Remote Detection of invasive pines (*Pinus spp.*) within Haleakalā National Park

Oahu Weed Workshop

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Background

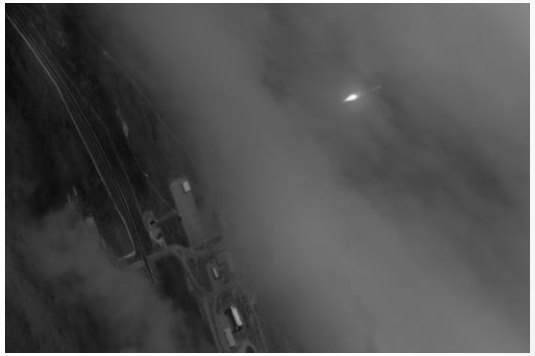
- January 2007 Polipoli Fire spreads invasive pine seeds across the montane region of East Maui.
- This stochastic event, coupled with wind dispersal from nearby populations, has resulted in an explosion of pines in Haleakala Crater.
- Control of these pines is vital before reproductive age is reached.

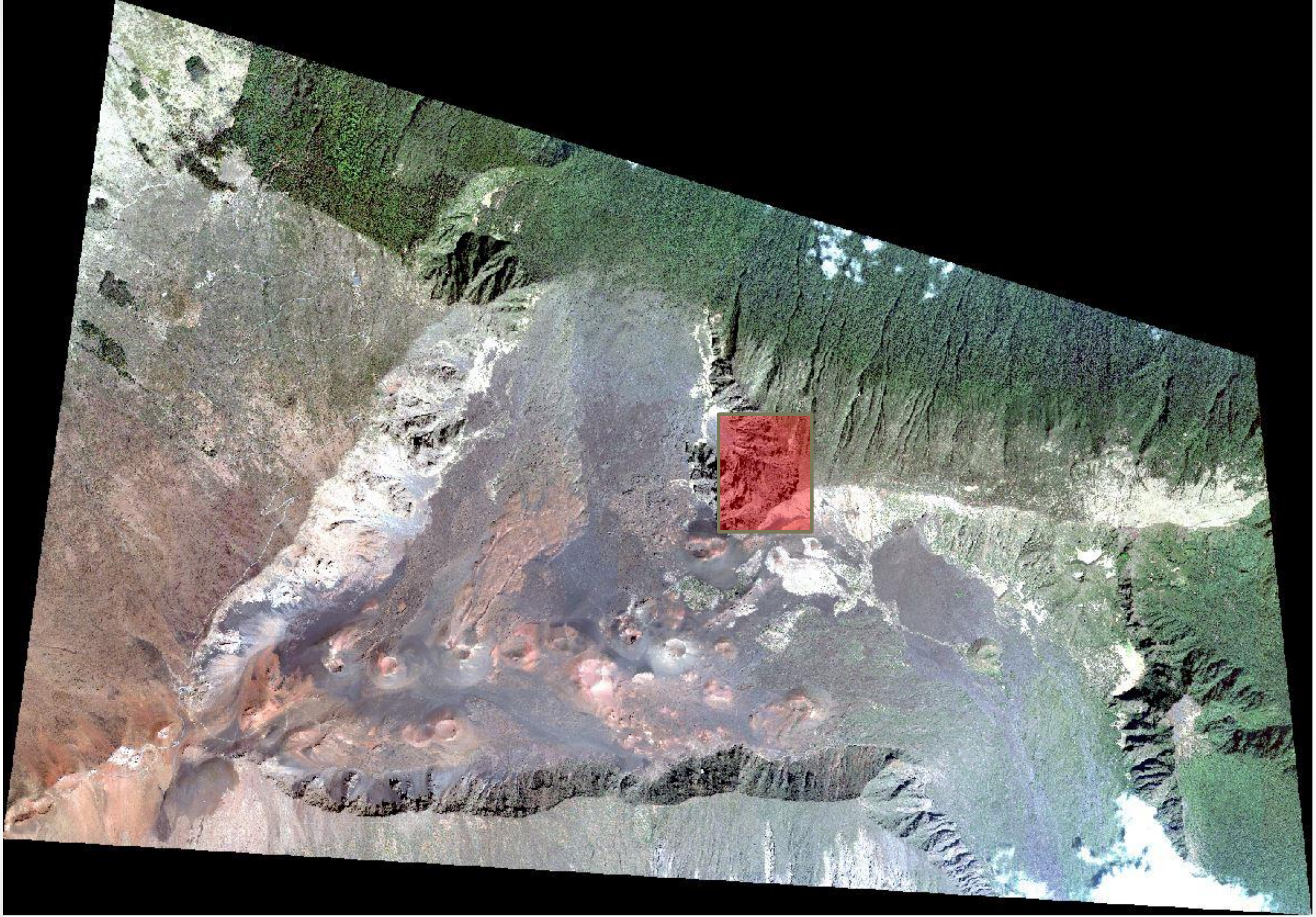
Photo Credit - Pacific Disaster Center

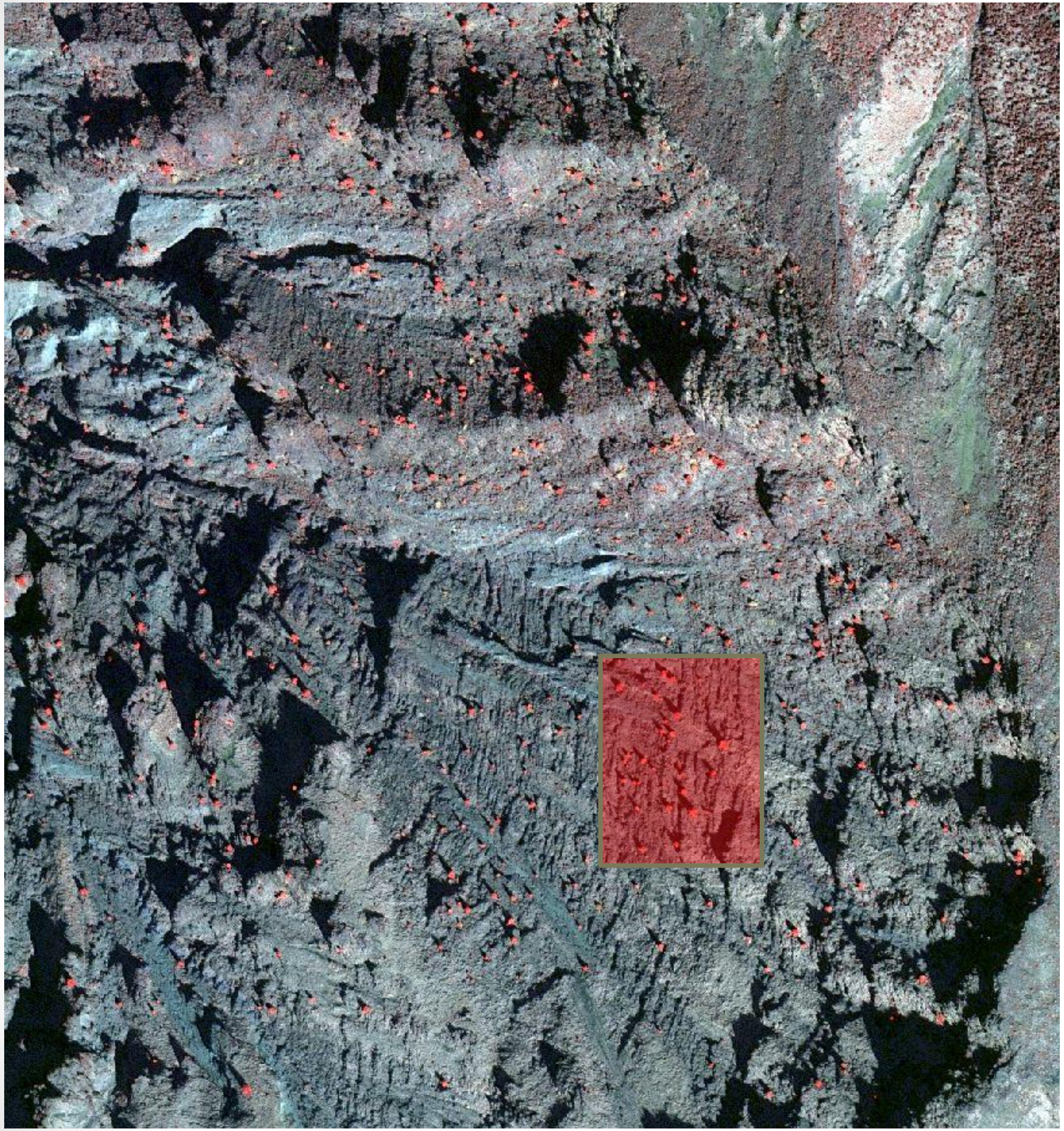

Mr. Pine tree, why do you still have leaves in winter?
Trees don't talk, dumbass.
morethanreality.com
ZEROPERCENTDISCOUNTCOMIC.TUMBLR.COM

