Revised Forest Appraisal Zones and Timber Values Used in Appraising Montana Private Forest Lands

Prepared for The Montana Department of Revenue

Final Report

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Introduction

The purpose of this report is to present the results of analysis of timber sold by the Montana DNRC in order to identify appraisal zones. In turn the appraisal zones are employed to identify a representative timber price for timber sold in each zone. The timber price along with management costs and forest productivity estimates are used by the Montana Department of Revenue (DOR) to assess the taxable value of forest land. An appraisal zone is a set of contiguous counties where market influences generate uniformity in the price of timber. Two timber sales sold in the same area and same period will ordinarily command different prices because standing timber is never homogenous in quality, terrain, mixture of species nor precise location. As a result, timber appraisals must account for variation in these underlying characteristics which create considerable variation in price.

Private timber sellers in Montana are not required to reveal the price of their sales. As a result, State of Montana timber managed and sold by the Montana Department of Natural Resources (DNRC) is used in the analysis. Montana received considerable lands in statehood via land grants. The lands are managed in trust for Montana people. Trust management has a strong fiduciary responsibility. DNRC sales best represent what a private seller with strong financial interests might be expected to receive for a similar sale.

The Timber Sales Used in the Analysis

During the period of July 2013 through June 2019 the DNRC auctioned 149 timber sales. Those which were not "arm's length" transactions (17) were dropped from the analysis. In addition, salvage sales were also excluded as the taxation law in Montana indicates that taxes are based on the growth (productivity) of green timber, not dead or dying timber. The resulting population of sales for the 6-year period was 119 transactions. (Some salvage sales were also noncompetitive).

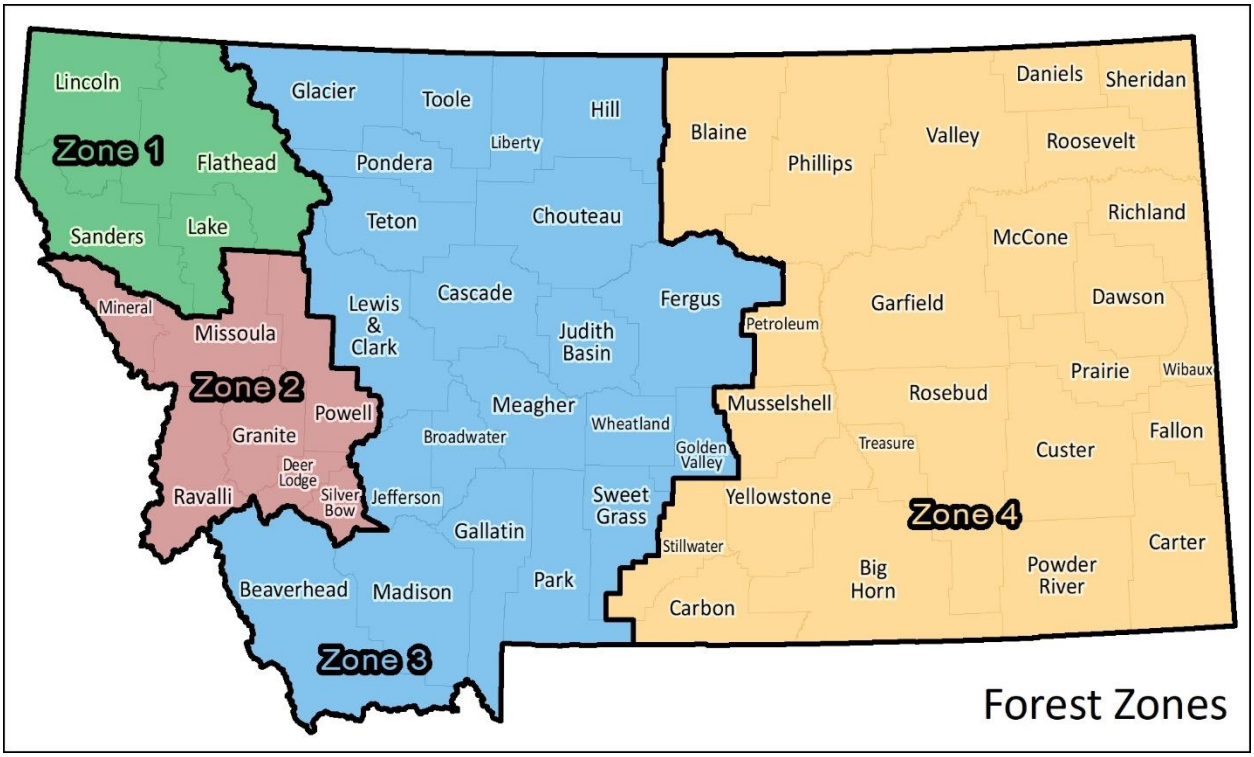
In prior appraisal analyses, four zones were established; a Northwest Zone, a Southwest Zone, a Central Zone and an Eastern Zone. Table 1 below shows the distribution of sales used in this analysis distributed among the previous appraisal zones and the new zones to be used in the reappraisal.

