

# **Timber Sale Characteristics on Oral Versus Sealed Bids from State Lands**

by

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by

Matthew B. Russell<sup>1</sup>, Charles R. Blinn<sup>2</sup>, and Tim J. O'Hara<sup>3</sup>

## **ABSTRACT**

The Minnesota Department of Natural Resources (MnDNR) offers the majority of its timber for sale through an auction process. The auction methods used by the MnDNR are (1) the first-price sealed bid auction where bidders submit single bids and the rights to harvest the tract of timber is awarded to the highest bidder at the highest bid price and (2) the ascending-bid auction (also known as the oral-bid auction) where the price is raised successively until only one bidder remains and the bidder wins the tract at the final price. Concerns have recently been raised about the methods and procedures used in deciding which bid type to assign to a tract of timber. Primary concerns were that sealed-bid tracts could be larger and contain more volume per acre than oral bid tracts. This analysis evaluated timber sale characteristics from oral and sealed bids sold on MnDNR lands from FY2010 through FY2014. Results showed that sealed bids were offered on tracts with greater appraised volume available for sale and larger tract sizes compared to oral bids. In the case for aspen-dominated sales, appraised volume per acre is greater on sealed bids (average of 14.0 cords) compared to oral bids (average of 12.5 cords). Whether a bid type is sealed versus oral is a significant determinant of total sale price for a tract of timber. The MnDNR office (i.e., RAN) in which wood is sold was ultimately the best-performing variable determining the sensitivity of selling price, indicating the importance of local competition and markets in determining timber prices. Additional timber sale metrics, such as whether wood is available for summer harvest, would be beneficial to include in timber sale data to make more informed assessments of the health and year-round sustainability of loggers and forest products industries across Minnesota.

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## **1. INTRODUCTION**

Owning nearly one-quarter of the state's timberland totaling 3.8 million acres (Miles and VanderSchaaf 2012), wood offered for sale on lands owned and managed by the state of Minnesota plays an important role in contributing to the forest products industry. Totaling 839,000 cords harvested in FY2011, timber harvested on state lands is second only to the total amount harvested on private lands (Minnesota Department of Forest Resources [MnDNR] 2014). Similarly, the management and harvesting of wood on state lands can be used as a tool to maintain healthy and productive forests. In particular, aspen species contribute to 49% of total statewide harvests (MnDNR 2014) and supply the State's pulp and paper, oriented-strand board, and specialty woods products firms. Forest management and timber harvesting can be used as a strategy for sustaining the aspen resource that faces a number forest health concerns including aspen decline, gypsy moth, and blowdown from windstorms (MnDNR 2012).

The MnDNR offers the majority of its timber for sale through an auction process. The remaining timber is sold at negotiated or advertised prices. The auction methods used by the MnDNR are (1) the first-price sealed bid auction where bidders submit single bids and the rights to harvest the tract of timber is awarded to the highest bidder at the highest bid price and (2) the ascending-bid auction (also known as the oral-bid auction) where the price is raised successively until only one bidder remains and the bidder wins the tract at the final price. A MnDNR policy (but not required) is to offer approximately one-third of its annual volume for sale through sealed-bid auctions.

Concerns have recently been raised by the Minnesota Forest Industries (MFI) with regard to the methods and procedures used in deciding which bid type to assign to a tract of timber. Primary concerns were that sealed-bid tracts could be larger and contain more volume per acre than oral-bid tracts. Such procedures could potentially result in the characteristics of some tracts being offered more frequently through a sealed-bid process. Thus, an analysis to evaluate the timber sale characteristics of oral- and sealed-bid types was conducted using recent timber sale records from across Minnesota.

## **2. OBJECTIVES**

The overall objective of this work was to evaluate timber sale characteristics from oral and sealed bids sold on MnDNR lands from FY2010 through FY2014 (July 1, 2009 – June 30, 2014). Specific objectives were to:

- (1) evaluate timber sale attributes (e.g., total sale volume, appraised price per cord, selling price per cord) on oral and sealed bids across Minnesota (statewide) and for aspen-dominated sales,
- (2) quantify the degree to which timber sale attributes related to bid type vary within specific regions of the state (e.g., Central, Northeast, and Northwest regions), and
- (3) assess how sensitive selling price per cord is when timber sale characteristics are known.

### 3. DATA ANALYSIS

Timber sale records for the state fiscal years 2010 through 2014 were obtained from the MnDNR. Each sale was purchased at an oral or sealed auction. Over-the-counter sales, sales where biomass was the only listed product, and salvage sales were discarded from the analysis. Given that sale volumes were measured in terms of cords or thousand board feet (MBF), all volume estimates were standardized to cords by assuming two cords per MBF.

This analysis focused on all remaining sales across the state and aspen-dominated sales. Aspen species comprised 51% of all appraised volume sold by the MnDNR in FY2010 through FY2014 (Table 1), closely matching the 49% values that represent total statewide harvests (MnDNR 2014). Timber sales were assessed from the Northeast, Northwest, and Central regions (Table 2), recognizing that variability exists across the various area offices within a region (Table 3). In total, data were analyzed from 2,541 total permits.

**Table 1.** Percent of appraised volume by species groups for the MnDNR timber sale data, FY2010 through FY2014.

Species group	DNR species names	Percent of appraised volume sold by MnDNR in FY2010 through FY2014
Aspen	aspen species, trembling aspen, largetooth aspen, balm of gilead	51.0%
Mixed hardwoods	American elm, ash, bitternut hickory, basswood, black cherry, black locust, black oak, black walnut, boxelder, bur oak, butternut, central hardwoods, cottonwood, green ash, hackberry, hybrid poplar, ironwood, lowland hardwoods, maple species, mixed hardwoods, northern pin oak, oak species, paper birch, red elm, red maple, red oak, shagbark hickory, silver maple, white oak, willow	12.1%
Pine	jack pine, pine species, Norway pine, white pine, Scotch pine, ponderosa pine	11.9%
Spruce	black spruce, mixed spruce, white spruce, spruce-balsam, Norway spruce	11.2%
Balsam fir	balsam fir	4.5%
Northern hardwoods	yellow birch, sugar maple, white ash, northern hardwoods	4.4%
Tamarack	tamarack, European larch	4.3%
Mixed conifers	eastern red cedar, mixed conifers, lowland conifers, white cedar	0.6%
Miscellaneous	“any listed species”, miscellaneous	0.0%
ALL SPECIES		100%

**Table 2.** Mean and standard deviation (SD) of MnDNR timber sale characteristics by region, FY2010 through FY2014.

Region	n	Total volume (cds)		Total sale price (\$)		Sale size (acs)	
		Mean	SD	Mean	SD	Mean	SD
Central	227	1,136	1,208	\$16,546	41,654	59	54
Northeast	1092	1,313	1,137	\$19,121	30,251	62	57
Northwest	1222	997	941	\$15,413	23,276	51	46

**Table 3.** Mean and standard deviation (SD) of MnDNR timber sale characteristics by region and area office, FY2010 through FY2014.

Region	Area	n	Total appraised volume (cds)		Total sale price (\$)		Sale size (acs)	
Central	Cambridge	22	Mean	757	SD	418	Mean	\$1,421
	Lewiston	23		288		184		\$388
	Little Falls	95		1,035		748		\$12,063
	Sandstone	87		1,567		1,655		\$29,398
Northeast	Aitkin	184	Mean	1,350	SD	1,165	Mean	39,284
	Cloquet	75		1,258		927		\$15,429
	Deer River	223		1,091		972		\$14,792
	Hibbing	180		1,053		845		\$13,585
	Littlefork	173		1,395		1,264		\$23,803
	Tower	181		1,604		1,246		\$24,423
	Two Harbors	76		1,671		1,450		\$9,861
Northwest	Backus	191	Mean	871	SD	771	Mean	10,045
	Baudette	192		1,712		1,426		\$32,238
	Bemidji	120		634		510		\$13,290
	Blackduck	140		717		538		\$9,533
	Park Rapids	357		788		613		\$12,166
	Warroad	222		1,194		1,003		\$16,263

Data were analyzed across the state and for aspen-dominated sales. Aspen-dominated sales were defined as any permit which offered greater than 50% of aspen species, as measured by total appraised volume in cords. Aspen-dominated sales comprised 87% of all timber sale permits occurring across Minnesota from 2010 through 2014.

