United States Department of Agriculture

Forest Service

Pacific Northwest Region

Southwest Oregon Forest Insect and Disease Service Center

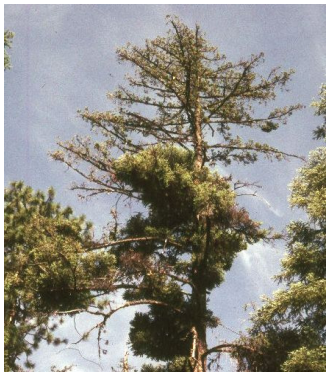
Central Point, OR

SWOFIDSC 11-01

September 2011

Comparison of two systems for rating dwarf mistletoe-infected Douglas-fir

Katy M. Mallams



Douglas-fir dwarf mistletoe-infected trees on the Rogue River-Siskiyou National Forest

Comparison of two systems for rating dwarf mistletoe-infected Douglas-fir

Abstract

The objective of this study was to compare two systems for rating the severity of Douglas-fir dwarf mistletoe. 554 Douglas-fir trees originally rated using a Broom Volume Rating System (BVR) were re-rated using the Hawksworth Six-class Dwarf Mistletoe Rating System (DMR). Sixty-seven percent of the dwarf mistletoe-infected trees received the same rating with both systems. The difference between the mean ratings of the two systems was only 0.05 rating classes. Mean BVR and DMR were nearly the same because the majority of heavily infected trees received higher ratings with the BVR system, while the majority of lightly infected trees received higher ratings with the DMR system. Only one percent of the infected trees differed by more than one rating class. Each rating system has strengths and weaknesses that should be considered when deciding which to use.

Background

In most conifer species, the severity of dwarf mistletoe is quantified using the Six-Class Dwarf Mistletoe Rating (DMR) System developed by Hawksworth (1977). This system is based on the proportion of mistletoe-infected branches in each third of the live crown. DMRs range from 0 for non-infected trees, to 6 for trees with at least 50 percent of the branches infected in each third of the live crown. The size of the brooms resulting from dwarf mistletoe infections is not a consideration in determining the DMR class. The DMR system works well in conifer species with open crowns, and with dwarf mistletoe infections that cause open brooms or no brooms, so that tree boles, branches and dwarf mistletoe infections are visible from the ground. Douglas-fir dwarf mistletoe-infected trees can be very difficult to rate using the DMR system because Douglas-fir dwarf mistletoe (*Arceuthobium douglasii)* often causes large, dense, complex brooms that obscure much of the tree bole and branches (Figure 1). Douglas-fir dwarf mistletoe plants are small, often less than two centimeters in height (Figure 2), and very difficult to see on infected branches if they have not yet formed brooms, especially in tall trees

(Geils and Mathiasen 1990). To cope with these difficulties, Tinnin (1998) developed the Broom Volume Rating System (BVR). BVR is based on the volume of each live crown third occupied by brooms. BVRs range from 0 for non-infected trees, to 6 for trees with at least 50 percent of the crown volume occupied by dwarf mistletoe brooms in each third of the live crown. The number of dwarf mistletoe-infected branches, or the number of individual dwarf mistletoe infections on a branch are not factors in determining the BVR class.

Fig. 1. *Mature Douglas-fir with large brooms caused by Douglas-fir dwarf mistletoe*

In 1992, I established ten permanent plots to measure the spread and impact of Douglas-fir dwarf mistletoe in mature infected stands in the southern Oregon Cascades on the Rogue River and Umpqua National Forests (Marshall 1998). I used the broom volume rating system described in the Work Plan (Mathiasen 1990), and by Tinnin (1998) to quantify the severity of Douglas-fir dwarf mistletoe in all live Douglas-fir (*Pseudotsuga menziesii*) trees greater than five centimeters (two inches) dbh in the plots in 1992, and at five-year intervals through 2007 (Mallams 2008a). Before comparing the results from these plots with the results of other studies of Douglas-fir dwarf mistletoe where severity was quantified using the Hawksworth DMR system, I decided to evaluate whether re-rating the trees in my plots using the DMR system would result in significantly different ratings.

