

## INTRODUCTION

Kalaupapa National Historical Park (KALA) was established in 1980, dedicated to preserving the memories and lessons of the past (NPS 2008). From 1866 until 1969, people of Hawaii afflicted with Hansen's disease (leprosy) were placed in forced isolation on the Kalaupapa peninsula on the island of Molokai. Kalaupapa settlement is still home for several surviving Hansen's disease patients whose memories and experiences are cherished values. Kalaupapa now serves as a place for education and contemplation.

KALA includes spectacular geologic and biotic features including sea cliffs, a conic volcanic crater, lava tubes and caves, lush valleys and rain forests, off-shore islands, and coral reefs. These areas also provide habitat for endangered Hawaiian plants and animals. Collections of the flora of this region have been made periodically by various individuals or organizations. From these studies, it is known that there are many rare species present within the park boundaries. However, no comprehensive survey has been made that thoroughly investigated these lands.

In studying terrestrial ecosystems with the goals of inventory, threat abatement, stabilization of resources, monitoring, and the restoration of selected components, there is much to be documented and learned. This study represents one major component – the inventory and documentation of the terrestrial vascular plants within KALA. This effort supports and lays the foundation for other KALA Natural Resource Management goals such as reducing the impacts of invasive species, and stabilizing or restoring native species and ecosystems. Developing an understanding of plant occurrences and distributions assists in planning and implementation of weed control and threat abatement projects. Documenting native plant species and related plant associations provides some indication of appropriate suites of species for use in restoration projects. Concurrent with the efforts of this inventory KALA staff conducted a variety of other projects: mapping the terrestrial vegetation within KALA; inventory of most taxonomic groups of higher terrestrial plants and animals; the stabilization of rare, threatened, and endangered plant through propagation, and outplanting; in-depth analysis into the estimation of the total number of species, species richness, taxonomic distinctness, the classification of the flora into collocated groups; fencing and ungulate control programs in selected special ecological areas (SEA), and targeted weed control of selected species within those SEAs. As a direct result specifically of our plant inventory efforts, we have also published two other works that may be of interest to readers: *Kalaupapa National Historical Park, Vascular Plant Inventory, Kalawao, Molokai, Hawaii* (Hughes et. al. 2007) and *New Hawaiian plant records for the Island of Moloka'i*. (Wysong et al. 2007).

The purpose of this project was to inventory the flora of Kalaupapa National Historical Park; create a permanent and usable herbarium in the form of physical vouchers and high resolution digital photographs for current and future park service staff, residents, and visitors; and duplicate a set of physical collections for the Bishop Museum in Honolulu for long-term archiving. Placing vouchers at the Bishop Museum and posting them on the web was intended to serve the greater conservation community in the state of Hawaii

by greatly increasing the floristic inventory and distribution data for native, including some rare and endangered, as well as non-native plants on the island of Moloka'i. Additional vouchers of mostly rare plants were deposited in the herbarium at the National Tropical Botanical Garden by permitted researchers who assisted on this project.

## METHODS

Collections within and outside of the park boundary were made between October 9, 2004 and March 4, 2006 in one of the 15 management units within KALA (Figure 1). We chose to reference our collections within the context of management units for a number of reasons. When posting vouchers on the internet, we intend to inform without providing the specific locations of individuals. Historical collections of rare, threatened, and endangered plant species were researched and photographed at the Bishop Museum. Some older collections were included in this inventory from the work of other park staff and contract botanists. In general, collections were made either as part of a team or independently. Due to the difficulty of terrain and limits on helicopter time due to budget constraints, a systematic collecting approach was not possible. Instead, collections were made opportunistically and reflect the amount of time spent in each area.

Habitat codes were frequently used during field collection to designate habitat types (see Table 1). Habitat codes were first developed by Jacobi (1989) and were subsequently adapted by Evangeline Funk (unpublished). The authors adapted these codes and applied them to the lowland, alien dominated vegetation found at KALA.

Plants were collected and immediately stored in a field press (including newspaper and large corrugates) and kept in a large Ziploc bag until return when further processing could take place. Collection information recorded for each specimen included collector's number and date, and other pertinent information including location, elevation, habitat, plant description, and any identifying characteristics. Field identification of collections was made when possible; unknown plants were determined in the lab using Wagner et al. (1999), and Palmer (2003) prior to pressing. Specimens not identified were brought to Bishop Museum for determination.

