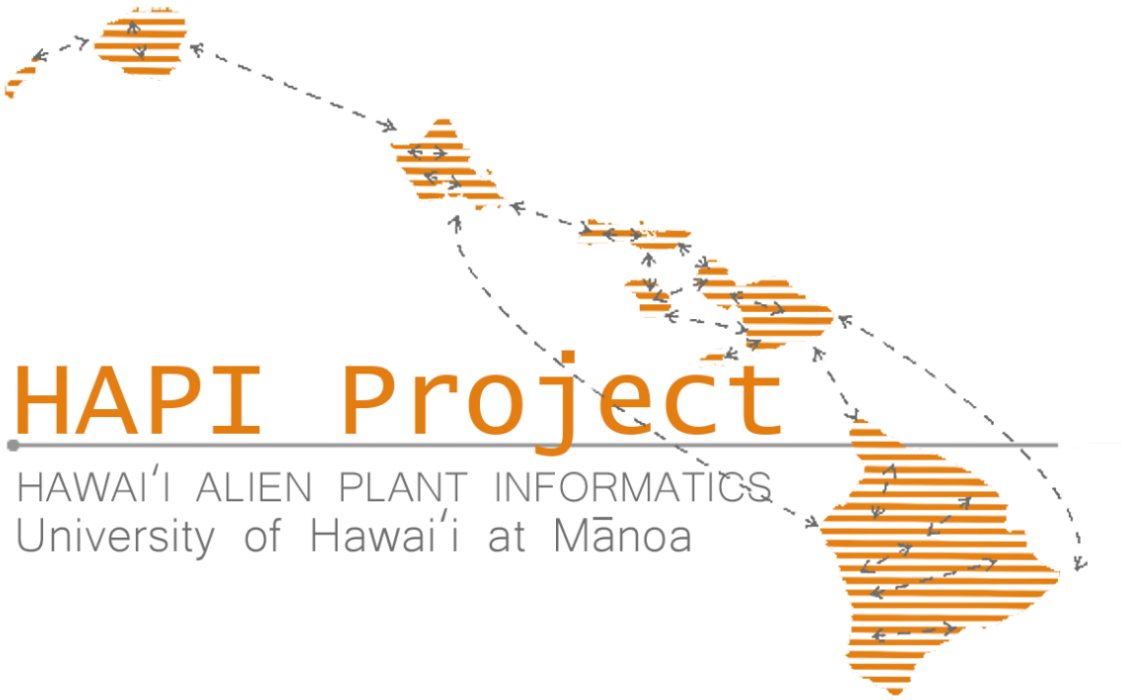
# Summary Report for the Hawai‘i Invasive Species Council for FY18

## The Hawai‘i Alien Plant Informatics Project: Informing Invasive Plant Prioritization and Management Decisions with Interconnected Data




Prepared by Kelsey Brock[1] and Dr. Curtis Daehler[2]

Department of Botany, University of Hawai‘i – Mānoa,
3190 Maile Way, Honolulu, Hawai‘i 96822 USA
Contact:

1) email: kcbrock@hawaii.edu, phone: (808) 320-0567
2) email: daehler@hawaii.edu, phone: (808) 956-3929

## Overview

The Hawai‘i Alien Plant Informatics (HAPI) project aims to compile alien plant biodiversity information while working to improve data infrastructure and provide decision support tools for invasive species managers in Hawai‘i. This report summarizes the efforts completed in this project’s first year with funding provided by the Hawai‘i Invasive Species Council (HISC), beginning February 16th,2018, and ending March 31st, 2019. The entirely of funds allocated to this project (~$32,000) went towards funding the salary and grad student research assistantship of Kelsey Brock, a PhD student in the Department of Botany at the University of Hawai‘i – Mānoa, except for a laptop computer which was also purchased. These funds allowed us to make progress by:

- Surveying invasive species managers about their most important data requirements and research questions in order to devise plans to address these needs.
- Proposing improvements to Hawai‘i’s alien plant tracking system and annotating recent records to account for population data and status uncertainty.
- Compiling alien plant biodiversity data from herbaria and invasive species management groups.

## Information and Research Needs

### *Online Survey*

We initiated this project with an informal online survey of people in Hawai‘i that collect and store information about alien plant species to better understand why they are collecting certain data types. This survey specifically sought to describe the collection of taxonomic (i.e, inventories linked to verifiable plant identifications), ecological (i.e., invasive behavior), and geospatial (i.e., location) data types commonly collected in Hawai‘i. We received 31 responses and 15 people identified themselves as conservationists who regularly make management decisions. Our respondents included endangered species managers, invasive species managers, horticulturalists, land managers seeking to protect abiotic resources (fresh water), herbarium curators, and researchers. Additionally, we asked respondents identifying as conservationists to tell us the largest hindrances to making informed conservation management decisions so that we could integrate this into our plans to construct biodiversity informatics tools that assist decision making. Based on our survey results, we found the following to be interesting:

1) Conservationists ranked understanding the feasibility and financial cost of control strategies as the most pressing research need, with assessing the impacts of invaders being second, and understanding the distribution of potential invaders and predicting which species will become invasive being tied for third.

