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DWARF MISTLETOE LOSS ASSESSMENT ON THE BITTERROOT AND LOLO NATIONAL
FORESTS, MONTANA

BY

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INTRODUCTION

We surveyed the Bitterroot and Lolo National Forests (figure 1) in 1979 to help us estimate incidence of dwarf mistletoe in Douglas-fir, lodgepole pine, and western larch. We also estimated cubic foot volume loss in lodgepole pine. Our survey should provide the land managers better information for use in decisionmaking.

<u>Species</u>	<u>Bitterroot</u>	<u>Lolo</u>
DF	43	17
LP	44	23
WL	52	30

Annual cubic foot volume losses were:

<u>Species</u>	<u>Bitterroot</u>	<u>Lolo</u>
DF	3,258 M	2,122 M
LP	467 M	701 M
WL	<u>32 M</u>	<u>240 M</u>
Total	3,757 M	3,063 M

OBJECTIVES

Our objectives were to:

1. Determine distribution and intensity of dwarf mistletoe in Douglas-fir, lodgepole pine, and western larch on the Bitterroot and Lolo National Forests in western Montana.
2. Determine cubic foot volume loss due to dwarf mistletoe on lodgepole pine.
3. Estimate cubic foot volume loss due to dwarf mistletoe on Douglas-fir and western larch.

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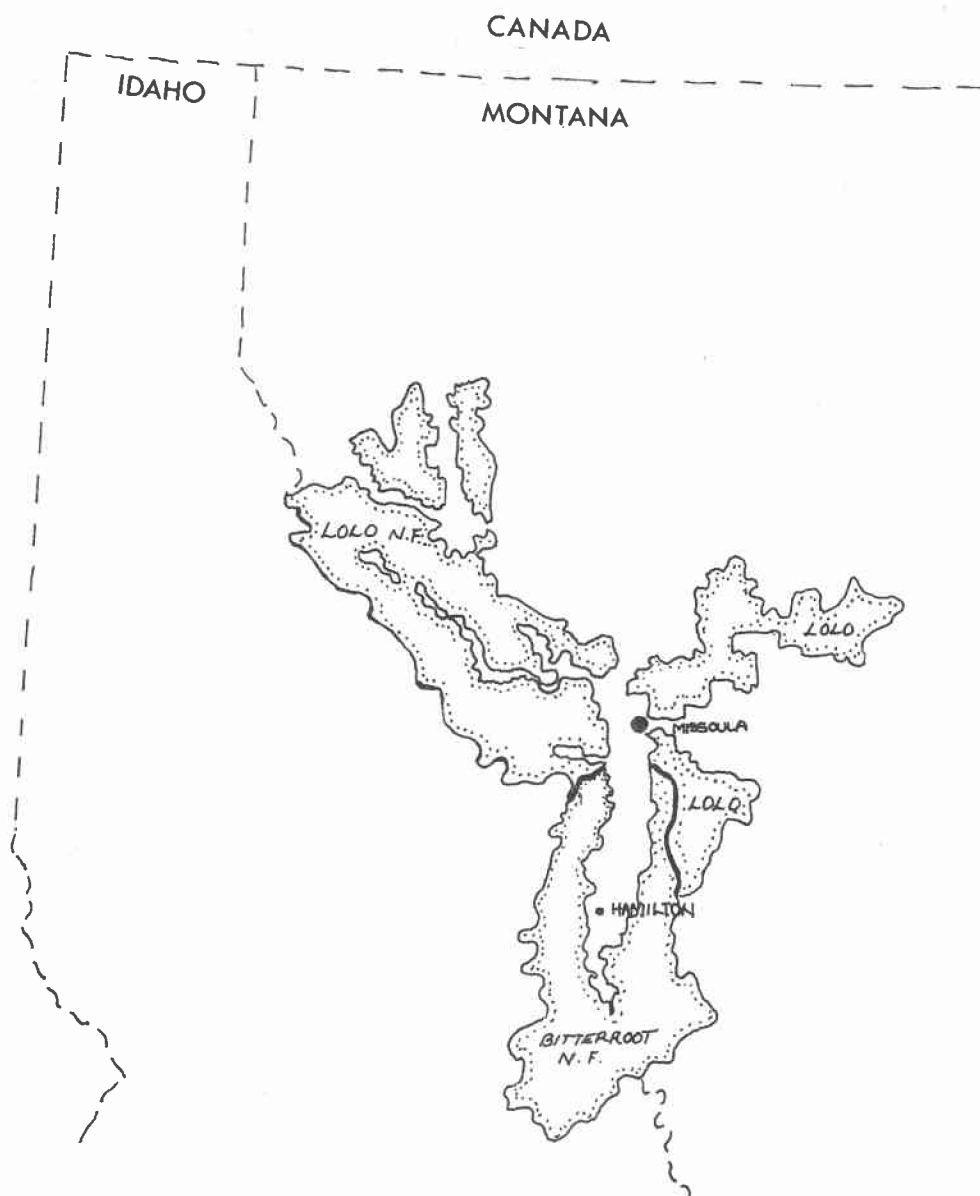


