Post Implementation Override Study
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The AMS, Livestock, Poultry, and Seed Program's Quality and Assessment Division (QAD) made several revisions to *Procedure 515, Beef Carcass Instrument Grading Procedures*. One of the revisions involved decreasing the marbling override tolerance from 100 to 40 marbling degrees for instrument marbling. The decrease in the tolerance could result in an excessive number of quality grade overrides thereby impacting the quality grade distribution. As such, the grade overrides were closely monitored.

Starting October 1, 2015, QAD graders recorded the daily overrides for six months. Graders cataloged overrides by type; downgrades such as Choice to Select, and, upgrades such as Choice to Prime. The Standardization Branch collected weekly override and grading data in addition to instrument validation data to examine the impact of a 40 marbling tolerance on instrument augmented grading and the grade distribution.

Methodology
Plants
The override data was collected at Cargill Meat Solutions (Dodge City, KS; Fort Morgan, CO; Friona, TX; Schuyler NE), Harris Ranch Beef Company (Selma, CA), Greater Omaha Packing Co, Inc. (Omaha, NE), National Beef Packing Company (Dodge City, KS; Liberal, KS), Nebraska Beef, Ltd (Omaha, NE), and Washington Beef LLC (Toppenish, WA). The collection period went from October 1, 2015 through March 31, 2016.

Nine of the plants utilized instrument grading systems manufactured by e+v Technology GmbH & Co (e+v). Seven of the plants used an e+v LED based system while the two plants used an e+v Xenon based system. One plant used a Xenon based instrument grading system manufactured by Research Management Systems, Inc. (RMS).

Override Data Collection
Overrides were classified as downgrades or upgrades. Downgrades were Prime to Choice, Choice to Select, Choice to Ungraded, and, Select to Ungraded. Upgrades were Ungraded to Select, Select to Choice, and, Choice to Prime. Overrides were recorded daily and by shift. Plant override data was sent weekly to the QAD Standardization Branch. Weekly plant grade volume data was obtained from the QAD Grading Branch.

Instrument Grading Marbling Validation

Instrument marbling validation data was collected to benchmark override data with instrument performance. Instruments are validated before each shift. Validation data consisted of the the marbling scores from four cards: low marbling (traces (RMS, E+V Xenon) to slight marbling (E+V LED)), medium marbling (modest marbling), high marbling (moderate (RMS, E+V Xenon) and slightly abundant marbling (E+V LED)). A USDA marbling card (slight marbling) was used to assess variability. Instrument readings from the low, medium and high marbling cards had to be within tolerances before an instrument was used officially for grading.

Statistical Analysis

Analyses were conducted using the procedures of SAS (SAS Inst. Inc.) MEANS and CORR procedures. Analysis for differences was conducted using MIXED procedures with a predetermined significance level of $P<0.05$. Nonlinear regression analysis was conducted using Microsoft Excel and the Generalized Reduced Gradient (GRG) Nonlinear option of Solver to fit an exponential decay model where % Override = $b_2 + b_1 \exp(-b_0 d)$ where b_2 is the distance from zero to the asymptote (curve approaches some constant value), b_1 is the distance from the asymptote to the y-intercept, b_0 is the rate of change, and t is days. The value of $b_1 + b_2$ represents the point where the line fit meets the y or vertical axis.

Results

Marbling Override Grade Changes

Grade change overrides were monitored from October 1, 2015 through March 31, 2016. During this period, 4,364,011 carcasses were graded. The percentage of grade changes are summarized in Table 1. Total downgrades, upgrades and grade changes gradually decreased over the monitoring period. The magnitude of final total grade change was half that of the starting total grade change by the end of the monitoring period (compare 9/27/15 to 3/27/16). A majority of the downgrades were associated with the Choice to Select grade change. With respect to upgrades, the Select to Choice and Choice to Prime were similar, 0.08% and 0.07%, respectively. The six-month period had a total of 0.94% grade changes. This was considerably less than the 5.30% of 7,685 carcasses from an earlier pilot trial. Three of the ten plants had essentially no upgrades.

The decrease in grade changes during the monitoring period is consistent with a Hawthorne effect[1]. USDA graders were aware that the overrides were being monitored and as such, their grading pattern at the start most likely did not reflect their normal day-to-day patterns. Their grading patterns would gradually return to their typical day-to-day pattern.