2) Conservationists readily seek out information about invasive impacts to inform their work. Additionally, many respondents (60%) collect qualitative data describing invasive impacts.
3) Locations of alien plants are regularly collected using handheld GPS devices and invasive species management groups collect the most detailed spatial data, often taking a GPS point for every plant observed or controlled.
4) Fifty percent of respondents submit herbaria vouchers to provide a verifiable taxonomic record of alien plant species, while others only submit material to herbaria when requesting identification or as supporting information in research publications.

We concluded that knowledge gaps and uncertainty is the norm for conservation decision-makers in Hawai‘i, and although different groups focus on collecting different data types, the compilation of data from multiple collectors may have a synergistic effect, allowing for more informed decision making (Figure 1). The potential end users of the HAPI data portal have advocated for the inclusion of distribution data, allowing managers to make decisions regarding the feasibility of control dependent on the potential population extent. Additionally, potential impact data, especially regarding impacts to native ecosystems, should be available to help prioritize management of the most impactful invaders.

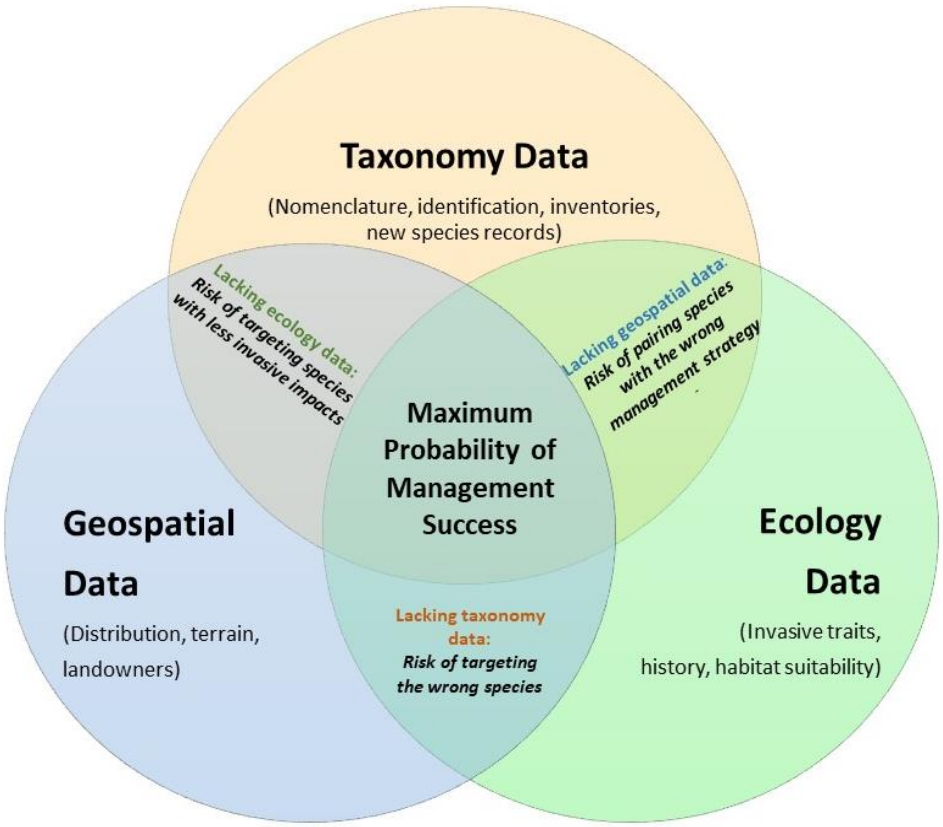



*Figure 1. The benefits of compiling taxonomic, ecological and geospatial data to guide management strategies.*

***Future Research Plans***

The survey was not only used to make plans to construct a data portal that would suit a diversity of management needs, but served as the basis for the following research questions, which will be explored while fulfilling the research requirements for K. Brock's PhD degree:

1) Are remote islands like Hawai'i more susceptible to plant invaders that have no invasive history elsewhere?
2) Which alien plant introductions contribute to the homogenization of plant diversity over time, making Hawai'i's unique and diverse flora increasingly similar between islands and between habitats?
3) Can machine learning accurately assign potential management strategies to each of the thousands of plant invasions in the Hawaiian Islands, giving managers a starting point for target species selection?

