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PESTS LINK SITE PRODUCTIVITY TO THE LANDSCAPE

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The importance of changes in landscape pattern to the potential productivity of a site is rarely recognized. One way in which landscape pattern influences site productivity is through its effects on pest epidemiology. Little concern has been shown for these consequences of change in forest landscapes.

Landscape pattern can be characterized by at least three components: intersection by roads or other corridors (Fig. 1), patch size, and diversity of stand age classes (Fig. 2). Changes in these components affect the ability of potential pests to find and exploit suitable resources.

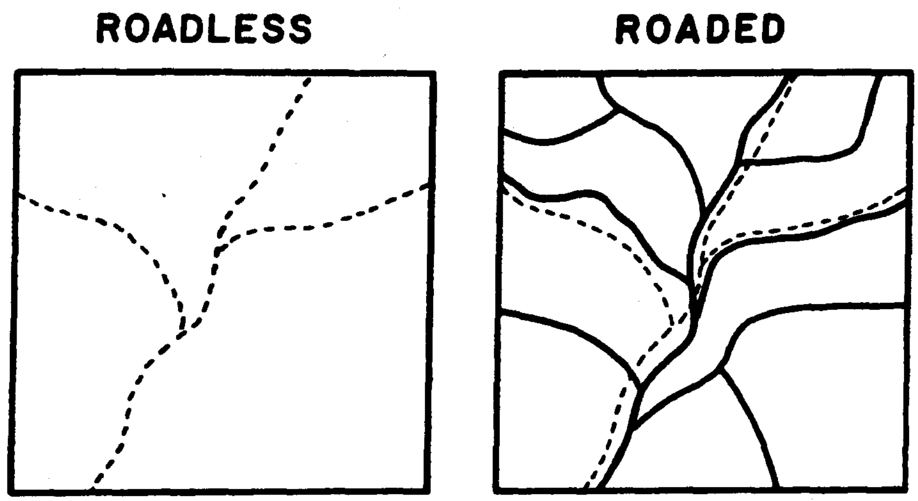

FIG. 1. Forest landscape before (riparian corridors only) and after road construction. Road construction stresses edgè trees and increases forest access for dispersing pests. Black-stain root disease. Port-Orford-cedar root rot, and gypsy moth are examples of pests associated with roads. Several are known to be spread along roads via harvest, replanting, and recreational activities.

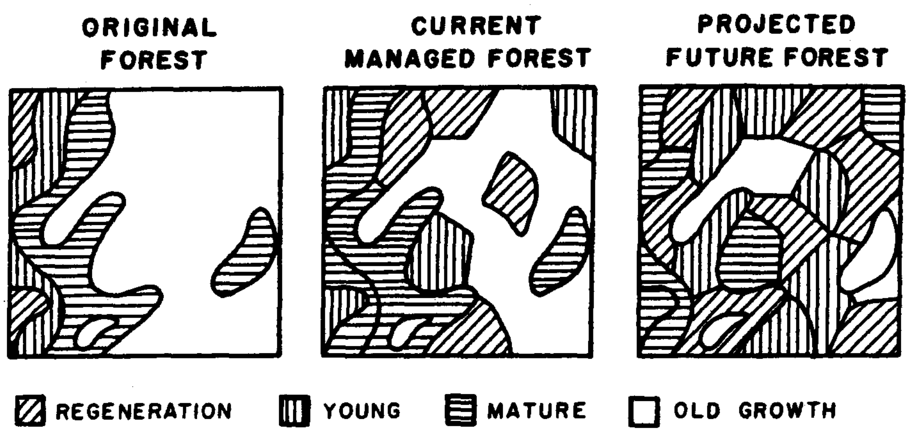

FIG. 2. Current and projected reduction in stand size and stand age-class diversity resulting from harvest and replanting schedules. Such landscape simplification removes physical and biological barriers to pest dispersal and allows pest populations to grow. Despite inherent resistance to pest activity, the shrinking old growth will lose its influence as a barrier to pests and as a source of predators and will become increasingly vulnerable to continuous pest pressure from surrounding managed stands.

Populations of potential pests are controlled naturally by availability of suitable host trees interacting with abundances of predators and by weather. Typically, insects and pathogens can survive on a relatively small number of host tree species, usually at particular stages of tree development or during periods of tree stress (Schowalter 1986). For insects, finding a suitable host often involves orientation to attractive odors. Nonhost plants or stands can hide suitable hosts or stands visually (Courtney 1986) or chemically, by producing odors which interfere with insect orientation (Visser 1986).

Pest success increases when intersection by roads, planting of monocultures (single-species stands) and decreased average size and age-class diversity of stands reduce the time necessary to find or reach suitable hosts (Fig. 3; also Hansen et al. 1986, Schowalter 1986). Forest simplification also reduces the diversity of habitats and prey species necessary to maintain populations of generalist predators, such as spiders and birds. These predators are more important in preventing pest outbreaks than are host-specific predators, such as parasitic wasps, which must be able to find and exploit a particular prey species. Thus, old-growth forests, with their complex array of tree and predator species, large stand size, and high age-class diversity, should be less vulnerable to pest outbreaks than are the simplified forests created through current harvest and regeneration practices (Table 1, Fig. 3).

TABLE 1. Mean arthropod densities in Douglas-fir [*Pseudotsuga menziesii* (Mirb.) Franco] canopies in old-growth (greater than 400-year-old) and young (10-year-old) intermixed stands in western Oregon.

