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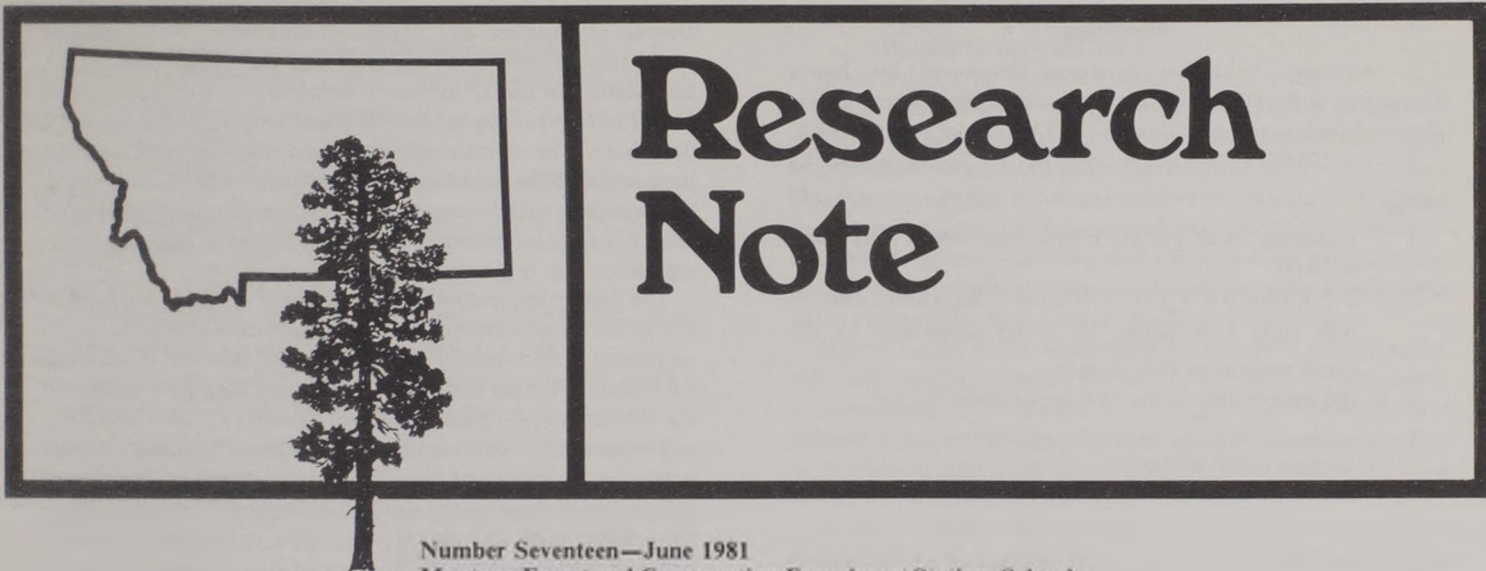
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Research Note

Number Seventeen—June 1981
Montana Forest and Conservation Experiment Station, School
of Forestry, University of Montana, Missoula, Montana 59812.

Some Economic Aspects of the Deadwood Harvest on the Bitterroot National Forest

by

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Increasingly intensive use of the wood fiber resource should be explored from many perspectives. Engineering, economics, ecology, and mensuration problems need to be addressed and resolved in order to facilitate effective decision-making by forest managers contemplating increased utilization of this resource. This study was designed to answer some economic questions regarding the historical use and projections for future availability of the dead, softwood resource in the Bitterroot Valley of western Montana. The underlying purpose of this study is to examine the nature of deadwood consumption in light of market and management variables and to use the resultant predictive models to examine the availability of this

resource under differing schemes of markets and management policy.

There are three objectives to this study:

1. To analyze the impact on bid price of deadwood amount and size that is used on larger timber sales by modifying a stumpage valuation model developed by Jackson and McQuillan (1979).
2. to develop a supply schedule for residue material based on harvest levels and wood prices.
3. to summarize the effect of changes in timber management policy and markets on residue availability by utilizing the results of 1 and 2 above. For example, changes in harvest levels, or the greater use of partial cuts and cable logging systems, may reduce the availability of this resource.

Wood residue is defined as the dead, softwood material classified as OD (other dead) or US (unsound sapwood) in Forest Service reports and appraisals. This material has generally been sold as sawtimber, pulpwood, fuelwood or houselog products. The study area is limited to the Bitterroot Valley generally from the Ravalli-Missoula County line to the south. Most of the federally-managed public lands in this area are administered by the Bitterroot National Forest of the USDA Forest Service.

Acknowledgements: thanks are due Wilma Finlayson of the Bitterroot National Forest Supervisor's Office and Eileen Allen of Timber Management, Northern Region Office, for their assistance and patience in data collecting.

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Methods

A stumpage valuation equation developed by James Merzenich of the USDA Forest Service Northern Region Office was modified to achieve Objective 1. This model is of the form:

$$Y = -275.94 + 14.31X_1 + 25.56X_2 + 1.231X_3 + 5.229X_4 \quad (1)$$

where:

Y = stumpage value per MBF (thousand board feet) (1978 dollars)

$X_1 = \sum [\ln(\text{dbh}_i) \cdot V_i]$ (\ln = Napierian logarithm, dbh_i = dbh class i in inches, V_i = the proportion of the stand volume in dbh class i)

X_2 = the proportion of the sale area tractor logged

X_3 = weighted average lumber price for a sale's lumber content (1978 dollars)

X_4 = net volume per acre (MBF).

Since variable X_4 includes only live sawlog volume per acre[†], variable X_5 , the deadwood harvested per acre on each sale, was added to the model. It was hypothesized that including deadwood volumes in the timber sale would reduce average stumpage prices; the sign of the coefficient would therefore be negative. The timber sale data were then analyzed using a stepwise regression computer program with the coefficients tested for significance at the $\alpha = .10$ level (one-tailed test).

The models were developed using data from 19 timber sales comprising all scaled sales larger than 500 MBF from 1968 to 1978. Helicopter sales and sales not yet completed were excluded from the data base. Data on volumes actually removed were recorded from the final summary of account computer printout for each timber sale. This printout is available at the Bitterroot National Forest Supervisor's Office, Hamilton, MT.

To accomplish Objective 2, cut and sold reports for fiscal years (f.y.) 1967 through 1980 were collected from the Bitterroot National Forest Supervisor's Office. In these reports, the amount and value of all timber sold and cut are outlined by fiscal quarter-year and by species and product. Also, total timber volume and value is given by sale size class with a further breakdown of volume and value sold, by species and product, in sales less than \$2000 in value.

