

Acceleration and mitigation of forest pestilence from *Dendroctonus* pine beetles

Matthew P. Ayres¹, Kier Klepzig², Sharon Martinson¹, Nicholas Friedenberg¹, and Daniel Slone²

Department of Biological Sciences, Dartmouth College, Hanover, NH; ² Southern Research Station, USDA Forest Service, Pineville, LA



Background

- Dendroctonus* bark beetles are the dominant source of biotic disturbance in coniferous forests of North America.
- They have recently killed trees over millions of hectares worth billions of dollars with broad consequences for forest structure and function.
- Dendroctonus* was prominent in arguments for the Healthy Forests Restoration Act of 2003.
- Better scientific understanding of bark beetles is needed to improve management of forests in the presence of these native insects with naturally explosive population dynamics

Research questions and hypotheses

- It is thought that per capita growth rates of *Dendroctonus* populations tend to increase with population size (positive density-dependence or Allee effect). This promotes pestilence by accelerating population growth. [What causes Allee effects in *Dendroctonus*?](#)

H1.1: Null hypothesis. The apparent phenomenon is actually just exponential growth and not truly an Allee effect.

H1.2: When local populations are larger, tree-specific attack rates are greater, resin defenses of trees are more quickly depleted, and per capita reproductive success is greater.

H1.3: Small infestations are more likely to collapse due to an interruption in attacks (from transient dynamics in age structure of beetles).

H1.4: In relatively small infestations, there is increased mortality of attacking adults because it is difficult for beetles to locate trees with a favorable (low to moderate) density of adults already present.

- It is thought that longleaf pine (*Pinus palustris*) is less susceptible to *Dendroctonus* than loblolly pine (*P. taeda*). If so, restoration of longleaf pine forests could mitigate pestilence. [Why are some pine species less susceptible to *Dendroctonus*?](#)

H2.1: Null hypothesis. The conventional wisdom that there are fewer infestations with longleaf is a false impression created by the low abundance of longleaf pine in the contemporary landscape.

H2.2: Compared to loblolly pines, the resin defenses of longleaf afford better protection against bark beetles.

H2.3: Greater inter-tree spacing in longleaf stands compared to loblolly limits the ability of *Dendroctonus* to aggregate during attacks and dampens population growth as a result.

H2.4: The searching behavior of dispersing adults of *Dendroctonus* is biased against stands of longleaf pine compared to stands of loblolly pine.

Publications. Available at: <http://www.dartmouth.edu/~mpayres/>

Friedenberg, N.A., J.A. Powell and M.P. Ayres. Synchrony's double edge: transient dynamics and the Allee effect in stage-structured populations. Submitted to *Ecology Letters*.

Pureswaran, D.S., B.T. Sullivan, and M.P. Ayres. High individual variation in pheromone production by tree-killing bark beetles (Coleoptera: Curculionidae: Scolytinae). Submitted to *Naturwissenschaften*.

Martinson, S.J., R.W. Hofstetter, and M.P. Ayres. Why does longleaf pine have low susceptibility to southern pine beetle? Submitted to *Canadian Journal of Forest Research*.

Friedenberg, N.A., B.M. White, D.H. Slone, S.J. Martinson, and M.P. Ayres. 2007. The differential impact of a destructive forest pest on two species of *Pinus*. *Canadian Journal of Forest Research*, in press.

