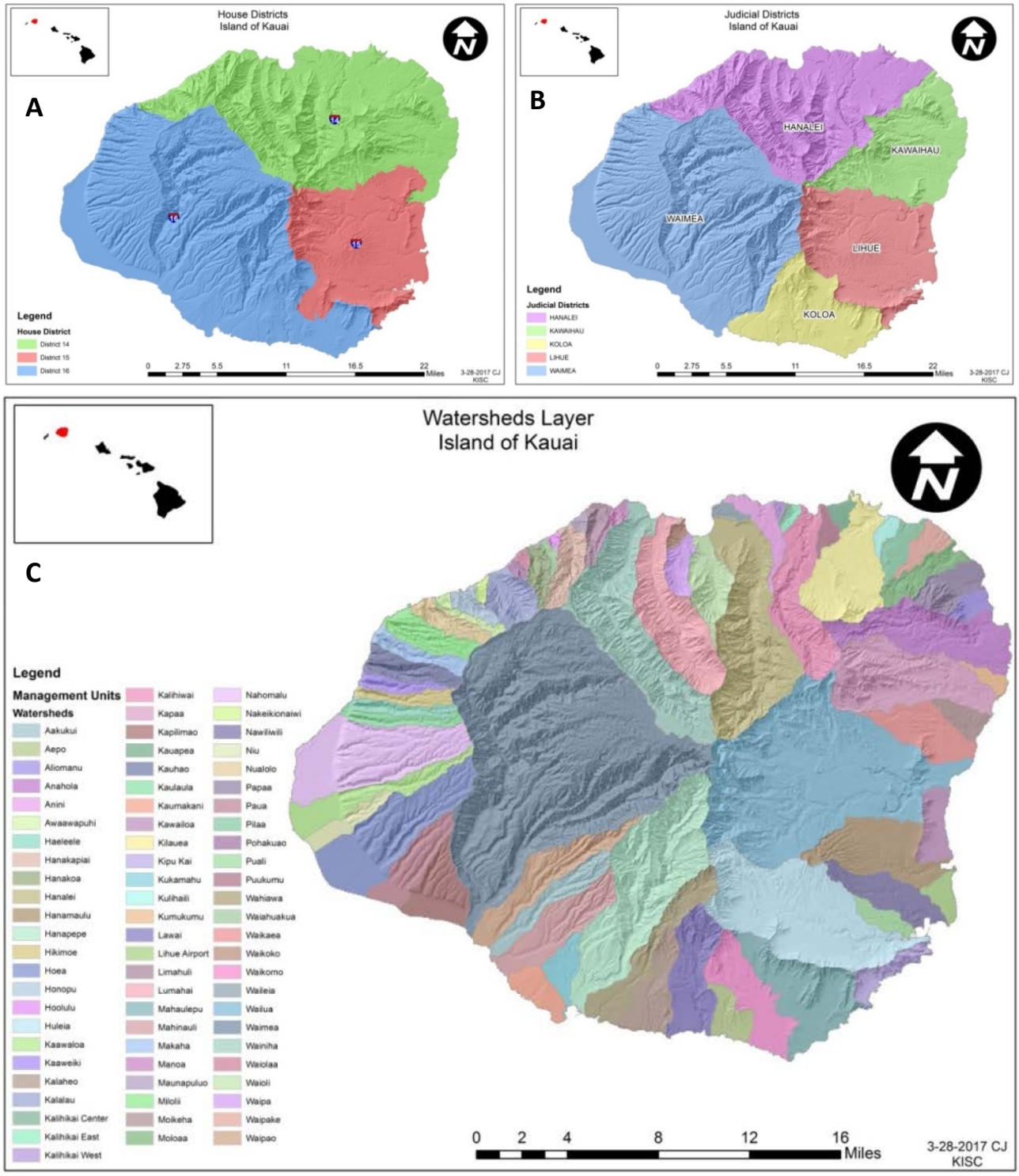

Figure 4. Map of house districts (A), judiciary districts (B) and watersheds (C) reported alongside survey data to assess distribution extent on Kauai.

Determining Naturalization Status

Plants identified as newly naturalized on Kauai were recorded, vouchered and submitted to herbaria and efforts are currently underway to publish new records in the *Bishop Museum Occasional Papers*. This publication is the accepted method to report this information in Hawaii such that new records can be added to the inventory of naturalized vascular plants statewide (Wagner et al. 2005, Imada 2012). However, the definitions of terms relating to an alien plant's invasive status appear to be disputed throughout Hawaii by both invasive plant managers and botanists. Consistent and accurate application of these terms is required to predict potential impacts and inform management decisions. The definitions of invasion tracking terms as used in this report are derived from Pysek et al. (2004) and Wagner et al. (2005) and are presented in **Table 4** . Efforts are underway to further define and categorize Hawaii's alien plants according to these statuses.

It is important to note that new island naturalization records are not necessarily suitable for KISC Target designation. Common plants are sometimes overlooked by botanists for many years when reporting new records, and plants often become naturalized after they have been widely cultivated for long periods of time and are therefore infeasible to eradicate.

Table 4. Definitions of invasion status terms used throughout this report.

Term	Definition
Adventive	A species with "Adventive" status refers to alien plants where cultivated individuals are known to produce non-cultivated individuals, but multi-generational, self-sustaining populations have not formed (although they may do so in the future). An adventive species may also be present in cultivation, but a status of "Adventive" supersedes "Cultivated" in KISC databases.
Cultivated	An alien species with "Cultivated" status refers to plants that are known to be grown or bred by humans on Kauai, but are not reproducing outside of these environments.
Naturalized	A naturalized species refers to alien plants that have established self-sustaining populations via vegetative or sexual means. They are not dependent on propagules from cultivated plants to sustain populations.
Naturalized - Invasive	Refers to an alien plant where harm to natural or human-controlled systems has been documented on Kauai (a.k.a. invasive impacts). A species may be considered naturalized, but not invasive. A status of "Naturalized - Invasive" supersedes a status of "Naturalized" in KISC databases.