The amount of deadwood sold from the Bitterroot National Forest^{††} for various products can thereby be separated, and the extent of correlation with market and management variables can be examined. Management variables included annual allowable cut (or potential yield), number of small sales (less than \$2000 in value) issued, and stumpage price charged for this material. Market variables included number of houselog manufacturers, volume cut in large sales (greater than \$2000 in value), and average stumpage price paid (in 1972 dollars) for large timber sales. Annual allowable cut or potential yield figures were obtained from timber management in the Northern Region Office. The number of houselog dealers was compiled from lists supplied by the Bitterroot National Forest, Montana State Division of Forestry, and the University of Montana

[†]The other independent variables are included in a timber sale prospectus. Implicitly, we have assumed that buyers will estimate deadwood volume and value before purchasing and that X_5 is a measure of the before sale buyer estimate.

^{††}A rather large deadwood sale, the Crystal Point Deadwood Sale of 5.7 MMBF, was sold and resold for several years. This sale was excluded from the data base because it was a somewhat experimental attempt at selling deadwood in large sales and a case like this has not been repeated.

Bureau of Business and Economic Research. Manufacturers were then telephoned to ascertain the year they began operations. Of the 17 log home manufacturers contacted, two would not reveal any information and were excluded from the data base. The number of log houses manufactured and the proportion of the houselogs that were from the Bitterroot Valley that went into each house may be a better predictor of deadwood sold, but such information on a historical basis from log home manufacturers is inaccessible.

The first order, second order, and first order cross products of the variables were entered as independent variables in the model to predict the amount of deadwood sold. Because of seasonal variations in timber sale activity, quarterly data were combined for the fiscal year, giving a sample size of 14 (1967-1980)^{†††}

The amount of deadwood sold (MBF) was separated into two categories by small and large sale sizes to determine the type of sale in which most of the deadwood is being harvested. These data were analyzed using a stepwise regression computer program and tested for significance at the $\alpha = .10$ level.

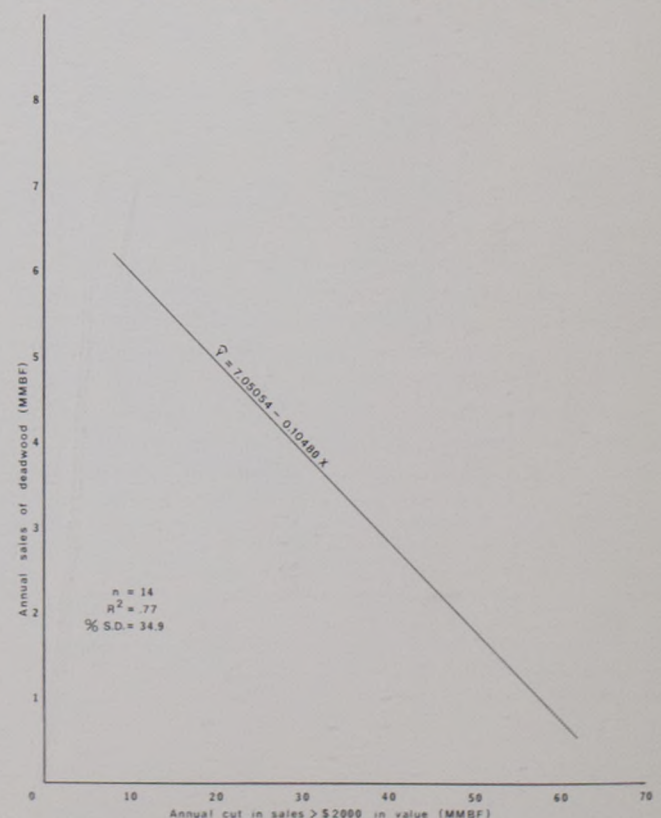
Objective 3 was accomplished by using the significant models obtained in Objectives 1 and 2 to examine the change in deadwood sold by varying the levels of management and market variables.

Results

Objective 1 — The model developed to examine the effect of deadwood volume harvested per acre in large timber sales on sale bid price took the form:

$$Y = -396.7186 + 72.6670X_1 + 0.4100X_2 + 1.217X_3 + 2.3755X_4 - 171.8009X_5 \quad (2)$$

Figure 1. Relationship between volume of deadwood sold and volume cut in large sales for Bitterroot National Forest, 1967-1980.



^{†††}F.y. 1976 was adjusted to compensate for the fifth quarter, or transition quarter, in this year.

where:

Y = statistical high bid in 1978 dollars per MBF

$X_1 = \sum [\ln(\text{dbh}_i) \cdot V_i]$ (ln = Naperian logarithm, dbh = dbh class i in inches, V_i = the proportion of the stand volume in dbh class i)

X_2 = the proportion of the sale area tractor logged

X_3 = weighted average lumber price for a sale's lumber content (1978 dollars)

X_4 = net volume per acre (MBF).

X_5 = deadwood volume harvested (MBF) per acre.

$R^2 = .93$, $n = 19$, % S.D. = 19.4, $F(5, 13) = 48.22$

Variables X_1 and X_3 were significant at the 99 percent confidence level, X_2 at the 97.5 percent level, and X_4 and X_5 at the 90 percent level of confidence. The equation predicts that stumpage value decreases at a constant rate as the amount of deadwood per acre harvested increases. For example, if a green timber sale had a stumpage value of \$50 and an associated deadwood harvest of 25 board feet per acre, then increases in deadwood in the sale to 50, 75, and 100 board feet per acre would decrease stumpage value to \$45.70, \$41.41, and \$37.11 per MBF respectively. The ranges of the sample data for the variables along with the associated statistics for the coefficients are given in the Appendix.

The model developed to examine the effect of total deadwood volume harvested on total sale value has the form:

$$Y = -523429.4 + 76.08601 X_1 + 2700.395 X_2 - 171.7116 X_3 - 1471.567 X_4 \quad (3)$$

where:

Y = statistical high bid in 1978 dollars

$X_1 = \sum [\ln \text{dbh}_i \cdot \text{Vol}_i]$ (ln = Naperian logarithm, dbh_i = dbh class i in inches, Vol_i = volume in dbh class i)

X_2 = weighted average lumber price for a sale's lumber content (1978 dollars)

X_3 = net live sawlog volume (MBF)

X_4 = total deadwood harvested (MBF)

$R^2 = .84$, $n = 19$, % S.D. = 25.6, $F(4, 14) = 23.99$

Variables X_1 , X_2 , and X_3 are significant at the 99 percent confidence level, and X_4 at the 90 percent level of confidence. This model predicts that including deadwood volumes in a green timber sale reduces the bid value of that sale; therefore this may indicate deadwood volumes have a negative average value in these types of sales.

Objective 2 — Two models were developed that predict total amount of deadwood sold per year from the Bitterroot National Forest. Model I is based on the independent variable of volume cut in large sales and is of the form:

$$Y = 7050.541 - 0.10480X \quad (4)$$

where:

Y = total MBF deadwood sold per year

X = total MBF live sawtimber cut per year in sales greater than \$2000 in value.