The majority of product types were comprised of woodsrun cordwood followed by woodsrun mixed products. The following variables were of interest and available for all timber sale records:

- bid type (oral versus sealed)
- DNR region (Central, Northeast, or Northwest; Table 2) and region area name (Table 3)
- total appraised volume (cords)
- total sale size (acres)
- number of species comprised in a sale
- number of product types comprised in a sale
- appraised volume per acre
- appraised price per cord
- selling price per cord
- selling price per cord by size of timber sale (acres)
- selling price per cord by volume of timber sale (cords)
- potential summer harvest wood available

Whether a permit was an oral versus sealed bid was the primary focus of this examination. Potential summer harvest wood available is typically offered for sale by the MnDNR in its second quarter (Oct-Dec; Doug Tillma, MnDNR, personal communication). Hence, potential

summer harvest wood available was categorized as a binary variable ‘YES’ if a timber sale occurred in Q2 or ‘NO’ if a timber sale occurred in Q1, Q3, or Q4.

To evaluate differences in timber sale attributes for oral and sealed bids across the state or within individual regions, *t*-tests were conducted. To compare total sale price on oral versus sealed bids, multiple regression techniques were employed. Total sale price was estimated using total sale size (acres) and a binary variable indicating whether wood was purchased via sealed or oral bid. All statistical tests were conducted at  $\alpha = 0.05$  using the R statistical package (R Development Core Team 2013)

Boosted regression models (Makler-Pick et al. 2011) were employed to assess model sensitivity when predicting selling price per cord. Of particular interest is the relative influence of each input parameter on model output. Input variables which were not directly related to bid price were analyzed. These variables included bid type, MnDNR region, MnDNR region area name, number of species comprised in a sale, number of product types comprised in a sale, total sale size (acres), appraised volume per acre, and potential summer harvest wood available. The relative influence metric for a specific input variable ranges from 0 (no influence) to 100 (complete influence), and the cumulative sum of relative influence scores totals 100.

## 4. RESULTS

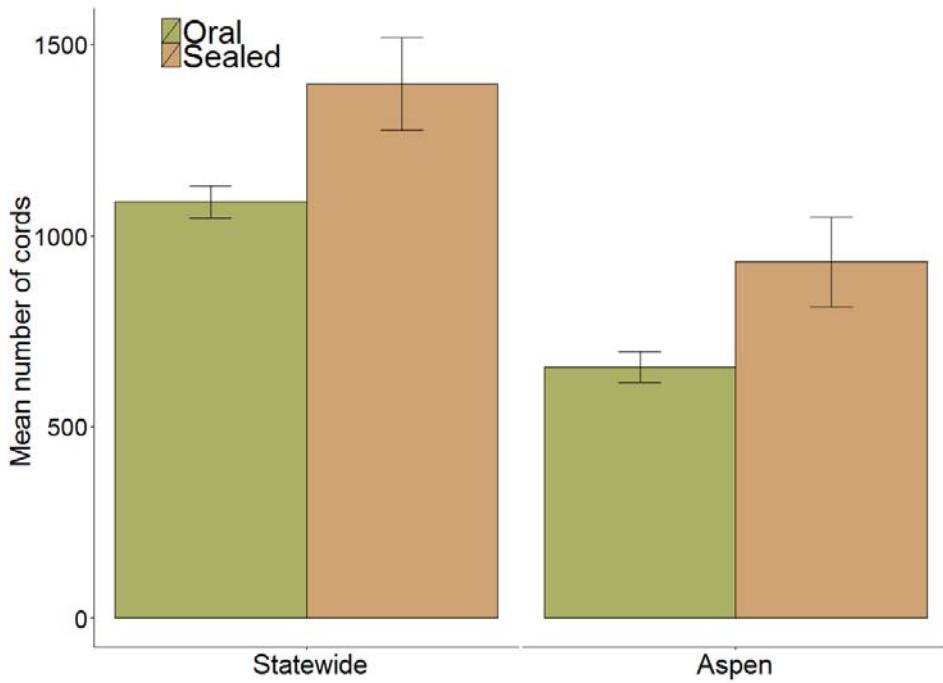
### 4.1 Trends in timber sale attributes in oral and sealed bids

#### 4.1.1 Total appraised volume

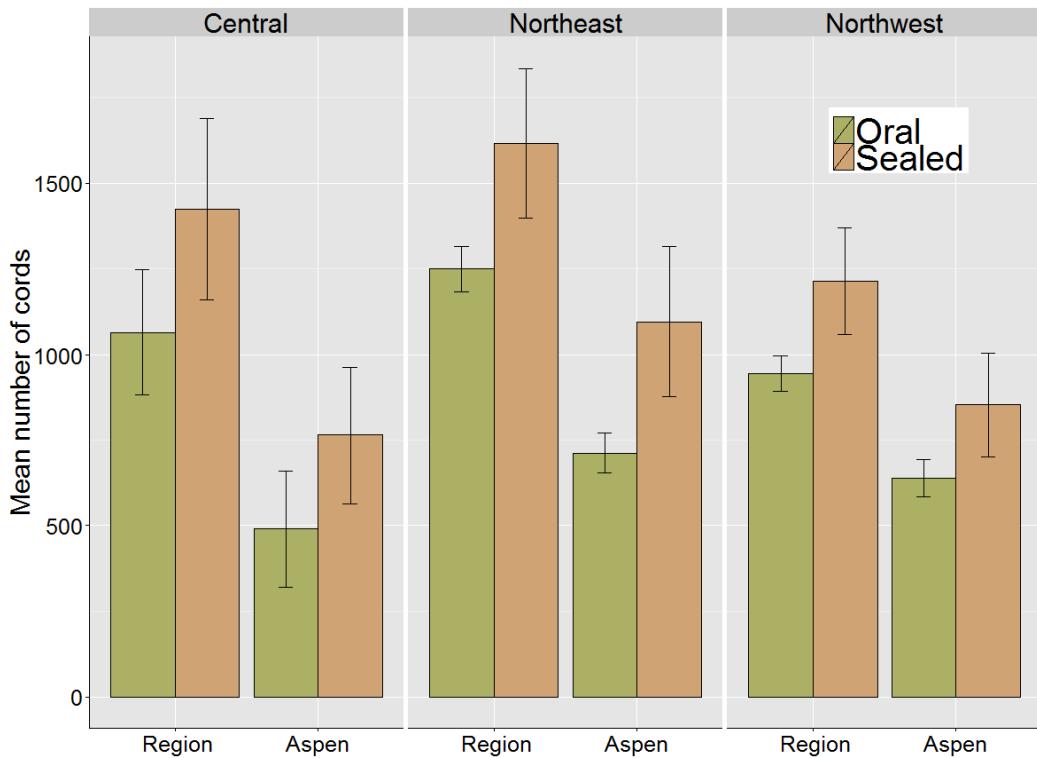
For both statewide and aspen-dominated sales, the total appraised volume offered on sealed-bid sales was significantly greater ( $p < 0.001$ ) than the appraised volume on oral-bid sales (Figure 1; Table 4). The average appraised volume on sealed bids was 309 cords. This was 209 cords more than the average oral bid. Similar trends were observed when analyzing total appraised volume by MnDNR Administrative region. The appraised volume on sealed-bid sales was significantly greater than the appraised volume on oral-bid sales for the Central, Northeast, and Northwest regions (Figure 2; Table 5).

**Table 4.** Statistics and *t*-test results of total appraised volume for oral- and sealed-bid types for MnDNR timber sale permits, FY2010 through FY2014.

Species group	Bid type	n	Mean (cds)	SE (cds)	p-value
Statewide	Oral	2072	1088.3	21.6	<0.001
	Sealed	469	1396.8	61.8	
Aspen	Oral	1758	655.4	20.0	<0.001
	Sealed	403	932.7	59.4	



**Figure 1.** Mean and 95% confidence limits (error bars) of total appraised volume (cords) for Minnesota timber sale permits, FY2010 through FY2014.