Specimens were then pressed following standard procedures and dried for several days in a custom made plant drier using up to 6 spotlights as a heat source. Specimens were then mounted on standard acid-free herbarium mounting paper using archival quality glue. Collection data was entered into the database and a standard label was printed up for the specimen (<http://www.hear.org/molokai/kalaupapa/herbarium/>). While duplicates of a collection were listed under the same collector number, every single voucher specimen received a unique catalogue number (beginning with KALA) to denote that it was part of this project. In addition, every single voucher specimen for this project was collected under the same accession number (KALA 00154) except for those specimens that went directly to the National Tropical Botanical Garden. The unique accession number identifies this project as one of the many archiving projects conducted at KALA. Finally, a photo of the complete specimen was taken and archived. Upon completion of the

project, these photos were sent to the webmaster of the Hawaiian Ecosystems At Risk (HEAR) website (see link above in this paragraph).

Upon completion, vouchers were stored temporarily at the Kalaupapa Natural Resources Management office in Bayview until originals could be sent to Bishop and duplicates could be kept for long-term storage at the Kalaupapa Museum facility (a.k.a. *Hale Malama*) in Kalaupapa.

## RESULTS

In total, 625 collections (with many duplicates) were made over 83 separate days yielding 963 vouchers. Collections represent 20 families, 38 genera and 63 species of ferns, two families, genera and species of gymnosperms, 83 families, 214 genera and 312 species of dicots, and 17 families, 52 genera, and 77 species of monocots. Approximately 45% of the species collected represent native (endemic and indigenous) taxa. Of all the vouchers produced, 509 were sent to Bishop (BISH; Table 2), 447 stayed at Kalaupapa (KALA; Table 3) and 23 went to the herbarium at the National Tropical Botanical Garden on Kauai (PTBG; Table 4). We refer the reader to view these collections on the internet at this location: <http://www.hear.org/molokai/kalaupapa/herbarium/>.

We have excluded our electronic photos of all the historical (pre-1950) collections of rare, threatened, and endangered species from this paper and the electronic herbarium posted on the internet. If permitted researchers are interested, historical resources are available on file at KALA (Table 4). In addition, many of our observations and collections of rare, threatened, and endangered species have also been omitted for sensitivity to the resource, and again, permitted researchers may make inquiries of KALA staff.

## DISCUSSION

Habitats were visited in an attempt to survey as much of the park as possible. However, due to the difficulty of the terrain, much of the park remains under-surveyed, especially the coastal cliff areas and steep gulches. As a result, this work reflects a larger proportion of collection on the peninsula and the Kalaupapa trail. Future efforts should be concentrated in inventorying the more remote areas of the park. KALA is currently working with the Pacific Islands Inventory and Monitoring Program to complete a vegetation map for the park. Further plant collection work may result from this effort, and the map itself may direct investigators to future areas of interest for plant collection and inventory. One product of the vegetation mapping effort will be in depth vegetation or habitat descriptions that were not within the scope of this project.

Prior to the completion of this project, 502 observed taxa were known from KALA records and previous inventories. Non-parametric estimators (ICE, Chao 2, Bootstrap) (Colwell 1997) were used to estimate the total number of vascular plant species occurring in natural areas in KALA indicating that at least 89% (502 observed of 564 mean estimated taxa) were identified within natural areas at KALA (Hughes et al. 2007). The

focus of this investigation in and around more developed areas in KALA expanded our knowledge of naturalized species to 581 plant taxa, 21 (2 endemic, 19 naturalized) new island records, 5 new naturalized records, and sightings of 34 rare plant taxa including five federally endangered species, two federally threatened species, one federal candidate, and 18 species of concern (Hughes et al. 2007, Wysong et. al 2007). This number represents 455 species collected on this project and 126 not yet collected but recognized within the park boundaries (Appendix 1)

It is important to note that several non-native species collected had what we perceive and hope to be very limited distributions. We made efforts to remove non-native populations of many of the species identified during the course of this work. Additional efforts should be made to revisit the sites of several of the new island records to further delineate the extent of the population and make determinations for extirpating nascent non-native plant populations. The three species that we took special note of were *Argemone mexicana*, *Cucumis dipsaceus*, and *Ehrharta stipoides*. There is a distinct possibility that these species were inadvertent, recent introductions that may be completely eradicated. KALA is having some success in managing the first two species that were found in scattered locations around the park in coastal areas. KALA is planning to survey the distributional extent of *Ehrharta stipoides* in Puu Alii NAR in the summer of 2008.

We collected 455 plant taxa, and given our other known observations, we estimate that at least 126 species remain uncollected from KALA (Appendix 1). Future work should concentrate on collecting these species. The information in this report is perhaps most valuable for it's information on occurrences and locations of noxious weeds and rare plants and we sincerely hope that it can be used to help guide management decisions in the future.

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