MAPPING THE FUTURE FOR EMERALD ASH BORER READINESS AND RESPONSE PLANNING

David Sivyer, Forestry Services Manager
City of Milwaukee

MILWAUKEE'S URBAN FOREST

Forest Structure

- 3.4 Million Trees
- 21.5% Canopy Cover
- Estimated 587,000 ash trees (17.4%)

MILWAUKEE'S URBAN FOREST

Forest Valuation

Structural Value

- $1.4 Billion Structural Value
- $9 Million Carbon Storage

Functional Value (annual)

- $321,000 Carbon sequestration
- $2,590,000 Pollution removal
- $903,000 Energy savings and carbon emission reductions

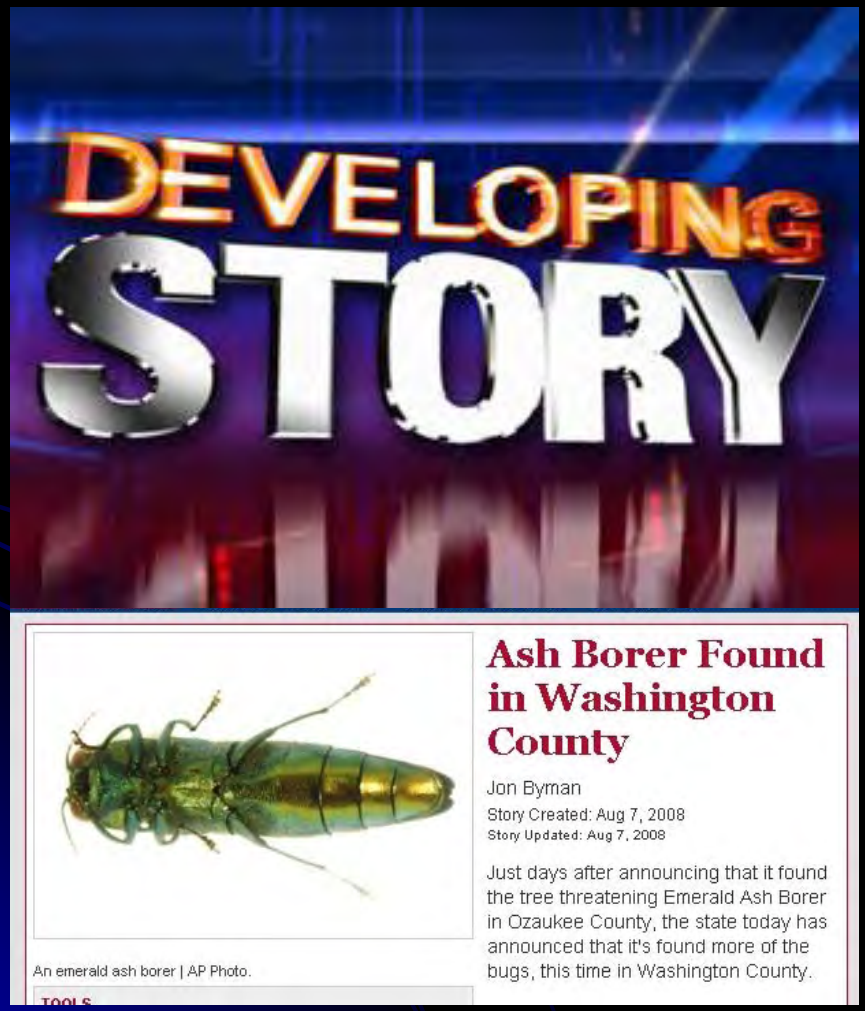
- $3.8 Million Total Functional Value

MILWAUKEE'S STREET TREES

Structure & Value

- 200,000+ Street trees
- 92% Generally healthy
- 36,000 Ash street trees (18%)
- $46 Million ash structural value
- $27 Million ash removal & replacement (3" cal.)

EAB CONFIRMED IN WISCONSIN



An emerald ash borer | AP Photo.

Ash Borer Found in Washington County

Jon Byman

Story Created: Aug 7, 2008

Story Updated: Aug 7, 2008

Just days after announcing that it found the tree threatening Emerald Ash Borer in Ozaukee County, the state today has announced that it's found more of the bugs, this time in Washington County.

LESSONS LEARNED & RECOMMENDATIONS

- Early detection is extremely difficult

LESSONS LEARNED & RECOMMENDATIONS

- Explosive population growth

LESSONS LEARNED & RECOMMENDATIONS

- Inventory trees under your jurisdiction

LESSONS LEARNED & RECOMMENDATIONS

- Budget to remove majority of ash within 5 years of detection

LESSONS LEARNED & RECOMMENDATIONS

- Plan for a large spike in wood waste

LESSONS LEARNED & RECOMMENDATIONS

- Diversify
- Many threatening non native species

NON NATIVE FOREST PESTS

EAB RISK ASSESSMENT

Host Assessment

- City-owned trees
  - Street Tree Inventory (sample/complete)
    - STRATUM Analysis
  - Park Tree Inventory (sample/complete)
- Private/other public-owned trees
  - Sample/complete inventory
    - UFORE Analysis
- Beetle Infested (100% Inventory)
- Remote Sensed
  - Hyperspectral Imaging

EAB RISK ASSESSMENT MILWAUKEE

Host Assessment

1. Spatial Street Tree Inventory
   - STRATUM Analysis
2. UFORE Analysis
3. Hyperspectral Imaging - Vegetation mapping

STREET TREE INVENTORY MILWAUKEE

EAB Structural Impacts

- 36,000 ash street trees
- 18% Canopy Loss
- $46 Million structural damage
- 27 Million removal and replacement cost (3” cal.)

EAB Functional Impacts

- STRATUM Analysis (2009)

UFORE CANOPY ASSESSMENT MILWAUKEE

EAB Structural Impacts

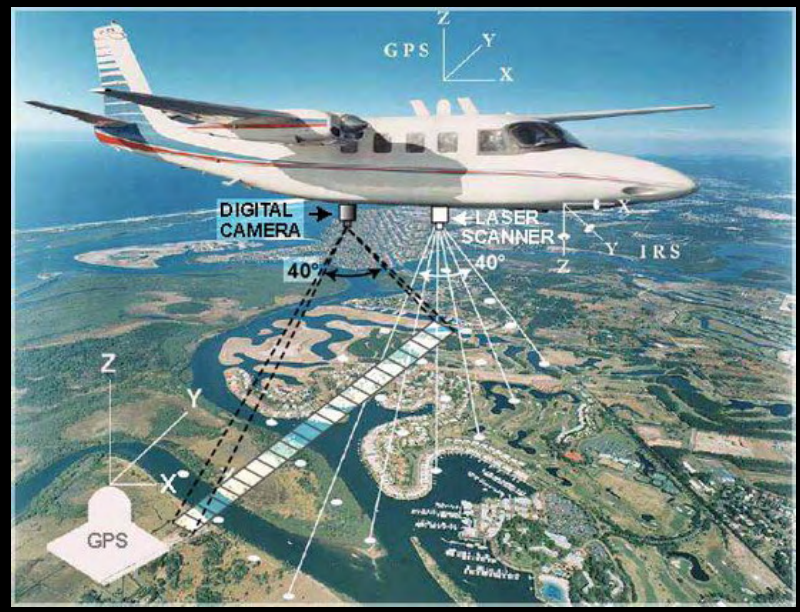
- 17.4% Canopy Loss
- $221 Million structural damage (citywide)

EAB Functional Impacts

- $243,785 less pollutant removal
- $138,000 less energy savings (cooling costs)
- $261,000 reduction in storm water benefits (1996 study)

HYPERSPECTRAL IMAGING VEGETATION MAPPING

- August 2008 Data Collection
- RFP Mapping & NCDC Imaging
- Ash target species
- 1.0 -1.2’ Spatial Resolution
- Simultaneous collection of LIDAR (Light Detection and Ranging) - improves positional accuracy and output



