

# Evaluation of sparse Douglas-fir tussock moth populations

Donald L. Dahlsten □ Nancy X. Norick

John M. Wenz □ Carroll B. Williams, Jr.

The Douglas-fir tussock moth (DFTM), *Orgyia pseudotsugata* (McDunnough),<sup>1</sup> is periodically a heavy defoliator of Douglas-fir (*Pseudotsuga menziesii* var. *glauca*) and true firs (*Abies* spp.) in the forests of western North America. In California, the larvae of the DFTM feed primarily on white fir (*Abies concolor*). This insect goes unnoticed for 5 to 10 years and then periodic population buildups can result in heavy defoliation that may cause trees to die (although, most trees can withstand considerable defoliation before mortality occurs). Defoliated trees suffer temporary growth loss and, frequently, top-kill; some are weakened and thus predisposed to attack by bark beetles.

The tussock moth is commonly a problem on ridge tops, generally on poor sites. Also, DFTM larvae possess urticating or poisonous hairs. The hairs cause itching, blotching of the skin, and swelling if the reaction is severe.

The DFTM has been the target of large-scale chemical control operations in several areas in western North America and the subject of direct control will no doubt surface with the next outbreak. Why these outbreaks occur is not known, but to answer the question procedures were developed to sample sparse DFTM populations. A mid-crown sampling procedure for 40-foot host trees, developed by the U.S. Forest Service, is suitable when DFTM larvae occur at high densities of two per 1000 inches<sup>2</sup> (0.64 m<sup>2</sup>) of foliage or higher. This procedure can be used to evaluate various control strategies only when distribution of DFTM life-stages is the same at low densities as it is at higher densities.

## Sampling procedures

The first objective of the DFTM investigation in California was to study the distribution of sparse populations (less than 2 larvae per 1,000<sup>2</sup> inches of foliage) in 25- to 40-foot-tall white fir trees. The size limitation was placed on the trees because of the difficulty in sampling larger trees and because previous studies used trees in this size range. Once distribution of life stages is known, an efficient, unbiased sampling procedure can be chosen, and sparse populations can be sampled and life tables developed. By studying populations over a number of generations and determining the effect of forest-site and stand-structure and

<sup>1</sup>*Lepidoptera: Lymantriidae.*



To sample Douglas-fir tussock moth populations, one worker numbers and cuts branches in the tree, while other workers hold a cloth basket below. Branch populations are then measured over a large white canvas trap.

other factors (such as parasitism, predation, and disease) on generation survival, it should be possible to determine why and when populations increase to high densities.

In 1976 six plots (three in El Dorado County and three in Modoc County) were established in areas of previous DFTM activity. Each plot had a road running lengthwise through it. Using a truck odometer, each plot was divided into four equal segments and two spots along the road in each segment were selected at random as sample sites. Choice of the left or right side of the road was determined by a flip of a coin. The nearest 25-to-40-foot-tall white fir became the sample tree. One tree was sampled at each site for selected developmental periods of the DFTM. There were five sampling periods in 1976 and four in 1977. Only one-half of the same spots were used in 1977 as two (paired) trees were used per spot in each segment; in either case eight trees were sampled per plot during each sampling period.

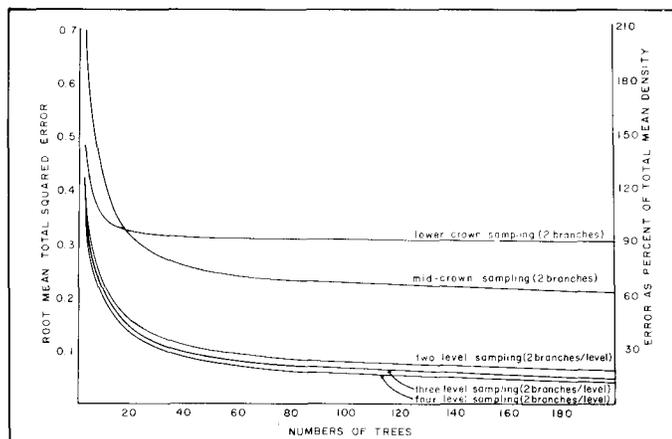
The DFTM has one generation per year and overwinters in the egg stage. Eggs are laid in a frothy mass and usually on top of the cocoon from which the female has emerged. Eggs hatch in late May or early June and the larvae go through five to six instars. Larvae begin to spin their cocoons in late August but some larvae

may spin cocoons as late as October. Because of this difference in developmental times, adult flight, mating, and egg laying occur from August to November. The sample periods were chosen, therefore, so as to span the development of the DFTM. One sample of egg masses was taken in spring and one of cocoons and egg masses in autumn. Three larval samples (early, mid, and late) were taken in summer 1976, but only two (early and late) were taken in 1977.

Approximately one-third of each tree's foliage was sampled randomly, measured, and the DFTM life stages (along with 64 other defoliators and predators, including spiders) were counted. Larvae of all the defoliators were returned to the laboratory for rearing of parasites. To select sample branches, each branch was numbered beginning with the first branch on the north side of the first whorl of branches in the crown and running clockwise from whorl to whorl to the top of the tree. A list of sorted random numbers was computer-generated for each sample tree and the branches were selected in this fashion. To take samples one person climbed the tree and numbered and cut branches, while one or two others held a cloth basket. One or two people on the ground beat and measured the branches over a large white canvas trap.