$r^2 = .77$, $n = 14$, % S.D. = 34.9, $F(1, 12) = 44.47$

Model II is based on the number of log home manufacturers in Ravalli County. The equation is of the form:

$$Y = 2723.98 + 1538.486X - 73.12531(X)^2 \quad (5)$$

where:

Y = total deadwood volume (MBF) sold per year

X = number of log home manufacturers operating in Ravalli County per year.

$R^2 = .76$, $n = 14$, % S.D. = 35.6, $F(2, 11) = 21.7$

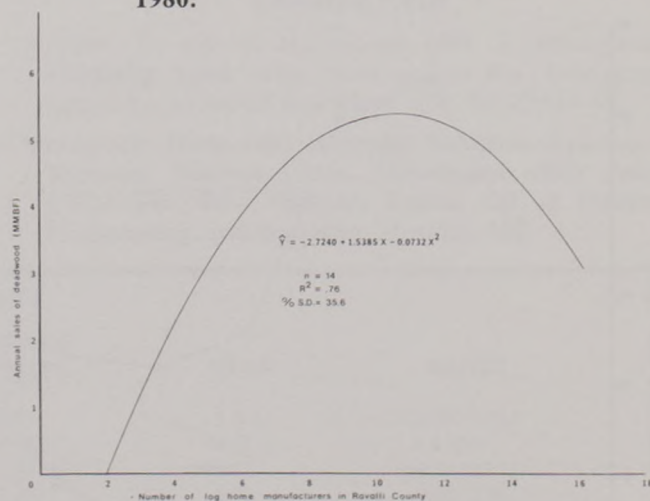
Figures 1 and 2 show the graphical relationship of the two models to total annual sales of deadwood. The other independent variables of allowable cut, number of small sales, deadwood stumpage value, and lumber prices were insignificant in predicting total deadwood sold per year. The amount of deadwood reported as being sold for pulpwood products was minor; consequentially no variables related to pulpwood such as price and volume were used in developing the models.

Figure 3 depicts the distribution of the sale of deadwood by sale size class. In general the sale of the deadwood resource accelerated in 1970, peaked in 1975, gradually declined until 1978 and has been rising since. Only in 1980 was the proportion of deadwood sold in large sales a significant part of the total amount of deadwood sold.

Apparently most of the deadwood resource is sold in sales of under \$2000 in value. Figure 4 shows the relationship over time between the total cut in large sales, amount of deadwood sold in small sales, and the number of small sales. The inverse relationship between the cut in large sales and activity in small sales is evident: when the cut in large sales decreases, the number of small sales and the amount of deadwood sold in small sales increases.

With the above information a supply schedule outlining the availability of the deadwood resource for utilization can be developed for varying levels of market and management variables. Tables 1 - 6 indicate the changes in deadwood utilization in large sales in relation to stumpage price, tree size, volume cut per acre, lumber selling price, and proportion of area tractor skidded.

Figure 2. Curvilinear relationship between volume of deadwood sold from the Bitterroot National Forest and the number of log home manufacturers in Ravalli County, Montana, 1967-1980.



Discussion

The models presented herein describe the historical harvests of deadwood from the Bitterroot National Forest. If these same relationships exist in the future, then changes in timber management policy and timber markets can have a significant impact on the amount of deadwood harvested. In the past, the availability of this resource for utilization has been directly linked to the economics of the timber industry. When mills are buying and timber prices are up, the total harvest of deadwood

††††% S.D. means the standard deviation as a percent of the mean response Y.

Figure 3. Volume of deadwood sold over time from Bitterroot National Forest.

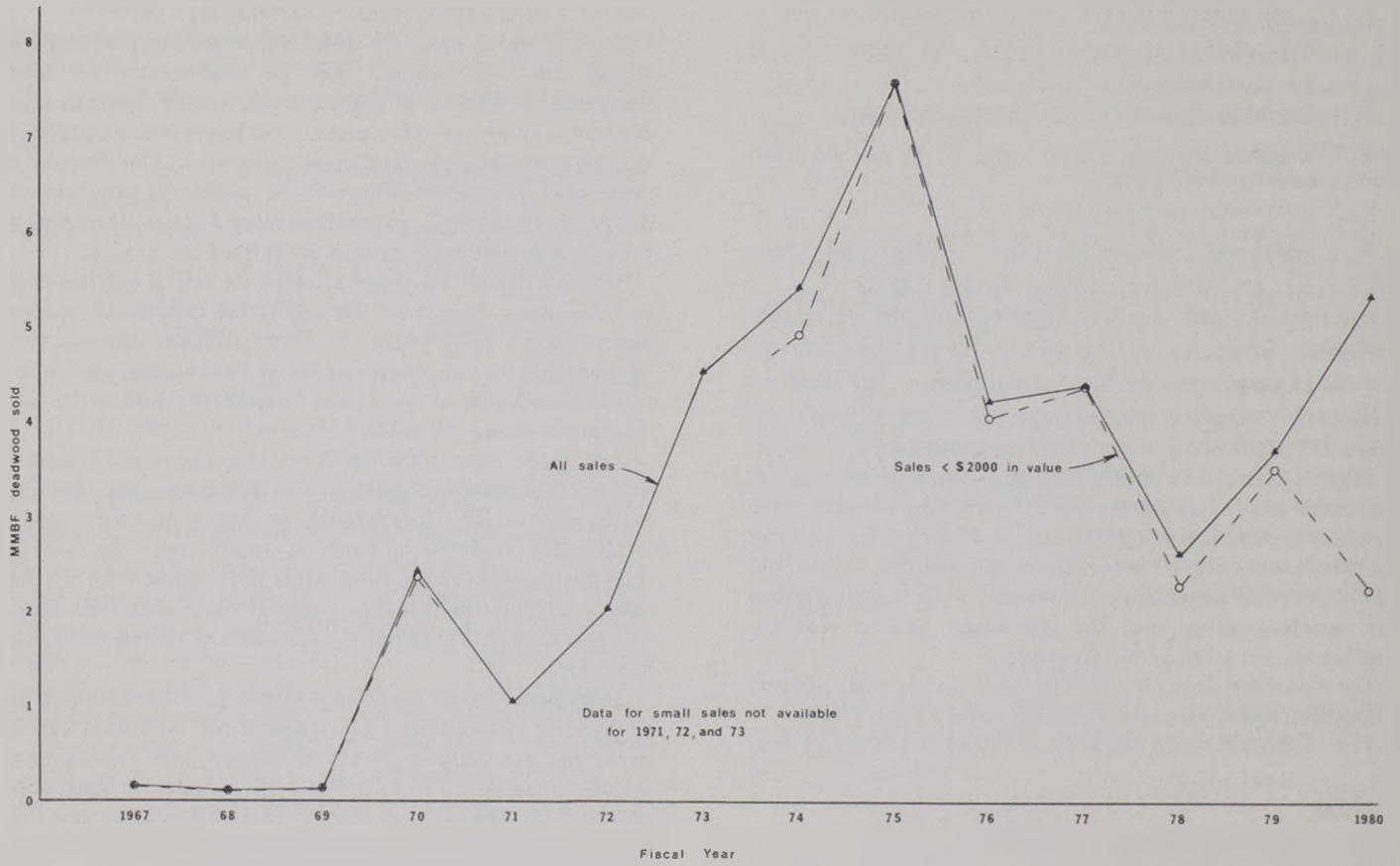


Figure 4. Relationship between volume cut in large sales (> \$2000 in value) and volume sold in and number of small sales on Bitterroot National Forest, 1967-1980.

