

S P E C I A L R E P O R T

*Maui Ecosystems at Risk*

**REMNANT WILIWILI FOREST HABITAT  
AT WAILEA 670, MAUI, HAWAII**



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## Summary

1. The southern 1/6 of the Wailea 670 is geologically distinct from the remainder of the property, because an a`a lava flow passed through there 10,000 years ago. Because of the unique soil properties of the a`a flow, this portion of the property supports self-maintaining populations of 12 endemic species of Hawaiian plants, as well as 8 indigenous species. In contrast, the northern 5/6 of Wailea 670 is devoid of endemic Hawaiian plants.
2. The wiliwili trees (*Erythrina sandwicensis*) and other Hawaiian species found on the a`a flow in Wailea 670 are remnants of low-elevation Hawaiian dryland forest. This habitat is one of the most highly endangered ecosystems in the United States. Fully 95% of this ecosystem has been destroyed by fire and cattle. The surviving 5% of this ecosystem on Maui occur mainly on recent (4000-10000 year old) a`a lava flows, which keep the vegetation sparse enough to survive fires in the surrounding areas, and prevent suffocation by invasive alien grasses.
3. Wailea 670 contains most of the 3rd largest contiguous area of wiliwili (*Erythrina sandwicensis*) habitat on Maui, approximately 110 acres in the southern 1/6 of the property. The oldest wiliwili trees are estimated to be hundreds of years old. The developer's current mitigation plan would set aside 6 of the 110 acres for preservation (95% destruction of the habitat area). The lower elevation portion of this habitat has already been destroyed by the development of the Makena Golf Course and Pa-lauea.
4. Wailea 670 is one of only two other sites on Maui where Rock's nehe (*Lipochaeta rockii*) survives. The physical morphology of the Wailea 670 nehe is found nowhere else besides this population.
5. Wailea 670 is one of only four other sites on Maui where the awikiwiki (*Canavalia pubescens*) survives. Awikiwiki is the vine whose purple flower is the original source for the Mauna Loa lei, has the highest priority rating for becoming a Federally listed endangered species.

6. The original plan to develop Wailea and Makena as a resort were drawn up at a time when little political value was placed on preserving native ecosystems in Hawaii. Thus, there was no evaluation given as to how the plans would threaten the surviving remnants of the wiliwili ecosystem. Today, much better data is available, and the public places a much higher value of the preservation of nature. However, the County approval process still does not provide resources for evaluating the impact of planned development on natural resources. Therefore, it falls upon developers and the public—individuals or organizations—to provide the County with the necessary information.
7. Because all of the remnant wiliwili habitat falls on one end of the property, it can be set aside as conservation land without posing difficulty for development of the other 5/6 of the property.
8. The County Council can vote to transfer to the rest of the development the existing development rights for the area comprising the remnant wiliwili forest, and put this area into a conservation easement, as has been done with other areas of high conservation value on Maui. The remainder of the property can be developed at a higher density and include all the features proposed by the developer.

## Overview

The Wailea 670 development proposal presents a situation in which a developer is proposing to destroy one of the largest remnants on Maui of a highly endangered Hawaiian ecosystem. This situation is the consequence of several forces. The primary factor is the weakness of current law and institutions in considering entire ecosystems. Current environmental protection laws focus on protecting listed endangered species. Protection of unique habitat and ecosystems enters into policy mainly through their relation to listed endangered species. (The notable exception to this situation is the protection offered to wetland ecosystems through the Clean Water Act.) Because the law and institutions have not been charged with protecting endangered ecosystems as such, a situation like Wailea 670 can come about where neither the developer nor the County, State, or Federal governments have been adequately apprised of the damage this proposed de-

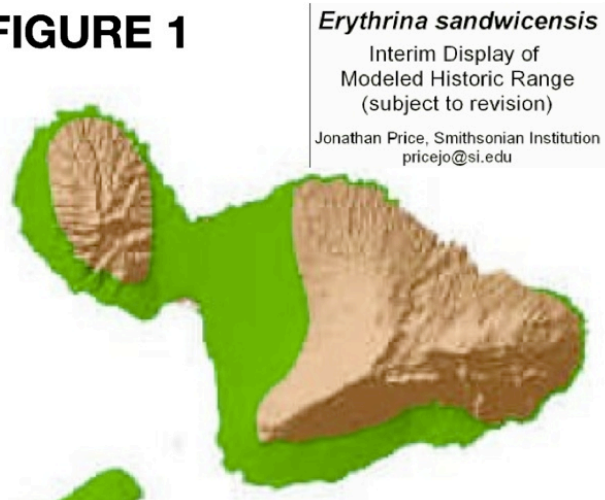


velopment would inflict on this endangered ecosystem.

