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LOW AVERAGE BLISTER-RUST INFECTION RATES MAY MEAN HIGH CONTROL COSTS

The Northeastern Forest Experiment Station, in cooperation with Federal and State forest-pest-control agencies, undertook a survey of blister-rust infection rates in the white pine region of the East during 1962 and 1963. Those engaged in blister-rust-control activities will not be surprised at the survey's results. We found that infection rates were significantly higher in high-hazard climatic zones than elsewhere. Hazard maps prepared by Charlton (1963) were used as the basis for delineating climatic hazard zones.

Control efforts also influence the rate of infection; and our survey showed that infection rates were uniformly low, regardless of climatic hazard, for some years after a control treatment. In addition, there was some evidence that infection rates tend to decline from north to south within hazard zones. The average rate of infection estimated for the East as a whole was about one-half the average rate reported for the Lake States.

However, the average infection rate for an area or a group of stands is only part of the story. More important for control activities is the frequency of serious injury. Most pine stands can absorb modest numbers of blister-rust fatalities without serious reduction of eventual yields. Control efforts are aimed at stands where infection is more serious. Our survey showed that, in groups of stands with low average infection rates, only 1 stand in 100 may now be experiencing serious blister-rust losses, while almost half of the stands in groups with high average infection rates may suffer serious losses.

Where average infection rates are low, then, control personnel must examine a large number of areas to find one that needs control. Since finding stands that need control is part of the cost of control, it would seem that control could be very expensive indeed in areas of generally low hazard. In response to this situation, blister-rust-control organizations drop from their control programs pine areas subject to little infection; and surveillance procedures on the remaining pine acreage are tailored to hazard conditions so that surveillance is most intensive where the chance of significant damage is greatest.

Survey Sampling and Analysis

Some 279 blister-rust-control areas[1] were chosen for examination throughout the thirteen Eastern States. This sample was distributed among the various states as shown in table 1. Within each state, control areas to be sampled were chosen at random from lists of all control areas regardless of their control history, current control status, or climatic environment. Only areas with a history of Ribes eradication were sampled in North Carolina, Tennessee, and Georgia.

Each sample area was subsampled to establish its infection rate by examining 200 saplings and/or pole-size pines, 100 located along each of two parallel lines transecting the area. Randomly distributed 10-tree clusters were used in most sample areas in New York, and 100-tree clusters were used in North Carolina, Tennessee, and Georgia. A count was kept of the sample trees that had contracted a fatal blister-rust infection during a 5-year sample period, 1952-56. In addition, information was obtained on sample area location and size, and on control history in most cases.

Five of the 279 sample areas were discarded because infection counts were incomplete. Forty-two others, many of them in Virginia, had never had a Ribes population nor any infection; so they were discarded. The remaining 232 areas, all with a history of Ribes eradication, were grouped by hazard zone and by 2 classes of control-treatment history (table 2).

Areas from the low- and medium-hazard zones were considered together, because preliminary analysis showed that infection rates were very similar for these two hazard zones. A north-south breakdown was made of each hazard zone, corresponding to Forest Service Region 8

[1]The cooperative blister-rust control program has resulted, over the years, in a comprehensive mapping of white pine stands throughout the range of the species. The total forest area stocked with pine is subdivided into work areas, variously called road blocks, grids, or control areas, to facilitate control operations. These are referred to here as control areas.

and the northern and southern zones of Forest Service Region 7. The states making up each of these three geographic areas are shown in table 1.

Two simple classes of control-treatment history were recognized as a further breakdown. Sample areas that had received no examination or treatment for 10 years before the sample period (1952-56), nor during the first 3 years of the sample period, were separated from blocks that had received some sort of examination or control treatment between 1942 and 1954. Treatment history was not available for a few areas, so some sample areas are not included in this breakdown.

Table 1. — *Distribution of blister rust sample blocks, by states*[1]

State	Total pine acreage	Areas sampled	Pines examined
	Acres	*No.*	*No.*
FOREST SERVICE REGION 7			
Northern Zone:			
Maine	983,136	48	9,600
New Hampshire	1,313,909	63	12,600
Vermont	174,039	9	1,800
Massachusetts	579,987	29	5,800
New York	695,024	22	4,400
Connecticut	109,761	5	1,000
Rhode Island	64,018	0	0
Total	3,919,874	176	35,200
Southern Zone:			
Pennsylvania	106,725	5	1,000
New Jersey	3,771	0	0
Delaware	242	0	0
Maryland	74,079	4	800
Virginia	800,492	40	8,000
West Virginia	340,127	17	3,400
Kentucky	48,179	0	0
Total	1,373,615	66	13,200
FOREST SERVICE REGION 8			
North Carolina	736,880	22	4,400
South Carolina	64,192	0	0
Tennessee	770,118	12	2,400
Georgia	544,478	3	600
Total	2,115,668	37	7,400
Total, all states	7,409,157	279	55,800

[1]Only states with significant acreages of white pine are listed.

