Activities

This research concerns interactions between below- and above- ground processes. Specifically, we are conducting long-term studies to test the hypothesis that tree mortality and gap formation occur by the following sequence: a) root herbivores and their associated fungi colonize roots of red pine trees, b) colonization by these organisms is not lethal, but it compromises defenses against subcortical insect-fungal complexes that exploit the main stem; c) colonization by the latter group of bark beetles and fungi is lethal to trees; d) root fungi spread to adjacent trees through root grafts; e) trees continue to be killed in a progressively expanding gap.

This project began in October, 2003, so our first field season is underway. The intervening period has been devoted to a) site selection, b) plot establishment, c) preparation for insect sampling, d) implementation of treatments, e) insect sampling, and f) development of methods for measuring insect dispersal.

Plots were established throughout Wisconsin, to provide spatially explicit information at three levels of scale: trees within a site, clusters of sites within a region of Wisconsin, and the state. The sites are distributed along a transect from the southeastern to west-central part of the state. The clusters of sites are located in four regions (see below): Kettle Moraine (southeast), Lower Wisconsin River (south central), Central Sands (central), and upper Mississippi River (west-central). Three types of sites were established, distributed among regions: Symptomatic controls, Symptomatic treated, Asymptomatic controls. Each plot was established by permanently marking and numbering all red pine trees within 20 m of the zone of mortality (or equivalent region in asymptomatic controls). Plot locations were recorded by GPS. Insect traps were constructed or purchased, and appropriate semiochemicals were purchased, for sampling the following insects based on our working hypothesis (above): *Ips pini, Ips grandicollis,*
Hylastes porculus, Hylobius radicis, Hylobius pales, Hylobius assimilis, Pachylobius picivorous, Dendroctonus valens.

Treatments consisted of severing root grafts m in advance of the mortality zone (see below), using mechanical equipment. The root-graft treatments were supplemented by deploying special traps for removing the bark beetle Dendroctonus valens, a major vector of the root fungi described in our working hypothesis. These treatments, coupled with controls allow for a direct test of the hypothesis that below- and above- ground organisms are interacting by the proposed mechanisms.

Insect sampling began in early spring, 2004. Populations are being sampled throughout the course of the summer. The expected insects have been observed in our traps. Prof. John Reeve has been developing methods for studying bark beetle and predator dispersal, in anticipation of studies on inter- and intra-stand movement, which are scheduled to begin during the summer of 2005.

During the remainder of this summer (2004), our primary goals are a) continued insect sampling, b) complete vegetation mapping of the stands, and tabulation and mapping of tree mortality, c) sampling arthropod biodiversity in each of the above stands, and in asymptomatic portions of symptomatic stands. The major plans for fall and winter (2004-2005) are a) identification, tabulation, and data entry of insects, b) data entry of tree mortality; c) preliminary analyses; d) preparation for 2005 season (trap repair, site visits, ordering semiochemicals and supplies, etc).

We have given the following presentations based on this work:


**Findings:** We have just begun our first field season, so we have no findings to report.

**Contributors**

The following individuals have contributed to the above results of our first year as follows: Jane Cummings Carlson and Kenneth Raffa jointly performed plot election and implementation of treatments. Undergraduate students Matt McMahon and Robert Murphy began semiweekly sampling of bark beetles, root insects, and predators in spring. This work is still underway. Volker Radeloff is coordinating vegetation mapping and spatially explicit tabulation of tree mortality. The undergraduate Adam Ridley (REU) is performing most of the fieldwork in this phase. Daniel Young is coordinating arthropod biodiversity sampling. The undergraduate Katrien Werner (REU) is performing most of the fieldwork in this phase. Jun Zhu and Brian Aukema have begun laying the templates for statistical analyses.

**Training**

We have established training opportunities at several different levels. These students are from various disciplines, and so we feel this blending of talents is one of the most instructive aspects of this project for young scientists. Students are gaining an opportunity to work both independently and in teams.

**Undergraduate level:**

We have established programs for two REU students. These students will conduct research within the framework of this overall study, but also have their independent portions. One will take responsibility for the vegetation-mapping component. This individual is a Forest Ecology & Management major, and will be under the direct supervision of Prof. Volker Radeloff. The other REU student will assume responsibility for the arthropod biodiversity component. She is an Entomology major, and will be under the direct supervision of Prof. Daniel Young. The two REU students work largely as a team.

A Forest Ecology & Management major is engaging in this project to fulfill his “professional Experience” requirement for his BS degree. This individual is assuming primary responsibility for coordinating activities between the University of Wisconsin and the Wisconsin Department of Natural Resources. A complete training program has been developed for this individual. In addition to salary, he will receive academic credit. In addition to his liaison capacity, he is involved in plot establishment and insect sampling.
A Zoology major is both working as a student hourly and conducting an independent study on semiochemical behavior of *Ips* beetles. The former activities include sampling insects, and working in concert with the above Forest Ecology & Management student. The latter activity includes a for-credit special project, under the joint direction of Eric Nordheim, Brian Aukema, and Kenneth Raffa.

A Zoology major is conducting an independent study on semiochemical behavior of *Dendroctonus valens*. This is under the direction of Kenneth Raffa.

**Undergraduate level:**

Prof. John Reeve has recruited a graduate student, to begin in September. This student will conduct the portion of this project investigating the role of insect dispersal in tree mortality. Specifically, he will investigate movement by *Ips pini* and *Thanasimus dubius*.

**Postdoctoral Level**

Dr. Brian Aukema has been working on the spatial modeling components of this project, in conjunction with Prof. Jun Zhu and Prof. Murray Clayton. He has also been gaining experience in mentoring, assuming partial responsibility for one of the undergraduates involved (see above).

**Outreach**

This project has had an extensive outreach component. Scientists from UW-Madison and the

1. Wisconsin DNR and UW-Madison personnel jointly presented the rationale and description of this work to land-owners and forest managers in the following counties: LaCrosse, Waupaca, Juneau, Sauk, Waukesha, Walworth, Adams, Portage, Dane
2. Kenneth Raffa gave a presentation to the Wisconsin Woodlands Owners Association in Feb. 2004
3. The syndrome of dying red pines caused by interactions among root insects, bark beetles, and fungi has caused mortality to the Natural Areas section of the UW-Madison campus. Ken Raffa has been instructing grounds personnel on how to amend the problem.
4. Ken Raffa (UW-Madison) and Jane Cummings Carlson (WI DNR) jointly presented this project at the annual DNR meeting.