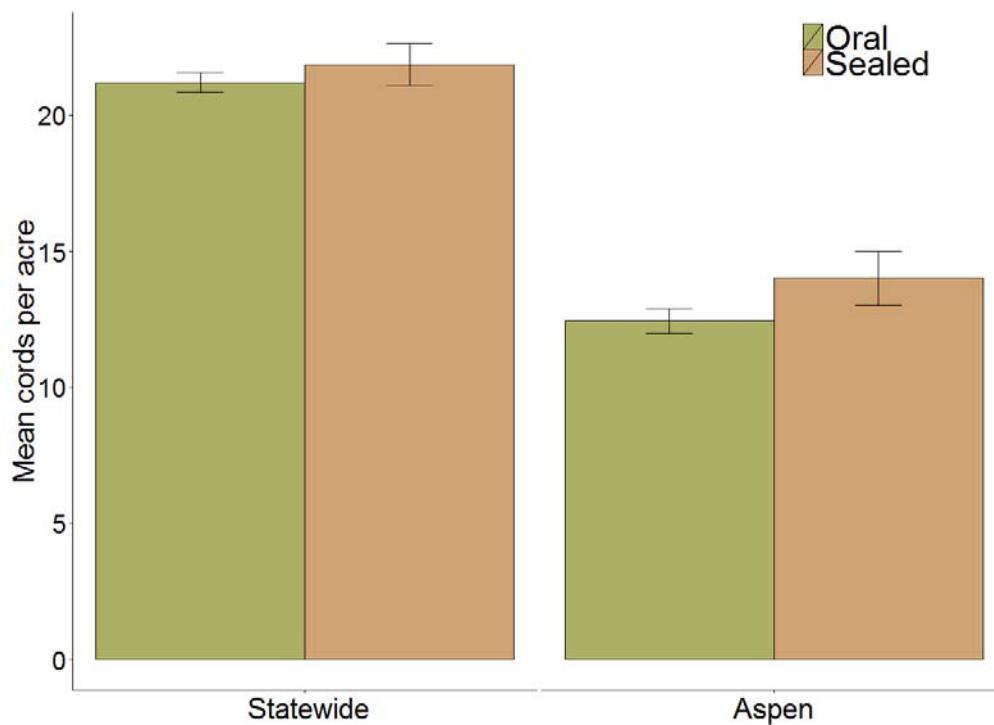
**Figure 2.** Mean and 95% confidence limits (error bars) of total appraised volume (cords) for timber sale permits by MnDNR region, FY2010 through FY2014.

**Table 5.** Statistics and *t*-test results of total appraised volume for oral- and sealed-bid types by MnDNR region, FY2010 through FY2014.

Region	Species group	Bid type	n	Mean (cds)	SE (cds)	p-value
Central	Region	Oral	182	1064.5	93.7	0.030
		Sealed	45	1425.2	134.7	
	Aspen	Oral	162	489.8	86.7	0.043
		Sealed	43	764.1	102.6	
Northeast	Region	Oral	903	1249.9	34.2	0.002
		Sealed	189	1616.1	111.0	
	Aspen	Oral	737	711.5	29.5	0.001
		Sealed	148	1095.8	112.6	
Northwest	Region	Oral	987	944.9	27.2	0.001
		Sealed	235	1214.9	79.4	
	Aspen	Oral	859	638.5	27.6	0.010
		Sealed	212	853.0	77.7	

#### 4.1.2 Appraised volume per acre

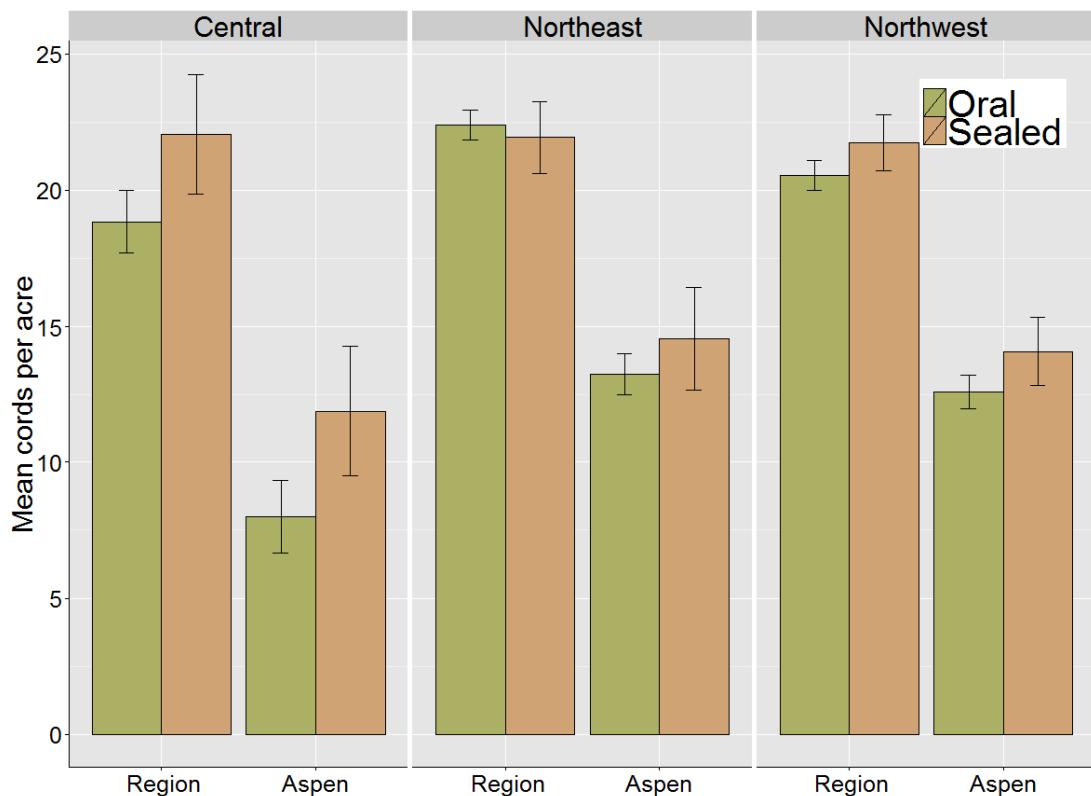
For aspen-dominated sales, the average appraised volume per acre on sealed-bid sales was significantly greater ( $p = 0.005$ ) than sales that were offered as oral bids (Figure 3; Table 6). The average appraised volume on sealed bids was 1.56 cords per acre greater than oral bids for aspen-dominated sales. Analyzed by region, appraised volume per acre was always significantly greater region wide (all species) and for aspen-dominated in the Central and Northwest regions, but not for the Northeast region (Figure 4; Table 7).



**Figure 3.** Mean and 95% confidence limits (error bars) of appraised volume per acre (cords/acre) for MnDNR timber sale permits, FY2010 through FY2014.

**Table 6.** Statistics and *t*-test results of appraised volume per acre for oral- and sealed-bid types from MnDNR timber sale permits, FY2010 through FY2014.

Species group	Bid type	n	Mean (cds/ac)	SE (cds/ac)	p-value
Statewide	Oral	2072	21.20	0.19	0.133
	Sealed	469	21.85	0.39	
Aspen	Oral	1758	12.46	0.23	0.005
	Sealed	402	14.02	0.50	



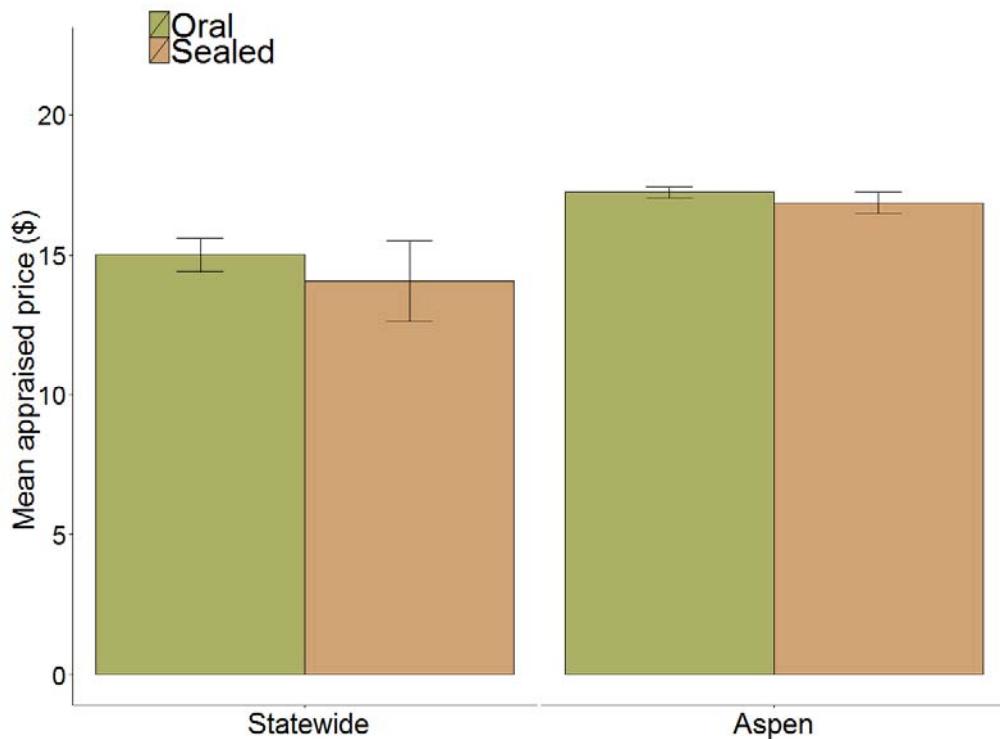
**Figure 4.** Mean and 95% confidence limits (error bars) of appraised volume per acre (cords/acre) for timber sale permits by MnDNR region, FY2010 through FY2014.

