Remote mapping of habitat suitability for at-risk plant species: implications for restoration and reintroduction

December 2014

Problem Statement

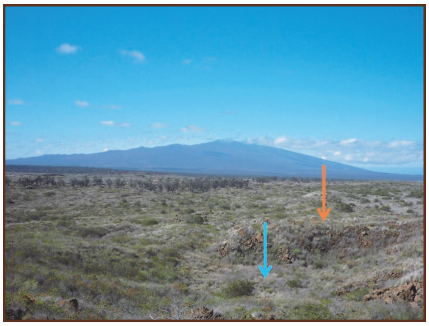
Reintroduction is a tool commonly used to sustain plant populations at risk of extinction; however, the success of reintroduction and outplanting programs for threatened, endangered, and at-risk plant species (TER-S) recovery have had limited success in some areas. Unpredictable annual precipitation patterns, competition with invasive plant species, predation by non-native species, and poor habitat quality all contribute to low survival rates. In particular, desiccation and water stress are significant barriers to plant survival in most reintroduction programs.

The endangered Halapepe (Dracaena konaensis) surrounded by invasive fountain grass (Pennisetum setaceum).

Research Objectives

Main Objective - improve the success of plant reintroduction by developing tools for better landscape planning:

1) We developed a topographic habitat suitability model (HSM) as a tool to enhance landscape planning for at-risk plant species reintroduction for a dryland landscape in Hawaii. The HSM identifies topographic depressions that are protected from prevailing winds (high suitability sites) and contrasts them with ridges and other exposed areas (low suitability sites).
2) We tested the ability of the model to reduce stressful conditions, enhance resource availability, and improve plant growth and survival.
3) We are testing the use of the HSM for a number of federally-listed at-risk species.
4) We are developing HSMs for other sites, including Pu'u Wa'awa'a, a lowland Hawaii site, and Vandenberg Air Force Base in CA using WorldView-2 satellite imagery.



The HSM identifies high suitability sites (shown in blue) and low suitability sites (shown in orange).

Research Collaborators

- California State Polytechnic University – Pomona
- USDA Forest Service
- Brown University
- Carnegie Institution for Science
- Hawaii Division of Forestry and Wildlife

Funding and Support

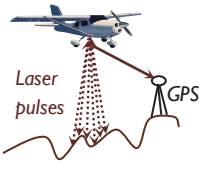
- US Department of Defense, Environmental Security Technology Certification Program
- Pohakuloa Military Training Area
- Hawaii Experimental Tropical Forest
- Vandenberg Air Force Base

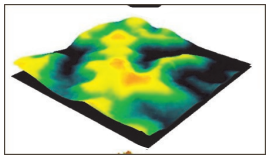
The Habitat Suitability Model

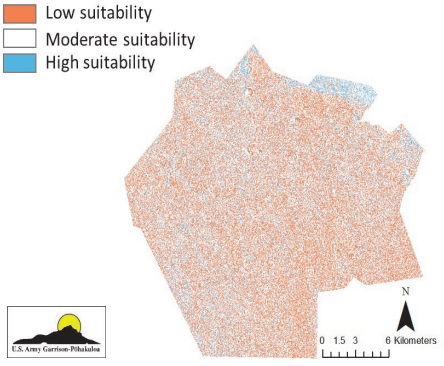
Airborne Light Detecting and Ranging (LiDAR) data from the Carnegie Airborne Observatory are used to produce a Digital Elevation Model (DEM) with 2.2m ground sampling distance.

Two criteria variables are modeled from the DEM to create the HSM: leeward position and descending topography.

LiDAR → **Digital Elevation Model** → **Habitat Suitability Map**



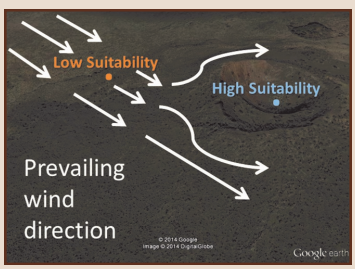




Habitat Suitability Map for Pohakuloa Training Area, Hawaii Island

Leeward Position

High suitability sites are protected from prevailing winds by topographic features.

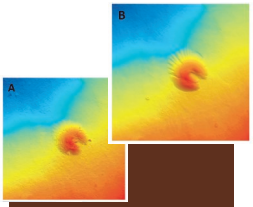


Descending Topography

High suitability sites are in topographic depressions.