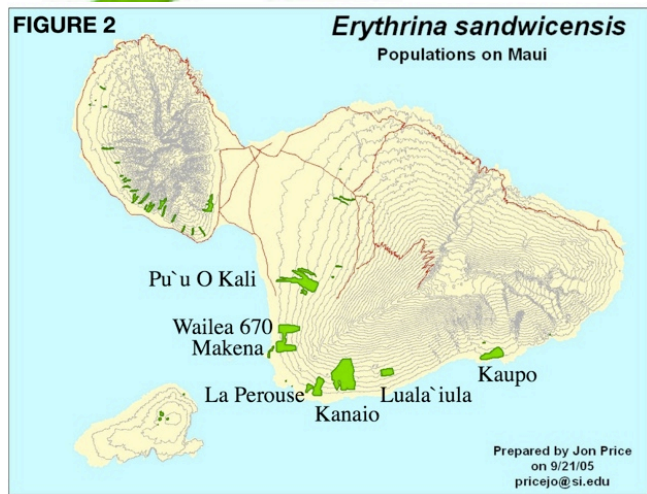
Fortunately, the developer has been willing to allow the author and colleagues the opportunity to survey the property for native Hawaiian species, making it possible to better inform him, the public, and the Maui County Council on its deliberations for a proposed rezoning ordinance. It is within the Maui County Council's zoning power to preserve this tract for future generations.

In this report, I will present our findings on the ecosystem resources that occur on the Wailea 670 property. Most importantly, this report will present the missing piece of the picture—the significance of this property to the survival of wiliwili forest ecosystems on Maui. In addition, it will discuss the unique genetic resources that this project will exterminate if approved in its present form.

**FIGURE 1**



**FIGURE 2**



## Wiliwili Forest Remnants on Maui

The current estimate for the original pre-settlement range of wiliwili forest is shown in Figure 1<sup>1</sup>. An estimated 95% of the original forest has been destroyed, leaving areas that are mainly open-canopy “woodlands” and savannas.

The best current map of the remaining wiliwili forest habitat on Maui is shown in Figure 2<sup>2</sup>. The eight largest

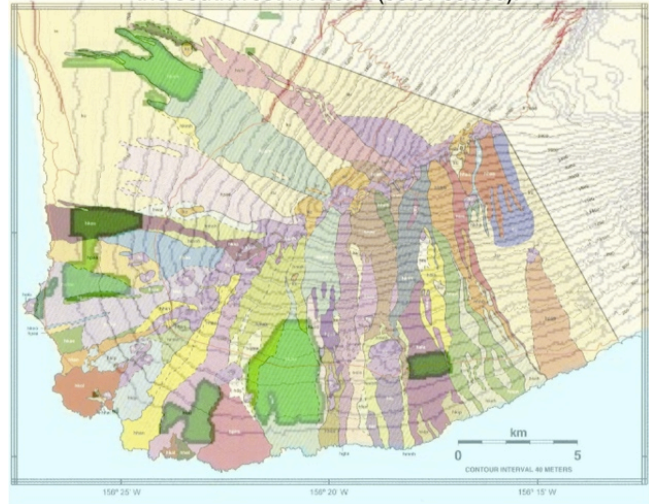
wiliwili forest remnants are, in decreasing order: Kanaio, Pu`u O Kali, Wailea 670, Makena, La Perouse, Kaupo, Luala`ilua, and Waikapu (see Figure 3). Other remaining remnants are substantially smaller in area, mainly along valleys in West Maui.

The causes of this severe ecosystem destruction are believed to be principally fire, cattle grazing, and invasive African buffel grass and Central American kiawe. The reason for the survival of wiliwili forest in the habitats that are left are believed to be due to their relative unsuit-

**FIGURE 3:** Comparison of the sizes of wiliwili remnant habitat areas, in decreasing order



**FIGURE 4:** Wiliwili remnants overlaid on the lava flows of the southwest rift zone (color coded).



<sup>1</sup> Jonathan Price

<sup>2</sup> Jonathan Price. Regarding the maps, Price notes: “The blobs on the map are actually what we would define as “areas of extent” rather than “areas of occupancy”... in other words the blobs are meant to enclose scattered individuals in each of the populations rather than depicting contiguous forest filling in each blob. That being the case, the amount of actual wiliwili is somewhat less than what the map actually shows. Many of these “forests” are actually woodlands (25% to 60% tree cover) or savannas (<25% tree cover). Therefore, the map paints a somewhat rosy picture, since its goal was to tell people where to look for wiliwili in order to collect seeds.”