Figure 1.--Montana National Forests surveyed for dwarf mistletoe impact in 1979.

METHODS

Our survey was based on a combination road/plot system developed by Drummond (1978). Three two-person crews drove all passable roads on the two Forests at speeds less than 10 miles per hour. The crews observed a 1-chain wide strip on the right side of the road and recorded mileage to the nearest 0.1 mile whenever there was a change in type, size class, or dwarf mistletoe infection intensity. These terms are defined as:

Type -

Douglas-fir = $>1/3$ of stand is Douglas-fir.

Lodgepole pine = $>1/3$ of stand is lodgepole pine.

Western larch = $>1/3$ of stand is western larch.

Size Class -

Seedling/Sapling = trees <4.9 inches d.b.h.

Pole = trees 5.0 to 8.9 inches d.b.h.

Mature = trees >9.0 inches d.b.h.

Infection Intensity -

0 = no infection.

1 = $<1/3$ of the trees infected.

2 = $1/3$ to $2/3$ of the trees infected.

3 = $>2/3$ of the trees infected.

The crews also established variable radius plots (BAF 10) at 3-mile intervals, normally placed 2 chains into the stand on the right side of the road. If that direction was nontype, the plot was placed on the left side of the road. If both sides were nontype, that fact was recorded and the plot discarded without replacement. The crews recorded d.b.h., height, and dwarf mistletoe rating (DMR) on the six-class system (Hawksworth 1977) for all Douglas-fir, lodgepole pine, and western larch >4 inches d.b.h. One representative lodgepole pine on each plot was aged from an increment core for site index calculations. Number of rings in the last inch of growth was recorded for Douglas-fir and western larch for growth rate calculations.

We used the road data to estimate the proportion of each type infested by determining the ratio of miles with infected trees present to the total miles of type.

We used the lodgepole pine plot data to relate cubic foot volume loss to dwarf mistletoe incidence. We first summarized the plot data using a Tektronix® desk-top microprocessor at Forest Insect and Disease Management/Methods Application Group (MAG), Davis, CA; then ran the data through simulated yield program RMYLD (Edminster 1978) on the Univac® 1100 at Ft. Collins, CO (FCCC).

Plot data for Douglas-fir and western larch were summarized either by hand or with the FCCC Univac® 1100. We currently have no simulated yield models for either Douglas-fir or western larch.