## Improving Hawai'i's Alien Plant Tracking System

***Publishing Guidelines to Increase Reporting Consistency***

A data portal to inform management decisions requires strong guidelines for data communication (a.k.a. data pipelines) so that information may be 1) updateable beyond the timeline of its initial construction and 2) used by managers to compare management scenarios between species and across time (Cheney et al. 2018). Taxonomic resources such as species checklists are based on high quality, verifiable plant identifications and account for species name changes. These resources form the foundation of informatics tools because the species name provides an anchor around which all other relevant management data pivots in biodiversity-structured databases (e.g., invasion risk, distribution). Thus, we focused our efforts on strengthening an existing pipeline, the *Records of the Hawai'i Biological Survey*, to increase the consistency of data the taxonomy, status, and basic distribution of alien plants in Hawai'i. We drafted a manuscript entitled *"Recommendations for Reporting Records of Alien Plant Species in the Hawaiian Islands"*, with input from 9 experts in floristics and invasive species management in Hawai'i. This manuscript will be submitted in 2019 to the *Bishop Museum Occasional Papers* and makes suggestions for data collection and the use of invasion status categories while providing terminology associated with tracking alien species along the introduction-naturalization-invasion continuum. Increased consistency in data collection and new record reports ensures alignment between Hawai'i's classification of alien plant statuses (Imada 2019; Wagner et al. 2012) and a globally utilized framework for invasive species (Blackburn et al. 2011). Additionally, guidelines for reporting extirpations are proposed, which provides invasive species management groups with an avenue to communicate likely eradications as a result of successful control programs (Figure 2). Moreover, reports of extirpations are required to accurately track the number of naturalized alien plants on each island.