HYPERSPECTRAL IMAGING VEGETATION MAPPING

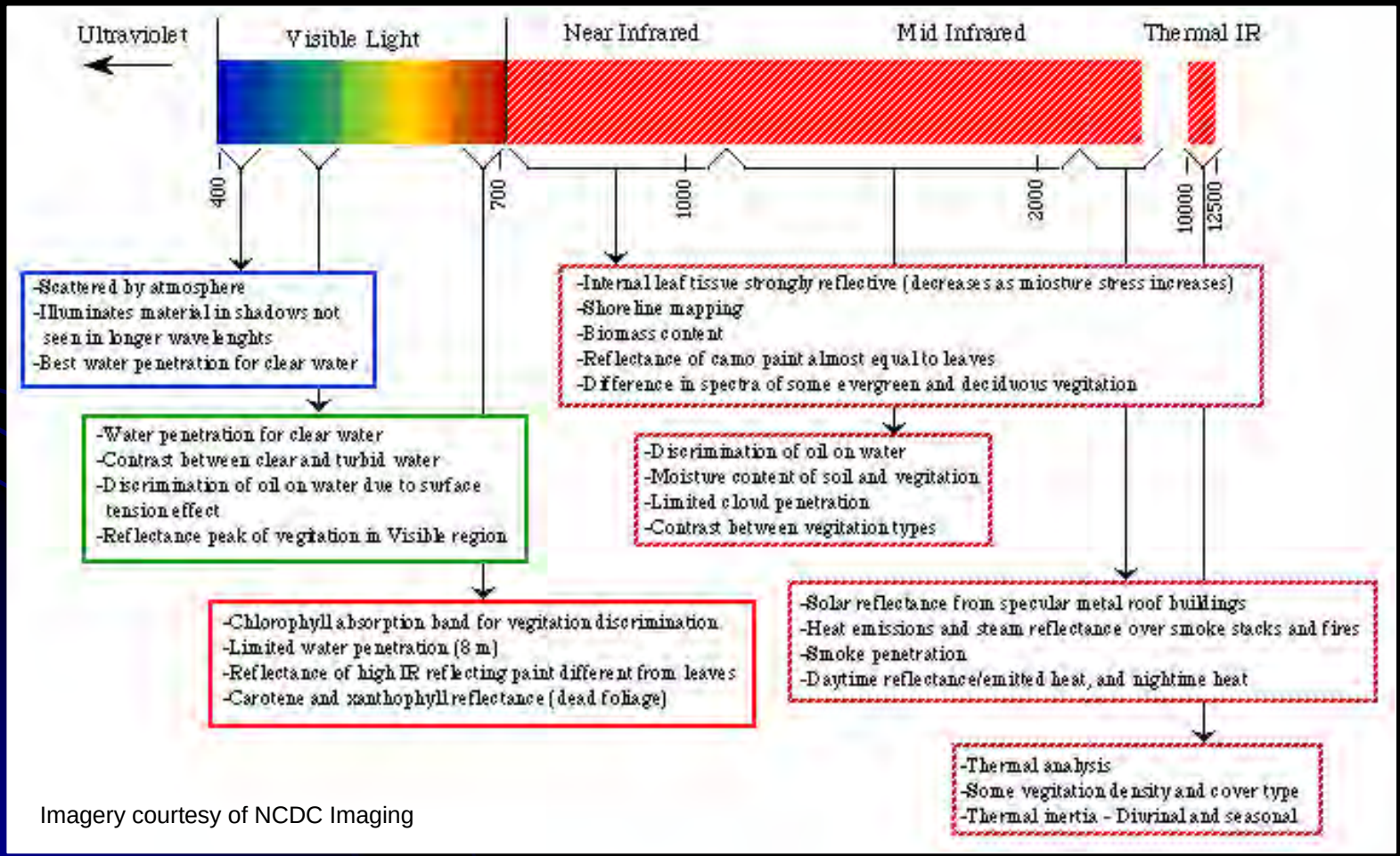
- Remote sensing technology whereby imagery from up to 356 bands in the electromagnetic spectrum is simultaneously collected, resulting in a dataset that can be used to map very distinct features such as individual species of vegetation.

HYPERSPECTRAL IMAGING VEGETATION MAPPING

- Combination of high resolution imagery from fixed wing aircraft and ground samples
- Provides species specific mapping and analysis
- Cost effective technology for host assessment ($2,000/ sq. mile)
  - Cost influenced by:
    - project size
    - targeted features (vegetation vs. manmade)
    - spectral uniqueness of targeted feature
- Simultaneous acquisition of HSI, LIDAR and high-resolution, digital aerial photography

SPECTRAL IMAGERY ATTRIBUTES

Spectral Range: The range of electromagnetic spectrum recorded or measured by remote sensing instrument.

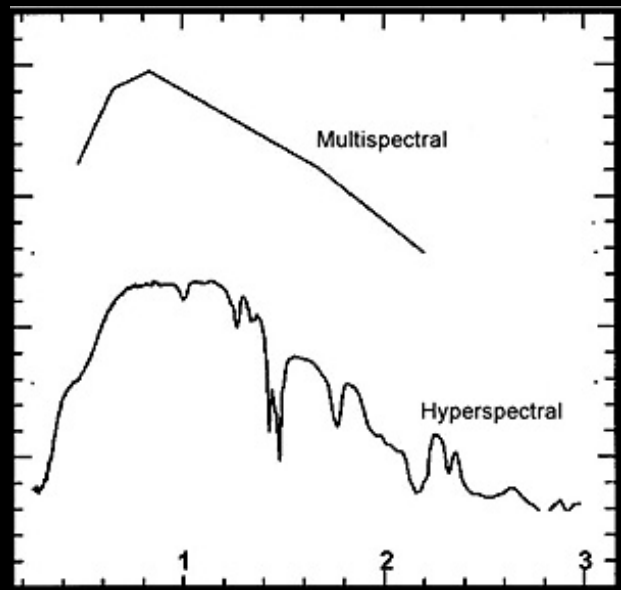


Imagery courtesy of NCDC Imaging

SPECTRAL IMAGERY ATTRIBUTES

- **Spatial Resolution:** The minimum resolving distance between two adjacent features or the minimum size of an object that can be detected.
- **(ground measurement – meters, feet, etc)**

- **Spectral Resolution:** The measure of a remote sensing instrument's power to resolve features in the electromagnetic spectrum.
- **(wavelength measurement – nanometers, etc)**



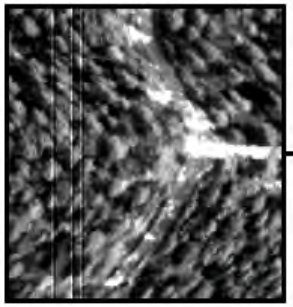
Imagery courtesy of NCDC Imaging

IMAGERY COMPARISON

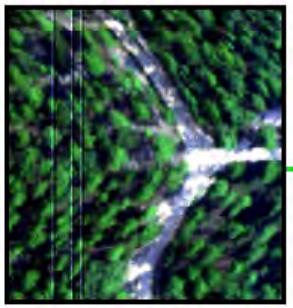
Panchromatic

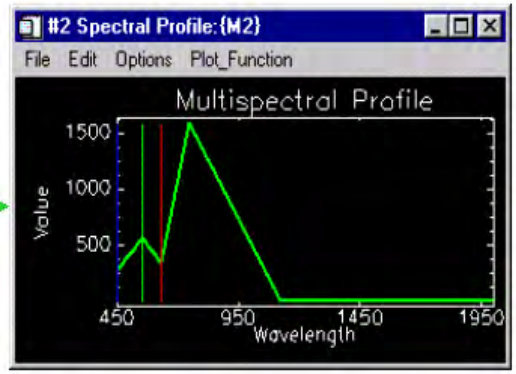
Multispectral

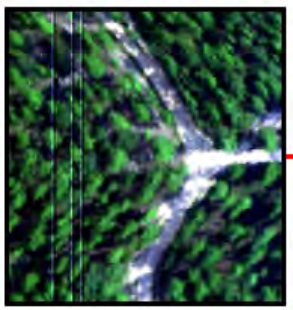
Hyperspectral

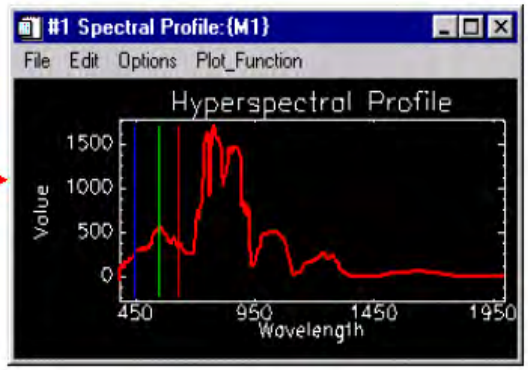


No spectral Information
Data may only be interpreted
Based on spatial information