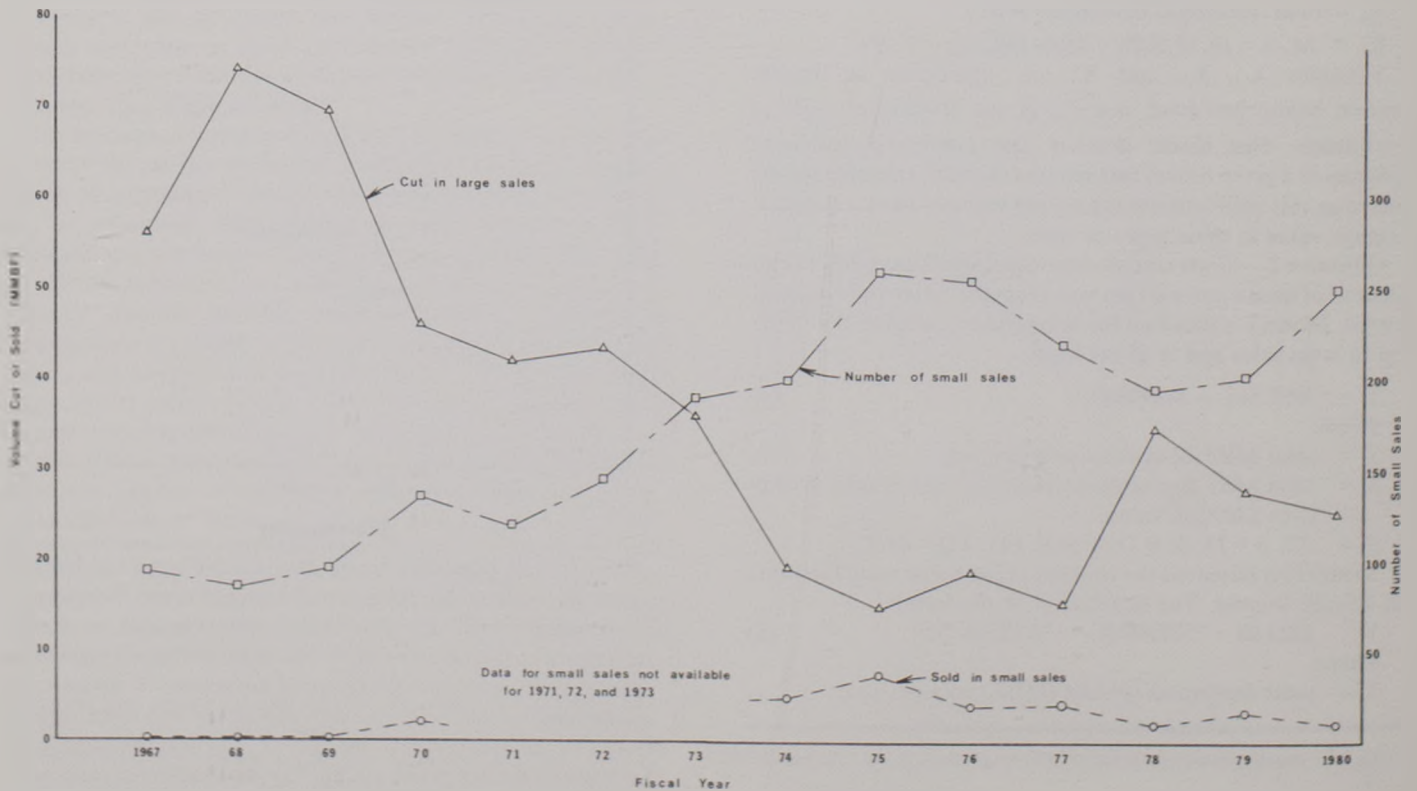
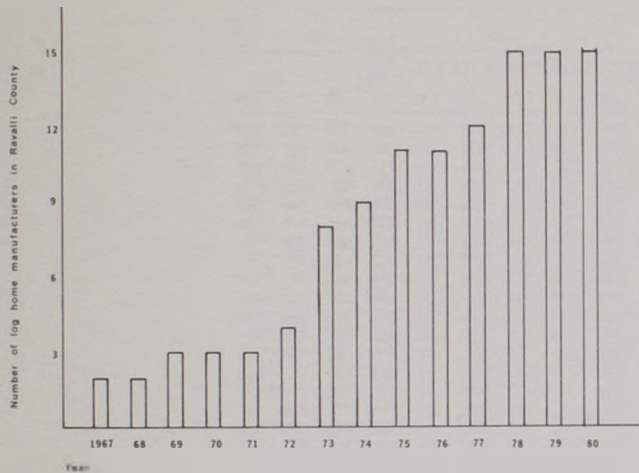


Figure 5. Growth of number of log home manufacturers in Ravalli County, Montana, over time.



declines. This relationship implies that loggers who normally work with deadwood sales to supply houselog manufacturers and small sawmills may switch to logging green timber sales when strong lumber markets exist. Conversely, when lumber markets are depressed, loggers who normally work in green timber sales may switch to deadwood sales in order to make a living.

As seen in Figure 3, most of the deadwood is harvested in sales under \$2000 in value. Current deadwood stumpage prices of \$1.00 per MBF would allow a substantial volume of deadwood (up to 2 MMBF) in a single sale. Because of the low price charged for this material, most deadwood is sold in "greenslip sales" of under \$300 in value (which can include volumes of up to 300 MBF of deadwood). These sales are readily obtainable by loggers and others; at the current stumpage value of \$1.00 per MBF substantial volumes of deadwood can be made available for utilization.

Considering large sales, historical changes in the lumber market, measured by the variable of lumber selling price, indicate that the harvest in MBF of deadwood per acre in large sales increases with higher lumber prices, other things being constant. This is probably a direct result of the purchaser being able to afford to harvest and transport lower quality material during strong market periods; the "marginal log" thus becomes smaller in size or of lower quality during strong markets.

