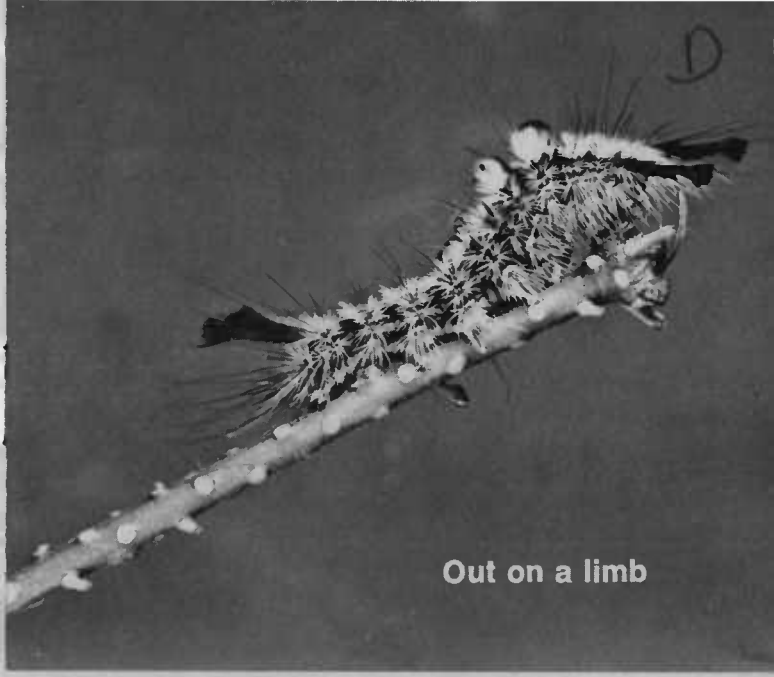

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THE DOUGLAS-FIR TUSSOCK MOTH

The Problem, Alternatives, and Impacts

Oregon State University Extension Service
EC 821 Revised March 1973

See March updating notice on inside of back cover. This affects the estimates of damage listed in Tables 1, 2, and 3. The information is based on laboratory tests completed March 13.

This circular was condensed by James T. Krygier, coordinator of forestry extension; Larry Streeby, assistant professor of forestry management; James M. Witt, extension chemist; and Joseph Capizzi, extension entomologist, from the complete task force report. The authors acknowledge the contributions of many faculty members at Oregon State University and information provided by public or private agencies in preparation and review of this document.

Cover photo—The tussock moth at work. Severity of tree kill depends on extent of defoliation.

THE DOUGLAS-FIR TUSSOCK MOTH

The Problem, Alternatives, and Impacts

In June of 1972 severe defoliation of fir forests was observed north of La Grande, Oregon. Surveys were initiated by the U.S. Forest Service and Oregon and Washington state forestry agencies. It was soon apparent that the caterpillars of the Douglas-fir tussock moth were chewing on vast acreages of trees in certain areas of the Blue Mountains, extending 70 miles north of La Grande into sections of Washington east of Walla Walla. A major part of the outbreak was in the Umatilla National Forest.

Aerial surveys of visible defoliation indicated that about 200,000 acres were infested. Later ground surveys of egg masses indicated a total possible infestation in some 412,000 acres.

The infestation has been of concern to all whose forest lands may be affected by the insect, and to the public when it became apparent that one of the alternatives was use of the chemical DDT, currently prohibited for use in forests. Immediately questions were posed about the insect, alternatives for solution of the problem, forest losses, and other values at risk. These are highly controversial and complex questions.

Public information about this infestation has been limited. The answers given in this circular are based on the best available knowledge and should assist the citizen in his decision making. A more extensive and detailed report has been prepared by Oregon State University working closely with state, federal, and private agencies. It will be published by the Oregon State University Extension Service. The report was prepared by a task group composed of staff of the OSU School of Forestry and School of Agriculture, in cooperation with several staff of the U.S. Forest Service, and the Department of Interior, Fish and Wildlife Service. This report will be available soon to persons interested in complete background data supporting the information summarized in this circular.