Satellite Remote Sensing & Dataset

- (Passive) Satellite remote sensing refers to the use of satellites to remotely image objects or features using reflected electromagnetic radiation.
- Valuable land cover classification and detection tool. There are specialist sensors capable of detecting small features (why not pine trees!?).
- Worldview 3 (Spec’s at nadir)
  - Provider - Digitalglobe
  - Spatial resolution - ~1.2m (Multispectral) and 25cm (Panchromatic)
  - Spectral resolution – 400nm – 1040nm (Multispectral)
  - Radiometric resolution – 11 bits per pixel (Multispectral & Panchromatic)







Target Species

- *Pinus radiata* (Monterrey Pine)
- *Pinus patula* (Mexican Weeping Pine)
- *Pinus pinaster* (Maritime Pine)

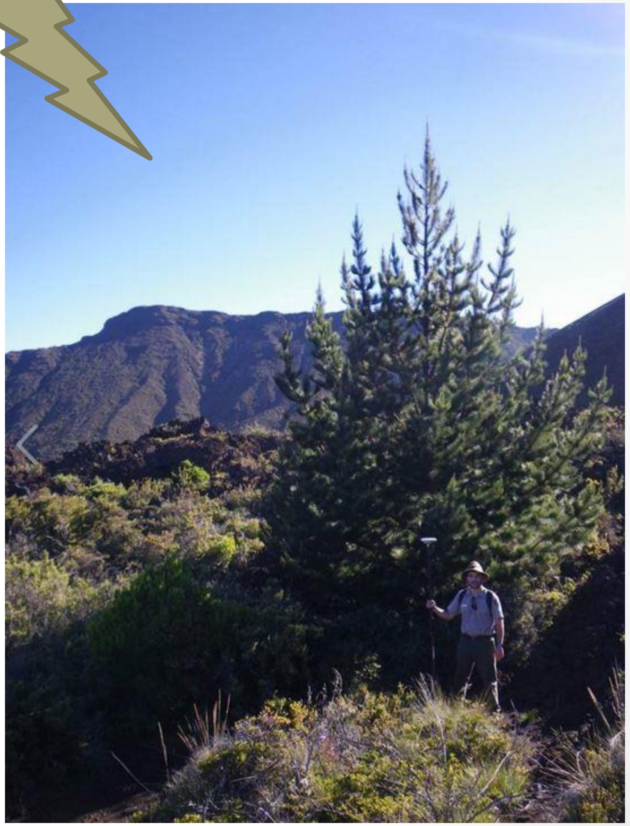
Goal and Objectives

- Project Goal:
  - Integrate remote sensing into Haleakalā National Park's vegetation management program as a detection and mapping tool to help address the invasive pine issue.