RESULTS AND DISCUSSION

Bitterroot NF

Road survey.--Road data are summarized in tables 1 and 2. Dwarf mistletoe infestation percentage was calculated for each type from tables 1 and 2:

Douglas-fir	43.2
Lodgepole pine	44.3
Western larch	51.8

Lolo NF

$$\frac{\text{Infestation percentage} = \frac{\text{Miles severity categories 1+2+3}}{\text{type miles}} \times 100}{}$$

Douglas-fir	17.4
Lodgepole pine	22.6
Western larch	30.0

Infestation percentages are:

Table 1.--Miles of road surveyed on the Bitterroot National Forest by species, size class, and dwarf mistletoe infection intensity

Dwarf mistletoe infection 1/ intensity	Douglas-fir				Lodgepole pine				Western larch			
	Size class 2/				Size class				Size class			
	SS	P	M	Total	SS	P	M	Total	SS	P	M	Total
0	6.1	53.8	93.6	153.5	45.2	36.2	8.6	90.0	0.6	0.5	0.2	1.3
1	3.3	36.1	21.4	60.8	4.0	27.2	15.1	46.3	--	--	.8	.8
2	2.2	23.6	19.6	45.4	.2	8.3	9.3	17.8	--	.1	.5	.6
3	.1	5.7	5.0	10.8	--	2.8	4.8	7.6	--	--	--	--
TOTALS	11.7	119.2	139.6	270.5	49.4	74.5	37.8	161.7	0.6	0.6	1.5	2.7

1/ Infection intensity:

- 0 - no infection
- 1 - <1/3 of trees infected
- 2 - 1/3 to 2/3 of trees infected
- 3 - >2/3 of trees infected

2/ Size class:

- SS - seedling-sapling, <4.9 in. d.b.h.
- P - pole, 5.0 to 8.9 in. d.b.h.
- M - mature, >9.0 in. d.b.h.

Table 2.--Miles of roads surveyed on the Lolo National Forest by species, size class, and dwarf mistletoe infection intensity

Dwarf mistletoe infection intensity	Douglas-fir				Lodgepole pine				Western larch			
	Size class				Size class				Size class			
	SS	P	M	Total	SS	P	M	Total	SS	P	M	Total
0	42.7	273.5	227.9	544.1	54.7	228.7	135.9	419.3	26.5	28.7	40.2	95.4
1	3.9	35.6	25.4	64.9	11.9	57.7	21.8	91.4	.3	8.2	11.2	19.7
2	2.2	15.7	10.2	28.1	1.7	14.0	8.6	24.3	--	5.4	8.7	14.1
3	.8	10.5	10.1	21.4	--	1.7	5.3	7.0	--	1.6	5.5	7.1
TOTALS	49.6	335.3	273.6	658.5	68.3	302.1	171.6	542.0	26.8	43.9	65.6	136.3

Plot survey, Douglas-fir.--We currently have no simulated yield programs for dwarf mistletoe-infested Douglas-fir. Haglund and Dooling (1972) compared a healthy stand to a severely infested stand on the Flathead Indian Reservation, and determined losses to be about 74 cubic feet per acre per year. Losses vary from none for light intensity infestations to the 74 cubic feet per acre per year found by Haglund and Dooling (1972). An average for all infestation intensities would be about 20 cubic feet per acre per year.

Douglas-fir type occurs on 377 M acres on the Bitterroot NF. Two hundred twelve plots were in type; 47 plots were dwarf mistletoe-infested (22.2 percent). The road survey data is used for determining the proportion of type infested, and that data showed 43.2 percent infested. About 162.9 M acres of type are infested for an annual cubic foot volume loss of 3,258 M.

Douglas-fir type occurs on 610 M acres on the Lolo NF. Five hundred twenty-eight plots were in type; only 38 plots were dwarf mistletoe-infested (7.2 percent). The road data showed 17.4 percent infested. About 106.1 M acres of type are infested for an annual cubic foot volume loss estimate of 2,122 M.

Plot survey, lodgepole pine.--Figure 2 is an example of the original field data summarized on the MAG Tektronix®. These figures were used to drive RMYLD to produce a simulated yield table for each plot. RMYLD calculates the impact of dwarf mistletoe in arriving at volume predictions. A subroutine on a second run suppresses all infection data, and tables are produced as though infection were not present. The difference between the two tables is then taken as the 10-year impact of dwarf mistletoe.