This assessment is based on the situation as it exists on February 10, 1973. New information and differing impacts and solutions may evolve.

The Insect and the Outbreak

- *What is the tussock moth and what does it do to forests?*

The tussock moth is one of the most injurious insect pests of Douglas-fir and true firs in the west. The caterpillars that hatch in June from egg masses laid in the previous fall feed voraciously on foliage until mid-August, consuming proportionately more food as they grow. When mature, the caterpillars pupate and emerge shortly thereafter as adult moths. Winged males mate with the wingless females, which deposit egg masses on or near the empty cocoons. Adult moths do not feed, nor do they live more than a few weeks, but in the egg masses is the capability of future host-plant defoliation.

The tussock caterpillar population can develop explosively in an outbreak year. Patches of trees throughout the infested area may be completely stripped of their foliage and killed, while other stands suffer damage of lesser degree.

- *What trees are defoliated by the insect?*

The caterpillar feeds on Douglas-fir and the true firs, including grand fir and white fir. In the Northwest, outbreaks have occurred only in interior forests east of the Cascades. During outbreaks this insect will attack other conifers, including ponderosa pine, when these species are found in mixed stands with firs.

- *Has this kind of outbreak occurred before?*

There have been a large number of recorded outbreaks of the insect in the United States. Since 1936, six serious infestations have occurred in Oregon and California, and others in western United States and Canada. The present infestation is the largest since the outbreak that occurred in 1947 in the area from Troy, Oregon, to Moscow, Idaho.

- *What are the normal patterns of this kind of outbreak?*

In the five outbreaks studied, the outbreak period seems to be compressed into three years. Several years of inconspicuous build-up probably are required to reach the level where this sequence occurs: 1) a season of rapid rise in population, 2) a season of major defoliation, and 3) a season of some defoliation, accompanied by a rapid population decline. In the case of most of the Blue Mountain outbreak, 1973 is expected to be the year of decline. This judgment is based on historical records of other outbreaks.

- *Will the insect spread into other parts of the forest?*

The infestations arise from populations already present (but at extremely low levels), rather than spreading from a single source of a high population level. Although very small windblown larvae are a method of dispersal of this insect, this spread does not create new infestations.

- *What causes the insect to decline?*

The typical third-year decline is brought about largely by the spread of a naturally-occurring virus disease in the insects, as well as by predators, parasites, and starvation.

Alternatives and a Dilemma

- *Why does the tussock moth outbreak in the Blue Mountains present a dilemma?*

A dilemma exists because a choice must be made among several courses of action. The insect may be permitted to decline naturally, or insecticides may be used to check further defoliation. The insecticides presently considered for use are DDT and Zectran. DDT is known to kill this insect effectively when used in the decline phase of an outbreak, but there is only limited data to show that Zectran would give satisfactory control. The environmental effects of Zectran are not a part of the dilemma because it breaks down rapidly and has few immediate and no long-term effects on wildlife. The dilemma arises in part because the use of DDT is prohibited in the forests and presents certain environmental hazards, whereas continued defoliation will increase forest losses. Another part of the dilemma is the question whether effective chemical control of the insect in the third year of the outbreak results in appreciable reduction of tree mortality.

- *If the moth will decline in 1973, why is control being considered?*

First, estimates of the rate at which the moth larvae population might decline vary. That rate can be estimated by the incidence of virus in the egg masses, now under study at the USFS Forestry Science Laboratory at Oregon State University. There may be significant defoliation in the summer of 1973 if the initial incidence of virus is low. Since that information will not be available until spring, planning for control is being undertaken on a contingency basis.

Second, where an infestation exists, the State Forester is required by law to pursue reasonable control measures if available.

- *Why not use biological control rather than consider the use of a chemical insecticide?*

The use of an applied virus in controlling the tussock moth is in an experimental stage, and though scientists will be testing virus in northeastern Oregon in 1973, insufficient viral material could be produced to treat more than a few thousand acres.