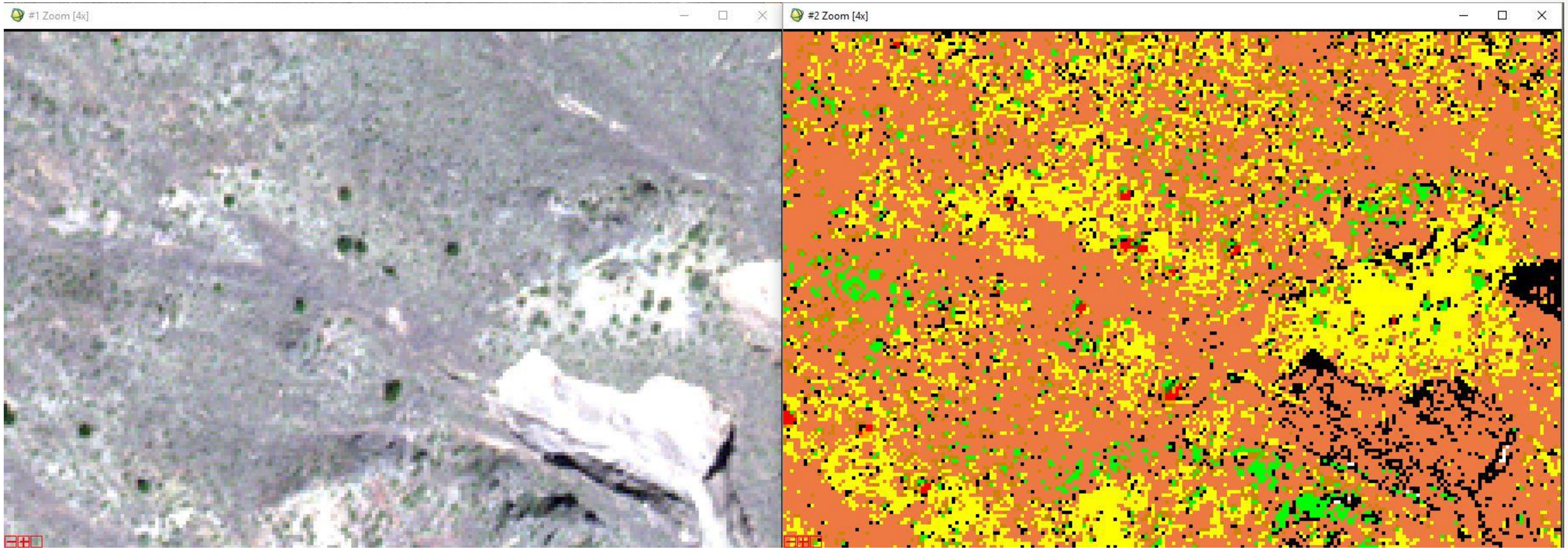
- Project Objectives:
  - Develop a satellite remote sensing protocol that accurately detects and maps invasive pines.
  - Develop pine occurrence datasets and maps for NPS and land manager use.
  - Develop change detection extent and density maps to better understand invasion dynamics of *Pinus spp.*

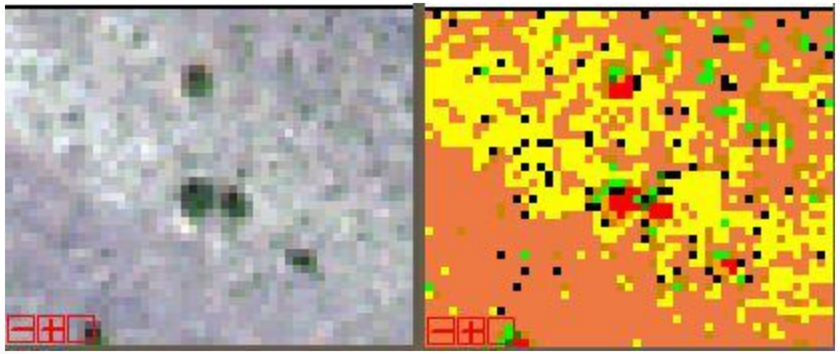
Methodology

- Land cover classification with ENVI and GIS.
  - "Target detection and extraction"
- Process (simplified)
  - Obtain satellite imagery & collect field training data.
  - Determine spectral separability.
  - Spectral classification using ENVI.
    - Supervised classification
    - Maximum Likelihood Classifier $g_i(x) = \ln p(\omega_i) - {}^1\!/_2 \ln|\Sigma_i| - {}^1\!/_2 (x - m_i)^T \Sigma_i^{-1} (x - m_i)$
  - Accuracy assessment
  - Map production and density / extent comparison across time series