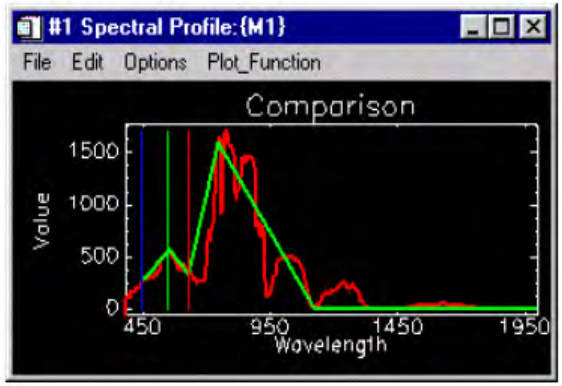






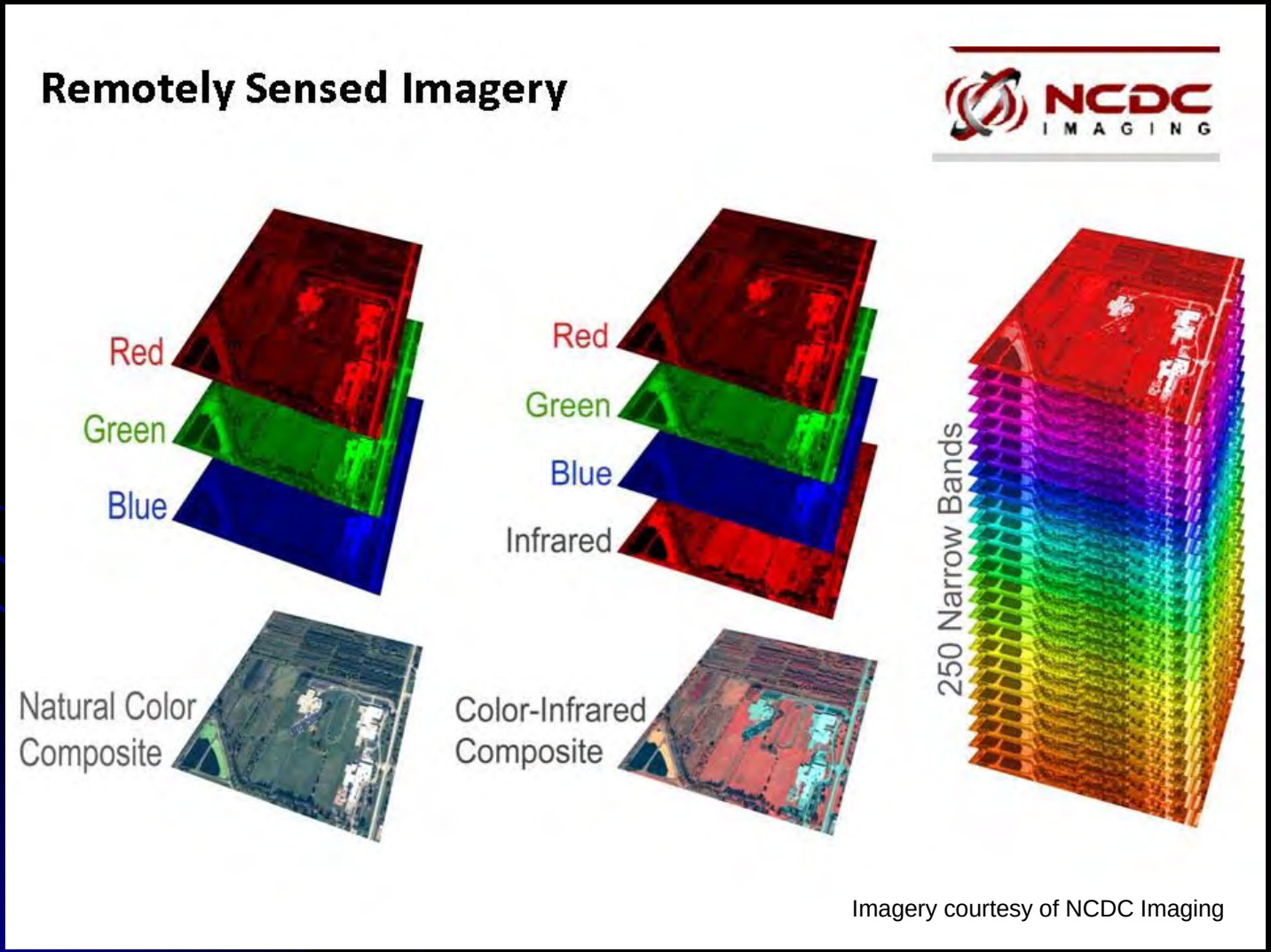


“Each substance produces a unique spectrum, almost like a fingerprint.”