Yield tables for one of the Bitterroot plots are shown in figures 3, infested, and 4, noninfested, as illustration. Loss data was summarized from the pairs of yield tables for each plot as cubic foot per acre per year volume loss by DMR class. Loss on the Bitterroot NF is 7.9 cubic foot per acre per year (table 3). Loss on the Lolo NF is 6.9 cubic foot per acre per year (table 4).

Lodgepole pine type occurs on 133.4 M acres on the Bitterroot NF. Eighty-nine plots were in type; 39 plots were dwarf mistletoe-infested (43.8 percent). The road data showed 44.3 percent infested. About 59.1 M acres of type are infested for an annual cubic foot volume loss estimate of 466.9 M.

DATA FOR THE LOLD TO BE RUN ON RMYLD

PLOT	SITE	AGE	CAL. DBH	HT	DEN	DMR	AGE +20 +10	#TR/ POINT	ACT. DBH	% LP
5	102	55	13.9	70.0	9	0.0	75	1	13.9	
9	118	51	12.4	76.0	24	0.0	71	2	12.4	
17	43	130	6.9	50.0	39	0.0	150	1	6.9	
22	68	60	6.4	50.0	134	0.0	80	3	6.4	
23	50	145	13.9	60.0	9	0.0	165	1	13.9	
28	95	35	4.8	46.5	545	0.0	155	10	15.8	
55	46	98	4.6	45.0	520	0.0	110	6	4.6	
52	73	173	14.2	90.0	18	0.0	193	2	14.2	
63	113	57	9.6	80.0	139	0.0	77	2	9.6	
64	114	66	8.8	90.0	47	0.0	86	2	8.8	
69	59	54	4.4	40.0	474	0.0	74	5	4.4	
70	76	53	6.1	51.2	591	0.0	73	12	6.1	
72	71	44	12.4	41.7	36	0.0	64	13	12.4	
73	81	48	12.9	50.0	11	0.0	58	1	12.9	
74	79	36	8.6	40.0	25	0.0	56	1	8.6	
78	85	42	9.5	47.5	41	0.0	52	1	9.5	
80	64	68	6.2	51.2	191	0.0	88	4	6.2	
83	86	42	8.4	47.9	208	0.0	52	8	8.4	
84	75	31	7.5	50.0	65	0.0	51	2	7.5	
85	37	17	9.8	55.0	76	0.0	37	4	9.8	
86	103	104	11.2	65.0	15	0.0	124	1	11.2	
88	78	73	6.6	51.4	505	0.0	93	12	6.6	
91	57	82	5.6	63.3	468	0.0	102	18	5.6	
92	81	65	6.4	75.0	806	0.0	85	18	6.4	
94	75	173	11.0		15	3.0	193	1	11.0	

Figure 2.--An example of original plot data summarized on the MAG Tektronix ^(R)

YIELDS PER ACRE
OF LODGEPOLE PINE
PLOT NUMBER 094
02/13/80

SITE INDEX, 67 FT.
THINNING INTENSITY-- INITIAL= .0 0-YEAR THINNING INTERVAL
SUBSEQUENT-- .0

CHARACTERISTICS BEFORE AND AFTER THINNING										PERIODIC INTERMEDIATE CUTS					
STAND AGE YEARS DMR	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	HEIGHT FT.	TOTAL VOLUME CU.FT.	MERCH. VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	TOTAL VOLUME CU.FT.	MERCH. VOLUME CU.FT.	SAWTIMBER VOLUME BD.FT.	MERCH. CU.FT.	SUBSAWLOG
150	4.3	223	96	8.9	56	2690	18	2460	16	10100					
160	5.0	201	103	9.7	57	2950	18	2730	17	11500					
										TOTAL YIELDS					
										2601/					
										11500					
										0					