The significant increase in deadwood volume sold in large sales in 1980 (Figure 3) is the result of houselog sales in excess of

\$2000 and not related to an increased demand for pulpwood. If pulpwood demand becomes stronger in the future the models presented should be reevaluated.

The implication of changes in timber management policy on the deadwood harvest can be inferred from Equations 2 and 3 and Tables 1 - 6. Requiring greater use of cable logging systems (decreasing the proportion that is tractor logged) in large sales would reduce the amount of deadwood harvested. Sales in stands of smaller diameter trees would also reduce volume of deadwood harvested, as would increased use of selective cuts that reduce the live volume per acre harvested.

Most of the deadwood is sold in sales under \$2000 in value; the majority of this is in "greenslip sales." Changes in sales contracts away from the present "greenslip sales" could therefore alter the total deadwood harvest and ultimately affect the small logging companies and log home manufacturers. Since well-known product-market cycles exist that do not necessarily coincide, small sales that include substantial volumes of deadwood act as an employment buffer for woods workers. The extent that this substitution of alternate employment acts as a buffer is unknown.

Figure 2 shows that as the number of log home manufacturers has increased, annual deadwood sales has increased, peaked and then fallen off. Figure 3 shows that the peak deadwood sales occurred in 1975 in spite of the fact that the number of manufacturers has continued to increase through 1980 (Figure 5). To date the major supply source has been greenslip sales contracts where procurement costs are low (\$1/MBF). Historically the Sleeping Child Burn has been a major area contributing houselogs to manufacturers in the valley. A considerable amount of the remaining deadwood is doubtlessly less accessible, suggesting that even more houselogs than the current 50 to 60 percent may be imported to the valley. Otherwise, manufacturers may close or relocate to be nearer supply sources.

Literature Cited

- JACKSON, D. and A. MCQUILLAN 1979. A technique for estimating timber value based on tree size, management variables, and market conditions. *For. Sci.* 25:620-626.
- MERZENICH, JAMES 1980. Stumpage Valuation Equation — Bitterroot National Forest. Unpublished office report. USDA For. Serv., Northern Region, Off. of Planning, Programming, and Budgeting. Missoula, MT.

Appendix

INDEPENDENT VARIABLE	REGRESSION COEFFICIENT	STANDARD ERROR	MEAN	RANGE
Equation 2				
X ₁	72.6670	19.33	3.045	2.632-3.453
X ₂	0.4100	0.181	48.91	9.6-100
X ₃	1.0217	0.0095	213.82	156.54-303.18
X ₄	2.3755	1.467	6.93	2.90-12.09
X ₅	-171.8009	106.70	0.030	0-0.135
Equation 3				
X ₁	76.08601	20.4727	11776.68	6731-15562
X ₂	2700.395	386.2132	213.82	156.54-303.18
X ₄	-171.7116	59.4186	3900.79	2170-8200
X ₅	-1471.567	920.5556	18.30	0-66.55
Equation 4				
X	-0.10480	0.0157	37427.71	15373-74286
Equation 5				
X	1538.486	313.852	8.07	2-15
X ²	-73.12531	18.412	89.79	4-225

**Table 1 Board Feet Per Acre Harvest of Deadwood in Sales Larger Than 500 MBF
\$10 Per MBF Stumpage Value (1978 Dollars)**

DBH	CUT MBF PER ACRE	LUMBER SELLING PRICE PER MBF (1978 DOLLARS)															
		160				200				240				280			
		PERCENT OF AREA TRACTOR SKIDDED															
		25	50	75	100	25	50	75	100	25	50	75	100	25	50	75	100
12	4	0	0	0	0	0	48	107	167	226	286	345	405	464	523	583	643
12	6	0	0	0	0	16	75	135	195	254	313	373	433	491	551	611	670
12	8	0	0	0	0	43	103	163	222	281	341	401	460	519	579	638	698
12	10	0	0	0	12	71	131	190	250	309	369	428	488	547	606	666	726
14	4	0	0	0	0	53	113	173	232	291	351	410	470	529	589	648	708
14	6	0	0	0	22	81	141	200	260	319	378	438	498	557	616	676	736
14	8	0	0	0	50	109	168	228	288	346	406	466	525	584	644	704	763
14	10	0	0	18	77	136	196	256	315	374	434	493	553	612	672	731	791
16	4	0	0	0	51	110	169	229	289	348	407	467	527	586	645	705	764
16	6	0	0	19	78	137	197	257	316	375	435	495	554	613	673	732	792
16	8	0	0	46	106	165	225	284	344	403	463	522	582	641	700	760	820
16	10	0	14	74	134	193	252	312	372	431	490	550	610	668	728	788	847
18	4	0	0	41	101	160	219	279	339	397	457	517	576	635	695	755	814
18	6	0	9	69	128	187	247	307	366	425	485	544	604	663	723	782	842
18	8	0	37	96	156	215	275	334	394	453	512	572	632	691	750	810	870
18	10	5	64	124	184	243	302	362	421	480	540	600	659	718	778	838	897
20	4	0	26	86	145	204	264	323	383	442	502	561	621	680	740	799	859
20	6	0	54	113	173	232	291	351	411	470	529	589	649	708	767	827	887
20	8	22	81	141	201	259	319	379	438	497	557	617	676	735	795	855	914
20	10	49	109	169	228	287	347	406	466	525	585	644	704	763	823	882	942
22	4	7	66	126	186	244	304	364	423	482	542	602	661	720	780	840	899
22	6	34	94	154	213	272	332	391	451	510	570	629	689	748	808	867	927
22	8	62	122	181	241	300	359	419	479	538	597	657	717	776	835	895	954
22	10	90	149	209	269	327	387	447	506	565	625	685	744	803	863	922	982
24	4	43	103	163	222	281	341	401	460	519	579	638	698	757	817	876	936
24	6	71	131	190	250	309	369	428	488	547	606	666	726	785	844	904	964
24	8	99	158	218	278	337	396	456	516	574	634	694	753	812	872	932	991
24	10	126	186	246	305	364	424	484	543	602	662	721	781	840	900	959	1019
26	4	77	137	197	256	315	375	434	494	553	613	672	732	791	851	910	970
26	6	105	165	224	284	343	402	462	522	581	640	700	760	819	878	938	997
26	8	133	192	252	312	370	430	490	549	608	668	728	787	846	906	965	1025
26	10	160	220	280	339	398	458	517	577	636	696	755	815	874	934	993	1053
28	4	109	168	228	288	346	406	466	525	584	644	704	763	822	882	942	1001
28	6	136	196	256	315	374	434	493	553	612	672	731	791	850	910	969	1029
28	8	164	224	283	343	402	461	521	581	640	699	759	819	878	937	997	1056
28	10	192	251	311	371	429	489	549	608	667	727	787	846	905	965	1024	1084
30	4	138	197	257	317	376	435	495	555	614	673	733	792	851	911	971	1030
30	6	165	225	285	344	403	463	523	582	641	701	760	820	879	939	998	1058
30	8	193	253	312	372	431	491	550	610	669	728	788	848	907	966	1026	1086
30	10	221	280	340	400	459	518	578	638	697	756	816	875	934	994	1054	1113

