

APPLICATION OF REMOTE SENSING TECHNOLOGY TO EMERALD ASH BORER SURVEY

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Abstract

Conventional ground survey for emerald ash borer (EAB) is difficult and time-consuming. Detection of new infestations outside the quarantine area is often haphazard, relying on chance sighting and reporting by citizens. EAB ground survey is especially problematic because all stages but the adult are spent inside the host tree, where signs of their presence are not readily evident. Thus, the survey for new EAB infestations using remote sensing holds great appeal from the standpoints of both ease and economic efficiency. We initiated this project in the summer of 2003 with the primary goal to develop maps of ash trees at risk from EAB for use by federal and state survey personnel. We made significant progress during the 2004 season. Four basic activities were necessary to meet our objectives: image acquisition, collection of spectral signatures for ash trees and other tree species, collection of ground truth information on ash trees and other hardwood species recorded in the imagery, and image analysis and map development.

Our remote sensing approach was hyperspectral imagery (HSI). SpecTIR Inc. of California collected aerial HSI for us in 2004. Their HyperSpecTIR sensor simultaneously recorded reflectance from trees and other ground features over 227 spectral bands ranging from visible light through shortwave infrared wavelengths. Images were collected over three flight lines in southern Michigan and three in northwestern Ohio. Individual flight lines were 2 kilometers wide and 15-40 kilometers long at ground spatial resolutions of one and two meters. Images were collected twice during the 2004 season, in early July and late August. These times represented periods of relatively low and high stress, respectively, due to beetle activity and water availability.

During the data collection flights, we were joined by several collaborators, including scientists from ITT Aerospace Sciences, Clark University, and the

USDA Forest Service. These collaborations were very productive, especially in getting HSI experts to the field to observe and discuss the technical details of the data collection.

One part of our activities on the ground was the collection of spectral signatures of ash trees and other tree species using a hand-held spectrometer. This work addresses two main questions: Can HSI distinguish ash trees from those of other hardwood species? Can it separate stressed ash trees from healthy ash trees? A fundamental goal of the spectrometry is to build spectral libraries of (1) different hardwood tree species at different stages of phenology over the growing season; and (2) ash trees over a range of EAB infestation and other ashes under stress by manual girdling and herbicide injections.

This work will assess the feasibility of distinguishing tree species using spectral characteristics. Preliminary work in 2003 using an ASD FieldSpec Pro spectrometer (which recorded spectral bands from the visible spectrum to shortwave infrared) indicated that tree species, including oak, walnut, maple, and cherry, were distinguishable from ash a high percentage of the time based on leaf signatures. Ash trees that had been girdled or treated with herbicide were also distinguishable from healthy ash at the leaf level. During the 2004 growing season, leaf level data were collected four times from June to September in replicated experimental plots set up by Michigan State University and USDA Forest Service to investigate signatures of stressed ash trees.

Around the time of the hyperspectral flights, large numbers of spectral signatures were collected from over 15 tree species under our flight lines in Michigan and Ohio. These data are being analyzed to help in classifying the airborne HSI. This work utilized the APHIS bucket

truck so that measurements could be made above tree crowns, replicating the perspective of the airborne sensor.

Ground truth data were collected during five missions throughout 2004. Three hundred ash trees in various states of decline and over 400 trees of other species were identified under the flight lines. We were especially interested in species that are often confused with ash, such as boxelder, hickory, and walnut. Ground truth observations typically consisted of GPS locations of individual trees along with notes as to their size and condition and digital photos. Ground truth data will be

used to develop models for mapping ash and to validate those models.

The data sets for each HSI flight totaled over 150 gigabytes. Because of their sheer size, we distributed them on large external hard drives. As of early November 2004, all data were in the hands of our collaborators, and the analysis is currently under way. Our collaborators bring many years of experience and considerable expertise to the analysis. As a result, we look forward to very productive results from our collective efforts in 2005.