MERCH. CU. FT. = TREES 6.0 INCHES D.B.H. AND LARGER TO 4.0-INCH TOP.
BD. FT. = TREES 6.5 INCHES D.B.H. AND LARGER TO 6.0-INCH TOP.
MINIMUM REMOVALS FOR INCLUSION IN TOTAL YIELDS--
0. CUBIC FEET AND 0. BOARD FEET PER ACRE.
SAWTIMBER TOTAL YIELD INCLUDES REMOVALS LESS THAN 0. BF/ACRE IF
MORE THAN 0. MERCH. CF/ACRE WAS REMOVED.
INITIAL THINNING FROM ABOVE ALLOWED IN STANDS WITH DWARF MISTLETOE.
D.M.P. ABOVE WHICH PERIODIC THINNINGS WILL NOT BE EXECUTED = 3.0.
NO NONCOMMERCIAL THINNINGS ALLOWED.
CULMINATION OF M.A.I. MERCH. CU. FT.--AGE= 160 MAI= 17.
CULMINATION OF M.A.I. TOTAL CU. FT.--AGE= 150 MAI= 18.

1/ 10-year growth on plot

Figure 3.--Simulated yield table, dwarf mistletoe-infested plot from the Bitterroot National Forest.

YIELDS PER ACRE OF LOGGEPOLE PINE
PLOT NUMBER 94
02/13/80

SITE INDEX, 67 FT.
THINNING INTENSITY-- INITIAL- .0 0-YEAR THINNING INTERVAL
SUBSEQUENT- .0

CHARACTERISTICS BEFORE AND AFTER THINNING

PERIODIC INTERMEDIATE CUTS

STAND AGE YEARS	DMR	TRFES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	HEIGHT FT.	TOTAL VOLUME CU.FT.	MERCH. VOLUME CU.FT.	SAWTIMBER VOLUME BO.FT.	TREES NO.	BASAL AREA SQ.FT.	AVERAGE D.B.H. IN.	TOTAL VOLUME CU.FT.	MERCH. VOLUME CU.FT.	SAWTIMBER VOLUME BO.FT.	MERCH. CU.FT.	SUBSAWLOG
150	.0	223	96	8.9	56	2690	18	2460	16	10100						
160	.0	221	116	9.8	57	3330	21	3090	19	13000						

6401/

TOTAL YIELDS

3330

3090

13000

0

MERCH. CU. FT. - TREES 6.0 INCHES D.B.H. AND LARGER TO 4.0-INCH TOP.
BD. FT. - TREES 6.5 INCHES D.B.H. AND LARGER TO 6.0-INCH TOP.
MINIMUM REMOVALS FOR INCLUSION IN TOTAL YIELDS--

0. CUBIC FEET AND 0. BOARD FEET PER ACRE.
SAWTIMBER TOTAL YIELD INCLUDES REMOVALS LESS THAN 0. BF/ACRE IF
MORE THAN 0. MERCH. CF/ACRE WAS REMOVED.

INITIAL THINNING FROM ABOVE ALLOWED IN STANDS WITH DWARF MISTLETOE.
D.M.R. ABOVE WHICH PERIODIC THINNINGS WILL NOT BE EXECUTED - 3.0.
NO NONCOMMERCIAL THINNINGS ALLOWED.
CULMINATION OF W.A.I. MERCH. CU. FT.--AGE= 160 MAI= 19.
CULMINATION OF W.A.I. TOTAL CU. FT.--AGE= 160 MAI= 21.

1/ 10-year growth on plot.