ability for these causes: the remnants are all on recent a`a lava flows whose soil cover is so sparse that it (1) produces an open canopy less able to propagate the fires that swept through many of these areas, (2) does not become choked with buffel grass, and (3) is a rugged substrate discouraging to cattle. As can be seen in Figure 4<sup>3</sup>, all of the large wiliwili forest remnants can be identified with particular lava flows. With the exception of the Kanaio flow, all the large surviving wiliwili remnants are on lava between 8 and 10 thousand years old, as shown in Table 1<sup>4</sup>.

Table 1: Wiliwili remnants, their associated lava flows, and age of flow.

Habitat Location	Kanaio	Pu`u O Kali	Wailea 670	Makena	La Perouse	Kaupo	Luala`ilua	Waikapu
Flow ID	hkam	hpae	hkea	hwkw	hkai	N/A	hale	N/A
Age	4070	8830	10290	c. 8100	c. 8100	N/A	8190	N/A

Figure 4.1 shows an aerial view of the area surrounding Wailea 670. The HKEA lava flow can be seen as a darker green band, indicating a distinct habitat, running through the southern end (right side) of Wailea 670.



The survival of wiliwili forest on these habitats, despite the 95% destruction of this

<sup>3</sup> Overlay of J. Price map and map from Bergmanis et al. 2000. Rejuvenated volcanism along the southwest rift zone, East Maui, Hawai'i. *Bull. Volcanol.* 62: 239-255.

<sup>4</sup> Data from Bergmanis et al. 2000. Rejuvenated volcanism along the southwest rift zone, East Maui, Hawai'i. *Bull. Volcanol.* 62: 239-255.

ecosystem on the rest of Maui, defines these areas as the only known habitat with characteristics allowing the survival of wiliwili forest. Thus, preservation of this habitat is critical to the survival of the low elevation Hawaiian wiliwili forest.

To put in perspective the severity of the loss of dry forest in Hawaii, we have this comparison tabulated by Noss *et al.* (2001)<sup>5</sup> for Hawaiian ecosystems:

- 90% loss of dry forests, shrubland, and grassland on all main islands combined (Hawaii State Department of Land and Natural Resources et al. 1992; Hawaii Heritage Program 1992).
- 80% of original habitat below 458 m severely altered by the year 1800 (Holing 1987).
- 67% of original forest cover lost, including 50% of rain forests (Hawaii State Department of Land and Natural Resources et al. 1992).
- 61% loss of mesic forest and shrubland on all main islands combined (Hawaii State Department of Land and Natural Resources et al. 1992; Hawaii Heritage Program 1992).
- 52% (74 of 141) natural-community types are considered imperiled or critically imperiled globally (Hawaii Heritage Program 1991).
- 42% loss of wet forest, shrubland, and bog on all main islands combined (Hawaii State Department of Land and Natural Resources et al. 1992; Hawaii Heritage Program 1992).
- 3% loss of subalpine forest, shrubland, and desert on all main islands combined (Hawaii State Department of Land and Natural Resources et al. 1992, Hawaii Heritage Program 1992).
- 12% loss of wetlands between 1780's and 1980's (Dahl 1990).

“Native dry forests are considered the most endangered ecosystem on the Hawaiian Islands with less than 10% remaining statewide.”<sup>6</sup>

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<sup>5</sup> Reed F. Noss, Edward T. LaRoe III, J. Michael Scott. 2001. Endangered Ecosystems of the United States: A Preliminary Assessment of Loss and Degradation. <http://biology.usgs.gov/pubs/ecosys.htm>

<sup>6</sup> Hawaii Army National Guard, 1999. Secretary of Defense Environmental Security Awards, Hawaii Army National Guard, Natural Resources Conservation. [https://www.denix.osd.mil/denix/Public/News/Earthday/SecDef99/Army-Awards99/Hawaii\\_nrc/hawaii\\_final.html](https://www.denix.osd.mil/denix/Public/News/Earthday/SecDef99/Army-Awards99/Hawaii_nrc/hawaii_final.html)



**FIGURE 5:** Proposed Developer's Plan for Wailea 670. Overlaid are GPS waypoints of native plants, and the purple outline shows the area containing the remnant wiliwili habitat, which could be put into a conservation easement.