**Table 7.** Statistics and *t*-test results of appraised volume per acre for oral- and sealed-bid types by MnDNR region, FY2010 through FY2014.

Region	Species group	Bid type	n	Mean (cds/ac)	SE (cds/ac)	p-value
Central	Region	Oral	182	18.85	0.58	0.014
		Sealed	45	22.05	1.12	
	Aspen	Oral	162	7.99	0.68	0.007
		Sealed	43	11.88	1.22	
Northeast	Region	Oral	903	22.40	0.28	0.532
		Sealed	189	21.94	0.67	
	Aspen	Oral	737	13.26	0.39	0.214
		Sealed	148	14.55	0.96	
Northwest	Region	Oral	987	20.54	0.27	0.043
		Sealed	235	21.75	0.53	
	Aspen	Oral	859	12.61	0.31	0.039
		Sealed	212	14.08	0.64	

#### 4.1.3 Appraised price per cord

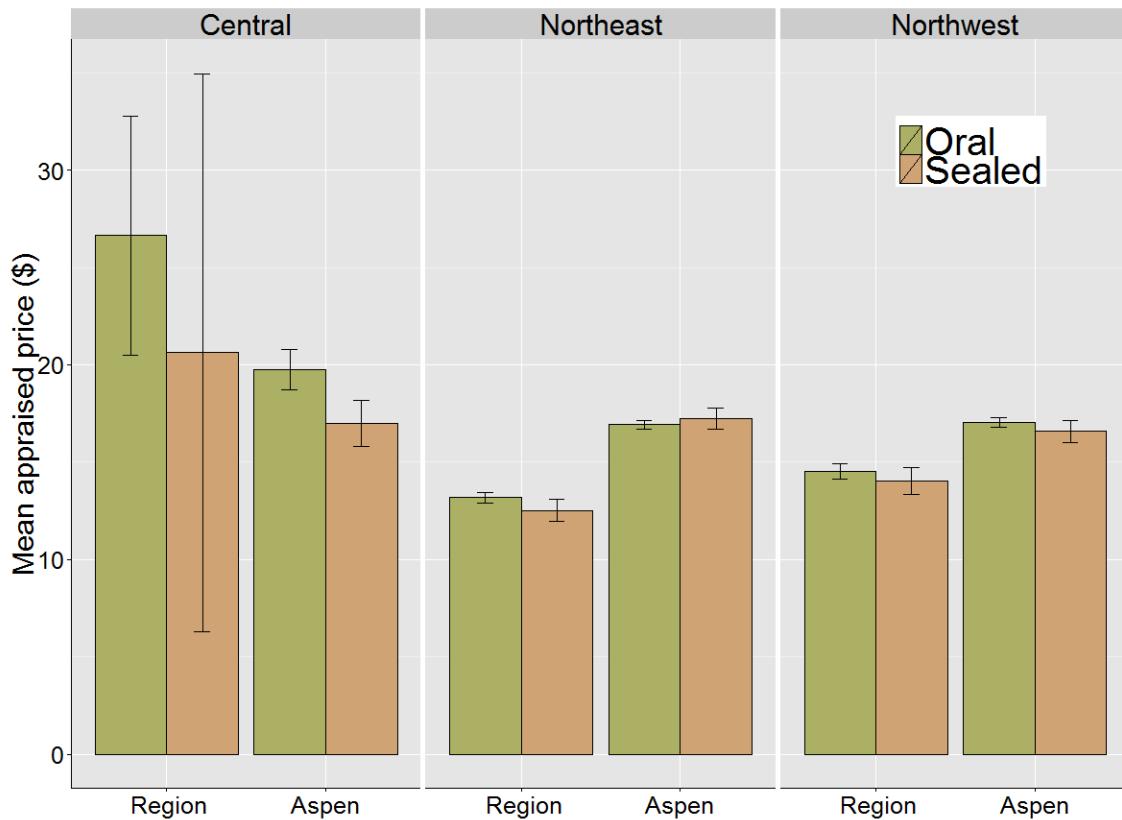
There were no statistical differences in mean appraised price per cord when comparing oral- versus sealed-bid timber sales across Minnesota (Figure 5; Table 8). When analyzing specific regions, the appraised price per cord on oral bids was significantly greater for aspen-dominated sales in the Central region ( $p < 0.001$ ) and all timber sales in the Northeast region ( $p = 0.045$ ; Figure 6; Table 9).



**Figure 5.** Mean and 95% confidence limits (error bars) of appraised price per cord (\$) for MnDNR timber sale permits, FY2010 through FY2014.

**Table 8.** Statistics and *t*-test results of appraised price per cord for oral- and sealed-bid types from MnDNR timber sale permits, FY2010 through FY2014.

Species group	Bid type	n	Mean (\$/cd)	SE (\$/cd)	p-value
Statewide	Oral	2072	15.01	14.00	0.237
	Sealed	469	14.07	15.88	
Aspen	Oral	1758	17.24	4.06	0.093
	Sealed	403	16.86	3.97	



**Figure 6.** Mean and 95% confidence limits (error bars) of appraised price per cord (\$) for timber sale permits by MnDNR region, FY2010 through FY2014.

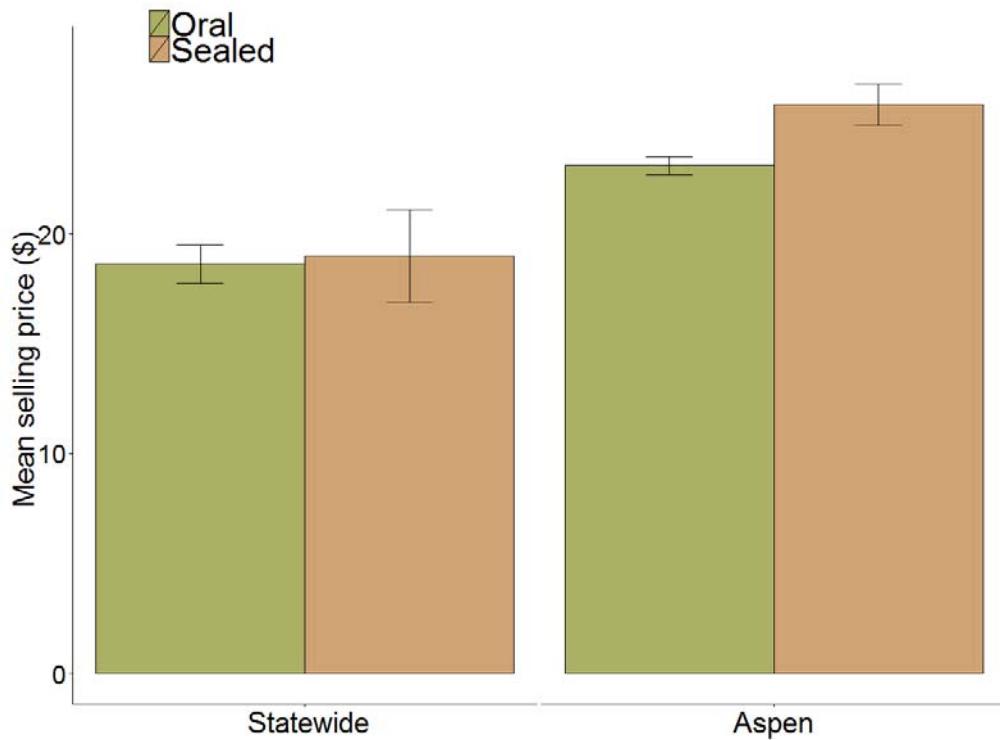
**Table 9.** Statistics and *t*-test results of appraised price per cord (\$) for oral- and sealed- bid types by MnDNR region, FY2010 through FY2014.