Figure 4.--Simulated yield table, dwarf mistletoe-free plot from the Bitterroot National Forest

Table 3.--Calculated growth impact from lodgepole pine
dwarf mistletoe on the Bitterroot National Forest

Plot	DMR 1/	Infested 2/ 10-year growth, ft ³	Healthy 2/ 10-year growth, ft ³	10-year difference ft ³	Annual difference ft ³
12	2.5	130	130	0	0
14	1.7	320	330	10	1
18	5.0	70	230	160	16
48	5.0	50	80	30	3
72	1.5	150	150	0	0
73	2.0	100	100	0	0
74	1.5	310	310	0	0
81	1.0	400	400	0	0
94	4.3	260	640	380	38
95	4.0	190	320	130	13
96	1.0	170	170	0	0
102	1.7	140	140	0	0
107	.3	640	640	0	0
108	1.5	250	250	0	0
115	2.7	510	510	0	0
117	.6	690	690	0	0
118	2.1	600	620	20	2
119	5.0	180	360	180	18
136	.5	370	370	0	0
142	3.9	290	720	430	43
146	3.7	340	340	0	0
151	5.0	110	190	80	8
157	4.2	210	410	200	20
150	3.2	440	440	0	0
154	2.3	290	320	30	3
155	.4	1,600	1,600	0	0
161	1.0	210	210	0	0
163	3.8	350	480	130	13
164	3.4	410	540	130	13
166	5.0	50	120	70	7
169	4.8	100	440	340	34
1015	3.2	210	280	70	7
1083	4.0	70	140	70	7
1084	2.0	460	490	30	3
2323	1.5	160	160	0	0
2367	1.6	550	550	0	0
2372	4.3	-150	370	520	52
2382	.4	540	540	0	0
2396	4.0	270	340	70	7
39				3,080	308

7.9 ft³/ac/yr

1/ 6-class rating system 2/ From yield tables (see figures 3 and 4)

Table 4.--Calculated growth impact from lodgepole pine
dwarf mistletoe on the Lolo National Forest

Plot	DMR <u>1/</u>	Infested <u>2/</u> 10-year growth, ft ³	Healthy <u>2/</u> 10-year growth, ft ³	10-year difference ft ³	Annual difference ft ³
84	4.0	300	360	60	6
94	3.0	130	160	30	3
97	.2	760	760	0	0
201	.5	700	700	0	0
202	6.0	-20	260	280	28
215	.3	240	240	0	0
251	2.8	680	750	70	7
282	5.0	50	110	60	6
287	4.0	130	130	0	0
288	2.0	140	140	0	0
295	2.0	550	560	10	1
307	3.0	230	230	0	0
311	2.4	1,140	1,360	220	22
312	1.5	370	370	0	0
322	1.2	710	710	0	0
325	4.2	370	930	560	56
328	1.0	230	230	0	0
329	6.0	-60	200	260	26
43	3.0	160	160	0	0
353	4.7	150	390	240	24
1003	4.2	560	900	340	34
1007	2.8	710	970	260	26
1012	2.0	140	140	0	0
1016	.3	710	710	0	0
1116	2.5	210	320	20	2
1385	.6	350	350	0	0
1145	1.0	130	130	0	0
1172	2.0	200	200	0	0
1179	3.2	320	350	30	3
1184	.4	430	430	0	0
2042	2.5	210	230	20	2
2074	2.0	150	150	0	0
2216	.1	1,340	1,340	0	0
2237	.1	1,440	1,440	0	0
2272	2.3	850	900	50	5
2306	.3	410	410	0	0
1307	3.0	170	220	50	5
1335	2.2	480	490	10	1
1338	2.0	210	210	0	0
1344	1.4	820	820	0	0
1345	6.0	-30	120	150	15
1348	3.7	230	410	180	18
1367	3.4	360	440	80	8
43				2,980	298

6.9 ft³/ac/yr

1/ 6-class rating system 2/ From yield tables (see figures 3 and 4)

Lodgepole pine type occurs on 449.4 M acres on the Lolo NF. Two hundred ninety-one plots were in type; 44 plots were dwarf mistletoe-infested (15.1 percent). The road data showed 22.6 percent infested. About 101.6 M acres of type are infested for an annual cubic foot volume loss estimate of 701 M.

Loss estimates in lodgepole pine for both Forests by DMR are shown in table 5. A more concise summary is shown in table 6.