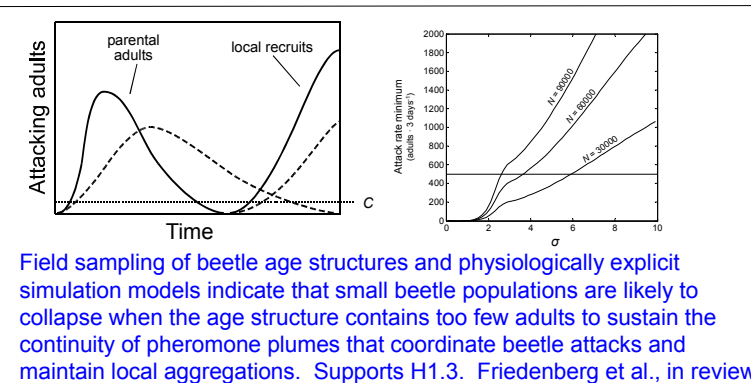
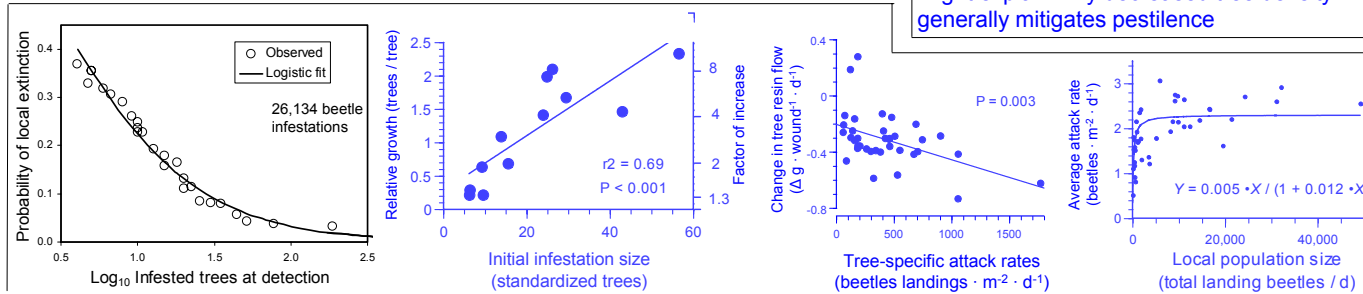
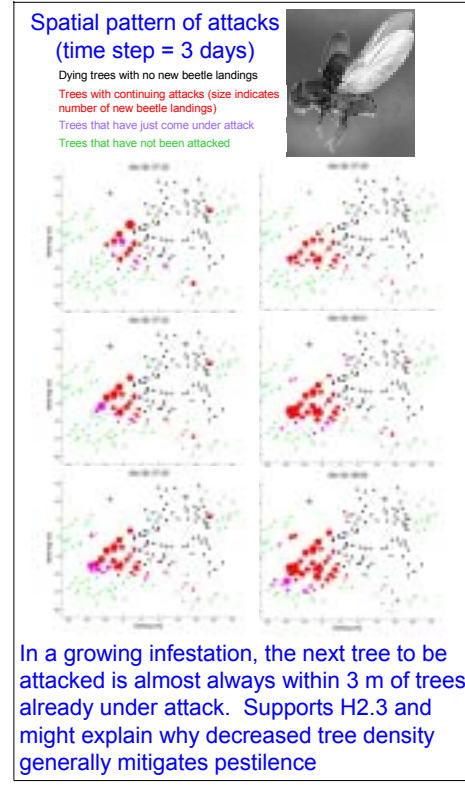
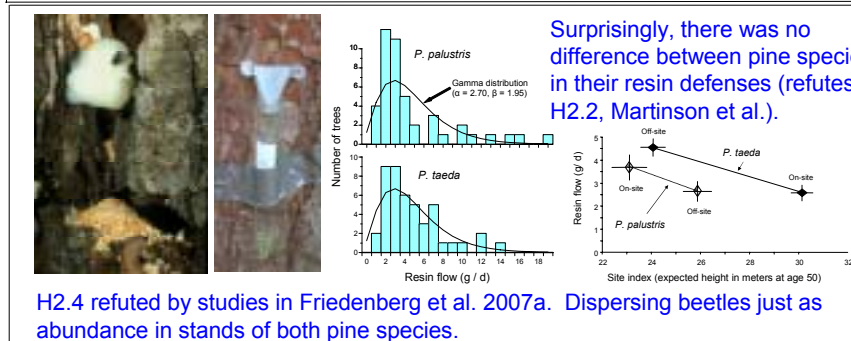
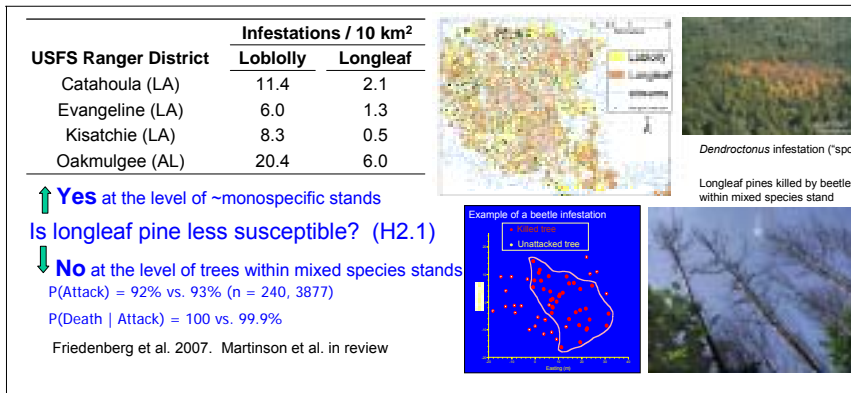
Pureswaran, D.S., B.T. Sullivan, and M.P. Ayres. 2006. Fitness consequences of pheromone production and host selection strategies in a tree-killing bark beetle (Coleoptera: Scolytinae). *Oecologia* 148: 720-728.

Ylioja, T., D. H. Slone, and M. P. Ayres. 2005. Mismatch between herbivore behavior and demographics explains scale-dependence of host susceptibility in two pine species. *Forest Science* 51: 522-531.

Hofstetter, R.W., J. B. Mahfouz, K.D. Klepzig, and M. P. Ayres. 2005. Effects of tree phytochemistry on the interactions among endophagous fungi associated with the southern pine beetle. *Journal of Chemical Ecology* 31: 539-560.

Wullschlaeger, S., S. McLaughlin, and Ayres MP. 2004. High-resolution analysis of stem increment and sap flow for loblolly pine trees attacked by southern pine beetle. *Canadian Journal of Forest Research* 34:2387-2393.

Klepzig, K.D., J. Flores-Otero, R.W. Hofstetter, and M.P. Ayres. 2004. Effects of available water on growth and competition of southern pine beetle associated fungi. *Mycological Research* 108:183-188.



Allee effects are clear and strong (refutes H1.1).

Trees that are attacked at higher rates succumb more quickly (consistent with H1.2), but tree-specific attack rates are ~invariant with local abundance (refutes H1.2) (Friedenberg et al., Ayres et al. in prep.)

Acknowledgements. The project was supported by the National Research Initiative of the USDA Cooperative State Research, Education and Extension Service, grant number 2004-35302-1482 to MPA and KDD. Research was made possible by the expertise and cooperation of U.S. Forest Service personnel within Forest Health Region 9, and within the following U.S. National Forests: Kisatchie, Talladega, Bankhead, DeSoto, Homochitto, and Bienville.