## The Remnant Wiliwili Forest at Wailea 670

The developer's plans for the property are shown in Figure 5. On the right most end of the diagram is the area in which all of the endemic species are found, enclosed in a purple outline. A closeup of the southern portion is shown in Figure 6, rotated so that north is now on top. Overlaid on the plan are the plots of individual native plants mapped using GPS. A total of 20 native plant species were identified, 12 of them endemic to Hawaii, and 8 of them indigenous. The area outside the purple boundary has no endemic species except for some isolated wiliwili trees; it is completely dominated by African buffel grass, kiawe, and haole koa. The area within the purple boundary coincides with the HKEA lava flow of 10000 years ago. The age of the other substrate is in the hundreds of thousands of years. The developer's current mitigation plan would set aside 6 of the 110 acres for preservation (95% destruction of the habitat area).



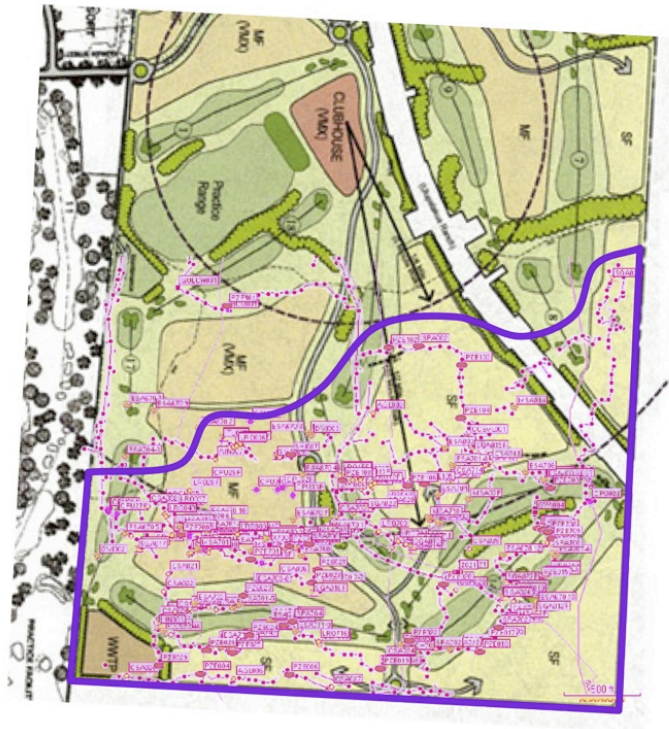
## Transect Surveys

In order to better characterize the distribution, abundance, and diversity of native vegetation at Wailea 670, the developer allowed the author and colleagues to conduct a series of transect surveys on 2003-2-2, 2004-2-14, 2004-8-14, 2005-3-20, and 2006-3-6. Random transects were walked through the area around the HKEA a`a flow. All specimens