TABLE 1

Previous Zones		New Zones	
Northwest	**69 Sales**	**Northwest Zone**	**69 Sales**
Southwest	**40 Sales**	**Southwest Zone**	**32 Sales**
Central Zone	**4 Sales**	**Central Zone**	**11 Sales**
Eastern Zone	**6 Sales**	**Eastern Zone**	**7 Sales**

Essentially, the new Southwest Montana Zone is limited to counties which are west of the continental divide. This zone now consists of Granite, Mineral, Missoula, Powell, Ravalli, and Silver Bow Counties.

Lewis and Clark, Beaverhead and Jefferson counties were moved to the Central Zone. Blaine County was moved from the Central to the Eastern Zone. The map included as Figure 1 shows the new configuration of zones.



During the last Montana Legislature, the appraisal law was modified so that timber prices are to be a "10-year rolling average." The virtue of a 10-year average is that tax rates should be considerably more stable than would be the case of short term averaging since timber markets are dependent on volatile wood product markets. However, Table 2 below shows the distribution of Montana DNRC competitive green timber sales over a six-year period. Calculating an average price for both the Northwest and Southwest appraisal zones would likely produce a reasonably good representative average value since there are several sales in each year. However, there are fewer sales in the Central and Eastern zones. In fact, there were no sales in these two zones in FY 2019. In addition, the Eastern Zone had only one sale in the three-year period of FY 2014 through 2016. Because of the high variability in timber prices a simple averaging of annual prices will likely cause significant valuation problems. Later in this report, a method is employed that yields accurate annual prices for each zone to be used in calculating a 10-year average price. Timber values are estimated for each zone even if no DNRC timber was sold in that zone in a year.

TABLE 2

NUMBER OF SALES BY YEAR

	Northwest	Southwest	Central	Eastern
FY2014	**9**	**6**	**2**	**1**
FY 2015	**11**	**5**	**2**	**0**
FY 2016	**13**	**6**	**2**	**0**
FY 2017	**7**	**6**	**3**	**3**
Fy2018	**11**	**3**	**2**	**3**
FY 2019	**18**	**6**	**0**	**0**
Totals	**69**	**32**	**11**	**7**

Identifying New Appraisal Zones

In past appraisals, four appraisal zones have been used to more clearly and accurately value standing timber. For tax appraisals, an appraisal zone is a set of contiguous counties. Four appraisal zones are again used in this analysis, (Northwest, Southwest, Central and Eastern). However, some counties which were previously in the Southwest Zone have now been included in the Central Zone. Additionally, Blaine county has been moved from the Central to the Eastern Zone. This is the new County alignment.

Northwest Zone Counties

Flathead, Lake, Lincoln, and Sanders

Southwest Zone Counties

Deer Lodge, Granite, Missoula, Mineral, Powell, Ravalli, and Silver Bow

Central Zone Counties

Beaverhead*, Broadwater, Cascade, Choteau Fergus, Gallatin, Glacier, Sweet Grass, Golden Valley, Hill, Jefferson*, Judith Basin, Lewis and Clark*, Liberty, Madison, Meagher, Park, Pondera, Teton, Toole, and Wheatland.

Eastern Zone Counties

All remaining counties are in the Eastern Zone including Blaine county which was formerly in the Central zone.

Because some counties have been moved from one zone to another, they will need special attention in calculating their 10-year rolling average timber prices. For example, Lewis and Clark county's price will be based on the annual prices for 2009 through 2014 for the Southwest Zone and the 2015 through 2019 annual prices for the Central zone.

Annual Timber Prices and Ten-Year Average

Table 3 summarizes the average annual prices to be used in the next appraisal. Methods for calculating these prices are presented in an Appendix.

Table 3

Calculated Yearly Timber Prices (2018 dollars) and 10-year Rolling Average ($/MBF) per zone

Year	Northwst	Southwst	Central	Eastern
2019	350.605	396.391	333.724	42.386
2018	363.154	408.941	346.275	54.936
2017	356.139	401.925	339.258	47.92
2017	332.833	378.619	315.952	24.614
2015	354.307	400.094	337.427	46.089
2014	361.699	407.486	344.818	53.481
2013	249.151	240.133	182.681	14.88
2012	188.975	182.414	115.28	14.88
2011	175.166	169.312	98.644	14.88
2010	174.401	168.762	96.45	14.88
Rolling Average	**290.643**	**315.408**	**251.051**	**32.895**

These prices represent considerable increases over the values from the previous appraisal. There are several reasons for these increases. First and foremost, wood product markets have recovered from the biggest recession since the Great Depression. Second, inflation has added about 11 percent to the prices over the previous appraisal. Third, moving some of the counties from the Southwest Zone to the Central Zone has likely increased the average price level in each of those zones. The counties which were moved had somewhat lower prices than those where timber was sold (most largely in Missoula and Mineral counties). In turn, sales in places like Lewis and Clark county may have brought up the average of that sold in the remainder of the Central Zone counties. However, the Northwest Zone has the same four counties that were in this Zone in the last appraisal. Prices adjusted for inflation in the Northwest Zone increased from 2010 to a peak in 2015 and then remained high but a bit lower for the remainder of the 10-year period. This is the same pattern in the other Zones. The Eastern Zone has the highest rate of increase of any of the zones. In the last appraisal there really was an inadequate set of comparable sales so other sources were relied upon. During the strong market the DNRC sold seven sales and some had exceptional prices. This really created a better picture of Eastern Montana timber values. Finally, the statistical appraisal models rely on wood product prices as predictors of the selling price of timber.