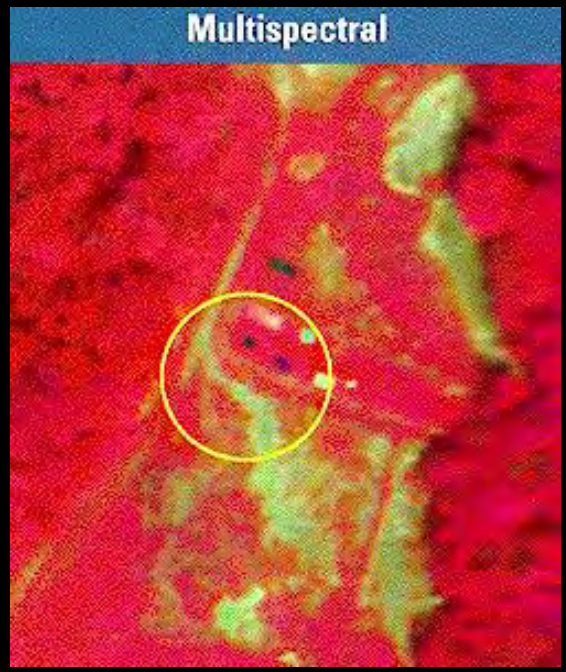


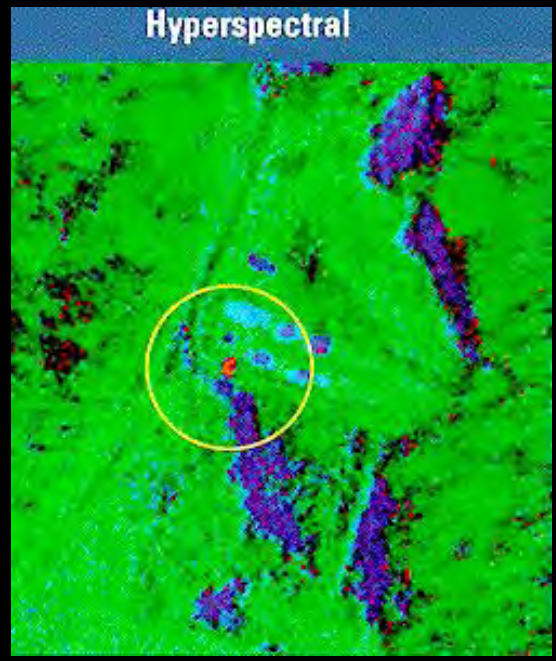
Imagery courtesy of NCDC Imaging

IMAGERY COMPARISON



IMAGERY COMPARISON

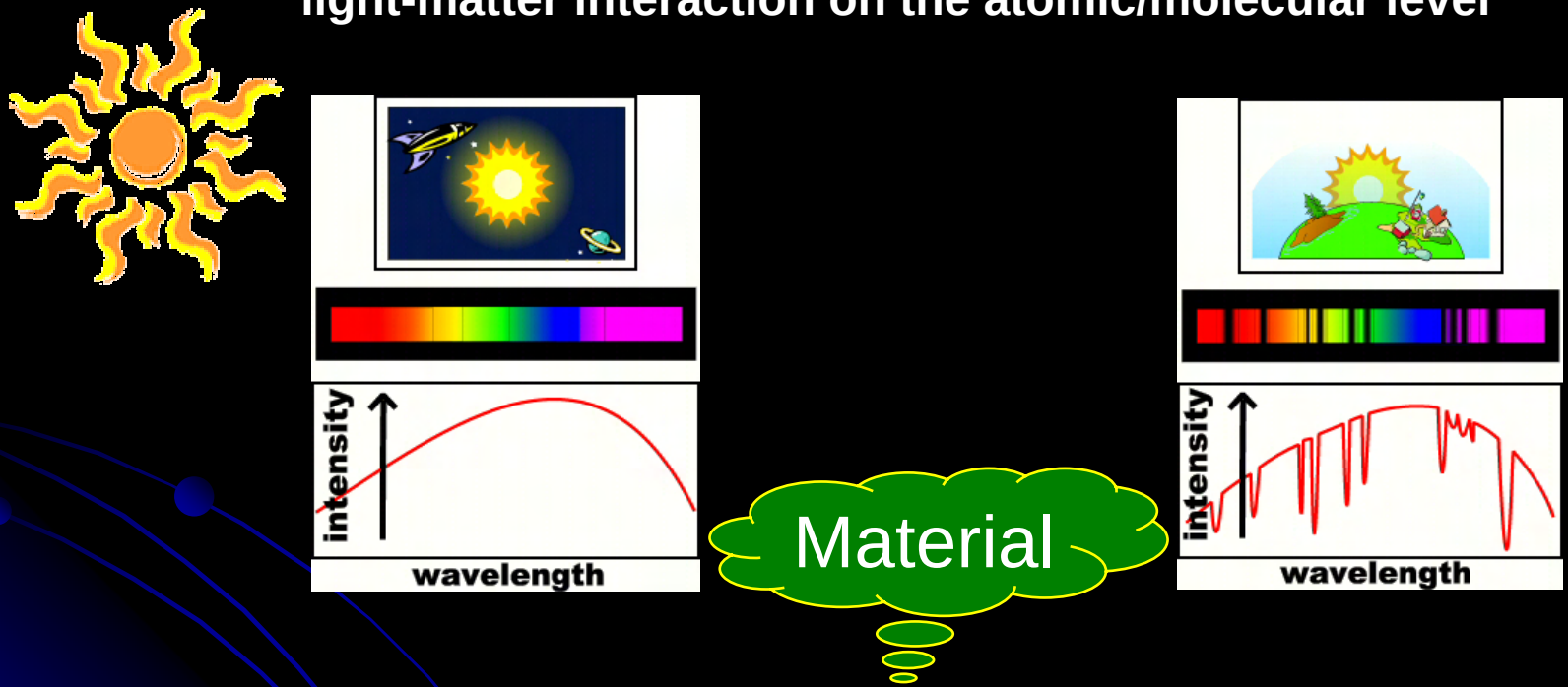




http://fas.org/irp/imint/hyper.htm

HYPERSPECTRAL IMAGING

Hyperspectral Imaging or Imaging Spectroscopy is the observation of light-matter interaction on the atomic/molecular level



Hyperspectral Imagery enables the identification of materials based upon their material composition by measuring and recording the unique spectral signature of materials as light is reflected or absorbed.

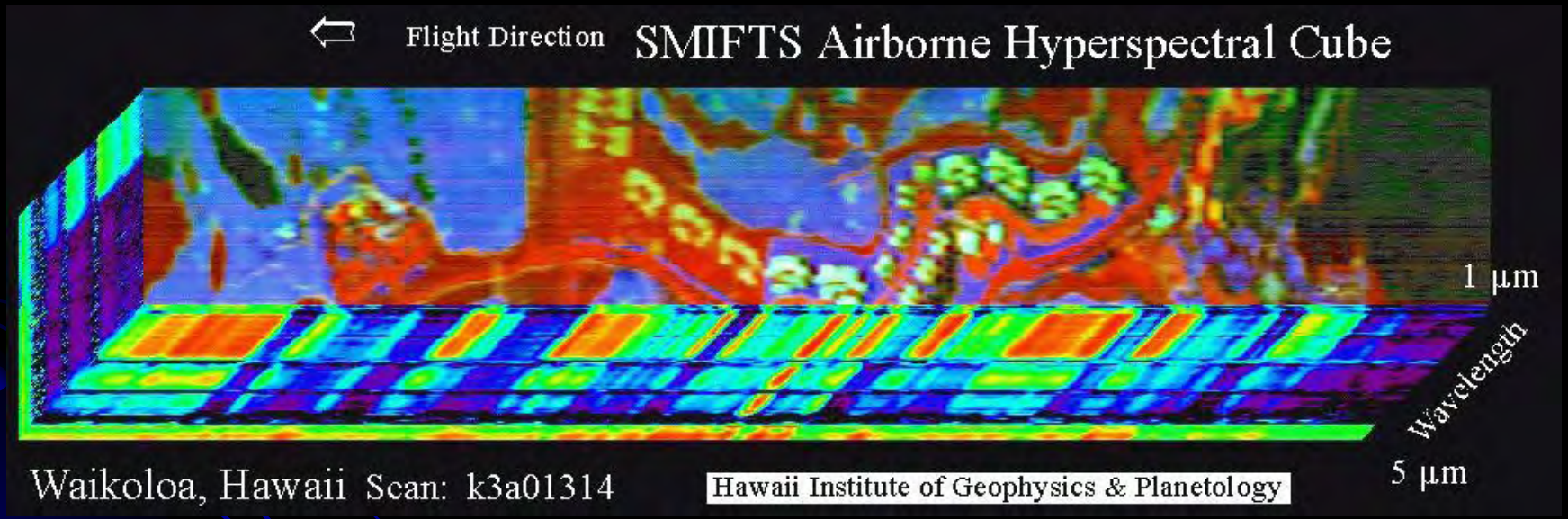
http://www.allaboutspace.com/subjects/astronomy/glossary/spectroscopy.shtml

HYPERSPECTRAL IMAGING

- Hyperspectral Data Cube

Image courtesy of Wikipedia.org

HYPERSPECTRAL DATA CUBE



http://fas.org/irp/imint/hyper.htm

FIELD SURVEY OF TARGET TREES

Field Spectral Data Collection

25-29 August 2008

Field Spectral Data Collection: *ASD Field Spectrometer*

Target Species: *Spectra collected from target tree species as well as predominant background vegetation and environment*

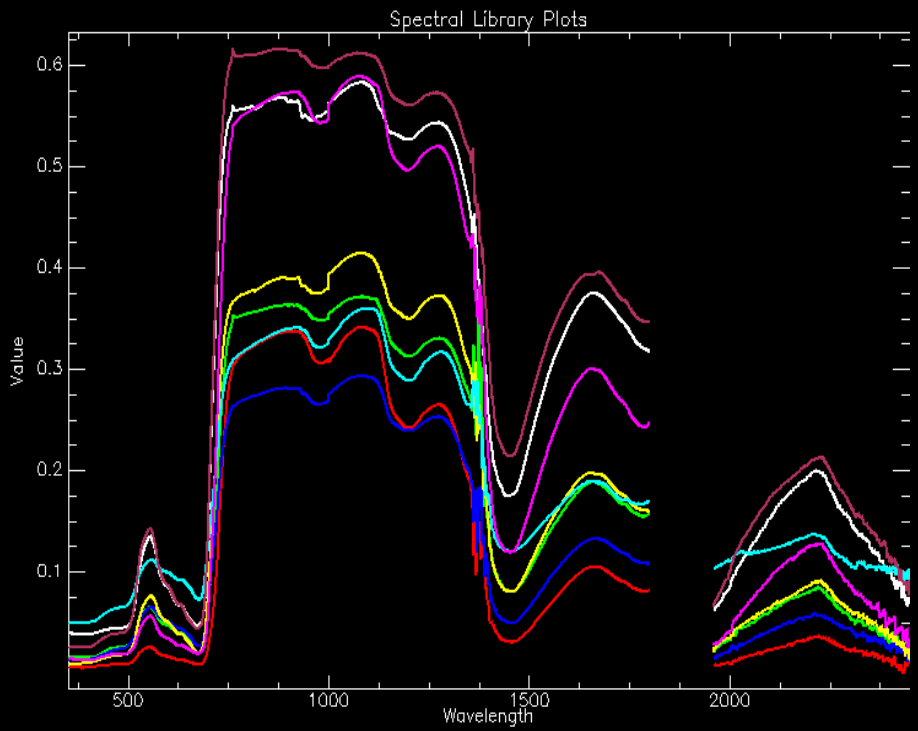
Collection Method: *'Sensor-view' from top of canopy*

Analysis: *Spectral separability assessed by analysis of optimal bands required to identify each target.*

- Field data collection used to confirm capability to detect and identify target tree species prior to aerial data collection
- Field spectra will be used to tailor analysis methodology for large-scale analysis of aerial data (>1Terrabyte)

MILWAUKEE HSI DATA

Comparison to 7 potential backgrounds results in 240 significant bands.