**Table 2 Board Feet Per Acre Harvest of Deadwood in Sales Larger Than 500 MBF
\$30 Per MBF Stumpage Value (1978 Dollars)**

DBH	CUT MBF PER ACRE	LUMBER SELLING PRICE PER MBF (1978 DOLLARS)															
		160				200				240				280			
		PERCENT OF AREA TRACTOR SKIDDED															
		25	50	75	100	25	50	75	100	25	50	75	100	25	50	75	100
12	4	0	0	0	0	0	0	0	51	110	169	229	288	347	407	467	526
12	6	0	0	0	0	0	0	19	78	137	197	257	316	375	435	494	554
12	8	0	0	0	0	0	0	46	106	165	225	284	344	403	462	522	582
12	10	0	0	0	0	0	14	74	134	193	252	312	371	430	490	550	609
14	4	0	0	0	0	0	0	56	116	175	234	294	354	413	472	532	592
14	6	0	0	0	0	0	24	84	143	202	262	322	381	440	500	560	619
14	8	0	0	0	0	0	52	111	171	230	290	349	409	468	528	587	647
14	10	0	0	0	0	20	79	139	199	258	317	377	437	496	555	615	675
16	4	0	0	0	0	0	53	113	172	231	291	351	410	469	529	588	648
16	6	0	0	0	0	21	81	140	200	259	319	378	438	497	556	616	676
16	8	0	0	0	0	49	108	168	228	287	346	406	465	524	584	644	703
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18	4	0	0	0	0	43	103	162	222	281	341	400	460	519	579	638	698
18	6	0	0	0	12	71	130	190	250	309	368	428	488	547	606	666	726
18	8	0	0	0	40	98	158	218	277	336	396	456	515	574	634	694	753
18	10	0	0	8	67	126	186	245	305	364	424	483	543	602	662	721	781
20	4	0	0	0	29	88	147	207	267	326	385	445	505	563	623	683	742
20	6	0	0	0	56	115	175	235	294	353	413	473	532	591	651	710	770
20	8	0	0	24	84	143	203	262	322	381	441	500	560	619	678	738	798
20	10	0	0	52	112	171	230	290	350	409	468	528	588	646	706	766	825
22	4	0	0	9	69	128	188	247	307	366	426	485	545	604	663	723	783
22	6	0	0	37	97	156	215	275	335	394	453	513	573	631	691	751	810
22	8	0	5	65	124	183	243	303	362	421	481	541	600	659	719	778	838
22	10	0	33	92	152	211	271	330	390	449	509	568	628	687	746	806	866
24	4	0	0	46	106	165	225	284	344	403	462	522	582	641	700	760	820
24	6	0	14	74	134	193	252	312	371	430	490	550	609	668	728	788	847
24	8	0	42	102	161	220	280	339	399	458	518	577	637	696	756	815	875
24	10	10	70	129	189	248	307	367	427	486	545	605	665	724	783	843	903
26	4	0	20	80	140	199	258	318	378	437	496	556	616	674	734	794	853
26	6	0	48	108	167	226	286	346	405	464	524	584	643	702	762	821	881
26	8	16	76	135	195	254	314	373	433	492	552	611	671	730	789	849	909
26	10	44	103	163	223	282	341	401	461	520	579	639	699	757	817	877	936
28	4	0	52	111	171	230	290	349	409	468	528	587	647	706	765	825	885
28	6	20	79	139	199	258	317	377	437	496	555	615	675	733	793	853	912
28	8	47	107	167	226	285	345	405	464	523	583	643	702	761	821	880	940
28	10	75	135	194	254	313	373	432	492	551	611	670	730	789	848	908	968
30	4	21	81	141	200	259	319	379	438	497	557	616	676	735	795	854	914
30	6	49	109	168	228	287	347	406	466	525	584	644	704	763	822	882	942
30	8	77	136	196	256	315	374	434	494	552	612	672	731	790	850	910	969
30	10	104	164	224	283	342	402	462	521	580	640	699	759	818	878	937	997

**Table 3 Board Feet Per Acre Harvest of Deadwood in Sales Larger Than 500 MBF
\$50 Per MBF Stumpage Value (1978 Dollars)**

DBH	CUT MBF PER ACRE	LUMBER SELLING PRICE PER MBF (1978 DOLLARS)																
		160				200				240				280				
		PERCENT OF AREA TRACTOR SKIDDED																
		25	50	75	100	25	50	75	100	25	50	75	100	25	50	75	100	
12	4	0	0	0	0	0	0	0	0	0	53	112	172	231	291	350	410	
12	6	0	0	0	0	0	0	0	0	21	80	140	200	259	318	378	438	
12	8	0	0	0	0	0	0	0	0	48	108	168	227	286	346	406	465	
12	10	0	0	0	0	0	0	0	17	76	136	195	255	314	374	433	493	
14	4	0	0	0	0	0	0	0	0	58	118	178	237	296	356	416	475	
14	6	0	0	0	0	0	0	0	0	27	86	146	205	265	324	384	443	503
14	8	0	0	0	0	0	0	0	0	55	114	173	233	293	352	411	471	530
14	10	0	0	0	0	0	0	23	82	141	201	261	320	379	439	499	558	
16	4	0	0	0	0	0	0	0	56	115	174	234	294	353	412	472	532	
16	6	0	0	0	0	0	0	24	84	142	202	262	321	380	440	500	559	
16	8	0	0	0	0	0	0	52	111	170	230	289	349	408	468	527	587	
16	10	0	0	0	0	20	79	139	198	257	317	377	436	495	555	615		
18	4	0	0	0	0	0	0	46	106	165	224	284	344	403	462	522	581	
18	6	0	0	0	0	14	74	133	192	252	312	371	430	490	549	609		
18	8	0	0	0	0	42	101	161	220	280	339	399	458	517	577	637		
18	10	0	0	0	10	69	129	189	248	307	367	427	486	545	605	664		
20	4	0	0	0	0	31	91	150	209	269	329	388	447	507	566	626		
20	6	0	0	0	0	59	118	178	237	297	356	416	475	534	594	654		
20	8	0	0	0	27	86	146	206	265	324	384	443	502	562	622	681		
20	10	0	0	0	54	114	174	233	292	352	411	471	530	590	649	709		
22	4	0	0	0	12	71	131	191	250	309	369	428	487	547	607	666		
22	6	0	0	0	39	99	159	218	277	337	396	456	515	575	634	694		
22	8	0	0	0	8	67	127	186	246	305	365	424	484	543	602	662	722	
22	10	0	0	36	95	154	214	274	333	392	452	511	570	630	690	749		
24	4	0	0	0	48	108	168	227	286	346	406	465	524	584	644	703		
24	6	0	0	0	17	76	136	195	255	314	374	433	493	552	612	671	731	
24	8	0	0	0	45	104	163	223	283	342	401	461	521	580	639	699	758	
24	10	0	0	13	73	131	191	251	310	369	429	489	548	607	667	726	786	
26	4	0	0	0	23	82	142	202	261	320	380	439	499	558	618	677	737	
26	6	0	0	0	51	110	170	229	289	348	408	467	527	586	645	705	765	
26	8	0	0	19	79	138	197	257	317	376	435	495	554	613	673	733	792	
26	10	0	0	47	106	165	225	285	344	403	463	522	582	641	701	760	820	
28	4	0	0	0	55	114	173	233	293	352	411	471	530	589	649	709	768	
28	6	0	0	23	82	141	201	261	320	379	439	498	558	617	677	736	796	
28	8	0	0	50	110	169	229	288	348	407	467	526	586	645	704	764	824	
28	10	0	18	78	138	197	256	316	376	435	494	554	613	672	732	792	851	
30	4	0	0	24	84	143	202	262	322	381	440	500	560	619	678	738	798	
30	6	0	0	52	112	171	230	290	349	408	468	528	587	646	706	766	825	
30	8	0	20	80	139	198	258	317	377	436	496	555	615	674	734	793	853	
30	10	0	48	107	167	226	285	345	405	464	523	583	643	702	761	821	881	