Prioritizing Species for Control

A semi-quantitative method for assessing the magnitude of potential impacts and feasibility of eradication for incipient alien species was developed by KISC in 2015. This process results in a comparative prioritization tool allowing allocation of resources to the highest-ranked species, leading KISC to designate certain "Early Detection" species as a KISC "Target" (outlined in **Figure 2**). Feasibility scores assume 1) the intention is to functionally eradicate the species from the island (in contrast to containment), and 2) a small staff similar to KISC's (approximately 4 crew members) will be conducting delimiting, control and monitoring efforts. A list of unresolved issues contributing to the uncertainty of invasive impacts or eradication feasibility scores is generated, and thus, scores may change as new information becomes available. Additionally, this method is intended to reassess current KISC Targets and will aid in evaluating the progress and challenges associated with eradication attempts. This may lead to the reclassification of current targets as "Retired" or "Partnership" or may return them to the Botanical Survey List for future monitoring (**Figure 2**). After initial completion, prioritization assessment reports for KISC Targets are to be updated periodically to account for new information regarding treatment methods or distribution data. Detailed instructions and rationale of the Prioritization and Feasibility of Control (PFOC) process can be found in **Appendix A**.

Informing the Nursery and Landscape Industry

KISC launched the Pono Endorsement Program in 2016 which seeks voluntary collaboration from nurseries and landscapers to prevent the spread of invasive plants in cultivation. One of the strategies of this program is to construct lists of species that should be discontinued from sale in businesses holding a Pono endorsement. These lists are referred to the "black list" and "phase out list", requiring businesses to immediately remove plants from sale or phase out stock over the course of two years, respectively. A major challenge in compiling these lists is that no inventories of nursery stock have been completed, and businesses frequently change which plants they order and propagate for sale. The absence of these data may increase the risk that the phase out list contains invasive plants that are no longer cultivated, rendering the list ineffective. 2015-2017 surveys were designed to work in tandem with the Pono Endorsement program, allowing the KISC Botanist to survey nurseries for listed plants, and while inventorying the nursery stock, as the KISC Outreach Specialist coordinates the removal of plants with nursery staff. Additionally, field surveys of were able to document invasive impacts of plants sold in nurseries on Kauai, allowing KISC to better select candidates for the phase out list.

Results and Recommendations

Kauai Alien Plant Survey List

Results

The 2015-2017 survey list consisted of 176 species that were mapped consistently, which are presented in **Appendix B**. This list was originally limited to 134 species to prevent surveyor error, but 42 additional taxa of interest not previously known to Kauai were accumulated during field surveys. Data was also gathered for unknown taxa not included on this list for identification purposes.

Ultimately, species were mapped for 5 reasons:

- Species was present on previous early detection survey lists or in KISC database, but it's unclear why it was not subsequently controlled by KISC.
- Species is a KISC Target.
- Species is a candidate for the Pono Endorsement Program's phase out list.
- Species was flagged as potentially incipient during field surveys or in the Kauai Alien Plant Database (See Methods–Creating a Survey List section) or by KISC's partners.
- Species was observed as adventive or naturalized during field surveys (not all adventive instances were mapped or reported on due to time constraints).

Eight of the taxa listed in **Appendix B** have not been identified to species, and are denoted using "sp." or "c.f." to indicate taxonomic uncertainty.

Recommendation

Hundreds of plants not previously known to Kauai via herbaria or other inventories were detected in cultivation during 2015-2017 surveys, especially in nurseries. This emphasizes the need for increased surveying and vouchering of alien plants on Kauai. The construction of lists used by KISC and other agencies outlined in the Hawaii Biosecurity Plan (HIBP 2016) is dependent on species being represented in long-term databases.

Unidentified species listed in **Appendix B** and **D**, which have all been vouchered, should be investigated further to determine whether these plants pose a risk to Kauai. Accurate plant identification was a major factor inhibiting our ability to predict potential impacts of incipient species for the 2015-2017 duration of this program.

Surveys

Results

2015-2017 surveys covered a total of 3,496 ha (8,640 acres) of Kauai (**Figure 5**) with 2,447 GPS points taken to denote plants of interest or unknown plants. Survey area was calculated using the length of survey track lines multiplied by the assumed line of sight for each survey method (ground 5m buffer, aerial 50m buffer, roadside 10m buffer). The majority of this coverage is from roadside surveys, accounting for 2,306 ha (5,698 acres) of area. Approximately 79.59% or 778 kms (483 miles) of roads were surveyed between 2015 and 2017 according to comparisons with the 2009 Kauai County centerline roads GIS layer. This GIS layer may include some roads that are private or decommissioned, as all publicly accessible roads were surveyed to our knowledge. Additionally, 287 kms (178 miles) comprising 30 separate hiking or walking trails were surveyed. Fifteen different sites considered to be at risk for invasive plant introductions were surveyed, including 6 nurseries (which are also Pono Endorsed), amounting to 91 ha (226 acres). The rest of the survey coverage is comprised of aerial surveys (342 ha/846 acres) and boat surveys (630/1,558 acres). Two hundred and ninety-four vouchers, amounting to 642 separate specimens (including duplicates) were collected, identified and are currently being submitted to herbaria. Approximately 80 vouchers still await identification before submission to herbaria.

