

CHAPTER 2

North Central Forest Insects

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This chapter describes three projects. One project addressed the impacts on American basswood (*Tilia americana*) from an exotic species, the introduced basswood thrips (*Thrips calcaratus*). As with many exotic species, little was known about the biology and behavior of this insect, and little was known concerning the possible negative impacts on the basswood resource in the North Central region. The project clarified the importance of *Thrips calcaratus* in a regional basswood decline episode. It also provided a great deal of basic biological information on the insect. The second project studied the responses of sub-boreal forest insect communities to a large windstorm and subsequent salvage activities and prescribed burning in northeastern Minnesota. Study results indicated that subcortical insect numbers and activity increased initially in the wind-disturbed areas, and contributed to the mortality of live residual trees after the windstorm, but subcortical insect numbers declined dramatically 4 years after the windstorm, and a widespread epidemic of bark and woodboring insects did not occur in these sub-boreal forests. The third study revolved around the evaluation of survey methodology for forest defoliators. This project proposed the development of a multi-scale approach to monitor defoliation extent and severity using high-resolution satellite imagery. Specific objectives were to link image-derived estimates of defoliation to measures derived from current forest health Detection Monitoring (DM) efforts (i.e., aerial survey). This research could pave the way towards standardized defoliation mapping using satellite-based methods.

Project NE-F-01-02: Impact of an Invasive Species on Forest Health: Phenological Differences as a Possible Explanation of Impacts on American Basswood in the Great Lakes Region

The objectives of this project were to (1) compare relative abundance and phenology of native and introduced insect herbivores and predators associated with American basswood, (2) evaluate reasons for differential damage of introduced

basswood thrips in its native and introduced range, and (3) assess basswood crown condition.

Introduced basswood thrips was first observed causing damage to American basswood in the Great Lakes region in the 1980s. This insect is not native to North America, and little was known about its biology or its ability to damage the basswood resource. This project clearly identified *Thrips calcaratus* as a significant cause of extensive dieback and decline in basswood stands in Wisconsin, Michigan, and Minnesota. However, there were other factors also involved in the ongoing regional basswood decline episode.

The project also evaluated several survey techniques. No technique was obviously better; tree size and cost and availability of tree climbers were key factors in selecting an appropriate survey method.

Utilization of project results—Peer reviewed publications and a thesis were developed from this project (Werner and Raffa 2004, Werner and others 2005). These have greatly increased our background knowledge on the behavior and impact of introduced basswood thrips and our ability to survey for the insect.

Suggestions for further investigation—No further evaluation on the health of the basswood resource has been conducted despite the continuing presence of introduced basswood thrips. A regional evaluation on basswood growth, regeneration, and overall health would be warranted. This has special significance since the eventual loss of ash (*Fraxinus* spp.) due to emerald ash borer (*Agrilus planipennis*) will require renewed emphasis on basswood as a major component in many Great Lakes forest stands.

Project NE-F-01-08: Prescribed Fire as a Management Tool for Curbing Potential Epidemics of Bark Beetles and Woodborers in a Forest Blowdown

The initial objective of this project was to evaluate if fire could be used as an important tool to control potential outbreaks of phloem and wood-dependent insects in disturbed stands to

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better achieve forest sustainability goals. This objective was broadened as discussed below.

The project investigators studied the responses of sub-boreal forest insect communities to a July 4, 1999, severe windstorm and subsequent salvaging and prescribed burning in northeastern Minnesota. Study results indicate that (1) subcortical insect numbers and activity increased initially in the wind-disturbed areas and contributed to the mortality of live residual trees after the windstorm; (2) these subcortical insect numbers declined dramatically 4 years after the windstorm, and a wide-spread epidemic of bark and woodboring insects did not occur in these sub-boreal forests; and (3) a woodboring *Monochamus* beetle instead of a bark beetle species became a more significant contributor to tree mortality in the wind-disturbed areas.

In regards to prescribed fire, results indicate that (1) both salvaging and burning altered populations and communities of forest insects; (2) burning resulted in increased invasion by an exotic ground beetle; (3) burning resulted in greater populations of both ground and subcortical insects at least for a short-term; (4) burning can maintain populations of fire-adapted ground beetles; (5) large-scale conversion of pine to aspen/birch forest may be problematic for some ground beetle species adapted to pine forests; and (6) subcortical insect populations in the wind-disturbed sub-boreal forests may decline naturally without the use of fuel-reduction activities.

Utilization of project results—The following peer reviewed publications were developed through this project: Gandhi and others 2007, and Gandhi and others 2008. Land managers have a better understanding of ecosystem response following a large scale wind disturbance in northern boreal forests. A key finding was that subcortical insect numbers declined dramatically 4 years after the windstorm, and a widespread epidemic of bark and woodboring insects did not occur in these sub-boreal forests. This information provides a context for future responses to large scale disturbances.

Suggestions for further investigation—Future studies should focus on comparing insect communities between naturally burned and prescribed burned sites. Wildfires were virtually absent during the duration of the study, but there have been a number of fires since 2003 in the wind-disturbed areas in the Superior National Forest. Also, this study did not evaluate the fate of live residual trees in salvaged and burned areas. Would we expect bark and woodboring beetles to contribute to tree mortality of residual live trees in these two fuel-reduction treatments, and would it be similar to trends observed in the wind-disturbed forests?

Large-scale forest disturbance events are not uncommon in the Great Lakes region. This study in a sub-boreal forest type cannot clarify what is likely to occur following similar events in other forest types. For that reason, repeated observations (studies) should be done following future disturbance events so that a better understanding of insect and pathogen behavior can be developed.

Project NC-EM-05-04: A Multi-Scale Remote-sensing Approach for Quantifying Regional Impacts of Insect Defoliators

This project proposed the development of a multi-scale approach to monitor defoliation extent and severity using Moderate Resolution Imaging Spectroradiometer (MODIS), Landsat (or similar), and high-resolution imagery (hyperspectral imagery). Specific objectives were to link image-derived estimates of defoliation to measures derived from current forest health DM efforts (i.e., aerial survey and plot-level forest health data) to predict impacts across two representative regions of North America (Upper Midwest and adjacent Canada, and the Mid-Atlantic Highlands) at the resolution of the National Aeronautics and Space Administration's MODIS imagery (250 m). The long-term goal of this work was to standardize defoliation mapping using satellite-based methods.

Development of the multi-scale mapping approach centered on multi-temporal Landsat imagery. Two late-summer Landsat images for each Landsat scene and year of disturbance were used. One image was from the year of interest for defoliation, and the second image was from a base year, in which no defoliation occurred at the sites of interest. The investigators calculated a Moisture Stress Index (MSI), which has been shown to be strongly related to forest stress and vegetation loss. They calculated a pixel-wise simple difference of MSI between years which represented the probability of change, where change was defined as disturbance, defoliation, or clearing. They then mapped percent defoliation as a simple regression model.

Utilization of project results—Articles by McNeil and others (2007) and deBeurs and Townsend (2008) describe the application of MODIS data to map defoliation across large regions. A key conclusion from this research is that “daily MODIS data can be used with confidence to monitor insect defoliation on an annual time scale, at least for larger patches ($> 0.63 \text{ km}^2$)” (deBeurs and Townsend 2008). This research could pave the way towards standardized defoliation mapping using satellite-based methods. Additional peer reviewed publications developed through this project were Wolter and others (2008), and Wolter and others (2009).

Suggestions for further investigation—Insect defoliation has been traditionally collected using labor and time intensive sketch map surveys. Field trials with the techniques described previously could provide a basis for comparing traditional defoliation data collection to a system relying on a multiscale approach as described earlier.

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