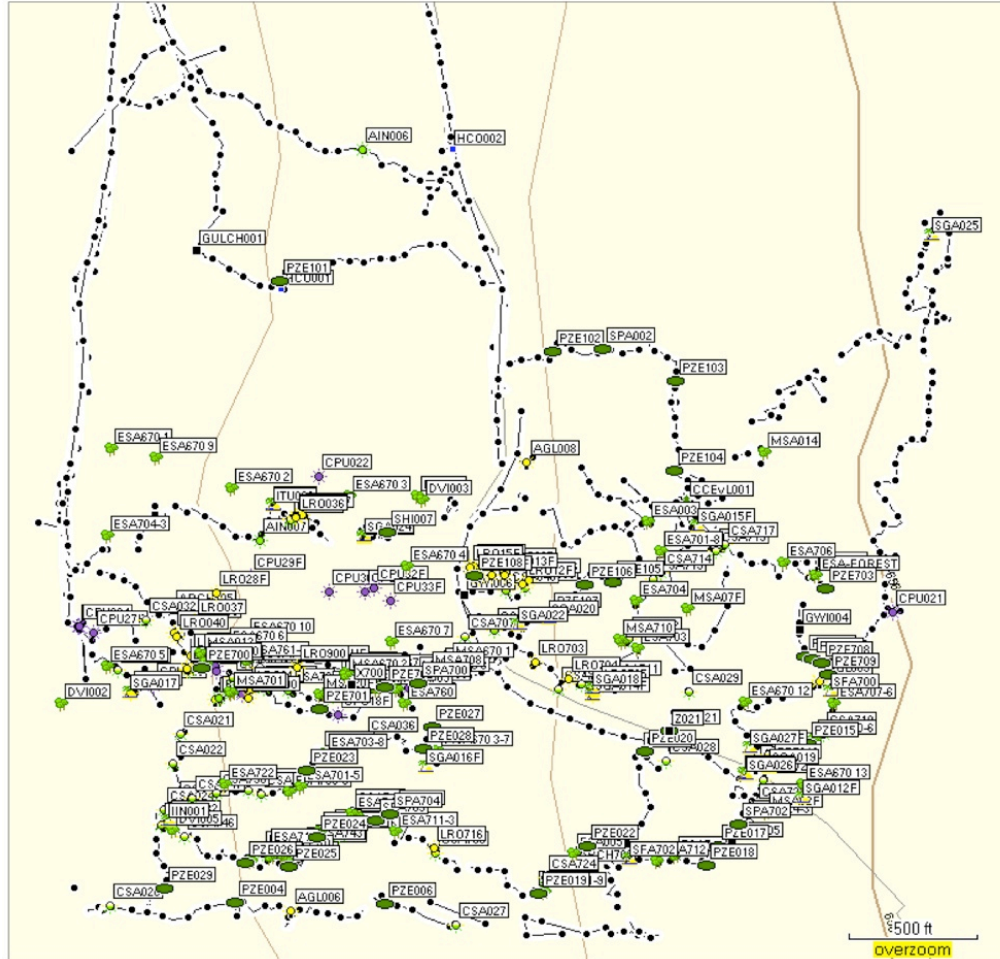
of the least numerous species were noted: naio, awikiwiki, nehe, heuhiuhi, a`ali`i, akoko. These include a single akoko tree and two dead akoko trees which were discovered by the author on 2003-2-2. Representative samples of more numerous species were also recorded: wiliwili, ilie`e, maiapilo, anunu, koaliawa. Plentiful species such as uhaloa and ilima were generally not recorded. Figure 7 shows all of the transects and the waypoints recording individual native Hawaiian plants. The transects that

do not have waypoints recorded reveal the lack of native species along that transect. The density of waypoints along the transects indicates the viability of the habitat for native species. Areas that do not have transects through them have not been surveyed. Plots for individual species of interest are shown in Figure 8.

**FIGURE 6:** Closeup of south portion of the Wailea 670 plan overlaid with the transect survey waypoints on individual native plants, labeled in red. Purple line marks the extent of native plant area. Top is north.