Results - Classification Output



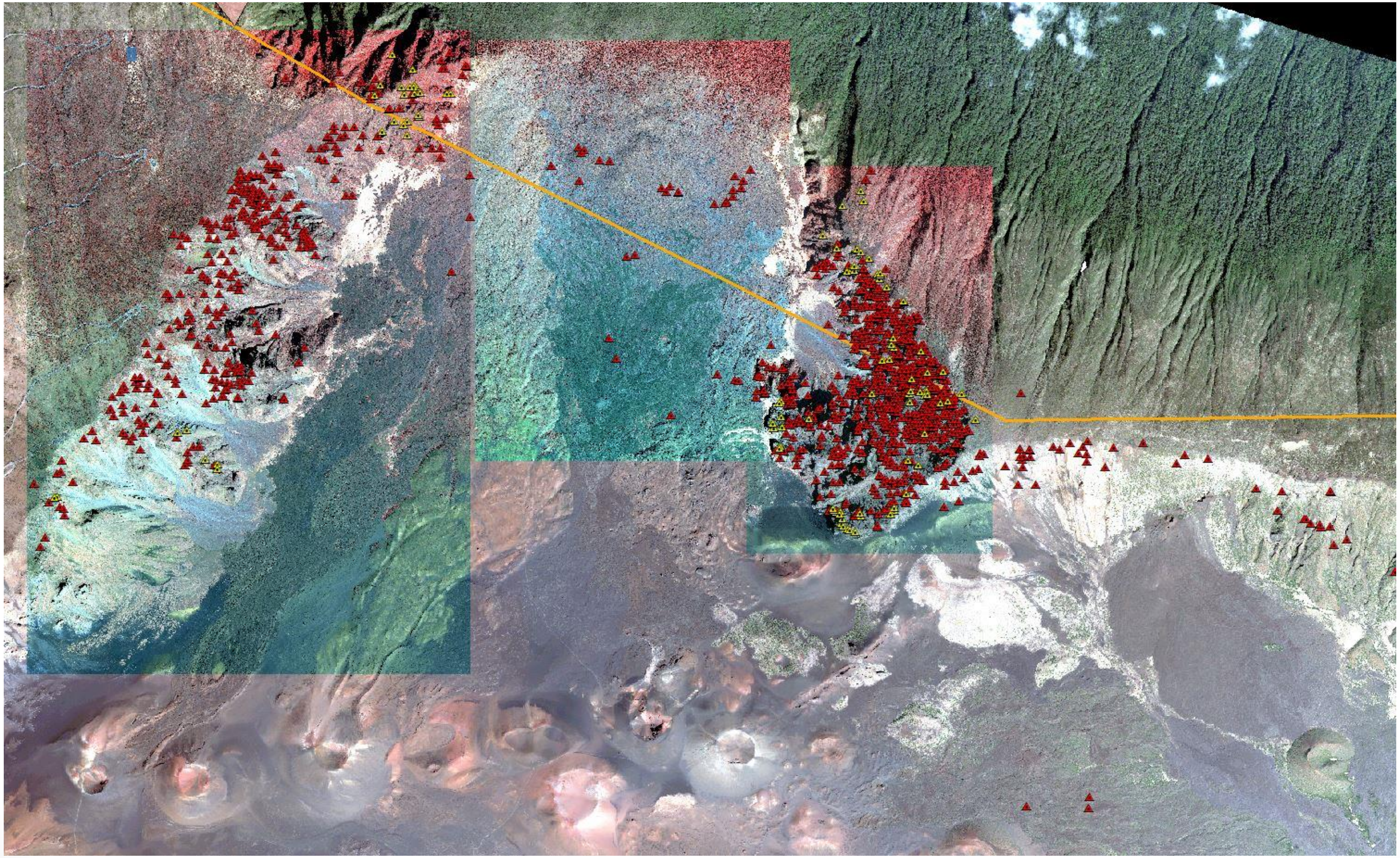


Pines – Red
Grassland – Yellow
Bare Ground – Brown
Native Scrubland – Green
Black - Unclassified