These wood product prices used in the analysis are from the same month of the timber sale. In calculating a yearly stumpage price, the yearly average product price was used along with the coefficients of the estimated equations. This will cause a small difference in the annual average since

the date of DNRC sales is not a random number. You will notice in Table 2, for example that the Northwest Zone had 69 sales in six years. There were 18 sales in 2019 and only 7 in 2017. If there was a simple average taken, the 2019 sales would have more than twice the influence on the calculated average than would the 2017 sales. Depending on the year, 30 % to 50% of DNRC timber is sold in June, July and August. Part of this likely is weather related as it is difficult to do the field work necessary to get timber on the market in the middle of a Montana winter. Others have speculated that the timing of DNRC timber sales has something to do with an agency trying to meet annual sale targets at the end of the fiscal year. The time of the year may also have an influence on price as summer months experience greater wood product demand than winter months.

Conclusions

An extremely robust model was developed which explains much of the variation in timber sales from place to place and over a 6-year period. This model does an excellent job in creating average annual prices for the period 2014-2019. Minor adjustments were made to price indices that were used in the earlier appraisal. This allowed the development of annual prices for three appraisal zones for the 2010 thru 2013 period. Eastern zone prices for the period 2010 thru 2013 were the inflation adjusted price used in the last appraisal

Appendix

Calculating Average Annual Prices

Background

Previously, appraisal zones were determined every five years and a timber price was estimated for each zone which represented a representative price for that five-year period. Montana DNRC prices were collected for the five-year period and regression analysis was used to determine the prices. Changes in the forest appraisal law require new techniques. This appendix shows alternative methods for determining prices which can then be used in estimating a 10-year rolling average. Because the law calls for a ten-year rolling average, information used in the previous appraisal which covered the years 2009 through 2013 can be included along with information for the years 2014 through 2019 to create a 10-year rolling average. The methods must also allow the Montana Department of Revenue to estimate a new value for each zone in the future. So, for example, the 10-year rolling average in 2020 would include new price information for the year 2020 while eliminating prices from the year 2010.

This Appendix uses both a new regression equation based on sales for the period FY2013 through FY 2019 and uses the regression equation for the previous appraisal (2009 through 2013). In the succeeding sections, the appraisal equation for the period 2009 through 2013 will be presented first. Next the equation for the previous period will be introduced. Next, these equations will be used to determine annual values for each appraisal zone. Finally, procedures will be discussed to show how to use the analysis for future reappraisals.

Analysis of the 2014 through 2019 Data

Perhaps the best way to explain this analysis is to present the regression model first. In doing so, the dependent and independent variables will be discussed.

Table 4

Regression Model for Montana DNRC Timber Sales

FY 2014 through FY2019

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Ordinary     least squares regression .............
LHS=RADBIDTN Mean                 =       46.92492
             Standard deviation   =       98.61259
----------   No. of observations  =            120  DegFreedom   Mean square
Regression   Sum of Squares       =    .110974E+07           8  138717.30252
Residual     Sum of Squares       =        47470.3         111     427.66070
Total        Sum of Squares       =    .115721E+07         119    9724.44334
----------   Standard error of e  =       20.67996  Root MSE        19.88935
Fit          R-squared            =         .95898  R-bar squared     .95602
Model test   F[  8,   111]        =      324.36299  Prob F > F*       .00000
--------+-------------------------------------------------------------------
        |                 Standard            Prob.      95% Confidence
RADBIDTN|  Coefficient       Error       t    |t|>T*         Interval
--------+-------------------------------------------------------------------
Constant|    136.855**     58.30896     2.35  .0207      22.572   251.139
NEWFR100|   -86.7823**     40.72771    -2.13  .0353   -166.6071   -6.9574
NEWFRASQ|    28.5517**     10.92723     2.61  .0102      7.1347   49.9686
NEWFRACU|   -2.83330***     1.02086    -2.78  .0065    -4.83414   -.83246
TN18STMI|    -.10936         .07709    -1.42  .1588     -.26046    .04173
   NEWSW|    6.92216        4.34999     1.59  .1144    -1.60365  15.44797
 NEWEAST|    56.1493*      31.61087     1.78  .0784     -5.8068  118.1055
ESTSTMIL|    -.74327*        .43173    -1.72  .0879    -1.58944    .10289
CENTSTMI|    -.13808*        .07277    -1.90  .0604     -.28069    .00454

***, **, * ==>  Significance at 1%, 5%, 10% level.
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The dependent variable is the winning bid of each timber sale. It includes both the amount paid for timber plus the amount paid to the forest improvement fund. Timber buyers make payments to two accounts. In addition to payment to the trust funds, a second payment supports management of state forest lands. The cost of building permanent forest roads is also included in the price because the forest tax system is based on the value of managed forest lands, not undeveloped lands. The bid price is expressed in dollars per ton because that is the way that the Montana DNRC sells timber. The ton price is converted to dollars per thousand board feet using the tons to thousand board feet (MBF) conversion ratio the DNRC estimates for each sale. The overall equation is statistically significant (overall F = 324.36299) and is an excellent predictor of the sale price (R-bar squared =. 95602). This means that the equation predicts an exceptionally large part of the variation in timber prices.