The Habitat Suitability Model

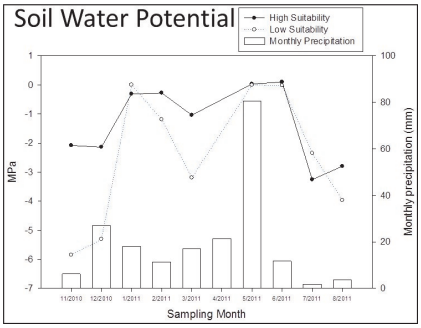
Unique ecosystems: Aiea (Nothocestrum brevifolium) is a critically endangered tree found in the dry forests of Hawaii Island that is the native host for the endangered Blackburn Sphinx moth (Manduca blackburni).



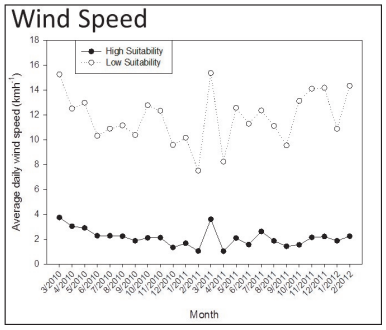
Ongoing work is using stereo imagery analysis of WorldView-2 (a) satellite imagery. We will compare these models with LiDAR (b) models.

Features of High Suitability Sites

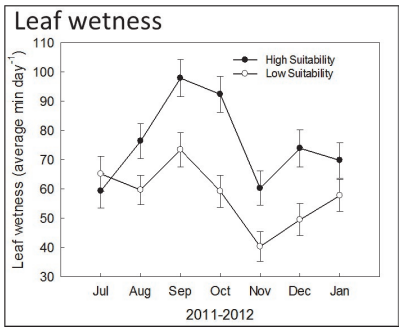
High suitability sites (HS) have microclimatic conditions that are more favorable for plant growth:



HS had wetter soils than LS.

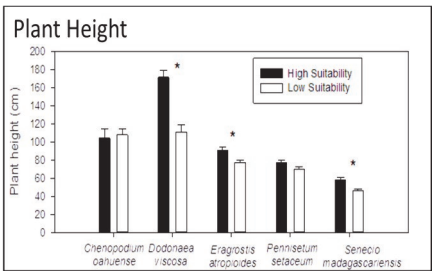


HS had lower wind speeds than LS.

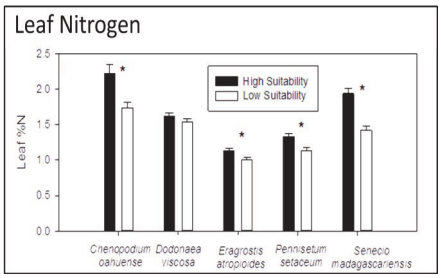


HS had greater leaf wetness than LS.

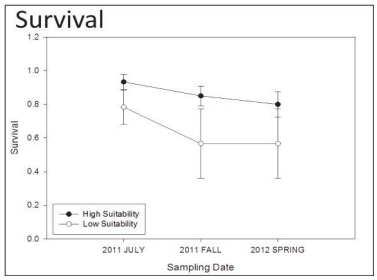
Plants respond to conditions in HS:



Plants in HS were taller than LS.



Plants in HS had higher leaf nitrogen than LS.



Outplants in HS had greater survival than LS.

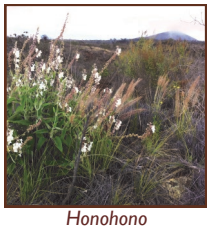
How can the HSM improve reintroduction success?

Ongoing experiments are testing the survival, growth, and performance of reintroduced federally-listed threatened and endangered species and state listed species of concern in high and low suitability plots at two sites on Hawaii Island: Pu'u Wa'awa'a (PWW) and Pohakuloa Training Area (PTA).

Number of individuals planted at each site:

Species Name	PWW	PTA
Honohono (*Haplostachys haplostachya*)	300	550
'Ihi (*Portulaca sclerocarpa*)	300	400
Spermolepis hawaiiensis	380	330
Silene lanceolata	350	40
Silene hawaiiensis	-	320
Ma'ohi'ohi (*Stenogyne angustifolia*)	300	550
Akoko (*Euphorbia olowaluana*)	-	350
Halapepe (*Dracaena konaensis*)	300	-
Kauila (*Colubrina oppositifolia*)	300	-
Ma'aloa (*Neraudia ovata*)	270	-
Uhiuhi (*Caesalpina kauaiensis*)	200	-
'Aiea (*Nothocestrum breviflorum*)	50	-

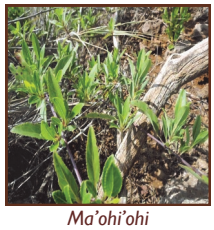
All plants used for testing the HSM were propagated in the greenhouse facility built by the project at PWW. By the end of November 2014, the project outplanted over 5000 TER-S plants at PWW and PTA.



Honohono

Data to be collected:

1) Survival
2) Growth
3) Physiology / Stress
4) Reproduction
5) Recruitment



Ma'ohi'ohi

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