Green Ash
Crab Apple
White Ash
Hackberry
Honey Locust
Spruce
Norway Maple
Red Sunset Maple

Input File:
site10_2_ga_ref00008.asd.ref.txt:C2

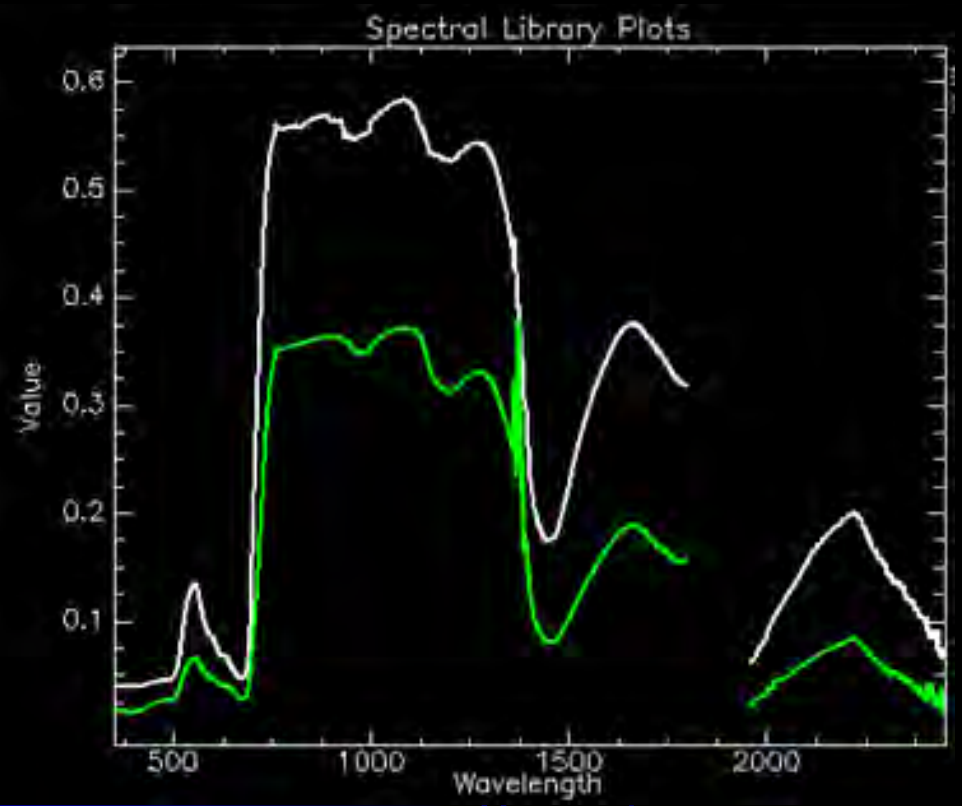
BandMax Parameters: 7 background spectra.
site10_1_ca_ref00006.asd.ref.txt:C2
site5_1_wa_ref00005.asd.ref.txt:C2
site5_6_hb_ref00000.asd.ref.txt:C2
site7_3_hl_ref00004.asd.ref.txt:C2
site7_4_spruce_ref00005.asd.ref.txt:C2
site8_4_nm_ref00004.asd.ref.txt:C2
site8_5_rs_ref00002.asd.ref.txt:C2

Band significance threshold: 0.7157

240 significant bands

Data and Imagery courtesy of NCDC Imaging and RFP Mapping , LLC

MILWAUKEE HSI DATA

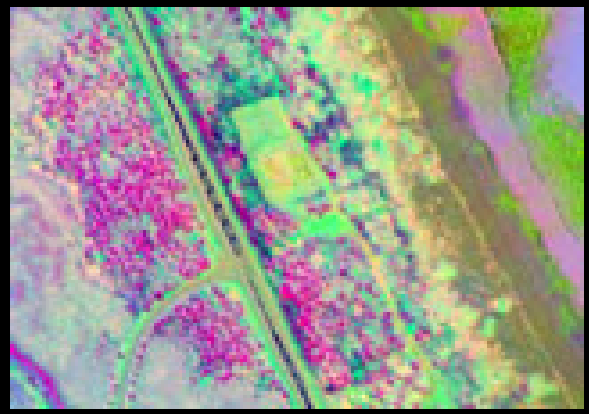


Comparison only to **White Ash** – by masking all other plant species other than Ash trees, both Green and White Ash should separate well.