**Table 4 Board Feet Per Acre Harvest of Deadwood in Sales Larger Than 500 MBF
\$70 Per MBF Stumpage Value (1978 Dollars)**

DBH	CUT MBF PER ACRE	LUMBER SELLING PRICE PER MBF (1978 DOLLARS)															
		160				200				240				280			
		PERCENT OF AREA TRACTOR SKIDDED															
		25	50	75	100	25	50	75	100	25	50	75	100	25	50	75	100
12	4	0	0	0	0	0	0	0	0	0	0	56	115	174	234	294	
12	6	0	0	0	0	0	0	0	0	0	24	83	142	202	262	321	
12	8	0	0	0	0	0	0	0	0	0	51	111	170	230	289	349	
12	10	0	0	0	0	0	0	0	0	0	19	79	139	198	257	317	377
14	4	0	0	0	0	0	0	0	0	0	2	61	121	180	239	299	359
14	6	0	0	0	0	0	0	0	0	0	29	89	149	207	267	327	386
14	8	0	0	0	0	0	0	0	0	0	57	117	176	235	295	354	414
14	10	0	0	0	0	0	0	0	0	25	85	144	204	263	322	382	442
16	4	0	0	0	0	0	0	0	0	0	58	118	177	236	296	356	415
16	6	0	0	0	0	0	0	0	0	26	86	145	205	264	324	383	443
16	8	0	0	0	0	0	0	0	0	54	113	173	233	292	351	411	471
16	10	0	0	0	0	0	0	22	81	141	201	260	319	379	439	498	
18	4	0	0	0	0	0	0	0	48	108	168	227	286	346	405	465	
18	6	0	0	0	0	0	0	0	17	76	136	195	255	314	373	433	493
18	8	0	0	0	0	0	0	0	45	104	163	223	283	341	401	461	520
18	10	0	0	0	0	0	13	72	131	191	251	310	369	429	488	548	
20	4	0	0	0	0	0	0	0	34	93	152	212	272	331	390	450	510
20	6	0	0	0	0	0	2	62	120	180	240	299	358	418	478	537	
20	8	0	0	0	0	0	30	89	148	208	267	327	386	446	505	565	
20	10	0	0	0	0	0	57	117	176	235	295	355	414	473	533	593	
22	4	0	0	0	0	0	15	74	133	193	252	312	371	431	490	550	
22	6	0	0	0	0	0	42	102	161	220	280	340	399	458	518	578	
22	8	0	0	0	0	10	70	130	188	248	308	367	426	486	546	605	
22	10	0	0	0	0	38	98	157	216	276	335	395	454	514	573	633	
24	4	0	0	0	0	0	51	111	170	230	289	349	408	467	527	587	
24	6	0	0	0	0	19	79	139	198	257	317	377	436	495	555	614	
24	8	0	0	0	0	47	107	166	225	285	345	404	463	523	582	642	
24	10	0	0	0	15	75	134	194	253	313	372	432	491	550	610	670	
26	4	0	0	0	0	26	85	145	204	263	323	383	442	501	561	621	
26	6	0	0	0	0	53	113	173	231	291	351	410	469	529	589	648	
26	8	0	0	0	21	81	141	200	259	319	378	438	497	557	616	676	
26	10	0	0	0	49	109	168	228	287	346	406	466	525	584	644	704	
28	4	0	0	0	0	57	117	176	235	295	354	414	473	533	592	652	
28	6	0	0	0	0	57	117	176	235	332	382	442	501	560	620	680	
28	8	0	0	0	53	112	172	232	290	350	410	469	528	588	648	707	
28	10	0	0	21	80	140	200	259	318	378	437	497	556	616	675	735	
30	4	0	0	0	26	86	146	205	264	324	384	443	502	562	622	681	
30	6	0	0	0	54	114	173	233	292	352	411	471	530	590	649	709	
30	8	0	0	23	82	141	201	261	320	379	439	499	558	617	677	736	
30	10	0	0	50	109	169	229	288	347	407	467	526	585	645	704	764	

**Table 5 Board Feet Per Acre Harvest of Deadwood in Sales Larger Than 500 MBF
\$90 Per MBF Stumpage Value (1978 Dollars)**

