Morice & Lakes IFPA

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Summary No. 10

Morice & Lakes Innovative Forest Practices Agreement

PROJECT SUMMARY

Morice & Lakes IFPA projects are exploring ways to enhance forest productivity through a better understanding of factors affecting productivity, through intensive silviculture treatments, by increasing the area of productive forest land, and by improving site productivity estimates.

Mountain Pine Beetle Green Attack Detection

Ecosystem Management

Forest Productivity

Public Involvement

Adaptive Management

Photo courtesy of Canadian Forestry Service

Introduction

In October 2001, Earth Imaging Technologies Inc. (a division of Silvatech Consulting Ltd.) was contracted by the Vanderhoof Innovative Forestry Practices Group to develop a methodology for the application of remote sensing in the detection of mountain pine beetle (MPB), at the early stages of attack.

The purpose of this study was to explore the operational feasibility and value of remote sensing technology for the identification and mapping of MPB infestation at an operational scale.

Utilizing airborne hyperspectral imagery (see sidebar page 2), the project demonstrated that remote sensing techniques could be employed operationally to assist in locating trees at the early (green) stages of attack. The following provides a brief synopsis of the project.

FOREST RENEWAL BC

Objectives

The largest epidemic of mountain pine beetle in the history of British Columbia has created a state of emergency in the working forests of the west-central interior. Operating within this destructive infestation, the members of the Morice and Lakes, and Vanderhoof Innovative Forest Practices Agreements (IFPAs) as well as members of the Caribou Lumber Manufacturers Association (CLMA), have consolidated their efforts to control the problem, with funding provided by Forest Renewal BC. The objective of this consortium has been to develop methods and strategies for early detection, monitoring, and control of MPB within their collective area of interest. As one part of this initiative, the Mountain Pine Beetle Green Attack Detection Project was undertaken with the following objectives:

- To demonstrate that remote sensing techniques can be used operationally to facilitate an early detection-mapping program.
- To collect airborne hyperspectral data from a representative 10,000-hectare study area located between Cheslatta Lake and Bird Lake in the Vanderhoof Forest District.
- To complete a comprehensive analysis of the airborne data, including image acquisition, the development of detection algorithms, remote sensing analysis, and ground confirmation by Earth Imaging Technologies Inc. (EIT).

What is Hyperspectral Imaging?

Hyperspectral imaging collects data from many channels along the electromagnetic spectrum (the extent of the sun's energy ranging from cosmic, gamma and x-rays to ultraviolet, visible and infrared radiation) to accurately model the spectral signature presented by surface features.

Methods

Digital imagery was collected from the study area in mid October 2001, using a single engine Helio Courier aircraft (SpectroTech Inc.). On board, the aircraft carried a 37 channel GER 3715 scanner. A total of 24 flight lines were collected under variable weather conditions.

During this same period, three half-hectare quality control field plots were established within the study area to identify the exact locations of healthy and attacked lodgepole pine. Other species and specific stand and ground information was also collected.

Once stem mapping of healthy and attacked (green and red) lodgepole pine and other species was completed in the sample plots, spectral signatures were collected using two methods. The first employed a helicopter and a handheld spectrometer to collect signatures above representative sample trees. The second method involved the collection of signatures from the hyperspectral imagery.

After pre-processing (cleaning), the data was analyzed to differentiate between healthy, green-attacked and red-attacked lodgepole pine as well as other tree species (spruce and understorey vegetation). ENVI software, developed by ENVI Research Systems, was used to highlight the location of green attack and healthy lodgepole pine sample trees. Based on this set of samples, image and data analysis determined that certain characteristics could be differentiated between healthy and green-attacked stems. EIT remote-sensing specialists then wrote a series of algorithms and developed a model to facilitate detection mapping. The model was tested on a known set of sample trees over many iterations until it appeared to be yielding logical results. At this point, detection maps were developed for one flight line and two field trips were completed to check the efficacy of the predictive mapping process and further refinements were made.

Once predictive mapping reached an acceptable level of confidence on one flight line, the process was applied to the adjacent sunlit flight lines.

The final test of the accuracy and operational effectiveness of the early detection system was a field trial with representatives of the industry consortium in the spring of 2002. Green-attacked trees and clumps of trees were selected at random from the predictive maps and then visited in the field to confirm the classification.

Results

To date, the model for predicting MPB green attack has only proven successful on flight lines collected under full sunlit conditions, and statistical results are based solely on the quality control (calibration) plot located within the sunlit portion of the study area. Of the 57 green attack lodgepole pine recorded within this plot, and spectrally visible on the imagery, the predictive mapping process correctly identified green attack on 54% of the stems. Of the 93 stems identified as green attack within the plot, 33% were correctly located and identified by the predictive mapping model. Of the 300 non-attacked trees in the sample plot, 18 (6%) were incorrectly labeled as attacked.

An additional three blind test plots are being established in the predictive mapping area to provide more objective statistical results.

Preliminary results indicate that the predictive maps are useful for the location of single stems and patches of green-attacked lodgepole pine

Discussion

The results indicate that remote sensing techniques and resultant detection mapping is able to direct the user to a patch of green-attacked lodgepole pine and assist in the field identification of attacked clumps and individual stems. The detection mapping has also proven useful in the identification of stressed stands predisposed to successful MPB attack.

The success realized on sunlit portions of the study area suggests that airborne hyperspectral imagery can be used to remotely identify patches of individual or clustered lodgepole pine trees at the green stage of attack with reasonable confidence.

Recommendations

1. This study indicates that this process provides a useful method of early detection, which can be used to effectively direct control measures at the landscape level.
2. Further refinement of the process should be undertaken before this technique is applied over a large area. To improve operational feasibility, additional algorithms should be developed to compensate for lower incoming and reflected solar energy levels under diffuse light.
3. Image acquisition should begin early in the fall to optimize solar angles (minimize shadow), while allowing sufficient time for tree stress symptoms to develop.
4. To improve image quality and accurate georeferencing, a stable aircraft equipped with an Inertial Navigation System must be employed in future applications.

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