- *What chemical insecticides can be considered for use in control of the tussock moth?*

A number of chemicals will kill the tussock moth in the laboratory. The most promising candidates for field use are DDT, which has been used operationally on several outbreaks, and Zectran, which has been used experimentally. The very characteristic that makes Zectran the least objectionable, that of rapid decomposition in the environment, limits its effectiveness as an insecticide for the tussock moth. The degree of control experienced with Zectran may be sufficient to provide adequate protection, but the decrease in tree mortality will not be known until operational tests have been conducted.

Forecast

- *What kind of damage will occur to trees?*

Some trees will die, depending on the degree of defoliation. Those trees with 90 percent or more defoliation probably will die. The chance of a tree dying decreases with lesser amounts of defoliation. There is evidence that many trees that survive partial defoliation are weakened and will succumb to a build-up of bark beetle population. Consequently, a great deal of the mortality will result from forces set in motion during the 1972 defoliation. Surviving trees will exhibit reduced growth for two to three years and some will suffer topkill. There will be a loss of seedlings, young, and mature trees.

- *How much will the losses be if the infestation is allowed to decline naturally?*

Estimated losses relate to the intensity of defoliation experienced in 1972 and the damage tussock moth populations will contribute in 1973. Several estimates are given in Table 1 as percentages of merchantable-size forest likely to be affected in the four defoliation-class categories established by infestation mapping.

Adult Douglas-fir tussock moth male. He is a dull, brown-gray, ordinary looking moth.

Table 1. Total Volume of Tree Mortality with Natural Decline (no treatment)

Estimate	Degree of defoliation			
	Class I, Intensive	Class II, Moderate	Class III, Light	Class IV, None
	Percent	*Percent*	*Percent*	*Percent*
OSU low[1]	84	16	0	0
OSU high[1]	84	19	0.5	1
USFS, Region 6[2]	84	34	6.7	3.4

[1] These estimatas wara devaloped at OSU with significant input from USFS research antomologists, and ara basad on interpretations from research data and historical outbreak mortality of trees. Estimates of mortality assume an early presence of tussock moth virus diseasa in 1973.

[2] These estimates were devaloped by tha Insect and Disease Control Branch, U.S. Forest Service, Ragion 6, and are based on a 1972 biological evaluation and interpretations from research.

- *How much of this loss might be saved by applying DDT?*

As before, there are several estimates. The mortality is expressed in Table 2 as a percentage of the volume in the classes.

Table 2. Saved Tree Mortality if DDT Control is Used, in Percent of Total Volume

Estimate	Degree of defoliation			
	Class I Intensive	Class II Moderate	Class III Light	Class IV None
	Percent	*Percent*	*Percent*	*Percent*
OSU low	2	2	0	0
OSU high	9	9	0.5	1
USFS, Region 6	----	34	6.7	3.4

Economic Impacts

- *How many board feet of timber will be lost if no chemical control is undertaken, and how much would DDT save?*

That depends on whether Forest Service roadless areas, which may not be available for timber production, are included and whether the mortality forecast is accurate. Estimates of total mortality range from 184 million to 462 million board feet, and estimates of mortality prevented by DDT range from 15 million to 369 million board feet. If Forest Service roadless areas are excluded, the mortality range is 146 million to 340 million board feet, and the mortality prevented ranges from 12 million to 261 million board feet. These amounts are shown in Table 3.

One hundred million board feet has a sale value on the stump of about 3½ million dollars.

- *What would these losses mean to local economies?*

There is a potential economic impact, which arises from economic activity generated by timber harvesting and wood processing. If the timber losses result in long-term reductions in wood availability, wood processing activity will be reduced, and local economies will suffer.

