Forest Appraisal Zones and Timber Values

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I. Introduction

The purpose of this report is to identify timber tax appraisal zones and appraisal values for the Montana Department of Revenue. The methods were developed under earlier reports (Jackson, 2002, 1996, 1992). Montana Department of Natural Resources and Conservation (DNRC) timber sales for fiscal years 2002 through 2006 (July 1, 2002 through June 300, 2007) were used as the basic appraisal data. Statistical analysis and methods were used to identify sets of contiguous counties with relatively homogeneous timber prices. Four appraisal zones have been identified. This is a change from the last appraisal study where five zones were identified. A list of the counties with DNRC timber sales used in this analysis is shown in Table 1. The list is arranged within the four appraisal zones.

There was a substantially different methodology used in defining zones 1, 2, and 3 than there was in that of zone 4. This was necessitated because the Montana DNRC appraises timber in Eastern Montana on more of an experiential basis while at the same time relying on a transaction evidence system for the remainder of the state. There is a substantial difference in the data base for sales in Eastern Montana from sales in the rest of the state which necessitated different approaches for appraisal. As a result, the appraised value used for the Eastern Zone is

simply the average selling price of the logs expressed in constant dollars. Sales for the rest of the state are pooled in one large sample, then a statistical model is developed which uses dummy variables for groups of adjacent counties. A zone is defined as a set of adjacent counties. An equation was estimated starting with the previous (past appraisal zones). Then a single county was moved from one adjacent zone to another and the equation was re-estimated. This repetitive process resulted in the best set of zones and the judgment was made by comparing the sum of squares for each estimate. Statistical tests were also employed to determine whether the difference in value for the groups of counties or appraisal zones is statistically significant.[1]

Since the DNRC no longer sells timber by volume (the scaled board foot) all values in the statistical analysis relied on predicting the winning bid of each sale in inflation adjusted dollars per ton. In a later section of this report the price per ton will be converted to dollars per thousand board feet using the conversion factors the state applies in their appraisal procedure. This allows the values to be tied directly to productivity estimates which are done in cubic feet

II. The Approach to Determining Appraisal Zones and Timber Prices

In the last appraisal study, five appraisal zones were identified. That was the point of departure for this study. However, relative intrazone

[1] The tests are outlined in Pindyck and Rubinfeld (1981). which utilize the residual sum of squares to test the significance of the dummy variables.

timber prices have apparently shifted over the past few years so that differences in price between at least some of the zones virtually disappeared. As a result, a new zone alignment was developed in this study. A variety of zone configurations were examined before arriving at the new set of zones. This is the way the new appraisal zones appear in terms of the location of DNRC sales. Excluded from the sample were salvage and limited access timber sales as the purpose of the study is to determine the competitive value of growing timber.

Table 1

Timber Sale Appraisal Zones

Zone Name and Number	**Counties in Sample**	**Number of Sales**
Zone 1- Northwest	Flathead Lake Lincoln Sanders	
Sub-Sample Size		35
Zone 2-Southwest	Beaverhead Broadwater Granite Lewis and Clark Mineral Missoula Powell Ravalli	
Sub-Sample Size		44
Zone 3 Central	Cascade Fergus Gallatin	
Sub-Sample Size		5
Zone 4-Eastern Montana	Custer	

	Musselshell Powder River Rosebud Stillwater	
Sub-Sample Size		7
Total Sales included in the study		91

The Zones are shown in the map included in Appendix A.

The data used to estimate the equation for all zones except Zone 4 is summarized in Table 2. The dependent variable (RABIDPT) is the winning bid per ton plus the earmarked funds per ton. The winning adjusted bid is expressed in constant year 2000 dollars as are all other variables which involve dollar estimates of costs or prices. The price index utilized was the Implicit GDP Deflator. The DNRC requires two forms of timber payments. Earmarked funds are set aside from other sale revenues to pay for such items as slash disposal and reforestation. These funds coupled with the winning bid form the basis for timber payments.