DBH	CUT MBF PER ACRE	LUMBER SELLING PRICE PER MBF (1978 DOLLARS)															
		160				200				240				280			
		PERCENT OF AREA TRACTOR SKIDDED															
		25	50	75	100	25	50	75	100	25	50	75	100	25	50	75	100
12	4	0	0	0	0	0	0	0	0	0	0	0	0	0	58	118	177
12	6	0	0	0	0	0	0	0	0	0	0	0	0	26	86	145	205
12	8	0	0	0	0	0	0	0	0	0	0	0	0	54	113	173	232
12	10	0	0	0	0	0	0	0	0	0	0	0	22	81	141	201	260
14	4	0	0	0	0	0	0	0	0	0	0	0	4	63	123	183	242
14	6	0	0	0	0	0	0	0	0	0	0	0	32	91	151	210	270
14	8	0	0	0	0	0	0	0	0	0	0	0	60	119	178	238	298
14	10	0	0	0	0	0	0	0	0	0	0	28	87	146	206	266	325
16	4	0	0	0	0	0	0	0	0	0	0	1	61	120	180	239	299
16	6	0	0	0	0	0	0	0	0	0	0	29	89	148	207	267	327
16	8	0	0	0	0	0	0	0	0	0	0	57	116	175	235	295	354
16	10	0	0	0	0	0	0	0	0	0	25	84	144	203	263	322	382
18	4	0	0	0	0	0	0	0	0	0	0	51	111	170	229	289	349
18	6	0	0	0	0	0	0	0	0	0	19	79	138	197	257	317	376
18	8	0	0	0	0	0	0	0	0	0	47	106	166	225	285	344	404
18	10	0	0	0	0	0	0	0	0	15	74	134	194	253	312	372	432
20	4	0	0	0	0	0	0	0	0	0	36	96	155	214	274	334	393
20	6	0	0	0	0	0	0	0	0	4	64	123	183	242	302	361	421
20	8	0	0	0	0	0	0	0	0	32	91	151	211	270	329	389	449
20	10	0	0	0	0	0	0	0	0	59	119	179	238	297	357	417	476
22	4	0	0	0	0	0	0	0	0	17	76	136	196	255	314	374	434
22	6	0	0	0	0	0	0	0	0	44	104	164	223	282	342	402	461
22	8	0	0	0	0	0	0	0	13	72	132	191	251	310	370	429	489
22	10	0	0	0	0	0	0	0	41	100	159	219	279	338	397	457	517
24	4	0	0	0	0	0	0	0	0	54	113	173	232	291	351	411	470
24	6	0	0	0	0	0	0	0	22	81	141	200	260	319	379	438	498
24	8	0	0	0	0	0	0	0	50	109	169	228	288	347	406	466	526
24	10	0	0	0	0	0	0	18	78	137	196	256	315	374	434	494	553
26	4	0	0	0	0	0	0	0	28	87	147	207	266	325	385	445	504
26	6	0	0	0	0	0	0	0	56	115	175	234	294	353	413	472	532
26	8	0	0	0	0	0	0	24	84	143	202	262	322	381	440	500	560
26	10	0	0	0	0	0	0	52	111	170	230	290	349	408	468	528	587
28	4	0	0	0	0	0	0	0	60	119	178	238	298	357	416	476	536
28	6	0	0	0	0	0	0	28	87	146	206	266	325	384	444	504	563
28	8	0	0	0	0	0	0	55	115	174	234	293	353	412	472	531	591
28	10	0	0	0	0	0	23	83	143	202	261	321	381	440	499	559	619
30	4	0	0	0	0	0	0	29	89	148	208	267	327	386	445	505	565
30	6	0	0	0	0	0	0	57	117	176	235	295	355	413	473	533	592
30	8	0	0	0	0	0	25	85	144	203	263	323	382	441	501	560	620
30	10	0	0	0	0	0	53	112	172	231	291	350	410	469	528	588	648

**Table 6 Board Feet Per Acre Harvest of Deadwood in Sales Larger Than 500 MBF
\$110 Per MBF Stumpage Value (1978 Dollars)**

DBH	CUT MBF PER ACRE	LUMBER SELLING PRICE PER MBF (1978 DOLLARS)																
		160				200				240				280				
		PERCENT OF AREA TRACTOR SKIDDED																
		25	50	75	100	25	50	75	100	25	50	75	100	25	50	75	100	
12	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	61	
12	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	29	88	
12	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	56	116	
12	10	0	0	0	0	0	0	0	0	0	0	0	0	0	24	84	114	
14	4	0	0	0	0	0	0	0	0	0	0	0	0	0	7	66	126	
14	6	0	0	0	0	0	0	0	0	0	0	0	0	0	34	94	154	
14	8	0	0	0	0	0	0	0	0	0	0	0	0	2	62	122	181	
14	10	0	0	0	0	0	0	0	0	0	0	0	0	300	90	149	209	
16	4	0	0	0	0	0	0	0	0	0	0	0	0	4	63	123	182	
16	6	0	0	0	0	0	0	0	0	0	0	0	0	59	118	178	238	
16	10	0	0	0	0	0	0	0	0	0	0	0	28	86	146	206	265	
18	4	0	0	0	0	0	0	0	0	0	0	0	0	53	113	173	232	
18	6	0	0	0	0	0	0	0	0	0	0	0	22	81	141	200	260	
18	8	0	0	0	0	0	0	0	0	0	0	0	50	109	168	228	288	
18	10	0	0	0	0	0	0	0	0	0	18	77	136	196	256	315	375	
20	4	0	0	0	0	0	0	0	0	0	0	0	39	98	158	217	277	
20	6	0	0	0	0	0	0	0	0	0	0	0	7	67	126	185	245	305
20	8	0	0	0	0	0	0	0	0	0	0	0	35	94	153	213	273	332
20	10	0	0	0	0	0	0	0	0	0	0	0	62	122	181	241	300	360
22	4	0	0	0	0	0	0	0	0	0	0	0	20	79	138	198	258	317
22	6	0	0	0	0	0	0	0	0	0	0	0	47	107	166	226	285	345
22	8	0	0	0	0	0	0	0	0	0	15	75	135	194	253	313	372	
22	10	0	0	0	0	0	0	0	0	0	43	103	162	221	281	340	400	
24	4	0	0	0	0	0	0	0	0	0	0	0	56	116	175	235	294	354
24	6	0	0	0	0	0	0	0	0	0	24	84	144	203	262	322	382	
24	8	0	0	0	0	0	0	0	0	0	52	112	171	230	290	350	409	
24	10	0	0	0	0	0	0	0	0	20	80	139	199	258	318	377	437	
26	4	0	0	0	0	0	0	0	0	0	31	90	150	209	269	328	388	
26	6	0	0	0	0	0	0	0	0	0	58	118	178	237	296	356	415	
26	8	0	0	0	0	0	0	0	0	26	86	146	205	264	324	383	443	
26	10	0	0	0	0	0	0	0	0	54	114	173	233	292	352	411	471	
28	4	0	0	0	0	0	0	0	0	2	62	122	181	240	300	360	419	
28	6	0	0	0	0	0	0	0	0	30	90	149	209	268	328	387	447	
28	8	0	0	0	0	0	0	0	0	58	117	177	237	296	355	415	474	
28	10	0	0	0	0	0	0	0	26	85	145	205	264	323	383	442	502	
30	4	0	0	0	0	0	0	0	0	32	91	151	210	269	329	389	448	
30	6	0	0	0	0	0	0	0	0	59	119	178	238	297	357	416	476	
30	8	0	0	0	0	0	0	0	28	87	146	206	266	325	384	444	504	
30	10	0	0	0	0	0	0	0	56	115	174	234	293	352	412	472	531	