Turning to the independent variables, the TN18STMI is the most complex variable in the model. It is the estimated stump to mill costs of converting standing timber to logs delivered to a mill. It is the combined cost of logging and hauling logs. It includes both costs of skyline and tractor yarding as well as hauling on both paved and unpaved roads. The value of this independent variable was estimated by equations developed by Mike Niccolucci, formerly of the US Forest Service. These are the equations utilized.[i]

Skyline yarding

Cost/ton = 51.867 -0.743 * Average Diameter + 0.326* Log Skidding distance (100 ft) – 1.967 *MBF per acre

The amount was converted from 2013 dollars to 2018 dollars using the Implicit GDP Deflator

Tractor yarding

Cost/ton = 28.200+0.331 Skid Dist. (100 ft) -Vol/Acre (MBF)

This amount was in 2017 dollars and was again converted to 2018 dollars

Log Hauling

Cost/ton = 5.83 +0.126 * total distance (miles) hauled. (in 2018 dollars)

After these costs were estimated for each sale they were added together to estimate the total cost of cutting a tree and delivering it to a mill (stump to mill costs). All values were expressed in 2018 dollars per ton. The price index used was the Implicit GDP Deflator which is determined and published by the US Department of Commerce, Bureau of Economic Analysis. The TN18STMI is included in three variables. Its regression coefficient is -.10936. This by itself means that for every dollar increase in total stump to mill costs, there is an 11-cent decrease in the winning bid. However, that is not the case in both the Eastern and Central Appraisal zones. Apparently logging costs are higher in these zones, not so much because Niccolucci's equations are wrong for these areas but because of other factors such as "mobilization" and "competition". Many logging companies are in Western Montana. Getting timber logged on a sale as far away as Carbon county may not be as desirable a location from the perspective of Montana logging operators. So, the estimated logging cost variable indicates a dollar increase in the independent variable (TN18STMI) will reduce the winning bid by about 85 cents in the Eastern Zone (divided by 19-.10936-.84237=-.85263). In the Central Zone the effect will be about 25 cents (-.10936-.13808=.24744).

The other variable of immense importance is the variable expressing lumber product value. This is the Random Lengths Framing Lumber Price index.[ii] It is expressed in three variables. It has been converted to 2018 dollars and then divided by 100. It is the NEWFRA100 variable. Because market prices affect standing timber prices in a curval linear relationship the NEFRA100 is both squared and cubed (NEWFRASQ and NEWFRACU). Thus, for example if the framing lumber price index increases from $350 to $400, the winning bid would increase by about $3.61. When Framing lumber prices are lower a $50-dollar change in price will have a greater influence on timber prices than when Framing prices are higher. The (0,1) variable NEWSW indicate that sales in the Southwest Zone are higher (other things equal) than sales elsewhere. We will see that some of this difference will be altered when actual sample means for each zone are used to determine zone prices. The constant term is an intercept for the equation. So, for example, if a sale is in the Northwest appraisal zone, its value is predicted by the following equation.

Winning Adjusted Bid = 136.855 -86.7823(NEWFRAM) + 28.5517*NEWFRASQ - 2.8333*NEWFRACU -.10936*TN18STMI

Because the sale is in the Northwest zone, the variables dealing with the Southwest, East and Central all have zero values. These actual calculations will be shown in a subsequent section of the Appendix.

The previous appraisal used a regression equation for three zones; Northwest, Southwest and Central. It is reintroduced here to show how it can be used to calculate a price for each zone in each appraisal year. It is:

READBID/ton=-19.72961+.06858*RKEEPT -.08578* PAV25UP + .36294*RFRAPT + 6.55134*LNDBH[iii]

Again, the dependent variable was the winning bid per ton including the forest improvement fee and new road construction. This equation is in 2009 dollars. In addition to the Constant term (-19.72961) the independent variables include two price indices; RKEEPRT, and RFRAPRT. The first is a Montana Bureau of Business and Economic Research price index for delivered saw and veneer logs. It reflects a mix of species. The other is the Random Lengths Framing Lumber Price index converted to a ton equivalent. The PAV25UP variable is a haul cost indicator. It is the number of paved haul miles plus 2.5 times the unpaved haul miles. These haul distances are typically presented in a timber appraisal and represent the distance to the nearest mill that could manufacture the logs into wood products. The LNDBH is the natural logarithm of the average diameter of the timber included in the sale. The above equation does not represent Eastern Montana timber values because the DNRC sold only one green timber sale in that zone during the 5-year period. Four other sales from other agencies were used which would not have ordinarily been used to determine an average value for the Eastern Zone in the last appraisal.