The equation includes two "dummy variables". Zone1 takes on a value of 1 for sales in the Northwest Zone. In all other sales it is zero. When a sale is in Zone 3 the value of the Zone 3 variable is 1, and again it is zero in the rest of the cases. Sales in Zone 2 are characterized when the Zone 1 dummy variable and the Zone 3 dummy variable *are both zero* so the equation then predicts the winning adjusted prices for those Zone 2 sales. The independent variables in the model are RLUMPRTN, the

price index for lumber in constant year 2000 dollars per ton. For instance, if the sale is half Douglas-fir and half Ponderosa Pine the Western Wood Products lumber prices for these spies are equally weighted and then converted to a value per ton using the estimated tons

Table 2

The Regression Model for Zones 1, 2, and 3

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+----------------------------------------------------+
| Ordinary    least squares regression               |
| Model was estimated Aug 07, 2007 at 04:31:50PM     |
| LHS=RABIDPT  Mean                 =   36.98578     |
|              Standard deviation   =   12.46165     |
| WTS=none     Number of observs.   =         84      |
| Model size   Parameters           =          8      |
|              Degrees of freedom   =         76      |
| Residuals    Sum of squares       =   5274.922     |
|              Standard error of e  =   8.331078     |
| Fit          R-squared            =   .5907521     |
|              Adjusted R-squared   =   .5530582     |
| Model test   F[  7,    76] (prob) =  15.67 (.0000) |
| Autocorrel   Durbin-Watson Stat.  =  1.7191166     |
|              Rho = cor[e,e(-1)]   =   .1404417     |
| White heteroscedasticity robust covariance matrix  |
| Br./Pagan LM Chi-sq [  7]  (prob) =   4.21 (.7554) |
+----------------------------------------------------+
+---------+--------------+----------------+--------+---------+----------+
|Variable | Coefficient  | Standard Error |t-ratio |P[|T|>t] | Mean of X|
+---------+--------------+----------------+--------+---------+----------+
Constant      16.7289186     5.68976071     2.940   .0043
 RLUMPRTN       .63927983      .07950222     8.041   .0000    48.6672504
 LNDBH          .05058632      .02189085     2.311   .0236   -9.49044327
 LOGSYS        -.08755915      .03067078    -2.855   .0055    121.905952
 HAULFCT1      -.03961270      .02070485    -1.913   .0595    50.2994048
 RREQCST       -.00974703      .00556872    -1.750   .0841    19.7704858
Zone1          7.57010702     1.85928231     4.072   .0001     .41666667
Zone3        -11.2573377      4.18503187    -2.690   .0088     .05952381
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per thousand board feet conversion ratio the DNRC estimated for that sale. LNDBH is the natural log of the average diameter for the timber in each sale transaction. LOGSYS is an index reflecting the logging systems required in each sale. It weights each logging system in a way which reflects general cost differences. Here is the way the index was

developed. The weight for tractor yarding is 1, the weight for ground lead yarding is 1.5, the weight for skyline yarding is 2.0 and the weight for helicopter yarding is 2.5. The index is developed for each sale by multiplying the proportion of the sale yarded by each particular method by the associated weight. HAULFCT1 is a log hauling cost index. It is developed by adding the appraised hauling distance on paved roads to the hauling distance on unpaved roads multiplied by a factor of 2.5. This reflects the belief that it costs about two and a half times as much to haul logs on unpaved surfaces as it does on paved surfaces on a tons per mile basis. RREQCST is the appraised cost of various sale development and other cost requirements. For instance a sale may require road construction and various other requirements.

The R-square for the equation is .59 and the R-square adjusted for degrees of freedom is .55. The calculated F statistic indicates that the overall equation is significant. In testing whether the differences in price for each zone are significant, Models were run for different zones and differences in the residual sum of squares were used to calculate an F test. These were not shown in the report simply to maintain some degree of clarity.

The coefficient associated with RLUMPRTN is approximately 0.64. This means that for each dollar increase in the lumber price per ton, the bid increases 64 cents. The sign of LNDBH is positive. That means that as the average diameter of a sale increases, the winning bid increases at

a decreasing rate. The LOGSYS variable is significantly negative. That means that the larger the number, the lower the bid price. Thus, for example, helicopter sales have lower prices than tractor yarded sales, holding other variables constant. It should be noted that helicopter sales could have lower sale development costs than sales using less expensive yarding methods and required development costs are included in a separate independent variable. The coefficient associated with the required development and purchaser obligation costs (RREQCST) is significantly negative. That means that as the state increases purchaser logging requirements, the bid price falls. The haul cost index (HAULFCT1) is significantly negative. That means that as the estimated distance to the nearest mill that is a likely candidate to process the logs increases, the bid price decreases.