Region	Species group	Bid type	n	Mean (\$)	SE (\$)	p-value
Central	Region	Oral	182	26.64	3.14	0.452
		Sealed	45	20.62	7.31	
	Aspen	Oral	162	19.74	0.52	
		Sealed	43	16.98	0.60	
Northeast	Region	Oral	903	13.18	0.14	0.045
		Sealed	189	12.53	0.29	
	Aspen	Oral	737	16.92	0.12	
		Sealed	148	17.24	0.28	
Northwest	Region	Oral	987	14.53	0.20	0.221
		Sealed	235	14.04	0.35	
	Aspen	Oral	859	17.03	0.13	
		Sealed	212	16.57	0.30	

#### 4.1.4 Selling price per cord

Sealed bids were characterized by significantly higher selling prices for aspen ( $p < 0.001$ ), but not for all permits across the state (Figure 7; Table 10). The average selling price was \$2.78 greater per cord on sealed bids compared to oral bids on aspen-dominated sales. When analyzing specific regions, sale prices on sealed bids were significantly greater in the Northeast region for

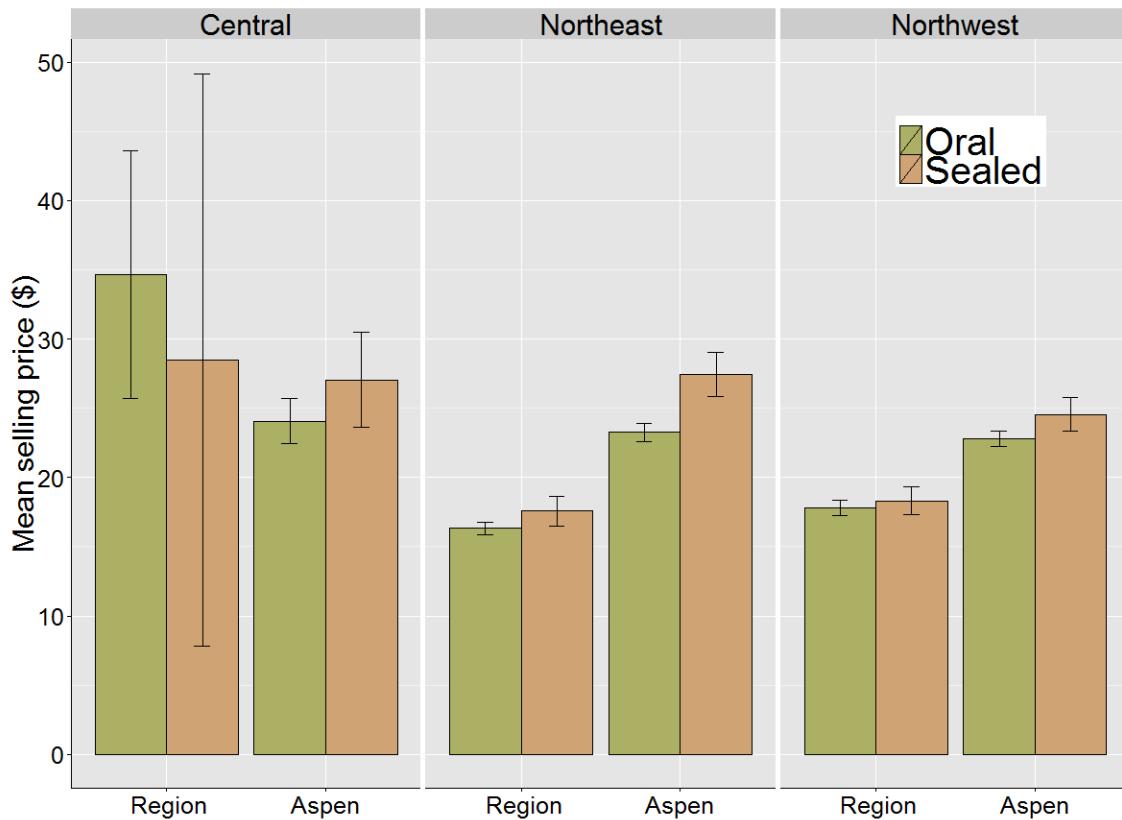
aspen-dominated sales ( $p < 0.001$ ) and all timber sales ( $p = 0.039$ ) and for aspen-dominated sales in the Northwest ( $p = 0.008$ ; Figure 8; Table 11).



**Figure 7.** Mean and 95% confidence limits (error bars) of selling price per cord (\$) for MnDNR timber sale permits, FY2010 through FY2014.

**Table 10.** Statistics and *t*-test results of selling price per appraised cord (\$) for oral- and sealed-bid types from MnDNR timber sale permits, FY2010 through FY2014.

Species group	Bid type	n	Mean (\$)	SE (\$)	p-value
Statewide	Oral	2072	18.65	20.23	0.762
	Sealed	469	19.00	23.16	
Aspen	Oral	1758	23.10	8.86	<0.001
	Sealed	403	25.88	9.63	



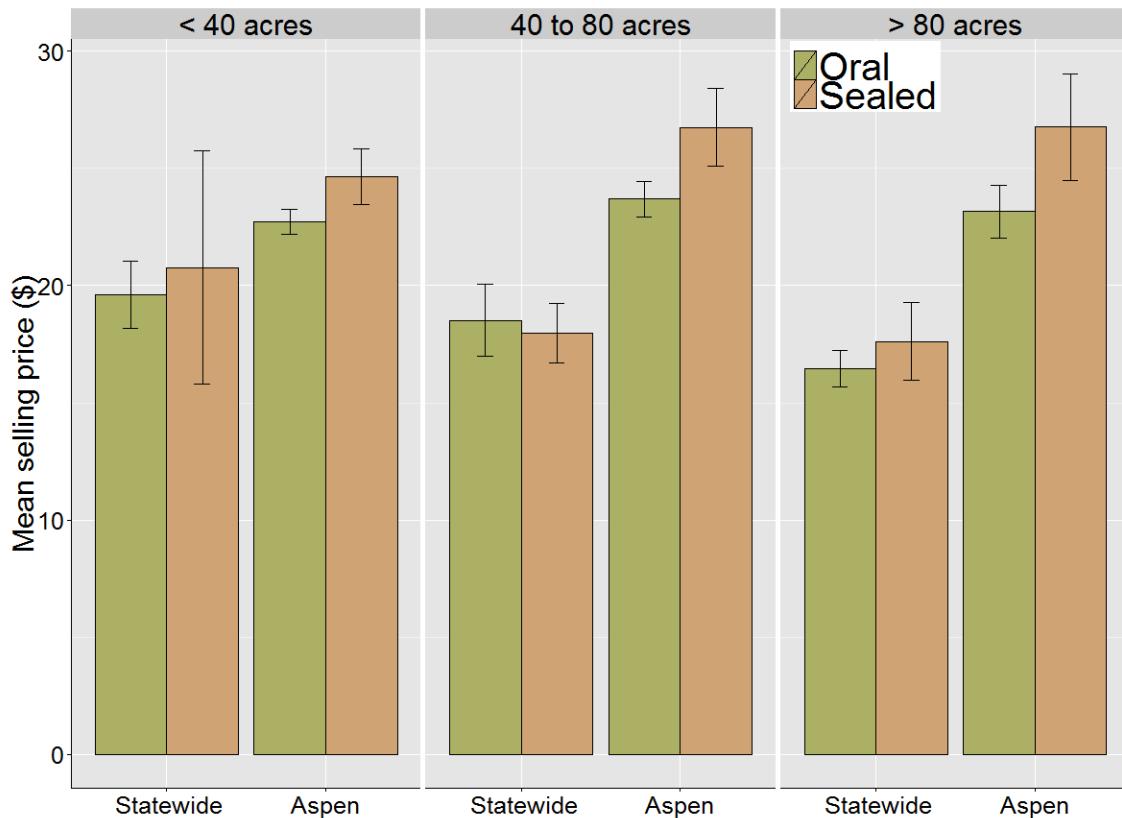
**Figure 8.** Mean and 95% confidence limits (error bars) of selling price per cord (\$) for timber sale permits by MnDNR region, FY2010 through FY2014.

**Table 11.** Statistics and *t*-test results of selling price per cord (\$) for oral- and sealed-bid types by MnDNR region, FY 2010 through FY 2014.

Region	Species group	Bid type	n	Mean (\$)	SE (\$)	p-value
Central	Region	Oral	182	34.66	4.55	0.593
		Sealed	45	28.49	10.55	
	Aspen	Oral	162	24.08	0.82	
		Sealed	43	27.06	1.74	
Northeast	Region	Oral	903	16.33	0.22	0.039
		Sealed	189	17.58	0.56	
	Aspen	Oral	737	23.26	0.33	
		Sealed	148	27.43	0.82	
Northwest	Region	Oral	987	17.82	0.27	<0.001
		Sealed	235	18.33	0.52	
	Aspen	Oral	859	22.79	0.28	
		Sealed	212	24.56	0.61	

#### 4.1.4.1 Selling price per cord by size of sale (acres)

Sealed bids were characterized by significantly higher selling prices compared to oral bids for aspen across all three sale size classes (< 40 acres, 40 to 80 acres, and > 80 acres), but not for all permits across the state (Figure 9; Table 12).



