Cost Analysis of the Fungicide Treatment for Annosum Root Rot Based on Various Distances Proposed in WI
WI DNR, Division of Forestry, Forest Health Protection
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Introduction: Annosum root rot is a disease caused by the fungus *Heterobasidion* sp. It is considered one of the most destructive diseases in temperate coniferous forests throughout the world. In the eastern United States the causal fungus has been identified as *H. irregulare*, and red, white, and jack pine are primary hosts of the fungus. Annosum root rot has been found in twenty-three Wisconsin counties including Adams, Buffalo, Columbia, Dunn, Green, Iowa, Jefferson, Juneau, LaCrosse, Marinette, Marquette, Oconto, Portage, Richland, Sauk, Shawano, Taylor, Trempealeau, Walworth, Waukesha, Waupaca, Waushara, and Wood counties.

Trees grown in plantations where thinning operations occur appear most susceptible to this disease. Thinning operations produce freshly cut stumps which are key infection points for the fungus. The pathogen can also spread from an infected tree to its neighbors by moving through root contacts. It is a basidiomycete fungus with conk-like fruiting bodies that produce large amounts of wind-dispersed spores. Infected trees exhibit thin crowns, reduced growth and eventual mortality. Immediate application of borate-based fungicides to freshly cut stumps has been proven effective to prevent annosum root rot infection in a stand. Although fungicide application can be done manually, the treatment is most effectively performed through a spray attachment to a processor at the time of harvesting. Currently there are more than a dozen loggers who are equipped with a spray attachment and offer the treatment.

The Wisconsin DNR is in the process of developing a risk-based treatment guide on state-owned land. In order to assess economic impact of implementing a guide, it is important to understand the cost of fungicide applications based on proposed radii from a stand confirmed with annosum root rot. This report summarizes estimated cost for treatment based on the four radii (1 mile, 10 miles, 25 miles, 50 miles) for state lands only and for all pine stands.

Materials & Method: Data were retrieved from the U.S. Forest Service's Forest Inventory Analysis (FIA) database, regarding the annual removals of red, white, and jack pine in cubic feet for each county in Wisconsin. The data were then divided by 78 to obtain the number of cords removed in each county. The 78 cubic feet per cord conversion was provided by the U.S. Forest Service (Research Paper FPL 454) for pines.

A percent area of each county located within a one, ten, twenty-five, and fifty mile radius of each known stand infected with *H. irregulare* was visually estimated. The number of cords of red, white, and jack pine annually removed in each county was multiplied by the percentage within each treatment radius. This calculation provided the number of cords that would be treated in each county according to the various treatment radii. The number of cords treated in each county was multiplied by two dollars and five dollars to calculate a range of treatment cost for all of the pine timber removed within each radius. The cost estimate was obtained from foresters and loggers who are familiar with the treatment through spray attachments on a processor.

Information concerning the acreage of red, white, and jack pine timberland in each county based on the ownership of the land was gathered from the FIA database. The percentage of land owned by the State of Wisconsin was then derived. Multiplying the cost of treatment by the percentage of pine acres owned by the state government resulted in the cost of treating state-owned lands based on the various radii.

Results/Conclusions: Annual removals of red, white, and jack pine, whether annosum has been confirmed in the county, estimated percent of the county within each treatment radius, and the percent of the pine stands located on state property for each county was shown in Appendix A.

Table 1 depicts the estimated number of cords that would have to be treated according to different radii. The quantity for cords removed on state lands is considerably less than the number of cords removed on all lands. A very small portion of pine timberland in Wisconsin is located on state property. Roughly 8% of the pine stands in Wisconsin are state-owned.

	Cords removed on state lands	Cords removed on all lands
1 mi	38	3,249
10 mi	1,284	76,895
25 mi	5,851	191,214
50 mi	15,402	312,492

Table 1: Estimated number of cords annually removed from state lands and all lands within various treatment radii

Table 2 shows the estimated cost of treatment for state lands and all lands. If the 1-mile radius were chose, the cost associated with the treatment on state lands is estimated as up to $2344. With the 10-mile radius, the estimated cost increases by 12 times. The cost to treat stands within the 25-mile radius would be approximately 4 times as much as the cost to treat stands within 10 miles. With the largest radius proposed (50-mile radius), the treatment cost would be twice as much as the cost for the 25-mile radius.

The estimated cost of treating all pine stands in Wisconsin is more than ten times greater than the estimated cost to just treat state lands. Although the proposed guide focuses on state lands, and it is possible that the guide will be adopted by other public/private lands. Hypothetically, if the 50-mile radius were selected for the guide and the guide were adopted in all pine stands, the cost of treatment could be more than $2M annually.