Tree, branch, and insect data were placed on data sheets to be keypunched. Once the distributions for each tree were reconstructed in the computer, it was possible to go back and sample in several different ways for each insect or spider for any sample period. In this way, sampling methods can be compared for overall error and bias. Costs of each method can be computed and the least expensive selected.

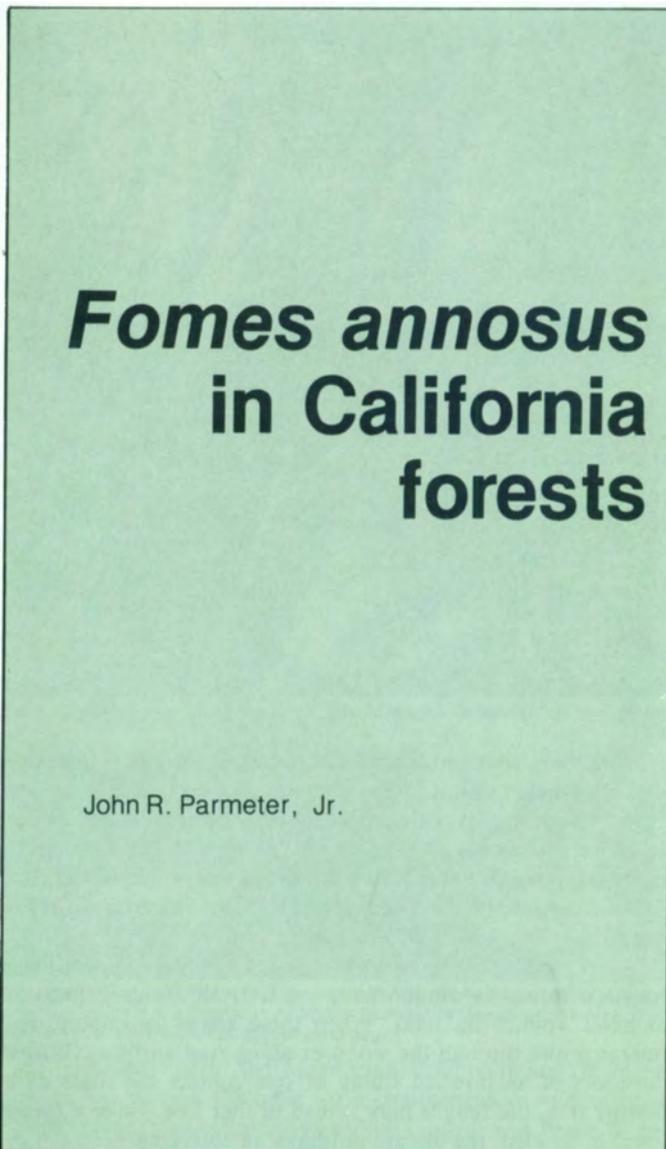
Results of the computer sampling of the 1976 DFTM early larval stage show that for low density populations the error in estimating early larval instar density is much higher when sampling two branches in the lower crown or mid-crown than when using multilevel sampling. The 1977 data for the early larval instars of DFTM corroborates the 1976 data. When cost of sampling was figured, the two- and three-crown level sampling procedures were found to be the most economical for all degrees of accuracy. A three-crown larval sampling procedure is currently being used in our studies of sparse DFTM populations.



Total error for each sampling method as a function of the number of trees sampled for early instar Douglas-fir tussock moth larva using 1976 distribution data.

Donald L. Dahlsten is Professor of Entomology, Division of Biological Control, U.C., Berkeley; Nancy X. Norick is Statistician, and John M. Wenz is Entomologist, Forest Insect and Disease Management, USDA, Forest Service, San Francisco; and Carroll B. Williams is Research Entomologist, Pacific Southwest Forest and Range Experiment Station, USDA, Forest Service, Berkeley.

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Each spring, fallen trees can be found in stands of large trees, their roots frequently showing a stringy to "laminated" decay. Other dead trees may be found grouped around an old stump or grouped with dead trees at the center and recently killed ones at the margins; generally some "unthrifty" trees stand just beyond them. Examination of these trees, stumps, and snags will often reveal the same decay of root and butt wood. Fungus conks with tan upper surfaces and white, finely-pored under surfaces may be observed in stumps that have been kicked apart or under bark knocked loose. These are the fruiting bodies of *Fomes annosus*, a primary cause of tree root decay and death throughout California forests.

*Fomes annosus* attacks mainly conifers, although hardwoods can sometimes be infected. Infection may result in several types of damage and loss. Pines are especially susceptible to cambium killing, and infected trees usually die from root girdling or they are predisposed to killing by bark beetles. In nonresinous species, such as red and white firs, or in incense cedar, root decay is more common. This may lead either to bark beetle attack or to windthrow. If trees neither die nor windthrow, decay may extend into the lower trunk, causing volume loss in the valuable butt log. The net result of these losses can be extensive reduction in productivity and usefulness.