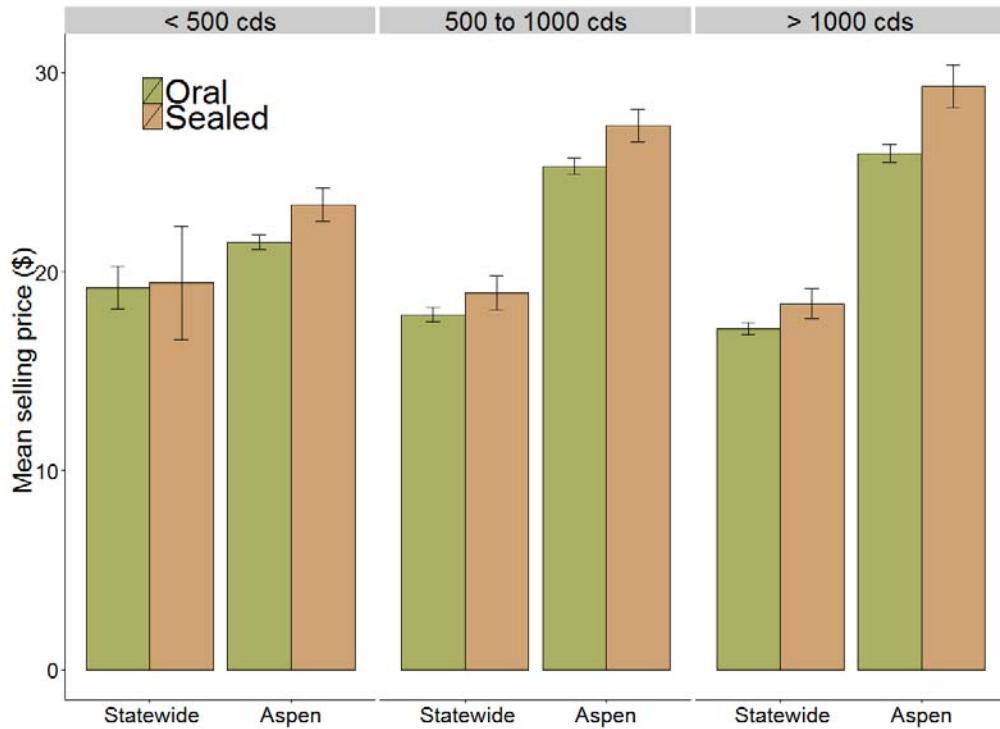
**Figure 9.** Mean and 95% confidence limits (error bars) of selling price per cord (\$) for timber sale permits by size of tract (acres) for MnDNR timber sale permits, FY2010 through FY2014.

**Table 12.** Statistics and *t*-test results of selling price for oral- and sealed-bid types by size of tract (acres) for MnDNR timber sale permits, FY2010 through FY2014.

Size of sale	Species group	Bid type	n	Mean (\$)	SE (\$)	p-value
Less than 40 acres	Statewide	Oral	1021	19.60	0.73	0.661
		Sealed	189	20.76	2.54	
	Aspen	Oral	882	22.72	0.27	
		Sealed	168	24.66	0.60	
40 to 80 acres	Statewide	Oral	649	18.52	0.78	0.582
		Sealed	157	17.96	0.65	
	Aspen	Oral	543	23.67	0.38	
		Sealed	133	26.75	0.85	
Greater than 80 acres	Statewide	Oral	402	16.44	0.40	0.211
		Sealed	123	17.62	0.85	
	Aspen	Oral	333	23.15	0.57	
		Sealed	102	26.77	1.16	

#### 4.1.4.2 Selling price per cord by total sale size

Sealed bids were characterized by significantly higher selling prices compared to oral bids for aspen across all three sale volume classes (< 500 cords, 500 to 1000 cords, and > 1000 cords), but not for all permits across the state (Figure 10; Table 13). On aspen-dominated sales that offered greater than 1000 cords of wood, the average selling price per cord was \$5.95 greater for compared to sales where less than 500 cords of wood were sold.



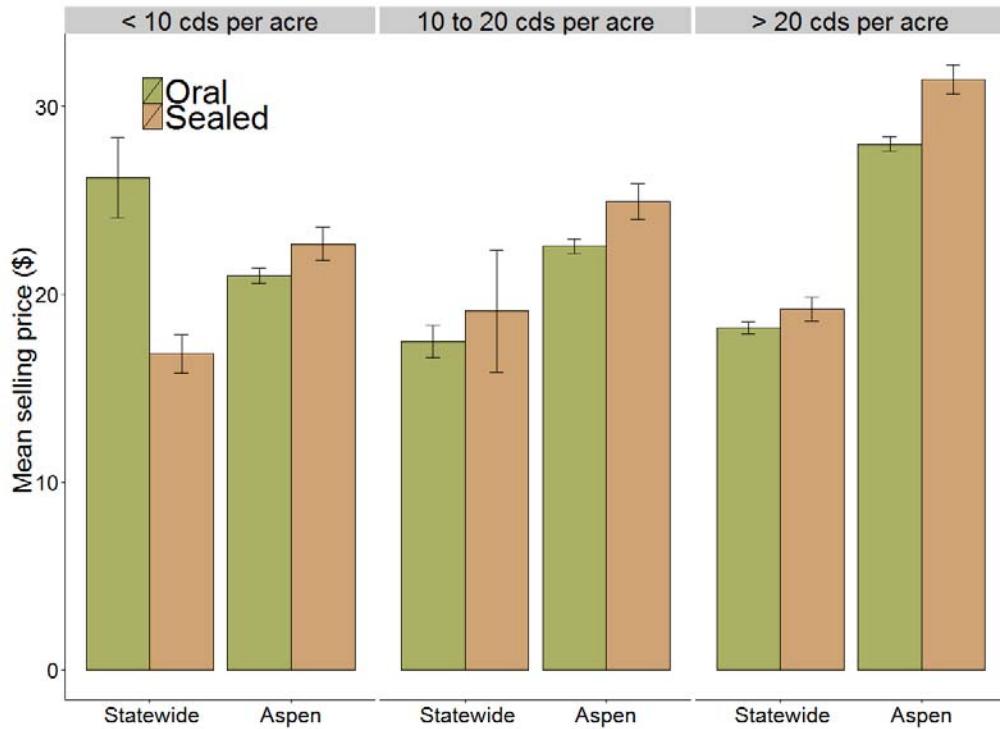
**Figure 10.** Mean and 95% confidence limits (error bars) of selling price per cord (\$) for timber sale permits by total appraised volume (cords) offered for sale from MnDNR timber sale permits, FY2010 through FY2014.

**Table 13.** Statistics and *t*-test results of selling price per cord for oral- and sealed-bid types by total appraised volume in cords offered from MnDNR timber sale permits, FY2010 through FY2014.

Sale volume	Species group	Bid type	n	Mean (\$)	SE (\$)	p-value
Less than 500 cords	Statewide	Oral	1264	19.19	0.54	0.994
		Sealed	238	19.42	1.44	
	Aspen	Oral	1026	21.47	0.19	
		Sealed	194	23.36	0.43	
500 to 1000 cords	Statewide	Oral	389	17.84	0.18	0.450
		Sealed	102	18.93	0.43	
	Aspen	Oral	340	25.29	0.20	
		Sealed	87	27.34	0.42	
Greater than 1000 cords	Statewide	Oral	395	17.14	0.15	0.217
		Sealed	123	18.40	0.38	
	Aspen	Oral	371	25.94	0.23	
		Sealed	117	29.31	0.55	

#### 4.1.4.3 Selling price per cord by volume per acre

Sealed bids were characterized by significantly higher selling prices compared to oral bids for aspen across all three sale volume per acre classes (< 10 cords per acre, 10 to 20 cords per acre, and > 20 cords per acre) and for relatively small (< 10 cords per acre) and large (> 20 cords per acre) permits across the state (Figure 11; Table 14). On sales that offered greater than 20 cords per acre, the average selling price per cord was \$8.76 greater for aspen sales with sealed bids compared to sales where less than 10 cords per acre were sold.