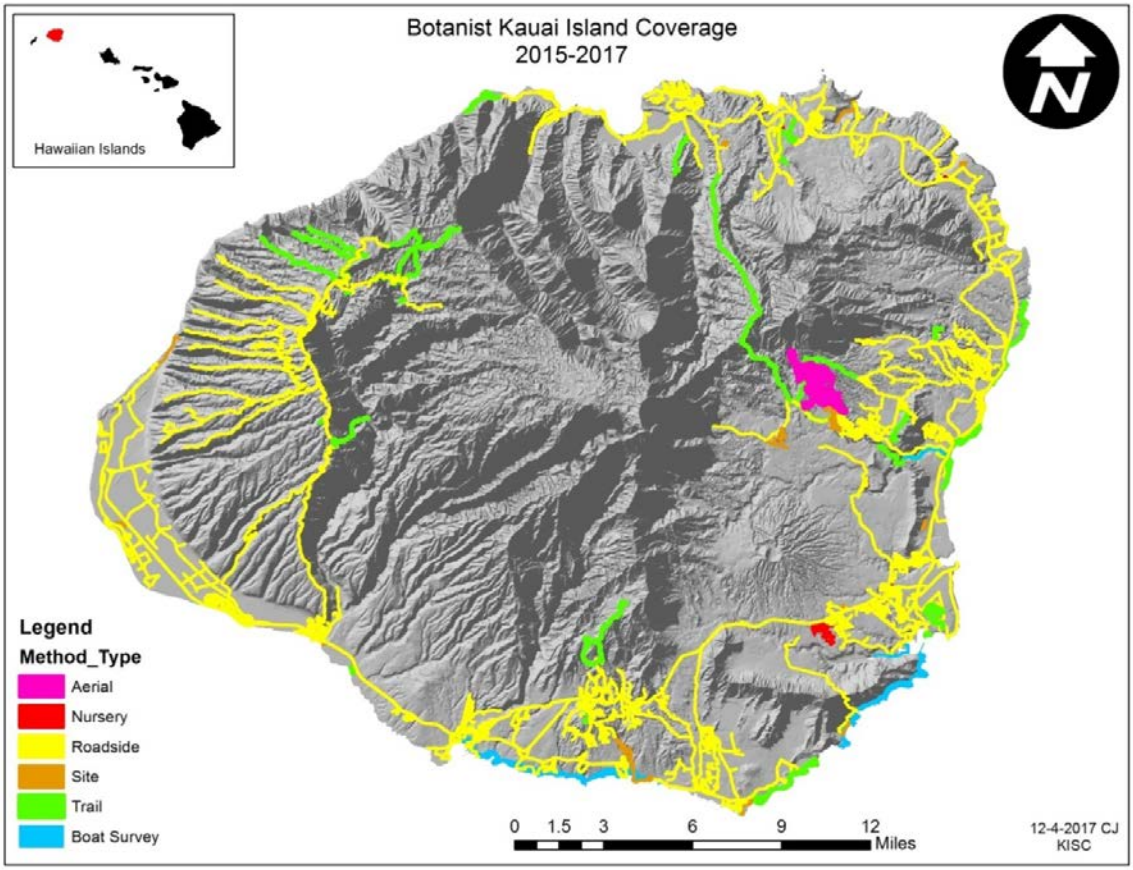

Figure 5. Island-wide survey effort by the KISC early detection botanist from August 2015 – November 2017.

Of the 176 taxa on the 2015-2017 survey list, 105 of the species detected and mapped were considered to be of interest to KISC. Information about each species is appended to this report according to how it will inform KISC goals. **Appendix C** contains potentially invasive (or known invasive) species that may be eradicable from Kauai that have received full prioritization assessments, while **Appendix D** contains background and distribution data of other species of interest, including: notable taxa that were found to be too widespread to eradicate, newly naturalized

species, and suitable taxa for future Pono Endorsement phase out lists. Additionally, **Appendix D** contains some species that may deserve full Prioritization Assessments that have not yet been written (such as current KISC Target species).

Notably, KISC may want to investigate the eradication status of certain species to measure the success of Kauai-based plant early detection programs and landowner cooperation. Two former Target species, *Senecio madagascariensis* (fireweed), and *Cortaderia* sp. (pampas grass; vegetative specimens of either *C. selloana* or *C. jubata*) are believed to be eradicated from their known sites, and 2015-2017 surveys did not detect additional plants. Cultivated and escaping individuals of *Cenchrus longisetus* detected during previous early detection surveys appear to have been removed by the landowner after he was asked by KISC. Similarly, this plant was not detected during 2015-2017 surveys. A single individual of *Ailanthus altissima* (tree of heaven) detected during 2010 surveys by KISC is approaching eradication by KRCP, according to their staff. Both known populations of *Picris hieraciodes* are reported to have been reduced to undetectable levels by DOFAW and KRCP staff, although these areas have never been surveyed by KISC. Specific surveys for *Spartium junceum,* which was last collected in 1972, also failed to detect this plant in Kokee, which seems odd since it is a well-known invader and was apparently viewable from the roadside. Additionally, KRCP, who have closely monitored Kokee for decades, have never seen *S. junceum*. One herbarium voucher (D.H. Lorence 9455, PTBG) notes that one acre of *Inga sertulifera* subsp. *leptopus* was eradicated from Lawai in 2005, which was possibly the only known population on the island.

Recommendation

The most time consuming component of 2015-2017 surveys was data entry and identifying unknown plants from field surveys. An electronic method for data collection in the field would likely reduce data entry time and increase surveying accuracy. Ample time should be allocated to plant identification as taxonomic uncertainty or an inaccurate inventory greatly affects prioritization assessments. As plants may arrive from anywhere in the world with a comparable climate, several resources and herbarium vouchers are often consulted, rather than a single publication as is common for native species. Thus, it is easy to underestimate the amount of time required for identification.