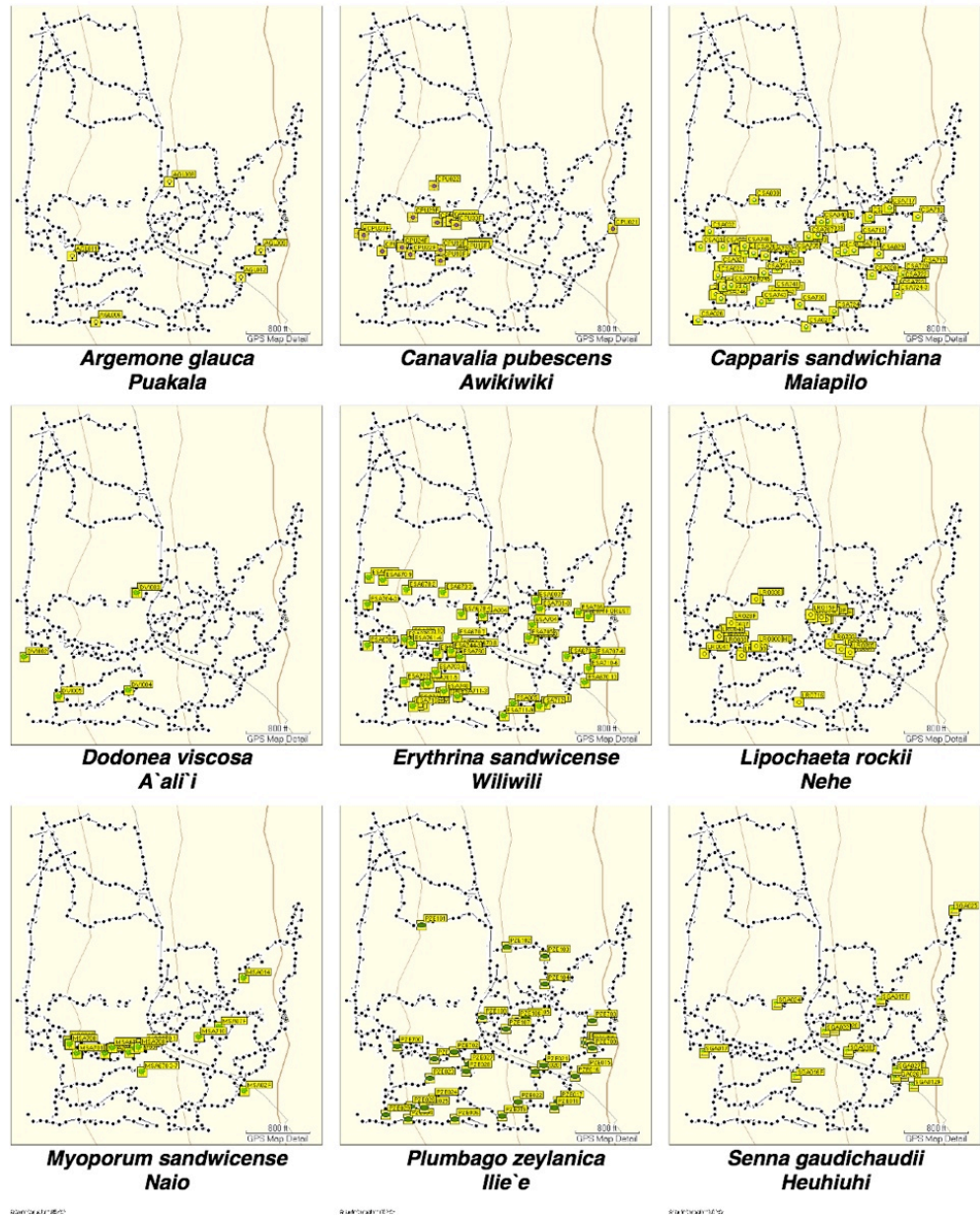


**FIGURE 7:** Plot of 5 transect surveys with waypoints marking individual native plants of interest.



Prior biological surveys conducted by Char & Associates (1988, 1991, 1993, 2004) missed a few endemic species including *Akoko Chamaecybe celastroides var. lorifolia*. Char also failed to give any information of the comparative value of this property within the inventory of remaining wiliwili habitat sites on Maui. It was merely described as “scrub vegetation”.

**FIGURE 8:** Distribution of selected native species over the southern 1/6 of Wailea 670





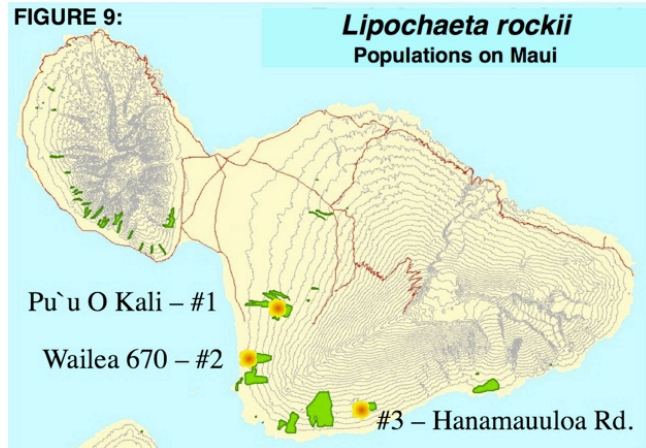
## Rock's Nehe, *Lipochaeta rockii*

*Lipochaeta rockii* is found on only two sites on Maui in addition to the a`a flow at Wailea 670. These populations would meet the conditions for endangered species listing had they not been taxonomically

lumped with the populations on Molokai. Each local population has unique morphological traits which distinguish them. The Wailea 670 population represents one end of the morphological spectrum, its leaves being the least dissected<sup>7</sup>. The neighboring population at Pu`u O Kali, 3.5 miles away, repre-

sents the other extreme of the spectrum, its leaves being the most dissected. The author has observed ecological differences as well: the Wailea 670 population dies back to the

roots during the dry season, whereas individuals in the Pu`u O Kali population have been found with green leaves even at the height of the dry season. For comparison, individuals from the Pu`u O Kali and Wailea 670 populations are shown in Figure 11. The cause of the differences between these neighboring populations has never been



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**FIGURE 10:** *Lipochaeta rockii* leaf morphology in Wailea 670 population