The coefficient for the intercept or CONSTANT term coupled with the two location dummy variables suggests the main differences associated in timber values in the three zones. When the timber is in Zone two, the values of Zone1 and Zone3 are zero. Thus the combined intercept is 16.73. Instead if the timber is in Zone 1, the value of Zone1 is 1 and the combined intercept is (16.73+7.57) or 24.30. In contrast if the timber is in Zone 3, the value of Zone3 is 1 and the value of Zone1 is zero. The combined intercept is 5.47 (16.73-11.26). Ignoring the role of species values, logging systems, tree size, hauling distance and required logging cost obligations; this means that timber in Zone 1 will sell for

$7.57 per ton more than timber in Zone 2 and timber in Zone 3 will sell for $11.26 per tone less than timber in Zone 2. The differences in zone prices can't be explained by the variation in other independent variables.

Table 3 contains the summary statistics for several variables associated with each of the 4 appraisal zones modeled in the equation summarized in Table 2.

Table 3

Descriptive Statistics
The Statistics include both Sample Statistics and Sample Weighted Mean (by sale size) Statistics

Zone 1

Variable	Mean	Std.Dev.	Minimum	Maximum	Cases
All observations in current sample					
RABIDPT	43.0657905	11.0363354	15.6755770	61.0908197	35
WTRADBIT	**43.0994371**	29.9305931	2.24639964	134.991625	35
RLUMPRTN	49.6886222	8.93815307	24.8552738	68.6359906	35
WTRLUMTN	50.4527052	36.1744026	2.57422846	182.578196	35
LNDBH	2.45129830	.152039846	2.19722458	2.99573227	35
WTLNDBH	2.42942529	1.49231984	.148188484	6.76837111	35
HAULFCT1	51.4792857	23.4673784	10.0000000	97.5000000	35
WTHAUFCT	48.7976374	38.2542529	4.00857732	185.898866	35
RREQCST	37.0056127	199.439811	.289304764	1183.14398	35
WTRREQCS	38.8796912	212.274038	.420320755	1258.71800	35
TONSMBF	6.44545822	.786416831	4.54000000	8.45000000	35
WTTONMBF	**6.52308408**	3.86812575	.282738321	15.5256196	35

Zone 2

Variable	Mean	Std.Dev.	Minimum	Maximum	Cases
All observations in current sample					
RABIDPT	33.9493887	11.2663165	3.99326727	51.4143895	44
WTRADBIT	**35.9548211**	28.3870126	2.21460610	114.639677	44
RLUMPRTN	47.6396737	11.1256944	4.89485182	89.6500640	44
WTRLUMTN	47.2074029	32.9291374	5.14245260	128.753650	44
LNDBH	2.42727478	.196912016	2.07944154	3.04452244	43
WTLNDBH	2.44010050	1.56223548	.297289603	6.52269980	43
HAULFCT1	61.3052326	44.4187874	9.50000000	253.500000	43
WTHAUFCT	55.3660603	45.3747630	4.83031759	195.557099	43
RREQCST	7.96440868	33.6650907	.000000000	225.542632	44

WTRREQCS	12.2215381	62.5008793	.000000000	416.905838	44
TONSMBF	6.73231258	.676375575	4.48000000	8.55400000	44
WTTONMBF	**6.69578455**	4.43728226	.713569644	18.8045925	44

Zone 3

Variable	Mean	Std.Dev.	Minimum	Maximum	Cases
All observations in current sample					
RABIDPT	21.1458733	9.16637085	11.8394957	36.1729261	5
WTRADBIT	**20.8117623**	13.9867006	6.22932650	34.5629563	5
RLUMPRTN	50.5603231	6.09723741	46.2875959	60.8711629	5
WTRLUMTN	50.1165730	34.1625711	18.4500940	98.3187103	5
LNDBH	2.32690178	.115199590	2.19722458	2.44234704	5
WTLNDBH	2.31715874	1.59912042	.955795641	4.57176520	5
HAULFCT1	157.250000	79.7983787	27.0000000	244.250000	5
WTHAUFCT	182.767668	186.745969	16.2238919	467.461087	5
RREQCST	3.01807636	2.73410044	.000000000	7.35014917	5
WTRREQCS	3.10664981	2.59066146	.000000000	6.39345950	5
TONSMBF	6.73987381	.255588001	6.49350000	7.13000000	5
WTTONMBF	**6.70376336**	4.55599925	2.58828922	12.8994380	5

The sample means for the adjusted bid prices indicate that timber in zone one was worth $43.10/Ton, Zone 2 was $35.95/Ton and Zone 3 timber was $20.81/Ton. These values reflect the interplay of all of the independent variables as well as the location variables and are weighted average values where the weighted adjustments are calculated using the sale volume relative to the average volume in each zone.