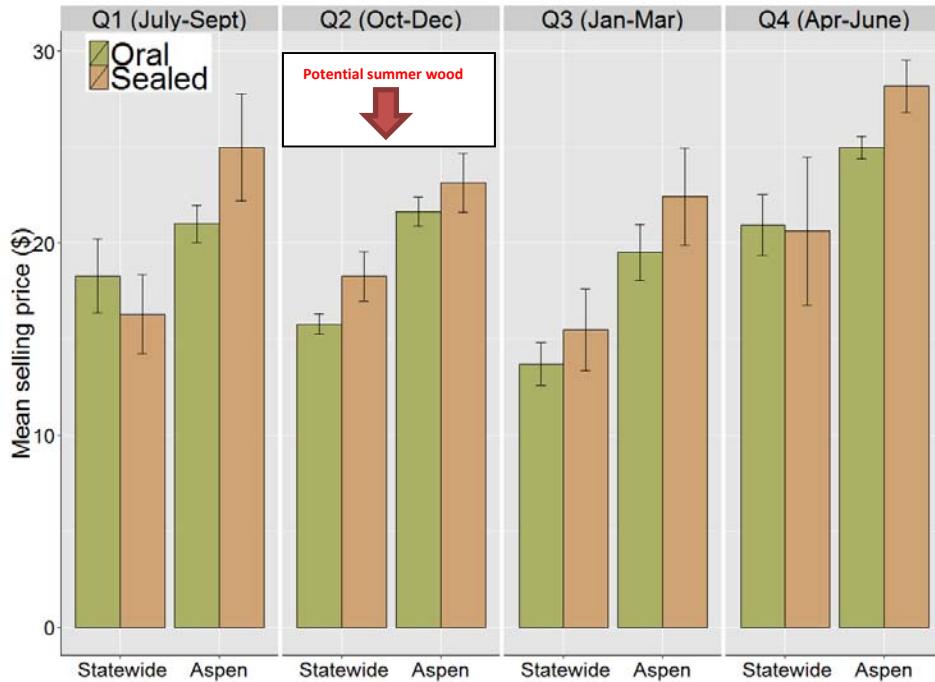
**Figure 11.** Mean and 95% confidence limits (error bars) of selling price (\$) for timber sale permits by average volume per acre.

**Table 14.** Statistics and *t*-test results of selling price for oral- and sealed-bid types by total sale volume.

Sale volume	Species group	Bid type	n	Mean (\$)	SE (\$)	p-value
Less than 10 cords per acre	Statewide	Oral	186	26.18	1.09	0.025
		Sealed	30	16.83	0.52	
	Aspen	Oral	778	20.99	0.20	0.036
		Sealed	151	22.68	0.45	
10 to 20 cords per acre	Statewide	Oral	795	17.50	0.44	0.559
		Sealed	184	19.10	1.66	
	Aspen	Oral	579	22.55	0.20	0.008
		Sealed	138	24.93	0.48	
Greater than 20 cords per acre	Statewide	Oral	1091	18.20	0.17	0.041
		Sealed	254	19.21	0.32	
	Aspen	Oral	401	27.99	0.19	<0.001
		Sealed	113	31.44	0.39	

#### 4.1.5 Selling price per cord by quarter (potential summer wood)

Potential summer harvest wood is typically offered for sale in the DNR's second quarter (Oct-Dec; Doug Tillma, MnDNR, personal communication). Analyzed by state fiscal year quarter, selling price of sealed bids in Q2 was significantly greater for statewide sales ( $p < 0.001$ ), but not for aspen-dominated sales (Figure 12; Table 15).



**Figure 12.** Mean and 95% confidence limits (error bars) of selling price per appraised cord (\$) for MnDNR timber sale permits by quarter, FY2010 through FY2014.

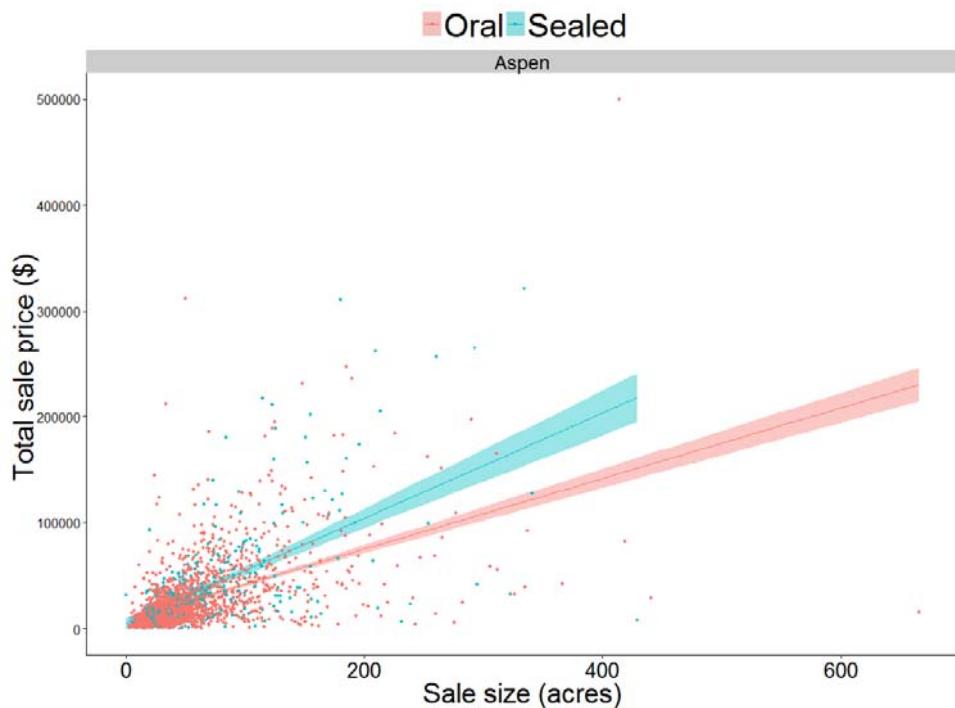
**Table 15.** Statistics and *t*-test results of selling price per appraised cord (\$) for oral- and sealed- bid types by quarter from MnDNR timber sale permits by quarter, FY2010 through FY2014.

Quarter	Species group	Bid type	n	Mean (\$)	SE (\$)	p-value
Q1 (July-Sept)	Statewide	Oral	292	18.27	0.99	0.168
		Sealed	58	16.28	1.05	
	Aspen	Oral	261	21.00	0.50	0.011
		Sealed	53	24.96	1.42	
Q2 (Oct-Dec)	Statewide	Oral	630	15.79	0.26	<0.001
		Sealed	119	18.26	0.66	
	Aspen	Oral	535	21.63	0.38	0.089
		Sealed	107	23.13	0.79	
Q3 (Jan-Mar)	Statewide	Oral	96	13.71	0.57	0.155
		Sealed	44	15.47	1.09	
	Aspen	Oral	84	19.51	0.75	0.055
		Sealed	37	22.42	1.29	
Q4 (Apr-June)	Statewide	Oral	1054	20.91	0.81	0.889
		Sealed	248	20.62	1.97	
	Aspen	Oral	878	24.97	0.30	<0.001
		Sealed	206	28.16	0.69	

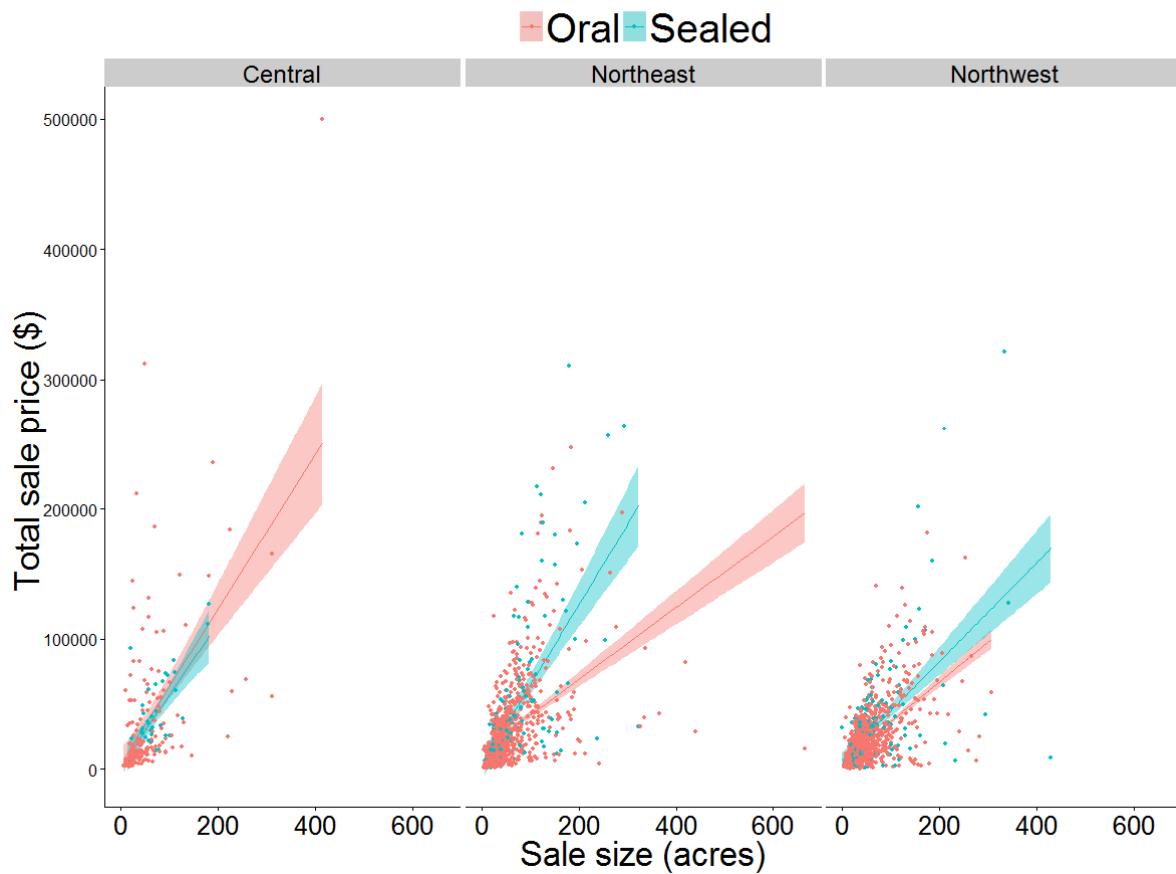
#### 4.2 Total sale price of sealed versus oral bids