Plants in Hawaii are notable for their staggered flowering and fruiting time throughout the year, which greatly influences the detectability of many species. As many plants are less noticeable in their vegetative state, multiple surveys at different times of the year are recommended for highly diverse sites such as nurseries, farms and botanical gardens. Thus, differences in the number and location of plants detected between 2010 and 2015-2017 surveys may be a result of plant detectability rather than recent removals or plantings, in some cases. A two person crew in the vehicle during roadside surveys may also increase detection rates.

Future island-wide detection surveys should focus on gaining access to private roads and residences as well as high-risk sites such as botanical gardens and nurseries, as 2015-2017 surveys focused on covering easy-to-access areas. Multiple nurseries, including small casual ones, could be surveyed in tandem with objectives for the Pono Endorsement Program. A few sites requiring permission from the landowner were surveyed during 2015-2017 and unquestionably provided immense value, resulting in dozens of species not yet recorded in the State of Hawaii. As an example, a survey of a cabin site in Kokee detected four species that are being prioritized as potential KISC targets or partnership species, as well as six species that were found to be naturalizing around Kokee during 2015-2017 surveys.

New Naturalization Records for Kauai and the State of Hawaii

Island-wide surveys yielded 46 new records that will be reported to the Hawaii Biological Survey such that they are reflected on Hawaii's Naturalized Plant Checklist (Brock et al., in prep; Imada 2019). These records include four plants representing their first known naturalization statewide, 22 new Kauai naturalization records, 18 showing

signs of naturalization but have possibly not yet formed self-sustaining populations, and two possible extirpations/corrections.

Ranking of Existing and Potential KISC Target Species

Forty-three species received prioritization assessments (**Appendix C**) between 2015-2017. An additional 11 taxa that are designated as KISC Targets have not been assessed but are presented in **Appendix D**. These species are ranked according to their combined score in **Table 5**, which reflects an additive value of feasibility and potential impacts as outlined in **Appendix A**. This ranking is the initial suggested order by which KISC should prioritize species for eradication, although additional scrutiny by the KISC committee is required before directing KISC actions. Notably, the order suggested in this table is somewhat different from that which would have been recommended by the Early Detection Botanist without this prioritization tool. This suggests that a semi-quantitative ranking system may be effective at removing biases associated with expert opinion. These biases may include: unrealistic impressions of eradication feasibility, disproportionate and illogical attention given to specific taxa among a highly diverse pool of candidate species, and a preference to recommend species where invasive impacts have been personally observed (rather than reported by the scientific or conservation community).

Table 5 is designed to be an adaptive management and decision-tracking tool. Additional species receiving prioritization assessments in the future should be added to the list, and versions of this table can be saved periodically over time to document information leading to score decreases, increases or designation of KISC statuses. This will allow KISC to analyze its past actions to better inform future decision-making and avoid redoing work that has already been completed. The final column of **Table 5** summarizes actions that should be taken by KISC before assigning a status (i.e. Target or Partnership species; **Table 2**). As these actions are accomplished, it is likely that feasibility scores for some species may decrease and thus the species should be reassigned a lower ranking based on the additional information.

Table 5. A compilation of scores from 43 prioritization assessments reported in Appendix C, ranked in order that they should be prioritized by KISC.

Recommended Ranking (based on combined score)	**Taxon**	**Common Name**	**Current KISC Status**	**HPWRA Score**	**Invasive Impacts Score**	Likelihood that Invasive Impacts Score will change in future (see last column)	**Feasibility Score**	Likelihood that Feasibility will change in future (see last column)	**Combined Score**	**KISC Status Recommend-ation**	**Are KISC actions necessary before recommended status is accepted?**
2	*Acacia auriculiformis*	Darwin black wattle	EARLY DETECTION	High Risk (13)	8	not likely	8	possible	**16**	Investigate as a Target Species– complete final column	Yes, requires: 1) project management (critical landowner communication), 2) crew time for survey; see Appendix C
3	*Morella cerifera*	wax myrtle	EARLY DETECTION	High Risk (21)	9	possible	6.5	possible	**15.5**	Investigate as a Target Species– complete final column	Yes, requires: 1) project management (critical landowner communication), 2) crew time for survey, 3) outreach commitment assessment; see Appendix C
4	*Pueraria montana*	kudzu	RAPID RESPONSE	High Risk (24)	8	Not likely	7	Possible	**15**	Investigate as a Target Species– complete final column	Yes, requires: 1) crew time (survey + control efficacy trials) 2) botanist or experienced crew member (survey) 3) outreach commitment assessment 4) project management (conservation agency partnership + county roadside mowing coordination); see Appendix C
5	*Jasminum polyanthum*	pink jasmine	EARLY DETECTION	High Risk (10)	7.5	not likely	7	possible	**14.5**	Investigate as a Partnership Species (Kokee) – complete final column	Yes, requires: 1) crew time for survey 2) project management (landowner communication + partnership with other conserv-ation agencies); see Appendix C
6	*Crotalaria verrucosa*	blue rattlepod	EARLY DETECTION	High Risk (10)	7	possible	7	possible	**14**	Investigate as a Target Species– complete final column	Yes, requires: 1) crew time for survey; see Appendix C
UNPLACED (somewhere between 2 and 8)	*Salix* sp.	willow	EARLY DETECTION	? (Unconfir med ID)	6 or 8 (depending on final ID)	certain	8	not likely	**14 or 16 (depending on final ID)**	Investigate as a Partnership Species (Kokee) – complete final column	Yes, requires: 1) project management (conservation agency partnership), 2) Botanist (plant ID) 3) crew time (survey); see Appendix C