Data and Imagery courtesy of NCDC Imaging and RFP Mapping , LLC

VEGETATION SPECIES MAPPING

Hyperspectral Imagery



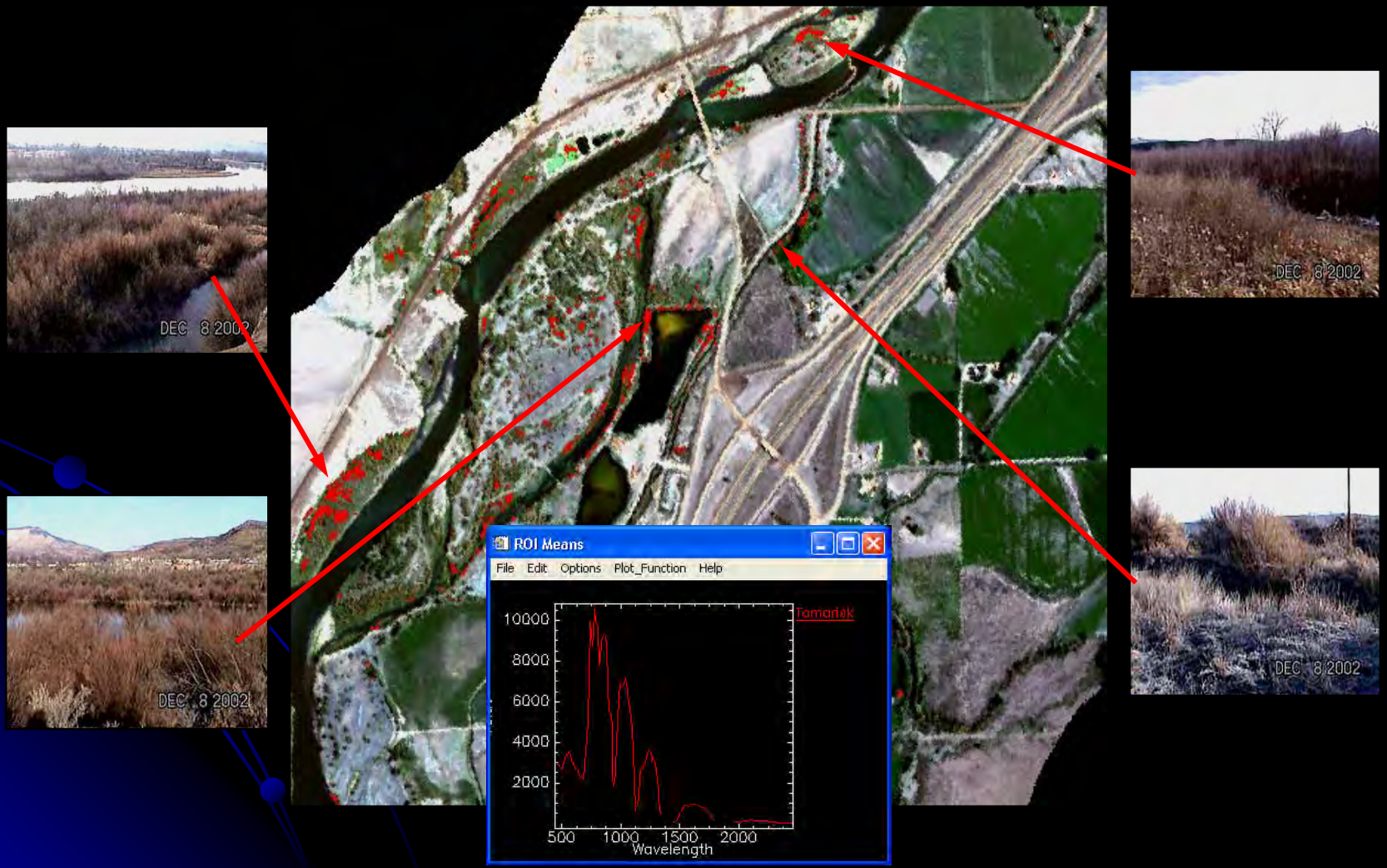
Hyperspectral Exploitation

Mapping Results

Images courtesy of the Galileo Group, www.galileo-gp.com

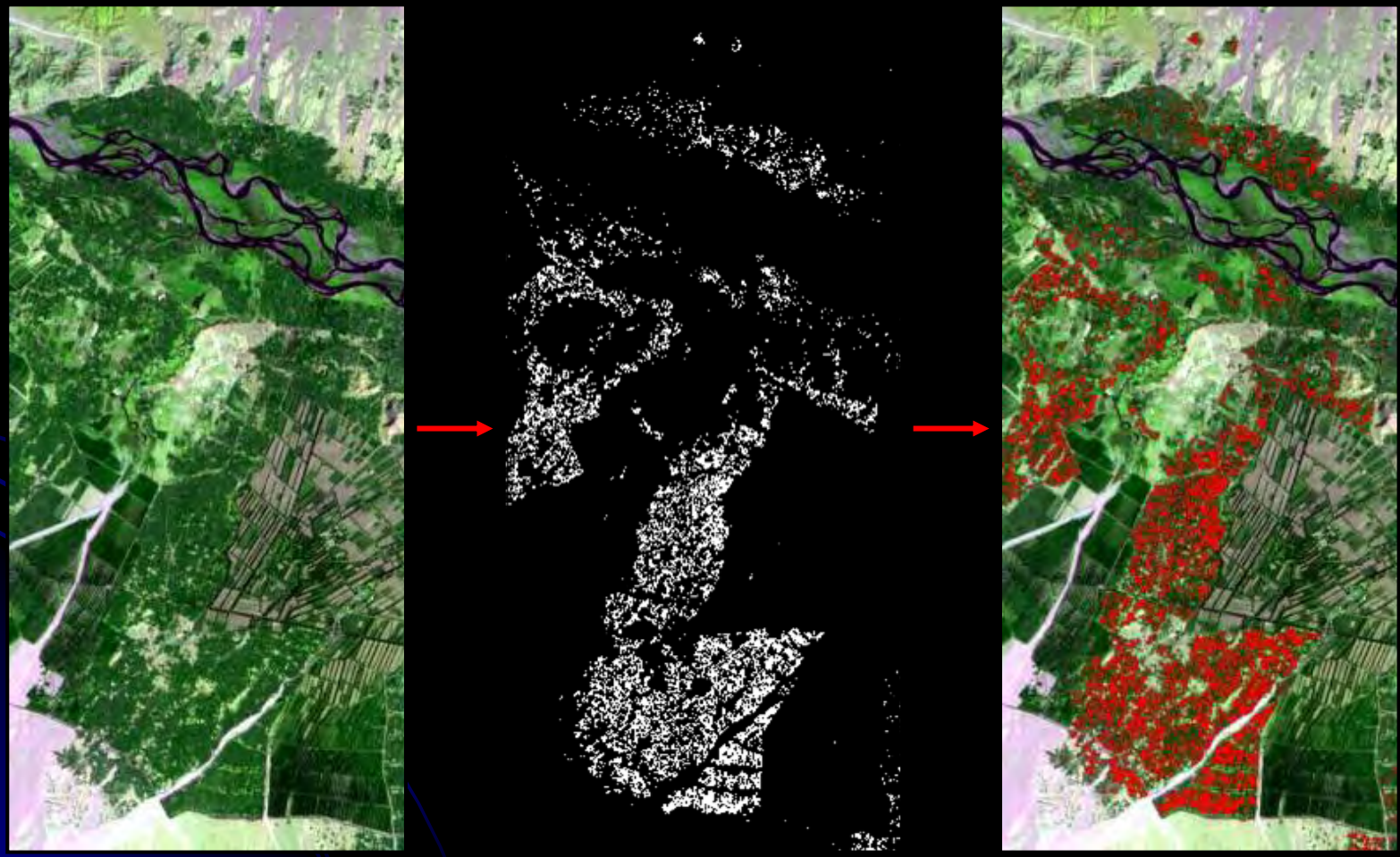
VEGETATION SPECIES MAPPING

Identification of Tamarisk



VEGETATION SPECIES MAPPING

Counter Narcotics

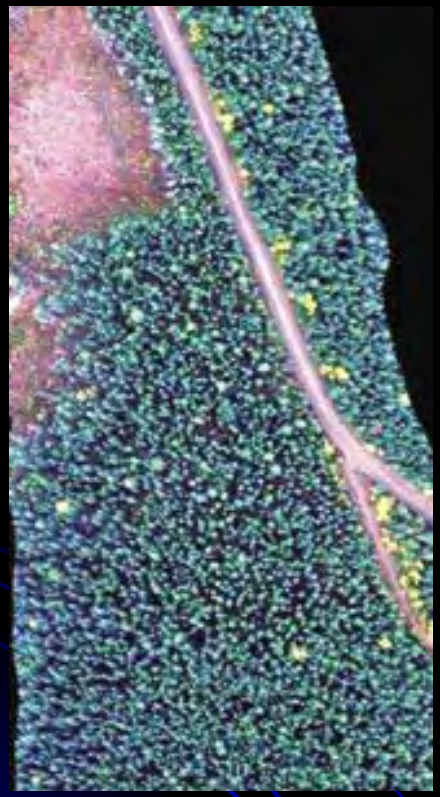


Identification of Poppy Fields

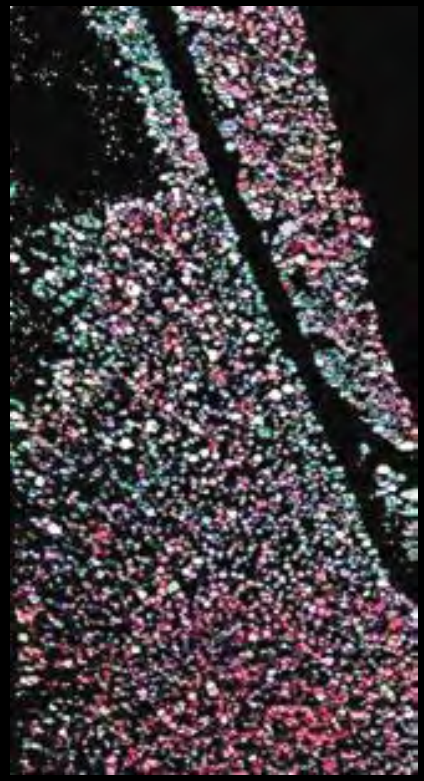
Data and Imagery courtesy of NCDC Imaging