	Estimated cost to treat state lands		Estimated cost to treat all lands	
	$2/cord	**$5/cord**	**$2/cord**	**$5/cord**
1 mi	$938	$2,344	$10,417	$26,043
10 mi	$11,251	$28,127	$125,008	$312,521
25 mi	$43,128	$107,820	$479,198	$1,197,996
50 mi	$74,067	$185,169	$822,971	$2,057,428

Table 2: Estimated cost of treatment for state lands and all lands

Appendix A: Annual removals (red, white, and jack pine), whether annosum has been confirmed, estimated percent of county contained in each treatment radius, and percent of the pine stands located on state property for each county

County	Annosum confirmed?	Total cords removed annually	Percent of county covered under each treatment radius				Percent of pine that is state-owned
			1 mi	10 mi	25 mi	50 mi	
Adams	Y	14,137	2%	95%	100%	100%	0%
Ashland	N	4,206	0%	0%	0%	0%	15%
Barron	N	437	0%	0%	0%	0%	0%
Bayfield	N	36,617	0%	0%	0%	0%	3%
Brown	N	0	0%	0%	5%	100%	0%
Buffalo	Y	0	1%	10%	95%	100%	0%
Burnett	N	33,729	0%	0%	0%	0%	9%
Calumet	N	0	0%	0%	0%	98%	0%
Chippewa	N	2,390	0%	0%	0%	95%	17%
Clark	N	3,913	0%	0%	25%	100%	0%
Columbia	Y	0	2%	35%	98%	100%	0%
Crawford	N	0	0%	0%	5%	100%	45%
Dane	N	0	1%	10%	90%	100%	0%
Dodge	N	0	0%	5%	80%	100%	0%
Door	N	0	0%	0%	0%	75%	0%
Douglas	N	24,641	0%	0%	0%	0%	11%
Dunn	Y	10,109	1%	0%	5%	80%	0%
Eau Claire	N	3,783	0%	0%	50%	100%	0%
Florence	N	21,069	0%	0%	15%	100%	0%
Fond Du Lac	N	0	0%	0%	10%	100%	100%
Forest	N	1,506	0%	0%	10%	80%	0%
Grant	N	0	0%	0%	25%	100%	0%
Green	Y	0	1%	20%	95%	100%	0%
Green Lake	N	8,701	0%	10%	100%	100%	0%
Iowa	Y	0	2%	40%	98%	100%	34%
Iron	N	0	0%	0%	0%	0%	63%
Jackson	N	27,888	0%	5%	50%	100%	20%
Jefferson	Y	0	3%	45%	100%	100%	0%
Juneau	Y	11,820	2%	20%	100%	100%	0%
Kenosha	N	0	0%	0%	5%	100%	0%
Kewaunee	N	0	0%	0%	0%	50%	0%
La Crosse	Y	0	1%	40%	100%	100%	0%
Lafayette	N	0	0%	0%	5%	100%	0%
Langlade	N	8,922	0%	0%	5%	80%	0%

Lincoln	N	23,253	0%	0%	10%	95%	11%
Manitowoc	N	0	0%	0%	0%	15%	0%
Marathon	N	2,569	0%	1%	60%	100%	0%
Marinette	Y	29,907	1%	35%	90%	100%	5%
Marquette	Y	0	4%	50%	100%	100%	11%
Menominee	N	127	0%	0%	95%	100%	0%
Milwaukee	N	0	0%	0%	50%	100%	0%
Monroe	N	22,959	0%	1%	60%	100%	4%
Oconto	Y	5,984	1%	15%	95%	100%	0%
Oneida	N	13,154	0%	0%	0%	25%	14%
Outagamie	N	0	0%	0%	75%	100%	0%
Ozaukee	N	0	0%	0%	0%	100%	0%
Pepin	N	0	0%	0%	40%	100%	0%
Pierce	N	3,835	0%	0%	0%	50%	0%
Polk	N	0	0%	0%	0%	0%	0%
Portage	Y	29,695	5%	90%	100%	100%	1%
Price	N	4,182	0%	0%	20%	90%	0%
Racine	N	0	0%	0%	50%	100%	0%
Richland	Y	0	1%	20%	90%	100%	0%
Rock	N	0	0%	3%	80%	100%	0%
Rusk	N	11,093	0%	0%	5%	80%	0%
St. Croix	N	2,385	0%	0%	0%	5%	0%
Sauk	Y	0	1%	10%	100%	100%	27%
Sawyer	N	43,611	0%	0%	0%	20%	0%
Shawano	Y	5,955	0%	0%	90%	100%	0%
Sheboygan	N	0	0%	0%	0%	50%	100%
Taylor	Y	11,595	1%	50%	95%	100%	0%
Trempealeau	Y	5,007	1%	25%	100%	100%	0%
Vernon	N	6,576	0%	0%	5%	100%	52%
Vilas	N	40,673	0%	0%	0%	0%	31%
Walworth	Y	252	1%	35%	100%	100%	93%
Washburn	N	11,110	0%	0%	0%	0%	0%
Washington	N	0	0%	0%	50%	100%	0%
Waukesha	Y	1,108	2%	50%	100%	100%	15%
Waupaca	Y	14,984	1%	25%	100%	100%	0%
Waushara	Y	6,865	5%	95%	100%	100%	0%
Winnebago	N	0	0%	0%	70%	100%	0%
Wood	Y	10,122	1%	25%	90%	100%	0%