Assessing Land Cover Dynamics and Evaluating Potential Management Implications of Gorse on Mauna Kea, Hawaii

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MEM Capstone
The Hawaiian Islands

- Geographic isolation and volcanic origin
- Home to many unique species & ecosystems
- Effects of invasions are greater on islands


Invasive species declared “the single greatest threat to Hawaii’s economy, natural environment and to the health and lifestyle of Hawaii’s people” - Hawaii State Legislature.
Gorse, (*Ulex europaeus*)

- Native to Western Europe & Coastal Mediterranean
- First introduced to Hawaii in 1910
- Has many invasive characteristics
- A severe infestation now occurs in the high-elevation lands of Mauna Kea on the Big Island of Hawaii

Gorse in Critical Watersheds

- Occurs in 2 watersheds that feed Hilo
- Gorse is estimated to cover 15,000 Acres (as of 2019)
- 2 key players trying to tackle it – MKWA & DHHL
- Decades of work – containment, direct treatment
- What are the factors that promote this thing????
Purpose of this Study

- To better understand the environmental drivers of gorse expansion on Mauna Kea to inform management.
What Environmental Factors Might Contribute to Gorse Establishment?

- Distance to invaded areas
- Vegetative Cover
- Fire disturbance
- Annual rainfall variability

(De Luis et al. 2005 *J. Env. Mgmt.* 76.2: 159–166)
(Cordero et al. 2016. *Ecosphere*, 7(3))
Remote Sensing Tool - The Hawaii Fractional Land Cover Series (HFLCS)

- Lucas used LANDSAT imagery and spectral unmixing to quantify land cover for the state of Hawaii.

- Annual, 30-meter resolution, percent cover of woody vegetation, herbaceous vegetation, and bare earth in Hawaii from 1999 to 2016.

Core Invasion – Study Area

- Core Gorse Population
- Heather Kimball 2015 data
- She used Worldview Imagery to map the gorse locations at .4 meter resolution

On the left: results of high-resolution supervised land cover classification of gorse from 2015, taken from Kimball, H. (2016). On the right: the selected study area, including Heather’s 2015 data re-projected to match HFLCS extent and resolution.

Defining Gorse Transitions

Establish baseline gorse distribution

Distribution of HFLCS percent cover values for all known gorse pixels

Establish gorse transition ruleset

Occurs if the change in cover is greater than 40%
Environmental Factors

Annual rainfall anomaly

Fire

Distance to gorse

Vegetation cover

Herbaceous cover year 2000
Results – Annual Rainfall Anomaly

Pixel Density as a Function of Annual Rainfall Anomaly

Probability of Gorse Establishment

Not invaded
Invaded

Annual rainfall anomaly (mm)
Results — Bare Earth Cover

Pixel Density as a Function of Bare Earth

Probability of Gorse Establishment

Bare Earth Cover
Results – Herbaceous Cover

Pixel Density as a Function of Herbaceous Cover

Herbaceous Cover

Probability of Gorse Establishment

Herbaceous Cover
Results – Distance

![Graph showing pixel density as a function of distance to nearest occupied gorse pixel.](image1)

![Graph showing probability of gorse establishment.](image2)
### Results – Fire

<table>
<thead>
<tr>
<th></th>
<th>0- not burned</th>
<th>1- burned</th>
</tr>
</thead>
<tbody>
<tr>
<td>0 - not gorse</td>
<td>162161</td>
<td>17879</td>
</tr>
<tr>
<td>1- gorse</td>
<td>8106</td>
<td>1630</td>
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</table>

Contingency Table

Pearson’s chi-square test = p-value of <.005

Management Implications

• Drought and grass die-back benefit gorse establishment.
  • The grass-gorse-climate interactions show that managers need to be able to respond during drought with expanded treatment programs/effort
• Use fire with care!
• Managers must be cautious and not let fires escape.
  • Burned areas adjacent to gorse areas will be far more likely to become invaded.
  • Fire exclusion from adjacent grasslands is critical.
• Results emphasize that the current containment strategy is necessary, as the invasion is most likely to expand adjacent to the core areas.
• Future directions- this sets up to create spread models
Mahalo!