Stumpage prices in the remaining zone for eastern Montana are shown in Table 5. The weighted sample mean is $13.00/ton in constant dollars for the sales in Eastern Montana.

Table 5
Descriptive Statistics
Zone 4 Eastern Montana (year 200 dollars)

Variable	Mean	n
RABIDPT	11.6633	7
WTRADBI	**13.002**	7
TONSMBF	7.50	7
WTTONMBF	7.50	7

The average price per ton in each zone can be converted to an average price per thousand board feet by using the weighted average tons per thousand board feet variable (WTTONMBF). Since the prices used in the analysis are expressed in constant year 2000 dollars, they must also be converted to 4th quarter 2007 dollars for the land appraisal process. Stumpage prices for each appraisal zone are shown in table 6.

Table 6

Stumpage Values in the Western and Central Appraisal Zones In 4th Qtr. 2007 Dollars

Zone Number	**1**	**2**	**3**	**4**
Bid per Ton (Incl. Earmark)	$51.97	$43.37	$25.09	$15.68
Bid per MBF Scribner	$338.93	$291.82	$168.20	$117.62

Discussion

There have been both major and minor shifts in prices from the past appraisal cycle to the current one. Eastern Montana (Zone 4) has experienced a decrease in the price of timber. Zone 1 has seen about a 13% increase in price, however the GDP deflator increased by about the same amount in the same time period so the effect is essentially an inflationary adjustment in Zone 1. This analysis essentially combines what were two zones in the last appraisal cycle into Zone 2. The two

prices for the old zones were $270.60 and $223.38. The new single price for the combined area is $291.82. As a result, the counties which were formerly in Appraisal Zone 2 experienced a real price decrease while those in what was previously Zone 3 experienced a slight after inflation price increase.

Some of the differences in prices between zones can be explained by differences in the independent variables included in the equations. However, other factors not included in the equations may also be important factors as well. For example, during the 5 year period, there have been some important mill closures in Montana and these mill closures may suggest that there is less competition for state sales and/or, remaining mills are being supplied with timber from different geographical areas than they had been in the past. The difference in the potential number of log purchasers could have greater influence on markets in some zones than in others. Plywood processing capacity has also dropped significantly and peeler logs have traditionally commanded a price premium. Lower plywood demand could also mean lower stumpage prices.

However, the timber prices developed in the analysis seem to be reasonable and should be a fair set of values for tax appraisal and valuation.