Fig. 2. *Douglas-fir dwarf mistletoe plants interspersed with Douglas-fir needles on an infected branch*

Methods

In July 2008, I re-rated the dwarf mistletoe in all live Douglas-fir trees in three of the plots using the Hawksworth DMR system (Mallams 2008b). Finding this sample size

insufficient, I re-rated the live Douglas-fir using the DMR system in the remaining seven plots in June 2009. While re-examining the trees and rating them using the DMR system, I did not look at the previous BVR ratings, which were done in 2007. Based on the data collection from previous years in the plots, I believe the level of dwarf mistletoe would not have changed appreciably between 2007 and 2009. After collecting the data, I calculated total DMR of each tree, and mean DMR by crown thirds for the Douglas-fir from all ten plots. The results were compared with the BVR values collected in 2007 from the ten plots using Microsoft Office 2003 Excel for Windows and SPSS Version 10.1.

Results and Discussion

Overall, there was little difference in the ratings using either the DMR or BVR system in the 554 Douglas-fir from the ten plots. 187 (67 percent) of the 280 dwarf mistletoe-infected trees received the same ratings using both the DMR and BVR systems (Table 1). The mean DMR (1.54) and BVR (1.48) of all live trees (including non-infected trees) differed by only 0.06 rating classes (Table 2). The mean DMR (3.04) and BVR (2.99) of live infected trees differed by only 0.05 rating classes. The difference between the mean ratings was small because the majority of trees received the same rating with both systems, and because most of the trees that differed, differed by only one rating class. Only three trees (one percent) differed by more than one rating class (Table 3).

Table 1. Difference in ratings between BVR and DMR

Difference in ratings by class		All live trees		Live infected trees				
	BVR - DMR	**N**	**Percent**	**N**	**Percent**	**Mean DMR**	**Mean BVR**	**Diff**
BVR < DMR	**- 2**	3	<1	3	1	2.97	1.92	-1.05
	- 1	58	10	58	21			
BVR = DMR	**0**	461	83	187	67	3.12	3.12	0
BVR > DMR	**+ 1**	32	6	32	11	2.72	3.72	+1.00
	Total	554	100	280	100			

Table 2. Mean ratings by dwarf mistletoe rating system and crown third

Mean	N	Tree total	Crown third		
			Bottom	Middle	Upper
DMR all trees	554	1.54	0.84	0.51	0.19
BVR all trees	554	1.48	0.82	0.49	0.17
DMR infected trees[1]	280	3.04	1.67	1.00	0.37
BVR infected trees	274	2.99	1.65	0.99	0.35

1. Includes six trees rated DMR 1 and BVR 0

Table 3. Number of trees by dwarf mistletoe rating system and rating class

	BVR						
DMR	**0**	**1**	**2**	**3**	**4**	**5**	**6**
0	274[1]						
1	6	45	8				
2		24	29	7			
3		1	9	40	8		
4			1	10	28	4	
5				1	6	22	5
6						3	23

1. Shaded boxes show the number of trees with DMR = BVR. Values in boxes to the right of the shaded boxes are the number of trees in each class with BVR > DMR. Values in boxes to the left of the shaded boxes are the number of trees in each class with DMR > BVR.

When Tinnin (1998) compared the DMR and BVR systems using a sample of 137 infected Douglas-firs, his ratings were the same for 77 percent of the trees. Mean DMR of his sample was 2.2 and mean BVR was 2.4. One reason for the smaller difference in means between the two rating systems in Tinnin's sample may be that the trees he rated were much shorter (approximately 3-12 m tall) than the trees in my sample (5-60 m tall). Individual infected branches and the location of brooms would be easier to see in short trees.

Ninety-three of the infected trees in my study received different ratings using the two systems (Table 1). DMR was higher than BVR in 61 of the 93 trees (66 percent). Mean DMR and BVR of these trees differed by 1.05 rating classes. BVR was higher than DMR in 32 of the 93 trees (34 percent), and mean BVR and DMR of these trees differed by 1.00 rating class. Trees that rated higher with the DMR system had many infected branches with small brooms, or had infections that were visible due to small swellings but had not yet caused brooms to form. Tinnin (1998) also found that trees with many small brooms rated higher with the DMR system. In addition, I found that trees in my study with brooms located in a different crown third than the point on the bole where the branch originated also received higher ratings with the DMR system if there were no other brooms in the crown third where the branch originated.

Trees were rated higher with the BVR system than with the DMR system when brooms were few in number, but large. Large brooms undoubtedly hid infected branches so they could not be accurately counted from below. Tinnin (1998) also found that Douglas-fir trees with a few large brooms were given higher ratings with the BVR system. Large brooms that overlapped crown thirds also resulted in higher BVR than DMR. A portion of the broom volume was included in each crown third, even though the brooms originated on a branch in only one crown third.