There probably will not be a significant reduction in timber harvest (allowable cut) from Forest Service lands, irrespective of whether a chemical program is conducted. Mortality in the younger age classes will result in loss of production on private lands with resultant reduction in local economic activity. Quantita-

Table 3. Area of Defoliation Classes and Estimated Mortality with Natural Decline and with Use of DDT

Estimate	Degree of defoliation I Intensive	II Moderate	III Light	IV None	Total
TOTAL AREA					
	Acres	*Acres*	*Acres*	*Acres*	*Acres*
Area in each class	12,000	64,000	115,000	221,000	412,000
Mortality with no chemical control					
	Mbf[1]	*Mbf*	*Mbf*	*Mbf*	*Mbf*
OSU low	94	90	0	0	184
OSU high	94	128	6	44	271
USFS, Region 6[1]	94	218	76	74	462
Mortality prevented by DDT					
OSU low	2	13	0	0	15
OSU high	10	58	6	22	95
USFS, Region 6[2]	—	218	76	74	369
ROADED AREA ONLY					
	Acres	*Acres*	*Acres*	*Acres*	*Acres*
Area in each class	10,000	50,000	76,000	159,000	296,000
Mortality with no chemical control					
	Mbf	*Mbf*	*Mbf*	*Mbf*	*Mbf*
OSU low	79	68	0	0	146
OSU high	79	97	4	29	208
USFS, Region 6[1]	79	164	47	50	340
Mortality prevented by DDT					
OSU low	2	10	0	0	12
OSU high	8	43	3	15	80
USFS, Region 6[2]	—	164	47	50	261

[1] Millions of board feet.

[2] Some differences may exist between this estimate and that in the USFS impact statement because of acreages included.

tive estimates of this reduction have not been developed because of insufficient information.

- *Are there other types of economic impacts?*

Local county government revenues could be reduced, even if the overall local community would not experience much economic loss.

Twenty-five percent of the money received by the U.S. Treasury from National Forest timber sales is returned to counties from which the timber was cut. This policy originated in an effort to compensate local government for the property tax loss it suffered due to Federal lands not being included on the property tax rolls. For this reason, these payments are called in-lieu-of-tax payments.

The tussock moth outbreak may result in a reduction of in-lieu-of-tax payments of from $222,000 to $519,000, divided among Baker, Grant, Morrow, Umatilla, Union, Wallowa, and Wheeler county governments in Oregon; and Asotin, Columbia, Garfield, and Walla Walla counties in Washington (assuming no chemical control). Roughly three-quarters of this reduction would fall on Oregon counties, with Umatilla and Grant counties being hit hardest. This total reduction would be spread over the two or three years during which most salvage operations were being conducted. It is caused by the lower prices received by the Forest Service for salvage sale timber as opposed to live timber.

- *Will this amount be serious?*

The amount might not be critical to the local governments if the products markets remain strong, as they are now. Recent stumpage prices have been high and this tends to increase in-lieu-of-tax payments.

- *How much difference in these payments would DDT make?*

The estimates of in-lieu-of-tax payments saved range from $18,000 to $398,000.

- *Might other parts of the community suffer economic losses?*

On an individual basis, the most immediate impacts will be sustained by the 200 or more small landowners whose property is infested. Many have their life savings in these lands. Effects may extend beyond timber market values to personal values placed on certain trees or wooded areas. Even though the local economy may

Tussock moth egg mass is attached on or near the female's cocoon. Covering of hairs has been removed for this photo.

not be affected seriously, individual owners may sustain serious impacts.

Larger private owners also may be affected seriously if mortality in younger stands is high.

- *Will there be additional costs of fire control?*

The increased numbers of dead trees and snag-topped trees increases fire hazards. Increased state and federal forest fire control costs are estimated at $130,000 annually over several years. While these are state and federal costs, they result in increased local income. This estimate has not been referenced to estimates of controlled versus a non-controlled forest situation.

Other Forest Values

- *Are streams and municipal water supplies influenced by the outbreak?*

The infestation covers about 30 percent of the Mill Creek watershed supplying water to Walla Walla. Dayton, Washington, obtains water from the Touchet River, which has light infestation at the headwaters. Jubilee Reservoir and Langdon Lake are near, but isolated, from zones of infestation. There are 18 miles of potential angling streams and 100 miles of small streams. Detritus from the outbreak can enter the stream, but is unlikely to affect water quality significantly. Salvage logging can be controlled to minimize sedimentation. The use of DDT will not affect municipal water quality. The amounts of DDT available from water will be only a small fraction of the average daily intake from food.