Table 5 below shows how the new appraisal equation is applied across each year for an 11-year period.

Table 5

Calculating Annual Prices with the 2014-2019 Appraisal Equation

Year	ZONE	CONSTANT	fram/100	fram/100sq	fram/100cub	tn18stmi	ESTSTMIL	Centstmi	GDPDEF	Year	$/TON'18$	tons/mbf	$/MBF '18$
	NOWEST	136.855	-86.7823	28.5517	-2.8333	-0.10936	-0.74327	-0.13808				6.189	
2019			3.749705745	14.06029318	52.72196211	62.92258	0	0	111.638	2019	56.64965179		350.604695
2018			4.699371032	22.0840881	103.7813239	62.92258	0	0	110.382	2018	58.67732752		363.15398
2017			3.870570064	14.98131262	57.98622013	62.92258	0	0	107.795	2017	57.54379605		356.1385537
2016			3.416975324	11.67572036	39.89564837	62.92258	0	0	105.77	2016	53.77810228		332.832675
2015			3.828841001	14.66002341	56.13089871	62.92258	0	0	104.688	2015	57.24791262		354.3073312
2014			4.014808533	16.11868756	64.71344433	62.92258	0	0	103.647	2014	58.44221178		361.6988487
2013			3.990091642	15.92083131	63.52557596	62.92258	0	0	101.773	2013	58.30329944		360.8391202
2012			3.146249867	9.898888226	31.14437576	62.92258	0	0	100	2012	51.33305723		317.7002912
2011			3.045327924	9.274022166	28.24243867	62.92258	0	0	98.112	2011	50.47149505		312.3680829
2010			3.153836477	9.946684526	31.37021649	62.92258	0	0	96.109	2010	51.39953259		318.1117072
2009			2.629335467	6.913404996	18.17766095	62.92258	0	0	94.999	2009	47.68615934		295.1296401
		averages	2010-'19=442.78		2015-'19=351.41								
	SOUWEST	143.77716											
2019			3.749705745	14.06029318	52.72196211	58.571	0	0	111.638	2019	64.04774058	7.162	396.3914665
2018			4.699371032	22.0840881	103.7813239	58.571	0	0	110.382	2018	66.07541631		408.9407515
2017			3.870570064	14.98131262	57.98622013	58.571	0	0	107.795	2017	64.94188484		401.9253252
2016			3.416975324	11.67572036	39.89564837	58.571	0	0	105.77	2016	61.17619107		378.6194465
2015			3.828841001	14.66002341	56.13089871	58.571	0	0	104.688	2015	64.64600141		400.0941027
2014			4.014808533	16.11868756	64.71344433	58.571	0	0	103.647	2014	65.84030057		407.4856202
2013			3.990091642	15.92083131	63.52557596	58.571	0	0	101.773	2013	65.70138823		406.6258918
2012			3.146249867	9.898888226	31.14437576	58.571	0	0	100	2012	58.73114602		363.4870627
2011			3.045327924	9.274022166	28.24243867	58.571	0	0	98.112	2011	57.86958384		358.1548544
2010			3.153836477	9.946684526	31.37021649	58.571	0	0	96.109	2010	58.79762138		363.8984787
2009			2.629335467	6.913404996	18.17766095	58.571	0	0	94.999	2009	55.08424813		340.9164117
		averages	2010-'19=388.56		2015-'19=397.14								
	CENTRAL	136.855											0
2019			3.749705745	14.06029318	52.72196211	87.863	0	87.863	111.638	2019	53.92216746	7.283	333.7242944
2018			4.699371032	22.0840881	103.7813239	87.863	0	87.863	110.382	2018	55.94984319		346.2735795
2017			3.870570064	14.98131262	57.98622013	87.863	0	87.863	107.795	2017	54.81631172		339.2581532
2016			3.416975324	11.67572036	39.89564837	87.863	0	87.863	105.77	2016	51.05061795		315.9522745
2015			3.828841001	14.66002341	56.13089871	87.863	0	87.863	104.688	2015	54.52042829		337.4269307
2014			4.014808533	16.11868756	64.71344433	87.863	0	87.863	103.647	2014	55.71472745		344.8184482
2013			3.990091642	15.92083131	63.52557596	87.863	0	87.863	101.773	2013	55.57581511		343.9587197
2012			3.146249867	9.898888226	31.14437576	87.863	0	87.863	100	2012	48.6055729		300.8198907
2011			3.045327924	9.274022166	28.24243867	87.863	0	87.863	98.112	2011	47.74401072		295.4876824
2010			3.153836477	9.946684526	31.37021649	87.863	0	87.863	96.109	2010	48.67204826		301.2313067
2009			2.629335467	6.913404996	18.17766095	87.863	0	87.863	94.999	2009	44.95867501		278.2492396
		averages	2010-'19=325.90		2015-1'19=334.53								
	EASTERN	193.0043											
2019			3.749705745	14.06029318	52.72196211	70.2943	70.2943	0	111.638	2019	6.848675384	6.989	42.38645195
2018			4.699371032	22.0840881	103.7813239	70.2943	70.2943	0	110.382	2018	8.876351111		54.93573703
2017			3.870570064	14.98131262	57.98622013	70.2943	70.2943	0	107.795	2017	7.742819636		47.92031073
2016			3.416975324	11.67572036	39.89564837	70.2943	70.2943	0	105.77	2016	3.977125869		24.614432
2015			3.828841001	14.66002341	56.13089871	70.2943	70.2943	0	104.688	2015	7.446936212		46.08908822
2014			4.014808533	16.11868756	64.71344433	70.2943	70.2943	0	103.647	2014	8.641235373		53.48060573
2013			3.990091642	15.92083131	63.52557596	70.2943	70.2943	0	101.773	2013	8.502323031		52.62087724
2012			3.146249867	9.898888226	31.14437576	70.2943	70.2943	0	100	2012	1.532080822		9.482048207
2011			3.045327924	9.274022166	28.24243867	70.2943	70.2943	0	98.112	2011	0.670518643		4.149839879
2010			3.153836477	9.946684526	31.37021649	70.2943	70.2943	0	96.109	2010	1.598556184		9.893464221
2009			2.629335467	6.913404996	18.17766095	70.2943	70.2943	0	94.999	2009	50.13282729		310.2720681
		averages	2010-'19=34.56		2015-19=43.19								