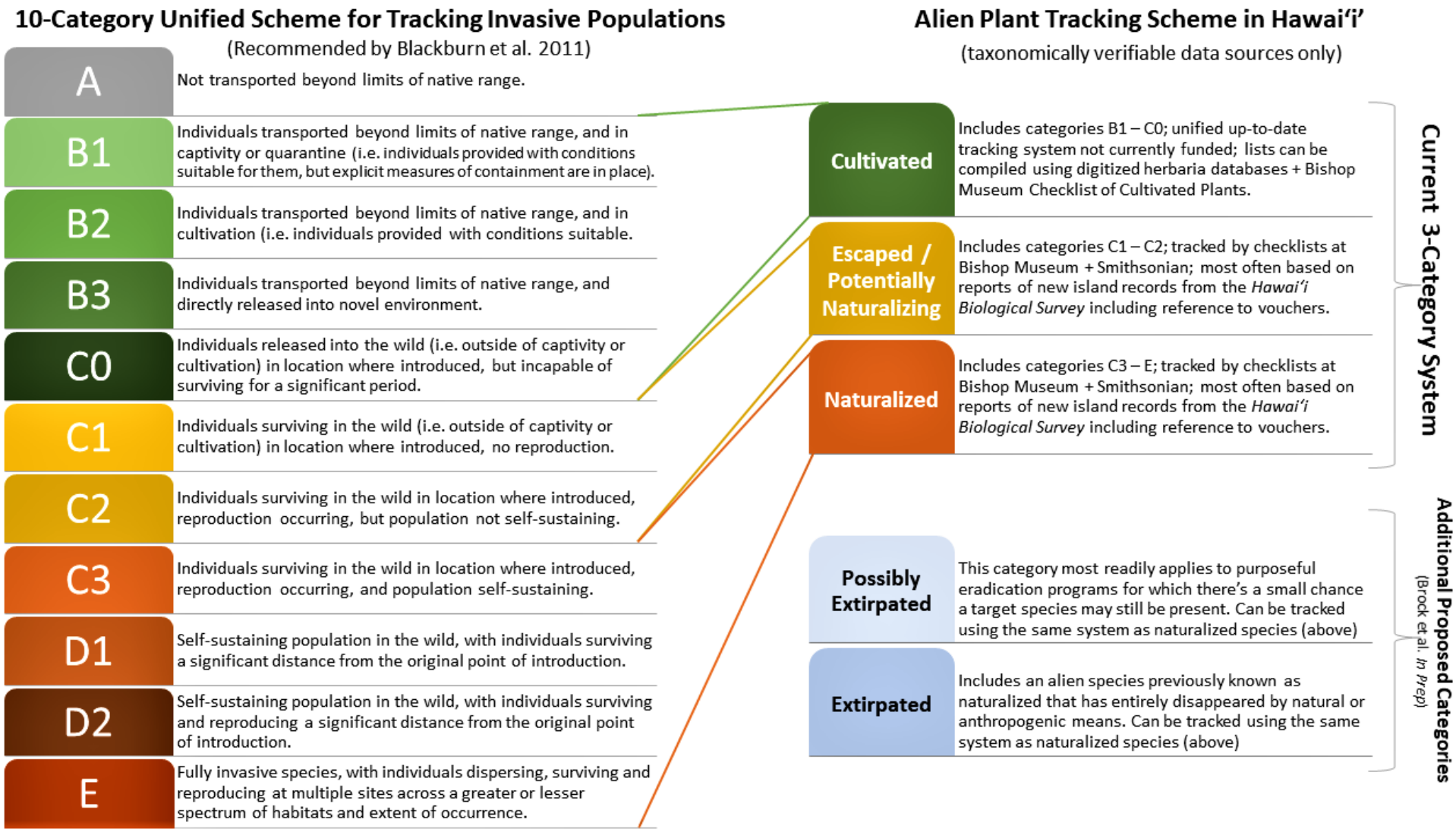



*Figure 2. A theoretical alignment between the detailed, globally recognized scheme (left) recommended by Blackburn et al. (2011) and the commonly used categories for tracking alien plant species in Hawai'i (right), forming the basis for the terminology and categories recommended in our in-prep manuscript. Additionally, categories for extirpation are proposed (bottom right).*

***Attributing the Existing Checklist with Population and Uncertainty Data***

We systematically attributed each naturalized species record (Imada 2019) with supporting information (gleamed from naturalization reports and herbarium records) about 1) the area covered by non-cultivated individuals, their density, and a description of the habitat; 2) the number of non-cultivated individuals observed, or, for vegetatively reproducing species, evidence that many, disconnected clones are present as a result of dispersed propagules (even if their dispersal is human-assisted); 3) the number and type of life stages present (mature, seedlings, etc.); and 4)the source of naturalization, if apparent (e.g., seed contamination, cultivated plants). This permits comparison between current populations and population descriptions from when a species was first reported, allowing us to use subsequent reports and herbaria vouchers to estimate whether a species has progressed along the introduction-naturalization-invasion continuum and, in some cases, provides justification to adjust the status of alien plant records such that it follows the aligned classification scheme represented in Figure 2. This data also allows for additional estimates of whether the first herbarium record occurred shortly after the approximate date of naturalization, or several decades later. Accounting for this information is critical when developing predictive invasion models, because the approximate date of arrival is an important factor when assessing the rate of spread or eradicability of populations. We have compiled a list of 43 recently introduced species (since 1990) for which little or no data exists regarding its population and are reaching out to field botanists statewide to help fill in this knowledge gap.

## Compiling Alien Plant Data

The goal of this project is to compile a statewide alien plant data set, representing all major conservation and research entities in Hawai‘i to create the platform upon which we will base our subsequent analyses and informatics tools. So far, we have compiled data from five organizations, amounting to 254,726 lines of data. We are establishing data sharing agreements with at least 8 additional organizations, which will enable us to construct the complete data set. Thus, characterizing the data set (% records with geospatial data, ecological data, taxonomically verified, etc.) is scheduled for completion in FY2019. Progress towards compiling this data set is expected to increase as we continue to strengthen our relationships with multiple conservation groups and relay our plans to ensure the privacy of private landowners. The currently compiled dataset represents a diversity of data collection methods of both herbaria and invasive species managers, allowing us to make progress on troubleshooting issues regarding the variable use of taxonomic synonyms. Additionally, we have written computer programming code to automate the extraction of data from the pdf reports produced by the Hawai‘i-Pacific Weed Risk Assessment, so they can be integrated into our data set as they are produced. This avoids transcription error and the need for labor to manually add the individual answers to questions regarding a plants’ potential to spread and cause damage (Daehler et al. 2004) to our developing data platform.

## References


Blackburn, T.M., Pysek, P., Bacher, S., Carlton, J.T., Duncan, R.P., Jarosik, V., Wilson, J.R.U., Richardson, D.M., 2011. A proposed unified framework for biological invasions. Trends in Ecology & Evolution 26, 333-339.

Cheney, C., Esler, K.J., Foxcroft, L.C., van Wilgen, N.J., McGeoch, M.A., 2018. The impact of data precision on the effectiveness of alien plant control programmes: a case study from a protected area. Biological Invasions 20, 3227-3243.

Daehler, C.C., Denslow, J.S., Ansari, S., Kuo, H.C., 2004. A risk-assessment system for screening out invasive pest plants from Hawaii and other Pacific Islands. Conservation Biology 18, 360-368.

Imada, C.T., 2019. Hawaiian native and naturalized vascular plant checklist (December 2019 update). Contributions to the Hawaii Biological Survey. Bishop Museum Technical Report.

Wagner, W.L., Herbst, D.R., Khan, N., Flynn, T., 2012. Hawaiian vascular plant updates: a supplement to the Manual of the Flowering Plants of Hawai'i and Hawai'i's ferns and fern allies. Washington, DC: Smithsonian National Museum of Natural History.