Literature Cited and Selected Sources

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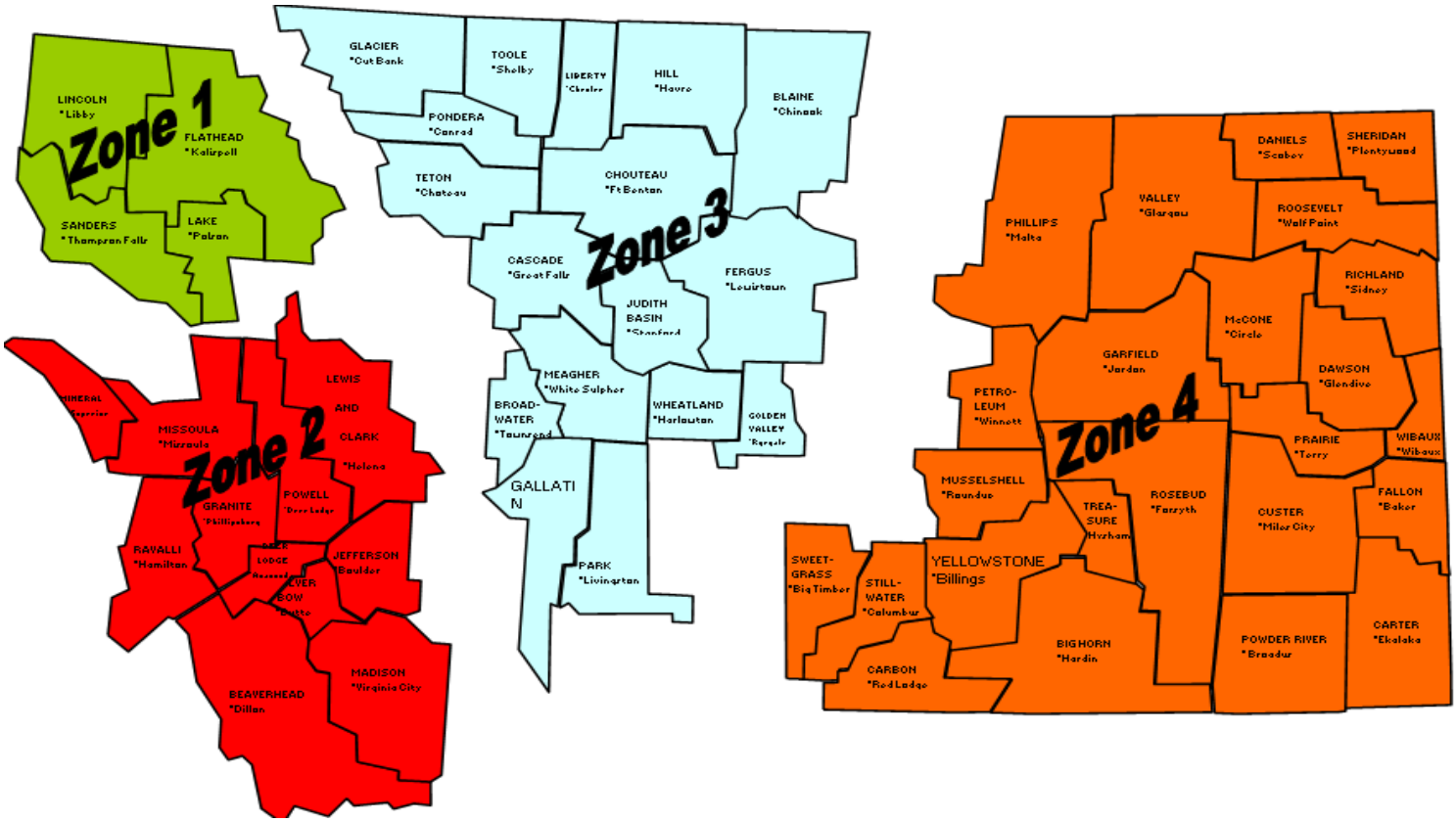
Appendix A


Zone 1
LINCOLN
*Libby
FLATHEAD
*Kalispell
SANDERS
*Thompson Falls
LAKE
*Polson
Zone 2
MINERAL
*Superior
MISSOULA
*Missoula
LEWIS AND CLARK
*Helena
GRANITE
*Philipsburg
POWELL
*Deer Lodge
RAVALLI
*Hamilton
DEER LODGE
Recessed
JEFFERSON
*Boulder
SILVER BOW
*Butte
BEAVERHEAD
*Dillon
MADISON
*Virginia City
Zone 3
GLACIER
*Cut Bank
TOOLE
*Shelby
LIBERTY
*Chester
HILL
*Havre
BLAINE
*Chinook
PONDERA
*Conrad
TETON
*Chateau
CHOUTEAU
*Ft Benton
CASCADE
*Great Falls
FERGUS
*Lewistown
JUDITH BASIN
*Stanford
MEAGHER
*White Sulphur
BROAD-WATER
*Townsend
WHEATLAND
*Harlowton
GOLDEN VALLEY
*Ryegate
GALLATIN
PARK
*Livingston
Zone 4
DANIELS
*Scobey
SHERIDAN
*Plentywood
PHILLIPS
*Malta
VALLEY
*Glasgow
ROOSEVELT
*Wolf Point
RICHLAND
*Sidney
McCONE
*Circle
GARFIELD
*Jordan
DAWSON
*Glendive
PETRO-LEUM
*Winnett
PRAIRIE
*Terry
WIBAUX
*Wibaux
MUSSELSHELL
*Roundup
ROSEBUD
*Forsyth
FALLON
*Baker
TREA-SURE
Hysham
CUSTER
*Miles City
SWEET-GRASS
*Big Timber
YELLOWSTONE
*Billings
STILL-WATER
*Columbus
BIGHORN
*Hardin
POWDER RIVER
*Broadus
CARTER
*Ekalaka
CARBON
*Red Lodge