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Table 5 (continued)

Recommended Ranking (based on combined score)	**Taxon**	**Common Name**	**Current KISC Status**	**HPWRA Score**	**Invasive Impacts Score**	Likelihood that Invasive Impacts Score will change in future (see last column)	**Feasibility Score**	Likelihood that Feasibility will change in future (see last column)	**Combined Score**	**KISC Status Recommend-ation**	**Are KISC actions necessary before recommended status is accepted?**
6	*Heterotheca grandiflora*	telegraph weed	EARLY DETECTION	High Risk (14)	6.5	not likely	7.5	possible	**14**	Investigate as a Target Species– complete final column	Yes, requires: 1) crew time (survey) 2) botanist or experienced crew member (survey) 3) project management (landowner communication - agriculture contamination, control methods); see Appendix C
6	*Juncus polyanthemos*	Australian silver rush	EARLY DETECTION	High Risk (12)	6.5	likely	7.5	likely	**14**	Investigate as a Target Species– complete final column	Yes, requires: 1) botanist or experienced crew member (survey) 3) outreach commitment assessment; see Appendix C
7	*Sesuvium* sp. nr. *verrucosum*	sea purslane species	pending	High Risk (9)*	5	not likely	8	possible	**13**	Investigate as a Target Species– complete final column	Yes, requires: 1) crew time (survey); see Appendix C
7	*Vicia sativa*	black-pod vetch	EARLY DETECTION	High Risk (16)	6	possible	8	possible	**14**	Investigate as a Partnership Species (Kokee) – complete final column	Yes, requires: 1) crew time (survey); see Appendix C
8	*Paulownia tomentosa*	princess tree	EARLY DETECTION	High Risk (9)	6.5	likely	7.5	likely	**14**	Investigate as a Target Species– complete final column	Yes, requires: 1) crew time for survey 2) outreach effort assessment; see Appendix C
9	*Acacia mangium*	brown salwood	EARLY DETECTION	High Risk (8)	8	not likely	5	very likely	**13**	Investigate as a Target Species– complete final column	Yes, requires: 1) crew time for survey 2) project management (conservation agency partnership + critical landowner communication); see Appendix C
10	*Juncus effusus*	Japanese mat rush	TARGET	High Risk (21)	7	not likely	6	possible	**13**	Adjust status to PARTNERSHIP species	Yes, requires: 1) project management (conservation agency partnership); see Appendix C

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Table 5 (continued)

Recommended Ranking (based on combined score)	**Taxon**	**Common Name**	**Current KISC Status**	**HPWRA Score**	**Invasive Impacts Score**	Likelihood that Invasive Impacts Score will change in future (see last column)	**Feasibility Score**	Likelihood that Feasibility will change in future (see last column)	**Combined Score**	**KISC Status Recommend-ation**	**Are KISC actions necessary before recommended status is accepted?**
10	*Bischofia javanica*	bishop wood	EARLY DETECTION	High Risk (7)	7	possible	6	possible	**13**	Investigate as a Target Species– complete final column	Yes, requires: 1) crew time (survey) 2) outreach commitment assessment 3) project management (landowner communication + certified arborist assessment); see Appendix C
10	*Dillenia suffruticosa*	shrubby simpoh	EARLY DETECTION	High Risk (11)	7	possible	6	possible	**13**	Investigate as a Target Species– complete final column	Yes, requires: 1) project management (critical landowner communication + arborist cost assessment), 2) botanist and outreach staff time (Pono Collector program planning regarding botanical gardens), 3) botanist or experienced crew member (nursery+ neighbourhood early detection surveys, delimiting survey); see Appendix C
10	*Cordia alliodora*	Spanish elm	EARLY DETECTION	High Risk (11)	7	possible	6	very likely	**13**	Investigate as a Target Species– complete final column	Yes, requires: 1) crew time (survey), 2) project management (critical landowner communication), 3) botanist and outreach staff time (Pono Collector program? planning regarding botanical gardens) see Appendix C
11	*Cissus rotundifolia*	Arabian wax cissus	EARLY DETECTION	High Risk (9)	6	not likely	7	possible	**13**	Pending ranking + committee evaluation	Yes, requires: 1) crew time for survey 2) project management (landowner communication); see Appendix C
12	*Wisteria sinensis*	Chinese wisteria	EARLY DETECTION	High Risk (9)	6	very likely	6.5	possible	**12.5**	Pending ranking + committee evaluation	Yes, requires: 1) crew time for survey 2) project management (landowner communication); see Appendix C

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Table 5 (continued)

Recommended Ranking (based on combined score)	**Taxon**	**Common Name**	**Current KISC Status**	**HPWRA Score**	**Invasive Impacts Score**	Likelihood that Invasive Impacts Score will change in future (see last column)	**Feasibility Score**	Likelihood that Feasibility will change in future (see last column)	**Combined Score**	**KISC Status Recommend-ation**	**Are KISC actions necessary before recommended status is accepted?**
13	*Harrisia eriophora*	apple cactus	EARLY DETECTION	High Risk (7)	4.5	likely	8	possible	**12.5**	Pending ranking + committee evaluation	Yes, requires: 1) crew time for survey 2) project management (landowner communication); see Appendix C
14	*Typha latifolia*	cattail	TARGET	High Risk (29)	8	not likely	4	very likely	**12**	Remain as TARGET?	Yes, requires: 1) project management (herbicide permitting); see Appendix C
14	*Buddleja madagascar-iensis*	smoke bush	EARLY DETECTION / Partnership	High Risk (21)	8	not likely	4	possible	**12**	Pending ranking + committee evaluation	Yes, requires: 1) crew time for survey 2) project management (landowner communication + partnership with other conservation agencies); see Appendix C
14	*Hiptage benghalensis*	hiptage	EARLY DETECTION	High Risk (8)	8	not likely	4	possible	**12**	Pending ranking + committee evaluation	Yes, requires: 1) crew time (survey) 2) botanist or experienced crew member (survey) 3) outreach commitment assessment 4) project management (conservation agency partnership); see Appendix C
15	*Yucca* cf. *aloifolia*	Spanish bayonet	EARLY DETECTION	High Risk (14)	6.5	possible	5.5	possible	**12**	Pending ranking + committee evaluation	Yes, requires: 1) crew time (survey) 2) crew supervisor (health and safety assessment) 2) botanist (identification) 3) outreach commitment assessment; see Appendix C
16	*Clerodendrum macrostegium*	velvetleaf glorybower	TARGET	High Risk (8)	6	possible	6	possible	**12**	Remain as TARGET	No, but : 1) project management (critical landowner communication), 2) crew time for survey still pending; see Appendix C

