MOUNTAIN PINE BEETLE INFESTATION: CYCLING AND SUCCESSION IN LODGEPOLE PINE FORESTS

W. H. Romme
Department of Biology
Fort Lewis College
Durango, CO

J. B. Yavitt
D. H. Knight
Department of Botany
University of Wyoming
Laramie

J. Fedders
Department of Biology
West Virginia University
Morgantown

Objectives

This work began in 1980 with the objective of studying the effects of mountain pine beetle outbreaks in Yellowstone and Grand Teton National Parks and the surrounding area. The immediate effects of outbreaks on stand structure have been documented (Roe and Amman 1970, Amman and Cole 1980), but little is known about long-term influences on ecosystem processes such as primary productivity, material cycling, and succession. Thus, our research deals with the effects of beetle outbreaks on (1) rates of growth in surviving trees and total stand productivity, (2) dead woody fuels and fire risk, (3) forest succession, and (4) nutrient cycling.

Methods

To examine tree growth and stand productivity following an outbreak, we examined a chronosequence of 10 stands affected by a major beetle outbreak from 1 - 20 years ago. We collected increment cores from surviving canopy, sub-canopy, and understory trees and measured mean annual ring width before and after the outbreak. We also sampled the density of the stands using belt transects and multiplied the annual bole volume increments of individual trees (calculated from radius increments and heights) by the density of trees of various size categories to estimate total stand productivity before and after the outbreak.

We used two approaches for examining changes in dead woody fuels. In the first approach, we sampled fuels in the above-mentioned

chronosequence of 10 stands using the planar-intercept method (Brown 1974). The second approach involved simulating the addition and loss of dead woody fuels through beetle-caused mortality, background litter fall, and decomposition.

Effects of outbreaks on nutrient cycling were measured through the use of 36 tube-tension lysimeters (Parizek and Lane 1970) established in 1980 in two stands near West Yellowstone. We collected leachate during the snowmelt periods of 1981, 1982, 1983, and 1984 and measured elemental concentrations in our laboratory in Laramie. These data will be used with our stand-level hydrologic model for lodgepole pine forests (already developed) to estimate the magnitude of nutrient loss associated with beetle outbreaks.

Results

We have completed all of our data collection, and have finished all of the analyses except those with the lysimeter data. Preliminary results were presented in our progress reports for 1982 and 1983 published in the UW-NPS Research Center Annual Reports. We published a paper dealing with the effects of outbreaks on tree growth and stand productivity (Romme et al. 1986), and are preparing a second paper on effects on fuels and fire risk. Both of these papers, plus a report on our lysimeter study and additional specific details on stand location, etc., will be assembled into a final project report to be submitted hopefully before the end of 1988.

Conclusions

Mountain pine beetle outbreaks dramatically alter stand structure and accelerate natural forest succession by selectively killing a large fraction of canopy trees, thus releasing understory trees from suppression. Total stand productivity decreases for about 5 years, but usually returns to pre-outbreak levels or higher within 10 - 15 years. Total dead woody fuel mass increases for at least 20 years after an outbreak, but nearly all of this increase is in the form of large tree boles which do not ignite readily nor burn completely in most fires. Therefore, the overall effect of beetle outbreaks on fire risk may be slight during the first 20 years, despite the very visible increase in large fuels.

Literature Cited

Amman, G. D., and W. E. Cole. 1980. Mountain pine beetle dynamics in lodgepole pine forests. Part I: Course of an infestation. USDA For. Serv. Gen. Tech. Rep. INT-89.

Brown, J. D. 1974. Handbook for inventorying downed woody material. USDA For. Serv. Gen. Tech. Rep. INT-16.

Parizek, R. R., and B. E. Lane. 1970. Soil water sampling using pan and deep pressure-vacuum lysimeters. J. Hydrology 11:1-21.

Roe, A. L., and G. D. Amman. 1970. The mountain pine beetle in lodgepole pine forests. USDA For. Serv. Res. Pap. INT-71.

Romme, W. H., D. H. Knight, and J. B. Yavitt. 1986. Mountain pine beetle outbreaks in the Rocky Mountains: regulators of primary productivity? Amer. Nat. 127:484-494.