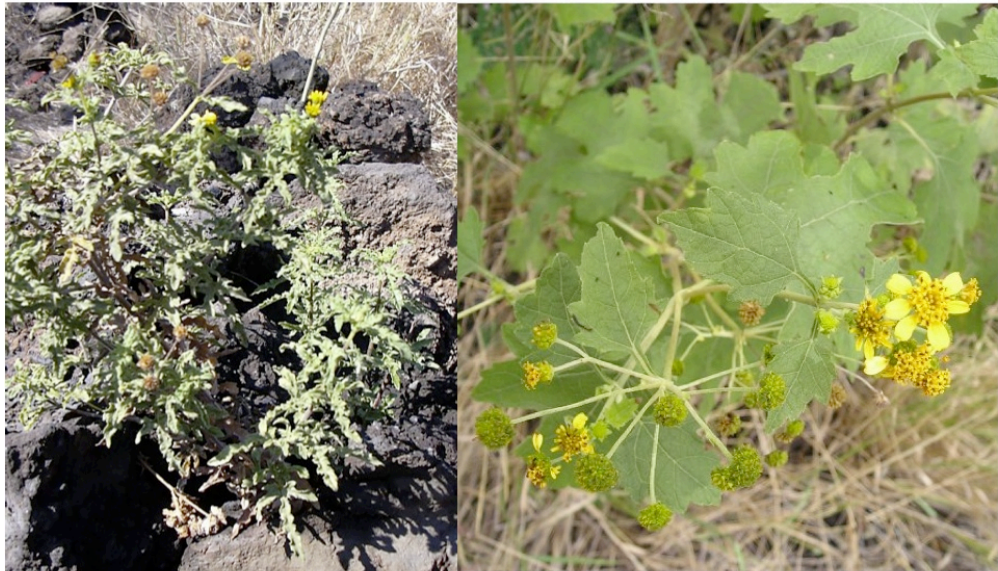


<sup>7</sup> Bob Hobdy, personal communication



solved scientifically. The developer's plans for Wailea 670 would destroy the remnant habitat in which this unique morph evolved, and even if the extinction of this morph could be prevented through perpetual cultivation, the ability to understand the evolution of *L. rockii* in its native habitat would be ruined.

**FIGURE 11:** Comparison of the morphological extremes of *Lipochaeta rockii*, 3.5 miles apart



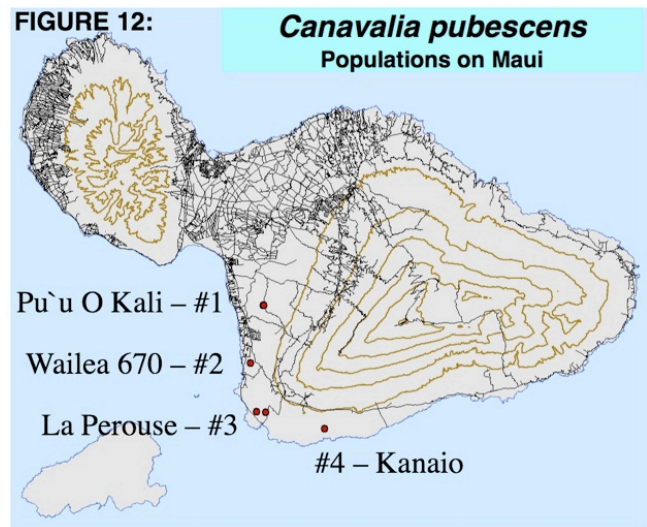
Pu`u O Kali morph

Wailea 670 morph

## Awikiwiki, *Canavalia pubescens*

The awikiwiki, *Canavalia pubescens*, is found on only 4 other sites on Maui besides Wailea 670, shown in Figure 12. This species has the status of a Candidate for listing as an endangered species. The most recent Proposed Rules from the *Federal Register* give *C. pubescens* the highest priority to be listed in its taxonomic category (R2). The report from the *Federal Register* reads:

***Canavalia pubescens* (Awikiwiki)**— The following summary is based on information contained in our files. No new information was provided in the petition received on May 11, 2004. Awikiwiki is a perennial climber found in lowland dryland forest on Maui, Lanai, Kauai, and is possibly on the island of Niihau, Hawaii. This species is known from at least 10 populations totaling less than 200 individuals. This species is threatened by development (Maui), goats that degrade and destroy habitat (Kauai and Maui), and by nonnative plants that outcompete and displace native plants (all islands). Feral goats have been fenced out of three of the ten populations where *C. pubescens* currently occurs and nonnative plants have been reduced in two of the populations



*that are fenced. This species is represented in an ex situ collection. Because the threats are ongoing in more than half of the known populations they are of a high magnitude and imminent. Therefore, we retained a listing priority number of 2 for this species.*<sup>8</sup>

It is notable that the Proposed Rules mention development on Maui as a threat to this species. This is a specific reference to the development proposed for Wailea 670, as development is not proposed for any of the other 4 populations of awikiwiki.