Table 2.—*Number of control areas sampled and average rates of fatal blister-rust infection for the 5-year period 1952-56, by climatic hazard zone, geographic location, and treatment history*

Item	All sample areas	Discarded areas	Areas with a history of Ribes eradication[1]					
			Retained areas	Trees infected	Areas treated, 1942-54	Trees infected	Areas not treated	Trees infected
	No.	*No.*	*No.*	*%*	*No.*	*%*	*No.*	*%*
High-hazard areas	134	27	107	1.5	67	1.0	28	2.7
R-7 northern zone	60	1	59	1.5	39	.8	8	5.9
R-7 southern zone	55	26	29	2.4	19	2.1	10	2.8
R-8	19	0	19	.0	9	.0	10	.1
Low and medium-hazard areas	145	20	125	.7	72	.5	43	.9
R-7 northern zone	116	11	105	.8	59	.6	36	1.1
R-7 southern zone	11	8	3	.0	1	.0	2	.0
R-8	18	1	17	.0	12	.0	5	.0
All areas	279	47	232	1.1	139	0.8	71	1.6

[1]Exact treatment history was not determined for some sample areas, so the numbers of areas listed under each treatment history classification do not total, in some cases, to the number shown under "All retained areas."

Results

Table 2 shows the average rates of infection found for various groupings of control areas. The number of sample areas upon which each infection-rate estimate is based is also shown. Medium- and low-hazard conditions for the southern zone of Region 7 are not well represented in this sample. The other control-area groups are adequately represented.

The average 5-year rate of fatal blister-rust infection among all sample areas with a history of Ribes eradication was 1.1 percent, which is somewhat less than one-half the average rate found by King (1958) for the Lake States. However, rust infection is not generally or evenly distributed in all pine stands, but is highly localized. About two-thirds of the sample areas, although they had a history of Ribes eradication, had no fatal infections on sample trees dating from the 5-year sample period. And 50 percent of the trees found to have fatal infections were concentrated on 12 of the 232 sample areas—half the injury was on 5 percent of the area.

Control areas in the medium- and low-hazard zones did not have high average rates of infection, nor did control areas in the high-hazard zone that had received an inspection or treatment within 10 years of the sample period (table 2). These groups had average 5-year infection rates of 1 percent or less, with the exception of recently treated high-hazard areas in the southern zone of Region 7.

Interpretation

From these survey results, idealized estimates of the incidence of blister-rust infection were made (table 3). Three control-area categories, defined by hazard zone and treatment history, are suggested, along with the average rate of fatal infection to be expected for areas in each category.

However, average infection rate is not a very meaningful statistic, because few control areas will actually experience this average rate. Rather, some areas in any category will remain free of injury for 5 years, while others will be heavily infected. Table 3 also shows the proportion of control areas in each category that can be expected to have infection rates higher than 2½ percent during the 5-year period, based on the survey data. Only 1 out of 100 category-1 areas will develop serious rates of infection during the next 5 years. But 10 percent of category-2 areas, and 45 percent of category-3 areas, are likely to be seriously injured by blister rust in the immediate future.

This means that a large number of areas that do not need treatment have to be examined in order to find a category-1 area that does need treatment. It takes a large investment in examination to locate areas needing control in this category. For this reason, control is much more expensive for category-1 areas than for areas in other categories. The same, of course, is true of category-2 areas as compared to areas in category 3.

Table 3. — *Idealized estimates of blister-rust incidence*

Control area category	Average 5-year infection rate anticipated	Proportion of areas that are expected to have rate in excess of 2½%
	%	%
1. Areas without a Ribes population or where no infection has been noted for two or more consecutive examinations.	([1])	1
2. Areas in Region 8; in low- and medium-hazard zones of Region 7, or in the Region 7 high-hazard zone if they have been treated in the last decade.	1	10
3. Areas in the high-hazard zone of Region 7 that have not received treatment during the last decade and where Ribes are known to occur.	4	45

[1]Close to zero.

Looked at in this way, hazard zone-treatment history categories are useful primarily in indicating the likelihood of encountering control areas that will require Ribes-eradication treatment, rather than in indicating the rates of infection to which these areas will be subject.

Using This Information

The Northeastern Forest Experiment Station, in cooperation with others, has undertaken a series of research studies to provide economic evaluations of various silvicultural and protection activities in eastern white pine. On the protection side, an analysis of white-pine weevil control has been completed (Marty and Mott 1964) and a similar study dealing with blister-rust control is now under way.

Blister-rust control has been carried on for many years in the East by state pest-control agencies in cooperation with the U. S. Forest Service. As a part of its technical contribution to this cooperative program, the Forest Service plans to develop and make available improved control standards or guides—guides that will help to identify those areas of pine that promise adequate financial returns for blister-rust-control expenditures. The information developed by this infection-rate survey will contribute directly to formulating these guides.

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