Satellite Remote Sensing for Assessing Insect Defoliation Damage in Canada

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Remote sensing involves acquiring information about an object by a sensor that is not in direct contact with the object being investigated. It is a technological tool that is complementary to, rather than being a replacement for, existing aerial and ground survey methods. In Canada, images from remote sensing satellites have been used to detect and map defoliation from a number of insects such as forest tent caterpillar (*Malacosoma disstria* Hubner), eastern spruce budworm (*Choristoneura fumiferana* [Clem.]), eastern hemlock looper (*Lambdina fiscellaria* [Guen.]), and jack pine budworm (*Choristoneura pinus pinus* Freeman). The range of remote sensing applications has included detecting and mapping defoliation, characterizing patterns of disturbance, modeling and predicting outbreak patterns, and providing data to pest management decision support systems. These applications result in information products that support forest management planning, impact studies, and contribute to regional and national reporting.

Insect defoliation affects the morphological and physiological characteristics of trees, and it is these characteristics that govern how trees absorb and reflect light. Successful use of remote sensing for entomological studies requires integrating knowledge of pest, host, and image. Knowledge of insect pest biology and its manifestation of damage can be related to species host phenology, composition, and structure in order to understand its damage impact. In turn, this knowledge is fundamental for remote sensing with respect to defining spectral regions appropriate for damage assessment, determining sensor spatial resolution requirements, identifying the optimum timing for data acquisition, and selecting or developing appropriate image processing methods.

In a review of four past and current studies, one for each of the insect pests listed above, three research issues were identified. First, a remote sensing spectral basis for damage class limits such as light, moderate, and severe, is required to achieve consistent detection and mapping of defoliation severity. Second, the timing of image data acquisition should coincide with the period when spectral changes resulting from defoliation are most observable. Third, the spatial and spectral resolution of the image must be appropriate to the defoliation problem being studied.

Timing of satellite remote sensing is notably one of the most difficult tasks to plan and achieve because of the need for cloud-free conditions during the dates of image acquisition. In future, the likelihood for obtaining cloud-free imagery during the narrow time periods when spectral changes are at their maximum, will increase as the number of suitable sensors increase. The technology to acquire images from airborne sensors is also becoming more widely available. Opportunities to acquire remote sensing images range from high (e.g., sub-meter pixel size) to coarse spatial resolution (e.g., 1 km pixel size), and the number of available sensors is increasing at an unprecedented rate (http://www.ersc.wisc.edu/ERSC/Resources/EOSF.html). Growing competition should help ensure that future prices will be competitive, and that data will be available, especially for those pests whose defoliation damage are best assessed within narrow time periods.

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