Had the awikiwiki been listed as an endangered species when it was first proposed, or should it become listed during the build out of Wailea 670, the regulations of the Endangered Species Act would apply to Wailea 670. Because there are so few habitats on Maui where the awikiwiki survives, one can infer that the Wailea 670 area would have been considered to be listed as Critical Habitat for the recovery of the awikiwiki. The behavior of the Department of the Interior, in failing to heed the advice of its own Proposed Rules and list *Canavalia pubescens* as an endangered species, does not change the biology of the situation for the awikiwiki. That *Canavalia pubescens* has survived in Wailea 670, despite browsing by deer, makes this habitat critical to its survival and recovery.

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<sup>8</sup> Proposed Rules, *Federal Register* 71(176): 53803, September 12, 2006

## Appendices

### Appendix I: List of native Hawaiian species in the southern 1/6 of Wailea 670:

Scientific name	Common name	Family	Status
<i>Argemone glauca</i>	Puakala	Papaveraceae	Endemic
<i>Boerhavia herbstii</i>	Alena	Nyctaginaceae	Endemic
<i>Canavalia pubescens</i>	Awikiwiki	Fabaceae	Endemic
<i>Capparis sandwichiana</i>	Maia pilo	Capparadaceae	Endemic
<i>Chamaecyse celastroides</i> var. <i>lorifolia</i>	Akoko	Euphorbiaceae	Endemic
<i>Heteropogon contortus</i>	Pili grass	Poaceae	Endemic
<i>Erythrina sandwicense</i>	Wiliwili	Fabaceae	Endemic
<i>Ipomoea tuboides</i>	Hawaiian moon flower	Convolvulaceae	Endemic
<i>Lipochaeta rockii</i>	Nehe	Solanaceae	Endemic
<i>Myoporum sandwicense</i>	Naio	Myoporaceae	Endemic
<i>Sicyos pachycarpus</i>	Anunu	Cucurbitaceae	Endemic
<i>Sicyos hispidus</i>	Anunu	Cucurbitaceae	Endemic
<i>Abutilon incanum</i>	Hoary abutilon	Malvaceae	Indigenous
<i>Dodonea viscosa</i>	A'ali'i	Sapindaceae	Indigenous
<i>Doryopteris decipiens</i>	Iwaiwa	Sinopteridaceae	Indigenous
<i>Ipomoea indica</i>	Koali awa	Convolvulaceae	Indigenous
<i>Plumbago zeylanica</i>	Iliee	Plumbaginaceae	Indigenous
<i>Senna gaudichaudii</i>	Heuhiuhi, Kolomona	Fabaceae	Indigenous
<i>Sida fallax</i>	Ilima	Malvaceae	Indigenous
<i>Waltheria indica</i>	Uhaloa	Sterculiaceae	Indigenous



## **Appendix II: The 21 Most Endangered Ecosystems in the U.S.**

**Based on: decline in original area since European settlement; present area; imminence of threat; and number of federally listed endangered and threatened species (Noss and Peters, 1995)<sup>9</sup>**

1. South Florida landscape
2. Southern Appalachian spruce-fir forest
3. Longleaf pine forest and savanna
4. Eastern grasslands, savannas, and barrens
5. Northwestern grasslands and savannas
6. California native grasslands
7. Coastal communities in the lower 48 states and Hawaii
8. Southwestern riparian forests
9. Southern California coastal sage scrub
- 10. Hawaiian dry forest**
11. Large streams and rivers in the lower 48 states and Hawaii
12. Cave and karst systems
13. Tallgrass prairie
14. California riparian forests and wetlands
15. Florida scrub
16. Ancient Eastern deciduous forest
17. Ancient forest of the Pacific Northwest
18. Ancient red and white pine forest, Great Lakes states
19. Ancient ponderosa pine forest
20. Midwestern wetlands
21. Southern forested wetlands

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<sup>9</sup> Noss, R.F. and R.L. Peters 1995. Endangered Ecosystems: A status report on America's Vanishing Habitat and Wildlife. Published by: Defenders of Wildlife, Washington DC. Available at: <http://www.defenders.org/pubs/endangereco.pdf>