Shown in the table is the regression coefficients presented earlier. The sample mean for the stump to mill costs are shown for each appraisal zone. The framing price index is the average index converted to 2018 dollars. Changes in the market value of wood products changes the predicted value of timber for each year. At the end of each appraisal zone are averages for each zone. The 10-year averages are estimated by forecasting backwards. Using this equation for all ten years would result in these 10-year average prices. The year 2009 is included in the table so that these prices can be compared with the prices used in the last appraisal that included the years 2009 thru 2014. The equation is used to estimate what timber would sell for during the earlier years by inserting the framing price index for each of those earlier years. It is interesting to note that this equation indicates a value for the earlier 2009

through 2014 period which is considerably higher in the Eastern appraisal zone than the amount in the last appraisal. That is because DNRC sales during the last 6 years are a better indicator of value in the earlier period than were the sales from National Forests and tribal lands that had to be used in the last appraisal. These equations can easily be used where there are no sales in a year or even more than a year.

Next, the earlier equation for the last appraisal is used to calculate an annual price that might be used in a 10-year rolling average. Rather clearly, the first half of a rolling 10-year average should have a strong resemblance to the values in the last appraisal.

Table 6

Calculating Annual Prices with the 2009-2013 Appraisal Information

Year	ZONE											GDPDEF	ann ton price	Price/mbf '09$	
	NOWEST	FYFRAPRICE	FRAPRI18$	fram'09$	Constant	RKeepr	kee ajd	forRkeep	pav25up	RFRAPRT	LNdbh		2009 dollars	6.23 tons/MBF	Price/mbf'18$
			coefficients		-19.7296	0.06895			-0.08578	0.36294	6.55143				
2019		378.75	374.970575	319.0833731	1	279.272	1.034933	289.027755	53.88	51.2172349	2.535	111.638	30.7736956	191.7201235	225.2997521
2018		469.333333	469.937103	404.4459683	1	279.272	1.203432	336.084979	53.88	64.919096	2.535	110.382	38.9912447	242.9154544	282.250273
2017		377.5	387.057006	341.1107059	1	279.272	1.171178	327.0772	53.88	54.7529223	2.535	107.795	34.6804472	216.0591862	245.1615277
2016		327	341.697532	306.9010483	1	279.272	1.168473	326.321792	53.88	49.2618055	2.535	105.77	32.6354159	203.3186409	226.370937
2015		362.666667	382.8841	347.4477173	1	279.272	1.297487	362.351789	53.88	55.7700991	2.535	104.688	37.4818043	233.5116407	257.3276208
2014		376.5	401.480853	367.9824749	1	279.272	1.350153	377.059929	53.88	59.0662079	2.535	103.647	39.6922202	247.2825319	269.7932882
2013		367.416667	399.009164	372.4511569	1	279.272	1.213972	339.028388	53.88	59.7834923	2.535	101.773	37.3302767	232.5676239	249.1510941
2012		284.666667	314.624987	298.8905911	1	279.272	0.994362	277.697464	53.88	47.9760178	2.535	100	28.8161047	179.5243325	188.9749708
2011		270.333333	304.532792	294.8702579	1	279.272	0.923866	258.009906	53.88	47.3306995	2.535	98.112	27.2244357	169.6082345	175.1660871
2010		274.25	315.383648	311.74116	1	279.272	0.895983	250.222964	53.88	50.0387095	2.535	96.109	27.6703713	172.386413	174.4006333
2009		226	262.933547	262.9335467	1	279.272	0.971771	271.388431	53.88	42.2044216	2.535	94.999	26.2863537	163.7639837	163.7639837