- *What parks are infested?*

There are only a few developed hunter campgrounds in the national forests. The Oregon state parks affected are: Blue Mountain Forest Wayside, Hilgard Junction Park, Hilgard-Percy Scenic Strip, and Fields State Park. The Wayside has 200 acres of defoliation and topkill; the Scenic Strip has 200 acres of complete defoliation, and defoliation is evident on an additional 500 acres; and the Junction Park has heavy infestation directly adjacent.

- *What would DDT save in these recreational areas?*

It is expected that some foliage would be saved, with a reduction in mortality among those trees now having extensive defoliation. Mortality savings would approximate that level given in Table 2.

- *How will the insect damage affect forest-wildlife habitats?*

In general, wildlife habitats will be benefited. The principal effect of heavy defoliation and tree killing will be an opening up of the forest canopy, with an increase in light available to understory vegetation. This in turn should promote growth of shrubs, forbs, grasses, and undamaged trees.

- *Will big-game herds be increased by habitat changes after heavy insect damage?*

Ranges for both elk and mule deer should be enhanced because of the shift from closed canopy, old-growth stands with low-carrying capacity to an earlier stage of forest succession with a higher game-carrying capacity.

- *Will any species of wildlife be affected adversely by these habitat changes?*

On large tree-killed areas, habitats will become less suitable for such species as the red squirrel and for birds of prey such as the Cooper's hawk, but no more than under ordinary logging operations.

Use of DDT

- *Who makes the decision for or against the use of DDT and when?*

Since the registrations for DDT in forest uses have been cancelled by the Environmental Protection Agency, the EPA will have to render a decision on the basis of an *emergency-use* or a *restricted-use* application. The Environmental Impact Statements of the U.S. Forest Service will play an important part in the decision making. If permission is granted to use DDT, the U.S. Forest Service, the Oregon Department of Forestry, and private landowners must decide if they will proceed with a control program, based on the level of virus infestation in the caterpillers and other conditions late in the spring of 1973.

- *Why was DDT banned?*

Three properties of DDT are involved in the concern that led to cancellation of nearly all DDT uses. These are its persistence, its widespread distribution in many organisms and the high levels of accumulation found in certain species, and its broad spectrum of biological activity.

- *Has DDT been used against tussock moth?*

DDT kills tussock moth caterpillars very effectively, but in most operational treatments the caterpillars already have been infested with the virus. The difficulty in ascribing reduction in tree mortality to DDT is evidenced by the wide range in estimates previously presented (Tables 2 and 3). DDT has been used in 1946 and 1965 in Oregon on tussock moth outbreaks.

- *How much DDT would be used?*

The rate of use would be 3/4 pound of DDT per acre. (By comparison, agricultural use commonly has been one to five pounds per acre.) If the treated acreage

included all classes of infestations then the treated acreage would be about 412,000 acres and the amount of DDT would be about 309,000 pounds. The cost would be about $4 per acre, or a maximum of $1,650,000. Dollar cost would be largely offset by the value of the timber saved. Alternative spray programs may reduce areas sprayed and amounts or kinds of chemicals used, with resulting changes in costs.

- *How does this compare with past DDT usages?*

The proposed use would be the largest in Oregon forests since 1958 and in United States forests since 1964. In the period of peak use in forests, DDT applications in U.S. forests were about three million pounds per year, with Oregon's forests receiving about 10 percent of the total.

Disposition and Biological Impact

- *When DDT is used in the forest, where does it go?*

The initial distribution is quite variable, but about 1/3 is deposited on the foliage, 1/3 is deposited on the forest floor, and 1/3 drifts from the target site. Some of the drift is deposited in adjacent forests within a few miles and some drifts much greater distances—perhaps contributing to global circulation of DDT. Some DDT goes directly into the streams and other surface waters. The amount going into any particular stream is highly variable, depending on the terrain, wind current, size of buffer strips, and method of application.