HSI FOREST HEALTH MAPPING

Images courtesy of ITRES www.itres.com



1) Hyperspectral CASI (Compact Airborne Spectrographic Imager) in true color

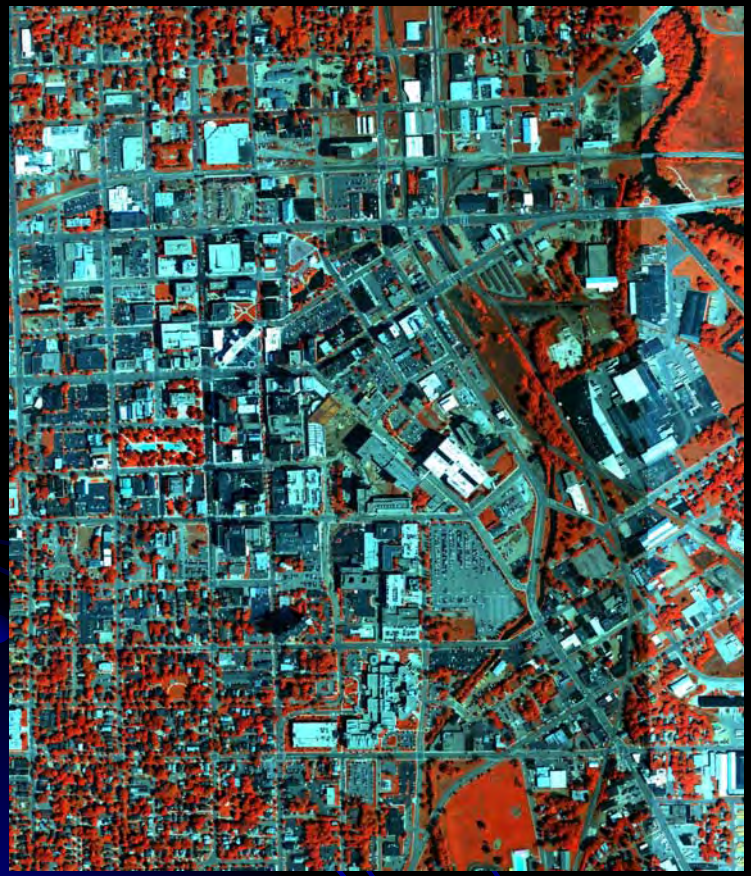


2) An intermediary tree crown map showing only the conifer tree crowns with the rest of the background blacked-out

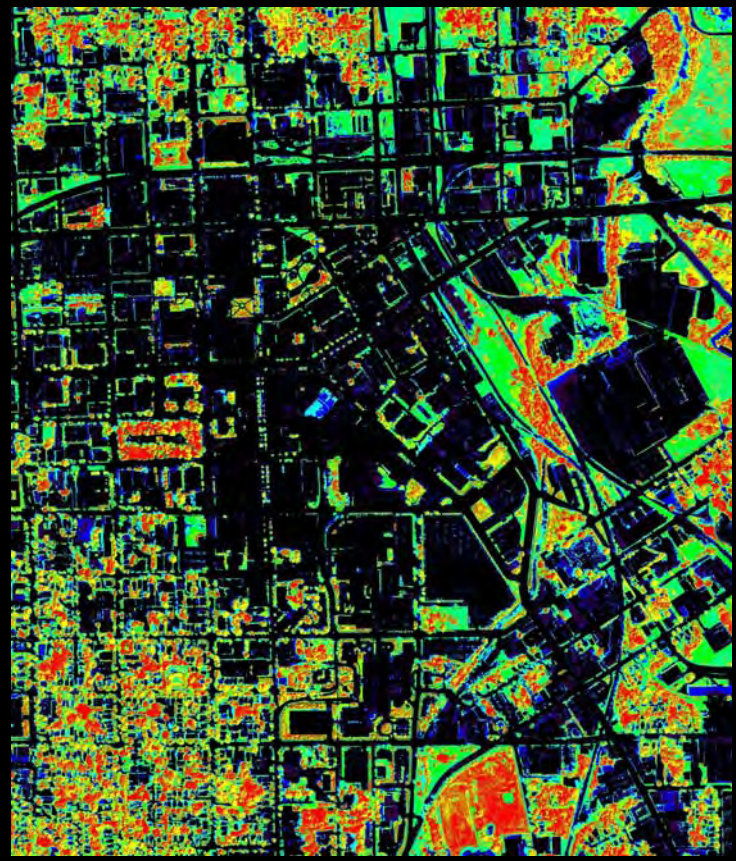
3) Forest health classification. Dark green indicates vigorous health, red indicates a dead/dying

HSI TREE HEALTH CLASSIFICATION

Images courtesy of ITRES www.itres.com

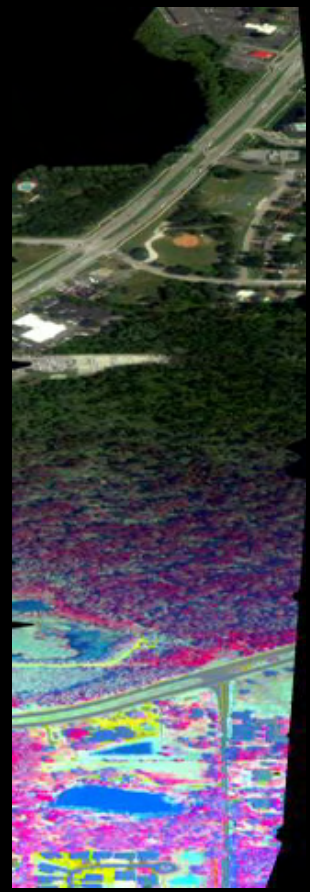


In infrared “false color” hyperspectral imagery, chlorophyll is reflected as red. August 2005, Kalamazoo, MI



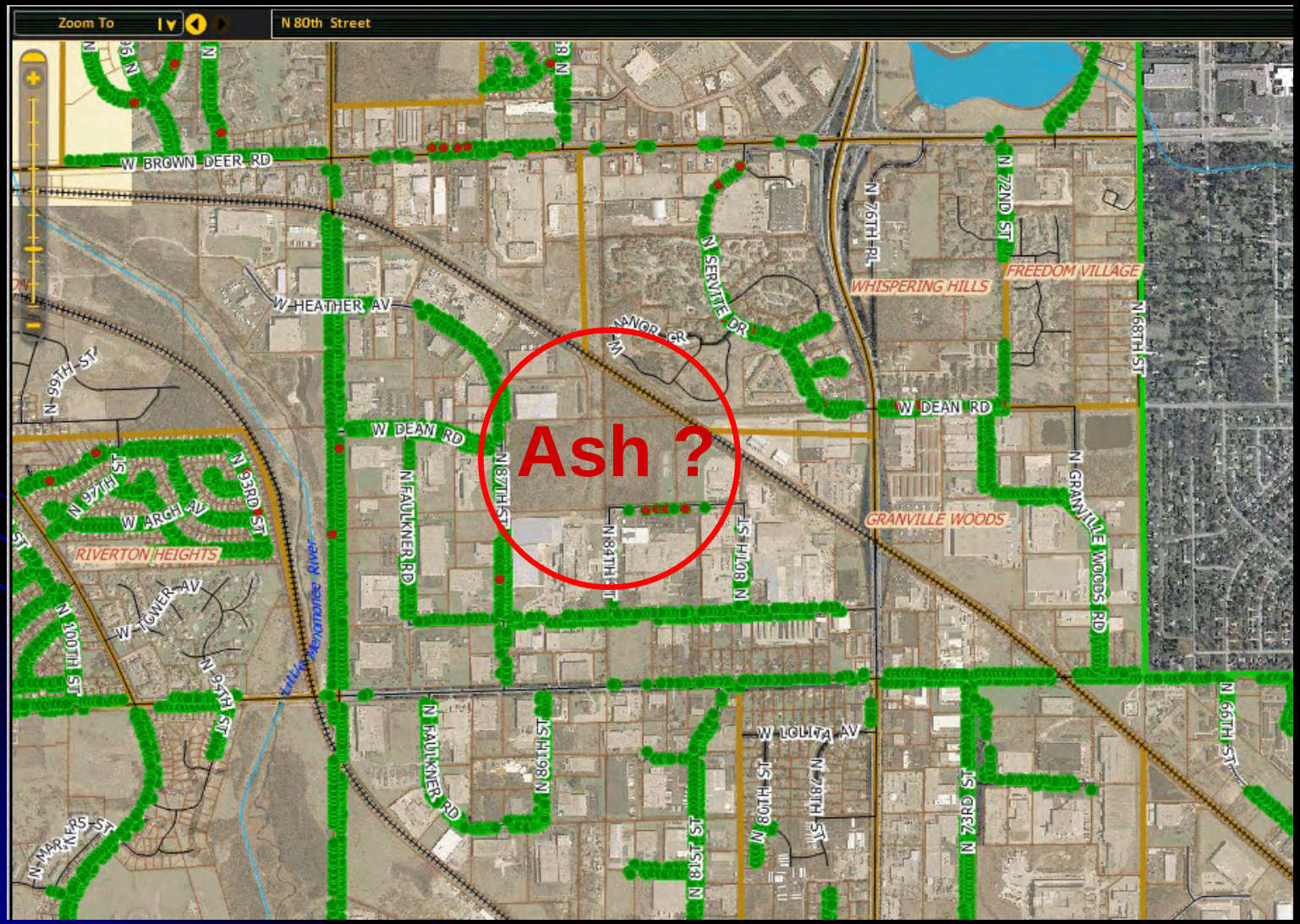
Relative tree health can be measured by differences in chlorophyll absorption bands. August 2005 Kalamazoo, MI