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Table 5 (continued)

Recommended Ranking (based on combined score)	**Taxon**	**Common Name**	**Current KISC Status**	**HPWRA Score**	**Invasive Impacts Score**	Likelihood that Invasive Impacts Score will change in future (see last column)	**Feasibility Score**	Likelihood that Feasibility will change in future (see last column)	**Combined Score**	**KISC Status Recommend-ation**	**Are KISC actions necessary before recommended status is accepted?**
16	*Alstonia macrophylla*	deviltree	EARLY DETECTION	High Risk (9)	5.5	not likely	6	possible	**11.5**	Pending ranking + committee evaluation	Yes, requires: 1) project management (critical landowner communication + arborist cost assessment), 2) botanist and outreach staff time (Pono Collector program planning regarding botanical gardens) see Appendix C
16	*Flemingia macrophylla*	large-leaf flemingia	EARLY DETECTION	Evaluate (5)	6	likely	7	very likely	**13**	Pending ranking + committee evaluation	Yes, requires: 1) crew time for survey; see Appendix C
17	*Cissus nodosa*	grape ivy	EARLY DETECTION	High Risk (8)	5	possible-deficient in ecological data	7	possible	**12**	Pending ranking + committee evaluation	Yes, requires: 1) crew time (survey) 2) botanist or experienced crew member (survey) 3) outreach commitment assessment 4) project management (conservation agency partnership); see Appendix C
17	*Crassula multicava*	Cape Province pygmyweed	EARLY DETECTION	High Risk (12)	5	possible	7	possible	**12**	Pending ranking + committee evaluation	Yes, requires: 1) project management (critical landowner communication), 2) crew time for survey; see Appendix C
17	*Dovyalis hebecarpa*	Ceylon gooseberry	EARLY DETECTION	High Risk (7)	4	possible	7	very likely	**11**	Pending ranking + committee evaluation;	Yes, requires: 1) crew time for survey, 2) project management (landowner communication), 3) botanist and outreach staff time (Pono Collector program planning regarding botanical gardens) see Appendix C
18	*Buddleja paniculata*	butterfly bush	EARLY DETECTION	High Risk (7)	4	very likely - data deficient	8	very likely - data deficient	**12**	Pending ranking + committee evaluation	Yes, requires: 1) crew time (survey) 2) botanist or experienced crew member to monitor fruit production 3) outreach commitment assessment 4) project management (conservation agency partnership); see Appendix C

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Table 5 (continued)

Recommended Ranking (based on combined score)	**Taxon**	**Common Name**	**Current KISC Status**	**HPWRA Score**	**Invasive Impacts Score**	Likelihood that Invasive Impacts Score will change in future (see last column)	**Feasibility Score**	Likelihood that Feasibility will change in future (see last column)	**Combined Score**	**KISC Status Recommend-ation**	**Are KISC actions necessary before recommended status is accepted?**
19	*Derris elliptica*	tubaroot	EARLY DETECTION	High Risk (8)	5.5	possible	6	very likely	**11.5**	Pending ranking + committee evaluation	Yes, requires: 1) botanist or experienced crew member for survey, 2) outreach commitment assessment, 3) project management (critical landowner communication), 4) crew time for herbicide trials; see Appendix C
20	*Ligustrum sinense*	Chinese privet	EARLY DETECTION	High Risk (20)	9	not likely	2	very likely	**11**	Pending ranking + committee evaluation	Yes, requires: 1) crew time for survey 2) project management (partnership with other conservation agencies, possibly specific funding acquisition); see Appendix C
21	*Merremia peltata*	merremia	EARLY DETECTION	High Risk (18)	8	not likely	3	very likely	**11**	Pending ranking + committee evaluation	Yes, requires: 1) botanist (for identification) 2) crew members for delimiting survey, 2) project management (critical landowner communication), 4) crew time for herbicide trials; see Appendix C
22	*Melochia umbellata*	melochia	EARLY DETECTION	High Risk (9)	7	possible	4	very likely	**11**	Pending ranking + committee evaluation	Yes, requires: 1) botanist or experienced crew member for early detection survey, 2) Field crew lead - safety assessment of steep terrain, 3) crew time for delimiting survey, 4) project management (partnership communication, cost assessment of certified arborist (or HDOT partnership) + landowner permission; see Appendix C
23	*Flindersia brayleyana*	Queensland maple	EARLY DETECTION	Evaluate (2)	6.5	likely	4.5	likely	**11**	Pending ranking + committee evaluation	No, but 1) project management (critical landowner communication), 2) crew time for survey still pending; see Appendix C

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Table 5 (continued)