- *What happens to DDT residues?*

Some of the DDT deposited on the vegetation and forest floor is vaporized in the first few days or weeks following application. The remaining portion on leaves and conifer needles gradually drops to the forest floor through leaf and needle fall. This continues for the life of the needles on the conifer plants or for a period of up to three years, and adds to the amount of residue in the forest floor. These residues are then taken up by organisms that consume forest litter and forest vegetation. Although these organisms degrade some of the DDT to harmless metabolites, some of the DDT and the metabolite DDE (which is not harmless) is stored in their bodies and transferred to still other organisms that prey upon them. Thus, some of the birds, shrews, deer, mice, fish, and other animals will carry biologi-

Douglas-fir totally defoliated and killed by the tussock moth. Note the apparently undamaged ponderosa pine, which is not preferred in the tussock moth's diet.

cally-significant levels of DDT in their tissues for up to several years. DDT will be essentially gone from the shrubs by the end of one year, from the conifers by the end of three years, and from the litter and organic matter in the forest floor by the end of eight to ten years.

- *How long would significant residues of DDT persist in mammals?*

They would persist at biologically-significant levels for less than one year in animals that feed on vegetation. Deer or cattle that are harvested or slaughtered in the fall of the treatment year can be expected to have DDT residues in their body fat that will average one to

three parts per million. However, some individual deer or cattle can be expected to carry more than the EPA-permitted tolerance of 7 ppm (in marketed meats) in their body fat in the fall of the treatment year. This would not create any health problems except for the unlikely possibility that this venison would constitute a major portion of any person's diet, but may create a legal problem for slaughtered cattle if they exceed this tolerance level.

- *What are the residues in other animals?*

Shrews and birds that feed in the forest floor will have significant DDT residues (1.5 to 3 ppm respectively) for up to eight years, as will hawks and other birds that feed on the songbirds and other animals feeding from the litter food-chain. In streams and lake environments DDT residues result from both the initial deposit and input in the runoff for several years. The level in fish can remain at one part per million, or more, for one to four years. The residue levels in the fish are highly variable, depending on the initial input, the nature of the body of water, the nature of the watershed, and several other factors.

- *Specifically, what harmful effects of DDT would there be on land animals?*

The predictions of effects on wildlife are based on average values of DDT residues and the extremes have been excluded. From 10 to 20 percent of a wildlife population can have residues several times greater than the average, and these individuals will sustain the greatest proportion of effects. These estimates of effects must be considered as low to intermediate estimates if one wishes to compare wildlife with timber.

Acute toxic effects on terrestrial organisms are not expected to occur because of the relatively low rate of application. In eastern deciduous forests treated with much higher rates of DDT, immediate kill of some songbirds has resulted.

Longer-term effects will be associated principally with hawks and other birds of prey that feed heavily on songbirds. It is expected that the residue levels of DDT and its metabolites would cause reduced reproductive success. Predators of the insect-feeding mammals, such as the shrews, would be subject to exposures associated with altered physiological and hormonal levels, but it is impossible to forecast effects on populations.

Historically, DDT use has often caused a resurgence of mite populations which damage trees. This happens in agricultural crops and also occurred in the Burns area following the DDT spraying in 1965. This occurs because DDT kills the parasite insects that provide some natural control against some mites and other insects. This effect also could cause a parasite-free environment in which the spruce budworm might develop. There is even a possibility that DDT use may reduce the interval between outbreaks of tussock moth. These effects, and others, range from *improbable* to *possible* when a potent, wide-spectrum insecticide such as DDT is used.

- *What harmful effects of DDT would there be on fish?*

Immediate effects can occur on fish if the terrain, wind current, or other circumstances permit direct contamination of the body of water. In spraying, every attempt is made to leave untreated areas adjacent to streams and lakes to reduce or eliminate these effects. In steep canyons, however, it is difficult to cover the trees and miss the streams entirely. Very young fish are the most susceptible, and their mortality could vary from no kill at all to a moderate or even severe kill, depending on spray conditions. Another immediate effect could be a kill of aquatic insects. The loss of this fish food would result in a movement of fish out of the affected area.