year															
	Southwest	FYFRAPRICE	FRAPRI18$	fram'09$	Constant	RKeepr	KeeAjd	forRkee	pav25up	RFRAPRT	LNdbh			6.11 tons/mbf	
			coefficients		-19.7296	0.06895			-0.08578	0.36294	6.55143				
2019		378.75	374.970575	319.0833731	1	266.7	1.034933	276.01658	49.66	51.2172349	2.542	111.638	30.2844267	185.0378469	217.44708
2018		469.333333	469.937103	404.4459683	1	266.7	1.203432	320.955427	49.66	64.919096	2.542	110.382	38.3559137	234.3546325	272.3032142
2017		377.5	387.057006	341.1107059	1	266.7	1.171178	312.353151	49.66	54.7529223	2.542	107.795	34.0730757	208.1864923	236.2284123
2016		327	341.697532	306.9010483	1	266.7	1.168473	311.631749	49.66	49.2618055	2.542	105.77	32.0303891	195.7056771	217.8948143
2015		362.666667	382.8841	347.4477173	1	266.7	1.297487	346.039783	49.66	55.7700991	2.542	104.688	36.7649431	224.633802	247.5443264
2014		376.5	401.480853	367.9824749	1	266.7	1.350153	360.085805	49.66	59.0662079	2.542	103.647	38.929706	237.8605037	259.5135488
2013		367.416667	399.009164	372.4511569	1	266.7	1.213972	323.766332	49.66	59.7834923	2.542	101.773	36.6858096	224.1502965	240.1335606
2012		284.666667	314.624987	298.8905911	1	266.7	0.994362	265.196345	49.66	47.9760178	2.542	100	28.3620042	173.2918456	182.4143892
2011		270.333333	304.532792	294.8702579	1	266.7	0.923866	246.395062	49.66	47.3306995	2.542	98.112	26.8314439	163.9401221	169.3122376
2010		274.25	315.383648	311.74116	1	266.7	0.895983	238.958666	49.66	50.0387095	2.542	96.109	27.3015495	166.8124675	168.76156
2009		226	262.933547	262.9335467	1	266.7	0.971771	259.171326	49.66	42.2044216	2.542	94.999	25.8518359	157.9547176	157.9547176

	Central	FYFRAPRICE	FRAPRI18$	fram'13$	Constant	RKeepr	Kee ADJ	ForKee	pav25up	RFRAPRT	LNdbh				
			coefficients		-19.7296	0.06895			-0.08578	0.36294	6.55143			6.58 tons/mbf	
2019		378.75	374.970575	319.0833731	1	247.73	1.034933	256.383905	192.25	54.8477663	2.617	111.638	22.772967	150.0738527	176.3591698
2018		469.333333	469.937103	404.4459683	1	247.73	1.203432	298.126314	192.25	69.5208833	2.542	110.382	31.0984239	204.9386134	238.1239174
2017		377.5	387.057006	341.1107059	1	247.73	1.171178	290.135906	192.25	58.6340808	2.542	107.795	25.3775779	167.2382383	189.764586
2016		327	341.697532	306.9010483	1	247.73	1.168473	289.465816	192.25	52.7537265	2.542	105.77	21.0074613	138.4391702	154.1354229
2015		362.666667	382.8841	347.4477173	1	247.73	1.297487	321.426455	192.25	59.7233601	2.542	104.688	26.8524391	176.9575736	195.0055733
2014		376.5	401.480853	367.9824749	1	247.73	1.350153	334.473403	192.25	63.2531134	2.542	103.647	28.9004639	190.4540572	207.7915732
2013		367.416667	399.009164	372.4511569	1	247.73	1.213972	300.737284	192.25	64.0212425	2.542	101.773	25.8757865	170.5214329	182.6806365
2012		284.666667	314.624987	298.8905911	1	247.73	0.994362	246.333298	192.25	51.3767958	2.542	100	16.6183782	109.5151122	115.2802789
2011		270.333333	304.532792	294.8702579	1	247.73	0.923866	228.869324	192.25	50.6857341	2.542	98.112	14.4937804	95.51401257	98.6438889
2010		274.25	315.383648	311.74116	1	247.73	0.895983	221.961869	192.25	53.5857012	2.542	96.109	14.4667763	95.33605566	96.44999393
2009		226	262.933547	262.9335467	1	247.73	0.971771	240.73683	192.25	45.1960802	2.542	94.999	12.2331939	80.61674806	80.61674806

	Eastern		
		$/MBF2103$	$/mbf2018$
2014		14.61	14.88
2013		14.61	14.88
2012		14.61	14.88
2011		14.61	14.88
2010		14.61	14.88

There are two price indices in the 2014 appraisal equation, and both are simple linear variables. One is the Bureau of Business and Economics Research delivered log price index. This reflects delivered log prices for each sawlog species in the state. As a result, it changes from sale to sale in the same time period as the mix of species will vary from sale to sale. The other index is Random Lengths Framing Price index that is also used in the current analysis. It was simply converted into a Lumber Price per ton. In the earlier appraisal the mean 5-year price delivered log value was used. In order to estimate a price each year, the delivered log price was adjusted by the percentage change in the annual average delivered log value. Thus, for example, the variable took on value of 271.388 in the year 2009 for the BBER price index in the Northwest Appraisal Zone. In addition, the Average Framing Price for all sales in the earlier Appraisal was used to estimate the value in each zone. In using the earlier appraisal to get annual prices the average annual price (converted to 2009 dollars) was used. In estimating an average annual price was used instead for the current project.