Recommended Ranking (based on combined score)	**Taxon**	**Common Name**	**Current KISC Status**	**HPWRA Score**	**Invasive Impacts Score**	Likelihood that Invasive Impacts Score will change in future (see last column)	**Feasibility Score**	Likelihood that Feasibility will change in future (see last column)	**Combined Score**	**KISC Status Recommend-ation**	**Are KISC actions necessary before recommended status is accepted?**
24	*Coccinia grandis*	ivy gourd	TARGET	High Risk (21)	6	not likely	5	possible	**11**	Remain as TARGET	No, but 1) project management (critical landowner communication), 2) crew time for survey still pending; see Appendix C
24	*Ficus religiosa*	bo tree	EARLY DETECTION	High Risk (7)	6	not likely	5	not likely	**11**	Pending ranking + committee evaluation	Yes, requires: 1) project management (critical landowner communication + arborist cost assessment), 2) botanist and outreach staff time (Pono Collector program planning regarding botanical gardens) see Appendix C
25	*Canavalia sericea*	silky jackbean	EARLY DETECTION	Evaluate (2)	5	possible	5.5	possible	**10.5**	Pending ranking + committee evaluation	Yes, requires: 1) crew (survey + control assessment), see Appendix C
26	*Heritiera littoralis*	looking-glass tree	EARLY DETECTION	Low Risk (-2)	3	possible - data deficient	7.5	not likely	**10.5**	Pending ranking + committee evaluation	Yes, requires: 1) crew time (survey) ; see Appendix C
27	*Mimosa caesalpiniifolia*	sabiá	EARLY DETECTION	High Risk (7)	5	possible - data deficient	5	possible	**10**	Pending ranking + committee evaluation	Yes, requires: 1) crew time (survey) 2) botanist or experienced crew member to monitor for naturalization potential 3) project management (critical landowner communication); see Appendix C
28	*Rubus sieboldii*	Molucca raspberry	TARGET	High Risk (13)	7	possible	3	possible	**10**	RETIRE or PARTNERSHIP SPECIES	Yes, requires: 1) project management (public meeting/critical landowner communication + special use herbicide permitting 2) botanist or crew member time; see Appendix C
-	*Angiopteris evecta*	mulesfoot fern	TARGET	High Risk (8)	6	possible	0 (2)	not likely	**0 (8)**	RETIRE or PARTNERSHIP SPECIES	Yes, requires: 1) project management (conservation agency partnership); see Appendix C

Recommendations

Table 5 was discussed during a KISC Committee meeting held on February 15, 2018, and it was suggested that KISC should begin investigation of all species with a ranking between (and including) 1-10. This includes 17 species total: 5 of which are to be investigated as potential Partnership Species (with organizations more familiar with the Kokee area) , 11 that should be considered for KISC Target designation and one that is currently deemed "Rapid Response" (*Pueraria montana*).

A disproportionate number of species that were prioritized are located in the Kokee area, including ten species listed in **Table 5** (and **Appendix C**) and eight other species of interest listed in **Appendix D**. This includes *Jasminum polyanthum*, *Salix* sp. and *Vicia sativa*, which received high priority rankings of 10 and lower. This is likely due to the fact that it is the only human settlement on Kauai with a temperate climate, and thus, many invasive species in the area were not planted elsewhere on the island. This is in addition to the two nearly eradicated taxa *Ailanthus altissima* and *Picris hieraciodes* mentioned above. Numerous additional species of interest have also been observed in Kokee (e.g. *Arctium minus* and *Acanthus mollis*) but are not reported here due to time constraints and the need for additional surveying in the area. As these potentially invasive plants are located adjacent to high-value native habitat and important tourist areas, it recommended that interagency collaboration and infrastructure be developed to effectively eradicate plants in the Kokee area that are also island-wide incipients (**Table 6**).

Additionally, six species were listed in **Table 5** that have the potential to cause damage to coastal ecosystems, including two species receiving a high priority rank less than 10 (*Heterotheca grandiflora*, *Sesuvium* sp. nr. *verrucosum*). Coastal areas remain one of the last lowland ecosystems in Kauai where one can find native-dominated vegetation, as few alien species can tolerate the wind shear and saline conditions of these sites. Additionally, the aesthetic appeal of Kauai's beaches has important impacts on tourism. Thus, the spread of species that are capable of competing with stress tolerant native species in coastal environments should be monitored carefully and controlled if possible.

Eight species prioritized in **Table 5** have the potential to cause damage to agricultural resources, including *Crotalaria verrucosa*, *Heterotheca grandiflora* and *Vicia sativa*, which received a ranking lower than 10. As protection of agricultural resources is specifically outlined in KISC's strategic plan (KISC 2017), identification of these plants may be useful when directing management actions towards agricultural protection as well as securing funding.

Several species listed in **Table 5** have a high impact score, but were prioritized below a ranking of 10. If KISC eradicates or demotes (due to decreasing feasibility scores) species nearer to the top of this prioritization list, species receiving lower rankings may be addressed by KISC in future years. However, it is likely that several species receiving high invasive impact scores (> 7) but low feasibility scores will not be controlled by KISC and will continue to spread on Kauai (**Table 6**). These species may be considered to be in the "management phase" of their invasion curves relative to KISC's available resources (**Figure 1**), and increased awareness and attempts to establish inter-agency control programs may yield significant benefits. Additional species listed in **Appendix D** may not have yet colonized their entire invasive range on Kauai and have the potential to cause large invasive impacts. However, these species did not receive a prioritization assessment as they were deemed too widespread for eradication by KISC (**Table 6**).