	Old-growth stands		*Young stands*	
	Individuals/kg of green branch	*Number of species*	*Individuals/kg of green branch*	*Number of species*
Predators				
Ants	0.8	2	2.4	1
Host-specific predators	4.5	12	17	7
Generalist predators	21	31	22	8
Potential pests				
Sap suckers	97	5	29,000	3
Defoliators	3.4	4	0	0
Predator:potential pest	0.26		0.0014	

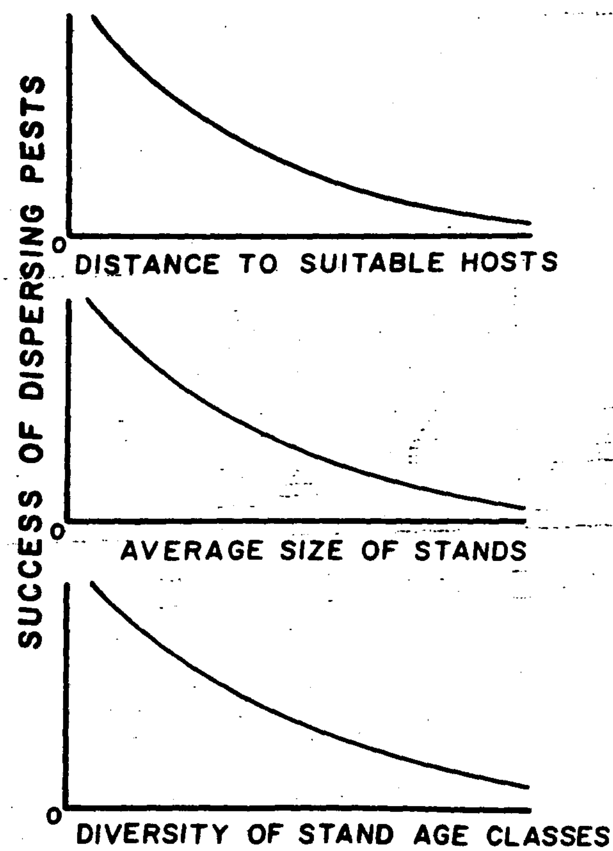

FIG. 3. Pest success depends largely on the pest's ability to find or reach a suitable host. This ability is determined by the distance to suitable hosts (top), as influenced by the average size of stands (middle), which determines that distance, and by the diversity of stand age classes (bottom), which determines the proportion of the landscape occupied by suitable host stands. The right side of each curve characterizes old-growth forest conditions, the left side managed-forest conditions.

Current forest-management concerns in the Pacific Northwest include root beetles, woolly aphids, gypsy moth, black-stain root disease, and Port-Orford-cedar root rot, all promoted by road construction and/or young monocultures. These concerns indicate the severity of future problems if we continue to convert landscapes dominated by old-growth forests with their physical and biological barriers to pest activity to landscapes dominated by extensively roaded young monocultures with no impediment to pest activity (Figs. 1-3; Hansen et al. 1986, Schowalter 1986). Remnant old-growth forests also may become more vulnerable because pest pressure from surrounding young stands will increase as old growth is cut. Meanwhile, old-growth forests will be increasingly valued for genetic diversity and as sources of biological control agents and of biomedical compounds such as the taxol derivatives, unique anticancer drugs derived from the bark of Pacific yew, *Taxus brevifolia* Nutt. (Kingston et al. 1982).

In conclusion, forest penetration by roads increases site access and tree susceptibility to a number of potential pests. Simplifying forest landscapes from large, multispecies, multilayered stands that include trees up to 1,000 years old to small monocultures of trees less than 150 years old removes predators and physical barriers to dispersing pests, thereby increasing the likelihood of regionwide pest outbreaks. Current management practices also are restricting the options available to forest managers for crop tree or stand selection in the event of insect and disease activity or of changes in markets for different tree species over the next rotation. Future site productivity depends in part on how landscape pattern affects pest epidemiology.

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EFFECT OF TIMBER HARVESTING ON CELLULOSE AND LIGNIN DEGRADATION IN A NORTHERN ROCKY MOUNTAIN FOREST SOIL

James A. Entry, Nellie M. Stark, and Howard Loewenstein

INTRODUCTION

Timber harvesting alters the activity and distribution of soil microorganisms by changing the amount and type of organic matter and the pH, temperature, and moisture of the soil (Harvey et al. 1980). This study was designed to determine the influence of harvesting treatments on the rate of cellulose and lignin degradation in the organic layer of a Rocky Mountain forest soil. Such information enhances our ability to maximize nutrient availability and site productivity after harvest, especially on nutrient-deficient soil.

MATERIALS AND METHODS

The study site is located in the Graves Creek drainage near Lolo Pass, Montana (Entry et al. 1986). Four harvesting treatments, each applied to one 40- by 40-m plot, were a clearcut on which stems were removed by hand and organic residue was left (RL); a clearcut on which whole trees (needles, branches, stems) were harvested and removed by hand (RR); a clearcut on which stems were removed by hand and organic residue was broadcast burned (RB); and an uncut control (C).

The ^{14}C-labeled cellulose and lignin were prepared with methods described in Crawford (1981). To determine degradation rates for lignin and cellulose, we mixed 100 mg of either ^{14}C-lignin lignocellulose (17,500 dpm/mg) or ^{14}C-labeled cellose (13,500 dpm/mg) with approximately 10 g (dry weight) of soil sample. The preparation was placed in a 1.9-L jar containing a vial of distilled water to maintain the moisture level and a vial of 2*M* NaOH to trap CO_2. The jar was sealed and incubated for 10 days at 22°C. All samples were indexed at 22°C, regardless of field temperature at the time of sampling. Trapped ^{14}C was quantified by liquid scintillation.

MAINTAINING THE LONG-TERM PRODUCTIVITY OF PACIFIC NORTHWEST FOREST ECOSYSTEMS

Edited by

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