Evaluating the Annual Estimates

What might at first seem like a simple task, as it turns out, is not quite so simple. How do these models reflect the real world? What makes things complicated is the fact that we have actual sale data for the period July 2013 through June 2019. In addition, we have the appraisal equation for the previous appraisal as well as the equation developed in this analysis. Together with the information on log and product prices from 2009 thru 2019, we have been able to make annual estimates for each zone. In addition, the alignment of counties has changed on all but the Northwest Zone. That makes it impossible to compare actual bids versus predicted bids for three of the four zones earlier than 2014.

However, the next Table does show the legitimate comparisons.

Table 7

Comparing Predicted and Actual Values ($/TON) 2018 dollars

Northwest Appraisal Zone

Year	Previous Model	New Model	Average Bid	Number of Sales
2019	36.16	56.65	53.50	11
2018	45.30	58.68	45.58	11
2017	39.35	57.54	46.03	7
2016	36.34	53.78	52.57	13
2015	41.30	57.25	64.09	11
2014	43.30	58.44	64.75	9
2013	39.99	58.44	n/a	n/a
2012	30.33	58.30	n/a	n/a
2011	28.12	51.33	n/a	n/a
2010	27.99	51.50	n/a	n/a
2009	26.29	47.68	n/a	n/a

In examining the above information where actual sales are available, the average for the period 2014 through 2019 using the previous model is $40.29/ton. Based on estimates of the new model the average price for the same time period is $56.99/ton and the average sale price per ton again for the 2014 through the 2019 time period is $54.42. I expect the difference is in part due to using the average annual Framing Price Index number instead of the number for the month in which the sale was sold. What is also apparent in looking at the numbers from 2014 through 2019 is that the estimates produced are smoother than are the actual numbers. The result will be that a rolling average calculation will have less variability than would be the case of using the actual bid for a zone.

This leaves the question of what should be used for the earlier time period. It appears that the earlier models do a better job estimating an annual appraised price. The average bid per ton for the period 2009 through 2014 is $30.54/ton. Using the Northwest Zone tons per thousand board feet ration for that period of 6.23 yields a price per thousand board feet of $190.29/MBF. Of course, this is in 2018-dollar values. The last appraisal set the price of timber in the Northwest Zone at $188.15 in 2013 dollars. Converting the last Northwest timber value to 2018 dollars yields a price of $204.06/MBF. The annual price developed using the earlier model are a very good estimate of what was the average price for that period.

In calculating a 10-year rolling average for the Northwest, Southwest and Central Zones, the earlier model gives the best indication of value for the years 2010 through 2014 and the new model gives better, more accurate values for the 2015-2019 period. That leaves one issue, what about the

Eastern Zone. The new model forecasts backwards for the 2009 through 2014 prices and produces much higher estimates than what was available and used in the last appraisal. Timber was likely under appraised in the Eastern Zone in the last appraisal. But I would not recommend using the new model for values in 2010 through 2014. Rather use the old Eastern Montana appraisal of $14.61/MBF adjusted for inflation to 14.88/MBF for the years 2010 through 2014. Add to this the values in Table 5 for the years 2015 through 2019. When the 10-year average is calculated the Eastern Montana value will more than double.

Future Appraisals

The easy part of a 10-year average is eliminating the earliest of the 10-year period. But what should the new number be and how should it be calculated? I am confident that the New Model will give reliable results for the new few years unless there is a significant downturn such as that what occurred about 10 years ago. All anyone must do is get the new framing lumber prices, convert them to 2018 dollars divide them by 100 then square and cube that number and put them in the equations presented in this analysis. That will work even when there are no timber sales in a zone. But appraisal zones should be reexamined periodically. The Northwest and Southwest Zones are looking more and more alike over the years. Mills come and go and the location and concentration of milling capacity as well as the concentration of logging companies underlie the definition of zones. I hazard to say that a reappraisal such as this should be done on a 5-year basis, even when the appraised amounts are calculated on a 10-year rolling average.

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[i] Personal correspondence with Michael Niccolucci. Updated based on research reported earlier in Keegan, C, Niccolucci, M, Fiedler, C. Jones, G. and Regel, R. 2002. Forest Products Journal. Vol. 52, N0. 78.

[ii] The index is available on line athttps://www.randomlengths.com/In-Depth/Monthly-Composite-Prices/

[iii] Jackson, David H. 2014. Final Report Appraisal Zones and Stumpage Values for Appraising Montana Forest Lands.