24 trees that were rated BVR 1 were rated DMR 2. Some of these trees had only one infected branch at the base of the crown, widely separated from the rest of the live crown (Figure 3). I gave these trees higher ratings using the DMR system because I included the space on the bole between the infected branch and the next higher branch in the bottom third of the live crown. This is the method recommended for rating trees for dwarf mistletoe (Goheen, E. 2011). This usually resulted in a rating of DMR 2 for the bottom

Fig. 3. A large Douglas-fir dwarf mistletoe broom at the base of the live crown

crown third because the infected branch was often the only branch in the bottom crown third. In most cases, I estimated that such brooms occupied less than 50 percent of the volume of the bottom crown third, resulting in a BVR of 1.

274 trees were rated zero (non-infected) using both the DMR and BVR systems. All the trees rated DMR 0 were also rated BVR 0. However, six trees that were rated BVR 0 were rated DMR 1. These six trees had small branch swellings caused by new dwarf mistletoe infections, but brooms had not yet formed. Dwarf mistletoe plants were visible on the swollen branches in only one case. To follow the procedure described in Tinnin (1998), I should have given new, unbroomed infections a rating of BVR 1 "to avoid an undesirable divergence of the scores of the two rating systems."

The focus of BVR on brooms and DMR on individual branches gives each system strengths and weaknesses that should be considered when deciding which to use for a particular project. BVR underestimated the amount of dwarf mistletoe when there were many branches with small brooms, or when new infections that had not formed brooms yet were not accounted for. DMR underestimated the amount of dwarf mistletoe when a few large brooms dominated the crown. DMR may be better for assessing changes in the level of dwarf mistletoe in small trees over time, such as in plantations, although Hawksworth (1977) does not recommend its use in trees that are less than ten feet tall or suppressed. As long as individual branches are still visible, and small brooms and dwarf mistletoe infections without brooms are common, DMR is probably more precise. BVR is probably better for rating mature trees for stand-level dwarf mistletoe severity to be used in prescribing silvicultural treatments. In tall trees with dense crowns, especially at moderate to high levels of infection, using BVR compensates for the inability to see whether branches hidden within large brooms are infected.

Acknowledgments

I would like to thank Greg Filip, Jim Hadfield, and Ellen Goheen for reviewing drafts of this report and making many helpful suggestions. The USDA Forest Service, Forest

Health Protection, Pest Trend Impact Plot System (PTIPS) Program provided funding to install and re-measure the plots.

Literature Cited

Geils, Brian W. and Robert L. Mathiasen. 1990. Intensification of dwarf mistletoe on southwestern Douglas-fir. Forest Science 36 (4): 955-969.

Goheen, Ellen M. 2011. Personal communication. Plant Pathologist, USDA Forest Service, Southwest Oregon Forest Insect and Disease Service Center, Central Point, OR 97502.

Hawksworth, Frank G. 1977. The 6-class dwarf mistletoe rating system. General Technical Report RM-48. USDA Forest Service Rocky Mountain Forest and Range Experiment Station, Fort Collins, CO. 7p.

Mallams, Katy M. 2008a. Permanent plots for measuring spread and impact of Douglas-fir dwarf mistletoe in the southern Oregon Cascades, Pacific Northwest Region: results of plot remeasurement 2002-2007. USDA Forest Service Pacific Northwest Region, Southwest Oregon Forest Insect and Disease Service Center, Central Point, OR. SWOFIDSC-08-01. 6p.

Mallams, Katy M. 2008b. Comparison of two dwarf mistletoe rating systems for infected Douglas-fir. USDA Forest Service Pacific Northwest Region, Southwest Oregon Forest Insect and Disease Service Center, Central Point, OR. SWOFIDSC-08-02. 2p.

Marshall, Katy. 1998. Permanent plots for measuring the spread and impact of Douglas-fir dwarf mistletoe in the Southern Oregon Cascades, Pacific Northwest Region: establishment and five-year remeasurement report. USDA Forest Service Pacific Northwest Region, Southwest Oregon Forest Insect and Disease Service Center, Central Point, OR. SWOFIDSC-98-03. 6p.

Mathiasen, Robert. 1990. Establishment of permanent plots for validation of dwarf mistletoe relationships related to growth and yield modeling: first year testing of field procedures for plot establishment. Work plan version 2.0. May 11, 1990. Unpublished report. USDA Forest Service Forest Pest Management, Intermountain Region, Ogden, UT. 21p.

Tinnin, Robert O. 1998. An alternative to the 6-class dwarf mistletoe rating system. Western Journal of Applied Forestry 13(2): 64-65.