HYPERSPECTRAL LIDAR FUSION



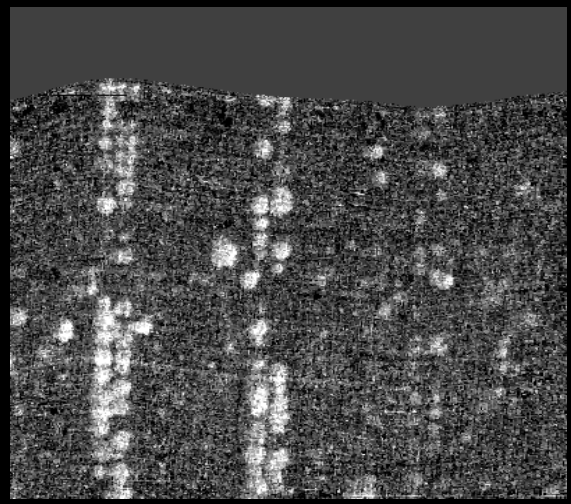
Images courtesy of the Galileo Group, http://www.galileo-gp.com/lidar_fusion.html

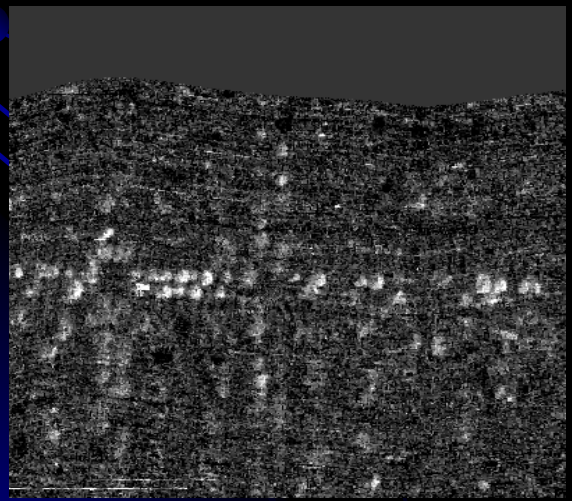
ASH TREE INVENTORY

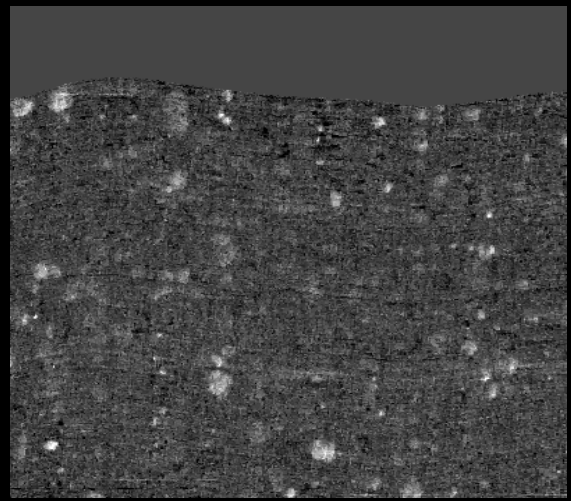


ASH INVENTORY PARCEL MAP

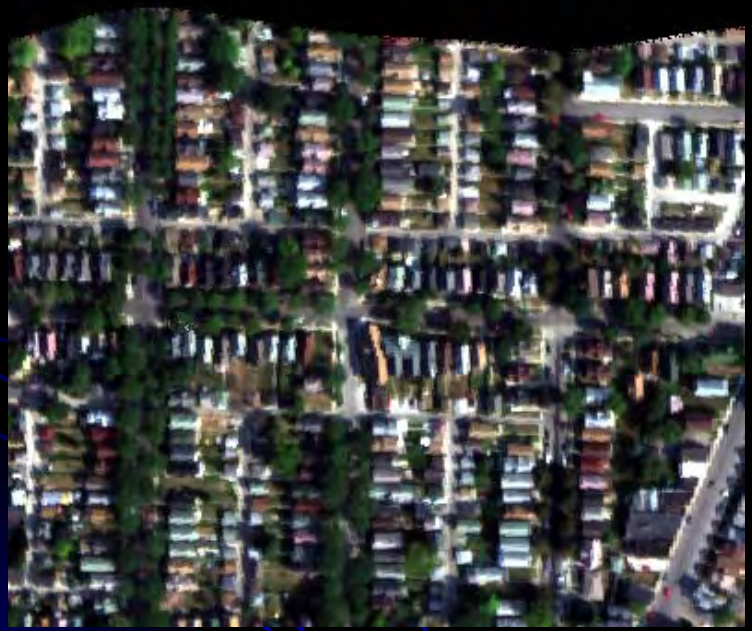
HYPERSPECTRAL IMAGERY MILWAUKEE URBAN FOREST



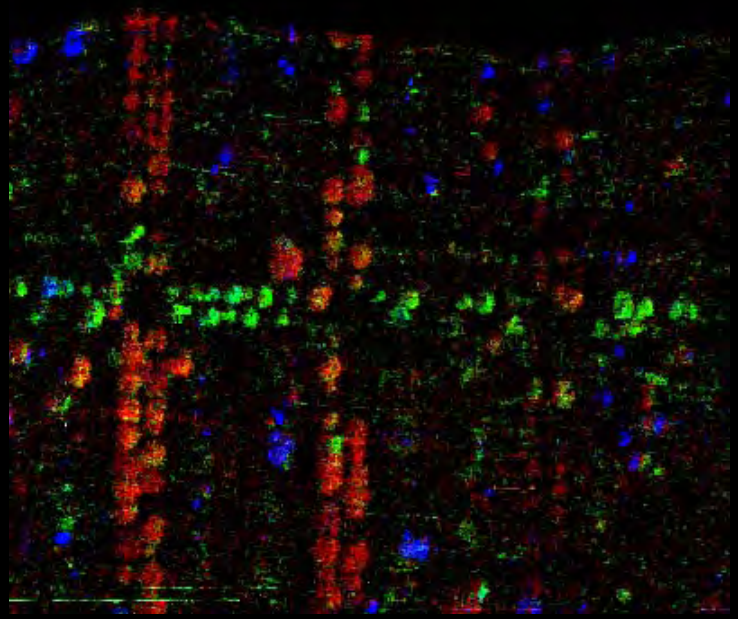




HYPERSPECTRAL IMAGERY MILWAUKEE URBAN FOREST



Hyperspectral Imagery



Hyperspectral Exploitation

HYPERSPECTRAL IMAGING & EAB

Benefits

- Cost-effective method for EAB host inventory
- Spatially map the location of all ash trees (80% or greater accuracy)
- Integration with existing planning resources, i.e. orthophotos, GIS map layers (parcel, watershed, storm water, etc.)
- Enhanced EAB management
  - Assess staffing needs based on quantifiable host assessment
  - Targeted inspections
  - Targeted educational outreach
  - Predictive movement of EAB based on host distribution
  - Improved eradication and chemical treatment management
- Volume estimation for wood waste projections

CONTACT INFORMATION

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