The most important effect on fish following a DDT application would be in the winter months when there are low temperatures and a low food supply and the fish are utilizing their stored fat tissues. Fish losses that occur at this time would be greater than those that occurred immediately after treatment. Decreased agility, behavioral changes, decreased ability to adapt to salt water or to temperature changes, etc., affect reproductive and population success. These are long-term effects associated with the residue levels that are expected to persist in the fish populations for a period of three to four years. Any effect of these factors on fish populations is expected to be low in relation to any previous mortality that occurred either immediately after or in the winter after treatment.

Effects on fish are subject to a higher degree of variability than those for mammals or birds because the DDT exposure is dependent on the success achieved in protecting the streams.

Effects on Humans

- *What effects would the proposed DDT treatment have on humans?*

No effects on humans are expected to occur, even for those persons consuming game from the treated area or living and working in the area.

- *Does the tussock moth affect humans?*

A discomforting allergenic reaction develops in many persons who have skin contact with the insect, or its remains. The State Health Department and others are investigating the problem at this time to determine severity of reaction.

Summary

- *What are the risks and benefits of the proposed DDT treatments?*

The benefit is saving the trees. Much of the damage the tussock moth will do to the timber resource probably already has been done. The amount of timber that a DDT treatment would save ranges from 12 million to 369 million board feet, depending on different estimates and whether roadless areas are excluded. The primary, identifiable, monetary impact is a reduction of federal payments to local counties. It has not been possible to assess impacts of damage to young stands of trees on state and private land.

At risk would be a decrease in certain populations of birds (especially birds of prey such as the sharp-shinned hawk and Cooper's hawk) predicted from the average value of DDT residues; some kill of fishes, particularly in the winter following treatment; altered fitness of some species within the treated area for a period of several years; and possibility of some individual deer and cattle carrying residues of over 7 ppm DDT during the fall of the treatment year.

Update—March 1973

The decision to request chemical control has been delayed pending laboratory analysis of the tussock moth population for incidence of virus. Eggs were collected from various affected areas during the past year and held In U.S. Forest Service laboratories at Oregon State University. They hatched early this month and were tested to see how many contained the virus that kills the tussock moth naturally. Results were released by USFS scientists at Corvallis on March 13.

The virus level is lower than anticipated. The percentages of moths with virus infection are as follows for the areas in each of the defoliation classes discussed in this circular: Class I, 1.1%; Class II, 0.4%; Class III, 0.15%; Class IV, 0.12%. The USFS research scientists at OSU, on whose work the projections in Table 1 (page 5) are based, have estimated that the level and distribution of virus are such that it will cause the tussock moth population to decline in 1973 as anticipated, but the low virus level could result in greater tree mortality than 19% projected in Class II areas in the OSU high estimate, Table 1. However, the fact that the virus is distributed throughout the populations in Classes III and IV indicated that there will be no out of phase outbreak centers. This will result in a decrease In the estimates of tree mortality for these areas shown in the OSU projections in Table 1.

Class I contains 12,000 acres and is expected to sustain 10,000 acres of damage. The area is not considered critical in 1973 because the damage was essentially completed in 1972.

The Class II area, totaling 64,000 acres, Is the critical area and could sustain from 10,000 to 22,000 acres of tree mortality.

Estimates predict light damage in Classes III and IV, ranging from 0 to 500 acres of equivalent tree mortality out of a total of 115,000 acres in Class III, and from 0 to 1,000 acres out of the 221,000 in Class IV.

The USFS Region 6 estimates of damage (Table 1) were based on no virus being present. The USFS is In the process of adjusting its estimates in view of the fact that the virus is present, but the new figures are not yet available.

FORESTRY **EXTENSION**

EXTENSION ENVIRONMENTAL EDUCATION PROGRAM

Photos courtesy U.S. Forest Service

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