Table 5.--Acres of dwarf mistletoe infestation represented by survey plots and annual cubic-foot volume loss estimates for Bitterroot and Lolo NF lodgepole pine stands by 6-class infection system

Dwarf mistletoe severity category	BITTERROOT					LOLO				
	No. plots	% rep.	M acres	Loss		No. plots	% rep.	M acres	Loss	
				Ft ³ /acre/year	Total loss M ft ³				Ft ³ /acre/year	Total loss M ft ³
0	50	56.2	75.0	0	0	247	84.9	381.6	0	0
0.1-1.0	8	9.0	11.9	0	0	12	4.1	18.4	0	0
1.1-2.0	9	10.1	13.5	.5	6.8	9	3.1	13.9	.5	7.0
2.1-3.0	4	4.5	6.0	1.5	9.0	11	3.8	17.1	6.7	114.6
3.1-4.0	9	10.1	13.5	11.5	155.4	5	1.7	7.6	10.2	77.6
4.1-5.0	9	10.1	13.5	21.9	295.7	4	1.4	6.3	37.8	238.1
5.1-6.0	0	0	0	0	0	3	1.0	4.5	58.6	263.7
TOTALS	89	100.0	133.4 ^{1/}	--	466.9	291	100.0	449.4 ^{1/}	--	701.0

^{1/} Total acres lodgepole pine type from land status records

Table 6.--Dwarf mistletoe-caused volume loss estimates for Bitterroot and Lolo NF lodgepole pine stands

Forest	Commercial type M acres ^{1/}	Infested ^{2/}		Volume lost ^{3/} ft ³ /acre/year	Volume lost ^{4/} M ft ³ /year
		Percent	M acres		
Bitterroot	133.4	44.3	59.1	7.9	466.9
Lolo	449.4	22.6	101.6	6.9	701.0
TOTAL	582.8	--	160.7	--	1,167.9

^{1/} From land status records

^{3/} Volume loss
Acres Infested

^{2/} From road survey (tables 1 and 2)

^{4/} Plot data

Plot survey, western larch.--We currently have no simulated yield programs for dwarf mistletoe-infested larch. On and Dooling (1969) compared a healthy stand to a severely infested stand in northwestern Montana, and determined losses to be nearly 100 cubic feet per acre per year. We feel this was an extreme case, and not valid for the Region. Our "best guess" estimate is 20 cubic feet per acre per year growth reduction due to dwarf mistletoe.

Western larch type occurs on only 4 M acres on the Forest. The road survey passed through only 2.7 miles of type; and only 3 plots were in type.

We consider our sample to be much too small to be valid. The road survey showed 51.8 percent of type infested; the plot survey showed 33 percent infested. If we assume something like 40 percent as the true level of infestation, then about 1.6 M acres of type are infested, for an annual cubic foot volume loss estimate on the Bitterroot NF of 32 M.

Western larch type occurs on 40 M acres on the Lolo NF. Two hundred fifty-five plots were in type; 47 plots were dwarf mistletoe-infested

(18.4 percent). The road data showed 30.0 percent infested. About 12 M acres of type are infested for an annual cubic foot volume loss estimate on the Lolo NF of 240 M.

Current volume impact in M cubic feet due to dwarf mistletoe is estimated to be:

<u>Species</u>	<u>Bitterroot</u>	<u>Lolo</u>
Douglas-fir	3,258	2,122
Lodgepole pine	467	701
Western larch	<u>32</u>	<u>240</u>
Total	3,757	3,063

We consider these estimates to be accurate within \pm 20 percent.

These loss estimates are much lower than our previous ones. Dwarf mistletoes, at least on the Bitterroot and Lolo NF's, are not quite the villains we once considered them. Even so, an annual volume loss of more than 6.8 MM cubic feet is not acceptable; vigorous efforts to reduce dwarf mistletoe impact through silvicultural practices should continue.

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