Additionally, several species that may be easy to eradicate were detected, although their corresponding invasive impacts scores are too low to warrant a ranking of 10 or lower (**Table 6**). Although these species may have moderate-low impacts or may simply be naturalizing, removal of these species from Kauai may be beneficial from an island-wide biodiversity standpoint. The current ratio of native to naturalized alien species in Hawaii is roughly 50:50% (Imada 2012), and as the consequences of alien species interactions are largely unknown (Simberloff et

al. 2013), pre-emptive removal and prevention of these species may have benefits that we are unable to predict. These species are listed in **Table 6**, although all species receiving a rank of 8 and above in **Table 5** also have high feasibility scores (>7).

The aforementioned observations may be useful if KISC wishes to apply for specific funding types, focus on specific ecosystems, or develop innovative methods to fill gaps not currently covered by conservation agencies on Kauai. Five strategies associated with these observations are outlined for consideration by KISC in **Table 6**.

Table 6. Species mentioned in this report that could be associated with specific management strategies to be additionally considered by KISC.

Potential Strategy	Species listed in Table 5 (Appendix C)	Other Species of Interest for Various Reasons (Appendix D)*
Removal of incipient invaders near high-value, high-elevation habitat in Kokee	*Jasminum polyanthum* (but at least one small location in lowlands), *Salix* sp., *Vicia sativa*, *Juncus effusus*, *Wisteria sinensis*, *Buddleja madagascariensis*, *Ligustrum sinense, Crassula multicava, Buddleja paniculata*	*Cotoneaster pannosus, Gladiolus dalenii*, *Philadelphus karvinskianus, Prunus campanulata, Prunus persica, Rosa laevigata, Veronica plebeia, Xyris complanata*
Removal of incipient invaders that may impact coastal habitats	*Heterotheca grandiflora*, *Sesuvium* sp. nr. *verrucosum, Harrisia eriophora, Yucca* cf. *aloifolia, Canavalia sericea, Heritiera littoralis*	*Cereus uruguayanus, Clerodendrum inerme, Euphorbia tirucalli, Euphorbia tithymaloides, Phoenix sp, Prosopis juliflora* (Target)*, Vitex trifolia*
Removal of incipient invaders that may impact agricultural resources	*Crotalaria verrucosa, Heterotheca grandiflora, Vicia sativa, Typha latifolia* (Target)*, Flemingia macrophylla, Pueraria montana, Juncus effusus, Coccinia grandis* (Target)	*Citharexylum caudatum, Grevillea banksia, Syngonium podophyllum, Cissus verticillata*
Interagency partnership and outreach regarding species that are potentially beyond eradication by KISC.	*Hiptage benghalensis*, *Ligustrum sinense, Merremia peltata, Melochia umbellata, Rubus sieboldii, Buddleja madagascariensis* (although this plant is currently being tackled by KRCP when funding is available). May also include *Acacia mangium* (rank 9) as its feasibility score is likely to be demoted.	*Cinnamomum* cf. *verum, Cissus verticillata, Citharexylum caudatum, Grevillea banksia, Rhynchospora caduca, Salvinia molesta, Setaria palmifolia, Xyris complanata*
Eradication of species with high feasibility scores, regardless of invasive impact scores (a.k.a. low-hanging fruit).	*Harrisia eriophora, Buddleja paniculata, Heritiera littoralis, Crassula multicava* and potentially *Dovyalis hebecarpa* (although may be cultivated) and *Cissus rotundifolia* and *C. nodosa* (but exploratory KISC control may indicate otherwise).	N/A

***** Other species of interest are provided in this table for use in supporting funding requests or characterizing invasive species problems for certain ecosystems. Attempts to eradicate these species should not be conducted unless additional information affecting prioritization assessments is provided.

Recommendations for the Pono Endorsement Program

Fourteen species were identified that may be considered for future Pono Endorsement "phase out" list, which adds new species every two years. Species on this list meet two criteria, 1) found in nurseries during 2015-2017 surveys and 2) surveys detected potential environmental, agricultural or cultural impacts on Kauai. Details regarding the background and populations of these taxa are outlined in **Appendix D**.

Barleria repens
Cereus uruguayanus
Citharexylum caudatum
Clerodendrum inerme
Cyperus papyrus
Euphorbia cyathophora
Euphorbia tirucalli
Euphorbia tithymaloides
Macfadyena unguis-cati (but only a single individual detected in nurseries – not in current sale area)
Megaskepasma erythrochlamys
Molineria capitulata
Syngonium podophyllum
Thevetia peruviana

Additional species in **Appendix D** should be investigated in the future (as indicated under the "current recommendation for KISC heading), as they were excluded from the list above due to insufficient data regarding their potential impacts (sometimes leading to an "Evaluate" HPWRA score).

A potential area of development within the Pono Endorsement program could be aimed at collaboration with living plant collections including botanical gardens and plant enthusiasts. Special consideration must be given to these collections because they are globally regarded as important sites of invasive plant introductions, but are invested (personally, morally or financially) towards maintaining a diversity of unusual species. For instance, some botanical gardens also play an important role in *ex situ* conservation and botanical research on a global scale, including the National Tropical Botanical Garden on Kauai. Both local and global perspectives on conservation are important to consider, and a collaborative plan with plant collectors is desirable. Species-specific management plans may be applied so that collections may maintain functionally sterilized species of interest. For instance, some species may be dioecious and could be managed by maintaining only one sex. Additionally, some species may have very specific habitat requirements or fruits that can be easily pruned to prevent spread. However, maintaining these collaborative management plans would likely be labor intensive and may require additional resources to support outreach staff.

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APPENDIX A: Methods for Species Prioritization Assessments

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APPENDIX B: 2015-2017 Alien Plant Survey List

APPENDIX C: Species Prioritization Reports

APPENDIX D: Background and Distribution Data for Other Species of Interest to KISC (These species have not received Prioritization Assessments)