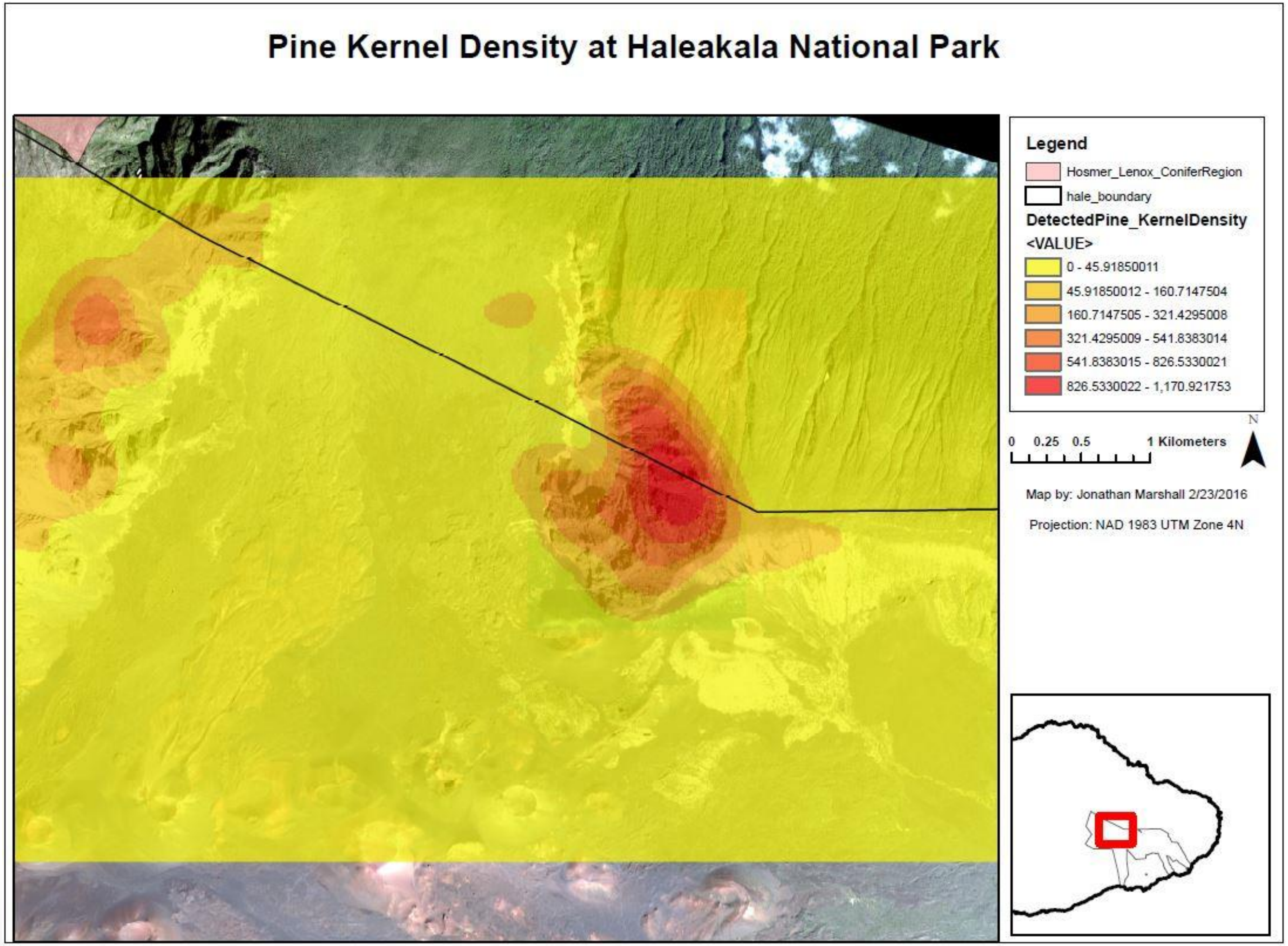
Results – Post Classification Accuracy Assessment

Classifier	Overall Accuracy	Kappa Coefficient	Information Class	Comission (%)	Omission (%)	Producer Accuracy (%)	User Accuracy (%)
Maximum Likelihood	(797/957) = 83.28%	0.813	Conifers/Pine	34.52	46.6	53.4	64.48
			Other Alien Forest	22.12	16.19	83.81	77.88
			Native Forest	23.88	16.19	86.44	76.12
			Bare Ground / Cinder	0.96	1.9	98.1	99.04
			Grassland	1.9	0	100	98.1
			Shadow	0	4.55	95.45	100
			Native Scrubland	20.79	20.79	79.21	79.21
			Cloud	0	42.16	57.84	100
			Alien Scrubland	0	7.27	92.73	100

Results – GIS Digitization



Results – Population Density



Challenges and Implementation

- Limitations of imagery
- Spectral detection with ENVI is noisy!
- Accurate training pixel selection is crucial.
- Worldview 3 cannot detect pines in the understory.
    - LiDAR or drone imagery?
- Smallest detectable feature size (Worldview 3) is ~1.2m.
    - Cannot see pines smaller than this.

Discussion

- Operation protocol for the use of remote sensing as a detection tool.
- Should aid in the prioritization of management effort.