Holding timber tract size constant, total sale prices of sealed bids on aspen-dominated sales are significantly greater than oral bids ( $p < 0.001$ ). For example, for a 200-acre aspen sale, the total sale price on a sealed bid would be \$6,630 more (on average) than an oral bid (Figure 13). Total

sale price was significantly greater on sealed bids compared to oral bids in the Northeast and Northwest regions ( $p < 0.001$ ). For example, a 200-acre aspen sale in the Northeast region would yield a total sale price \$12,555 more for sealed bids compared to oral bid. For the same tract size, an aspen sale in the Northwest region would yield a total sale price \$5,309 more for a sealed bid compared to an oral bid. No differences in bid types (oral versus sealed) were observed for the Central region (Figure 14).



**Figure 13.** Scatterplots with least-square regression lines for oral and sealed bids for a given tract size on aspen sales from MnDNR timber sale permits, FY2010 through FY2014. Shaded regions indicate 95% confidence limits.

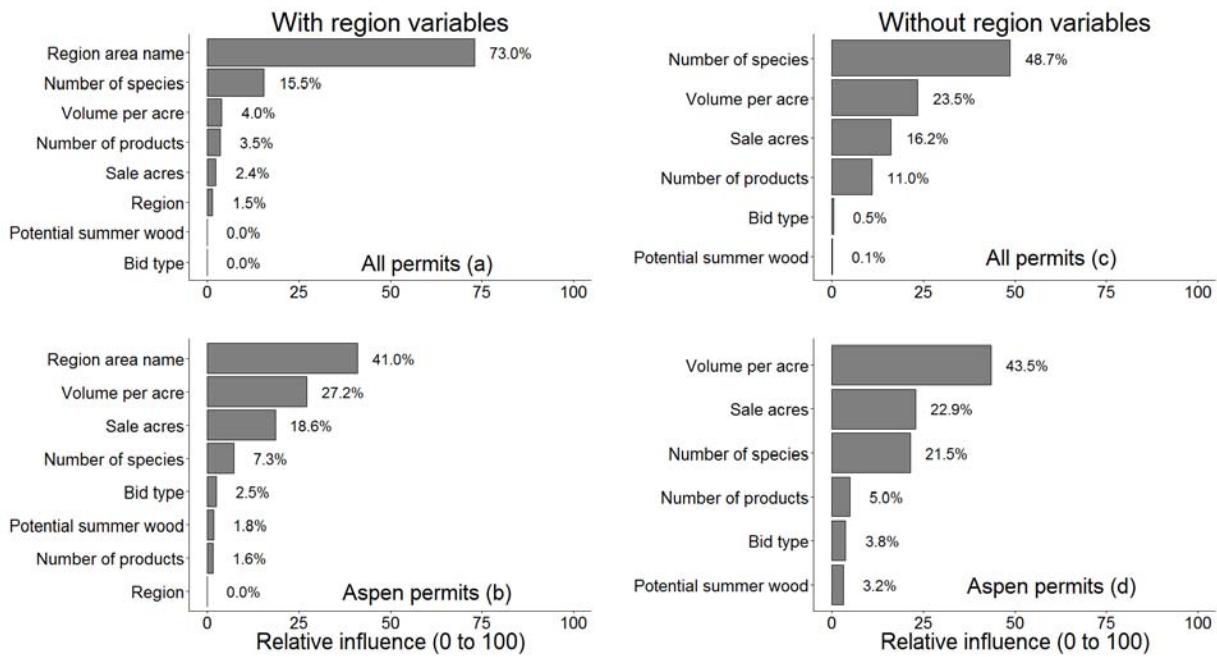


**Figure 14.** Scatterplots with least-square regression lines for oral and sealed bids by region for a given tract size on aspen sales from MnDNR timber sale permits, FY2010 through FY2014. Shaded regions indicate 95% confidence limits.

#### 4.3 Sensitivity of selling price to timber sale attributes

Two versions of the sensitivity analysis were conducted, one version that included MnDNR region variables (i.e., MnDNR region [Central, Northeast, or Northwest] and region area name [Table 3]) and one version that excluded them. For the version that included regional variables, region area name was the most influential characteristic influencing selling price for all permits (statewide; Figure 15a) and aspen-dominated sales (Figure 15b). For all permits, the number of species in a sale, appraised volume per acre, and the number of wood products offered in a sale (including woodsrun cordwood, sawtimber, woodsrun mixed products, and others) were the next three most sensitive variables influencing selling price (Figure 15a). For aspen-dominated sales, appraised volume per acre, the total size of the sale (acres), and the number of species in a sale were the next three most sensitive variables (Figure 15b).

For the version that excluded regional variables, selling price was most sensitive to appraised volume per acre, the number of species in a sale, and total size of the sale (acres), although in a different order for all sales (Figure 15c) and aspen-dominated ones (Figure 15d).



**Figure 15.** Sensitivity analysis results comparing which factors influence selling price per cord for Minnesota timber sale data, FY2010 through FY2014. Relative influence score ranges from 0 (no influence) to 100 (complete influence) using generalized boosted regression models.

## 5. SUMMARY AND CONCLUSIONS

Findings highlight differences in the attributes of sealed versus oral bids for MnDNR timber sales sold FY2010 through FY2014. Sealed bids are offered on tracts with greater appraised volume available for sale and larger tract sizes compared to oral bids. In the case for aspen-dominated sales, appraised volume per acre is greater on sealed bids (average of 14.0 cords) compared to oral bids (average of 12.5 cords). With the exception of the Northeast, these trends are across the MnDNR regions. Appraised prices do not differ depending on bid type; however, selling prices are generally greater for aspen sales purchased with sealed bids compared to oral bids. With the exception of the Central region, the sale price of aspen is similarly greater when analyzing data by region. In the case for aspen, there are significant differences in the sale price per cord between sealed (average of \$25.88) and oral bids (average of \$23.10). Whether a bid is sealed versus oral is a significant determinant of total sale price. For a 200-acre aspen sale, the total sale price on a sealed bid would yield \$6,630 more (on average) than an oral bid. Total sale price on aspen sales was significantly greater on sealed bids compared to oral bids in the Northeast and Northwest regions, but not for the Central region.

Similar trends emerge when analyzing information within various categories of timber sale characteristics (e.g., sale acreage, appraised volume), at least for aspen-dominated sales. Sealed bids yield significantly greater selling prices for each category of sale size (< 40 acres, 40 to 80 acres, and > 80 acres) and total sale volume (< 500 cords, 500 to 1,000 cords, and > 1,000 cords).

The MnDNR office (i.e., RAN) in which wood is sold is the best-performing variable determining the sensitivity of selling price, indicating the importance of local competition and markets in determining timber prices (i.e., Figure 14). If MnDNR region variables are removed when evaluating timber sale characteristics, whether a sale is offered via oral or sealed bid has low influence on selling price per cord, for all permits statewide and for aspen-dominated sales. Selling price was most sensitive to appraised volume per acre, the number of species in a sale, and total size of the sale when MnDNR region and the local RAN were removed. This indicates the importance of interpreting all available variables which may influence timber sales. Greater volumes per acre and larger-sized sales (in terms of acreage) are typically offered via sealed bids, which appears to yield the higher selling prices observed.

Trends in harvesting practices in Minnesota indicate a higher percentage of wood being harvested during winter and a decreasing percentage during summer dating back to 1991 (Blinn et al. 2015). Nearly 28% of Minnesota loggers producing more than 5,000 cords per year do not harvest any timber in the summer months (Blinn et al. 2015). Although whether a sale occurred in the second quarter serves as a coarse metric to indicate whether a sale can be harvested during the summer, an indicator variable that better represents summer wood availability would be advantageous if included in the MnDNR timber sale database. This information could be better used in assessments of the health and year-round sustainability of loggers and forest products industries.

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