The decline in overrides over the review period was characteristic of an exponential decay curve (Figure 1). The override data was analyzed using nonlinear regression. Parameter estimates for each nonlinear regression model are presented in Table 3. The b2 parameters suggest that in six additional months or longer, the grade changes would be around 0.517% for

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[1] Newstrom, J. W., & Davis, K. (2002). Organizational behavior: Human behavior at work (11th ed.). Boston: McGraw-Hill

Total Downgrades, 0.132% Total Upgrades, and 0.676% Total Grade Changes. The estimates compare favorably with the Total Downgrades (0.14%) and Total Upgrades (0.67%) for the week beginning 3/27 in Table 1. The estimate for Total Grade Changes was less than the Total Grade Changes (0.81%) for the week beginning 3/27. Total Upgrades decreased at a faster rate (b_0=2.757%) than either Total Downgrades (b_0=1.045%) and Total Grade Changes (b_0=1.365%).

The grade distributions (% Prime, % Choice and %Select) for each week were monitored to ascertain if the number of overrides resulted from a grader-instrument override or from an increase/decrease the number of carcasses graded of that particular grade. For example, a large number of Prime carcasses might result in more Prime carcasses being downgraded because there are a greater number of prime carcasses. Table 2 displays the overrides within quality grade along with the grade changes that would place carcasses "In" that grade as well as grade changes that would take "Out" carcasses from that grade. Within each quality grade, greater changes occurred with the Select grade followed by the Prime grade while the Choice grade had the least. Downgrades and upgrades within each quality grade were slightly related to changes in quality grade. There also was a gradual decrease in Total Grade Changes over the review period in a fashion similar to when the % grade changes were based on total carcasses graded.

Four of the ten plants were one shift plants while the others were two shift plants. With respect to two-shift plants, there was no consequential difference between day and night shifts with the exception of Choice to Select (Table 4). The one shift plants were different from the day shift of the two shift plants. The major difference between one- and two-shift plants were the amount of Prime to Choice downgrades, 0.64% vs. 0.02%, respectively. Two of the one shift plants had very few upgrades (0.001% and 0.003%) while the upgrades of the other two plants were either similar or exceeded two shift plants (0.239% and 0.586%). There was a two shift plant that only had one upgrade during the six-month period.

To ascertain if instruments performance influenced overrides, the validation card targets were subtracted from the validation readings. A positive difference would indicate that the instrument marbling scores would be higher around that target value while a negative value would have lower marbling scores. Data characterizing the differences from the targets are presented in Table 5. The mean differences were within one standard deviation of zero while the minimum and maximum of the difference data were within 20 of the target values. The mean percent of total overrides was within one standard deviation of zero as well.

Pearson correlation coefficients were used to quantify linear associations among validation targets differences in addition to total percent overrides (Table 5). Correlation coefficients of 0.3 or less indicate that the correlation coefficients are weak indicating little to no linear association. Of the correlation coefficients, there was a negative relationship between the medium and high cards suggesting as the high card difference became more positive, the medium card difference became more negative. However, the percent override correlation coefficients suggest that instrument performance had little to no influence on the overrides.

Summary

Over the six-month monitoring period, 4,364,011 carcasses were graded. There were 0.94% total override grade changes during the monitoring period. A majority of the grade changes were Choice to Select followed by Prime to Choice. With respect to upgrades, the Select to Choice and Choice to Prime were similar in magnitude and represented 88% of the upgrades.

There was a gradual decline in total overrides from 1.64% to 0.81% over the review period. A six-month extrapolation of the exponential decay curve for total grade changes resulted in an estimate of 0.68% for October 1, 2016 versus 1.63% observed a year earlier.

There was difference between one-shift plants and two-shift plants. The major difference between one- and two-shift plants was the amount of Prime to Choice downgrades. There was quite a difference within the one-shift plants in that two of the one-shift plants had very few upgrades while the other two had upgrades that were similar or exceeded two-shift plants. There was a two shift plant that only had one upgrade during the six-month period.

Instrument performance was found not to influence overrides based on instrument validation readings.

Table 1. Instrument marbling score overrides by grade change as a percentage of carcasses graded (n=4,364,011)

Grade Change	9/27/15	10/4/15	10/11/15	10/18/15	10/25/15	11/1/15	11/8/15	11/15/15	11/22/15	11/29/15	12/6/15	12/13/15	12/20/15	12/27/15
Prime to Choice	0.15%	0.12%	0.12%	0.08%	0.10%	0.17%	0.18%	0.13%	0.18%	0.15%	0.14%	0.13%	0.20%	0.11%
Choice to Select	0.89%	0.69%	0.76%	0.62%	0.67%	0.76%	0.57%	0.64%	0.55%	0.59%	0.62%	0.62%	0.60%	0.47%
Choice to Ungraded	0.05%	0.02%	0.01%	0.02%	0.04%	0.01%	0.04%	0.02%	0.01%	0.02%	0.00%	0.01%	0.00%	0.02%
Select to Ungraded	0.18%	0.10%	0.10%	0.09%	0.11%	0.09%	0.13%	0.09%	0.07%	0.08%	0.10%	0.11%	0.09%	0.04%
Total	1.28%	0.92%	0.99%	0.81%	0.92%	1.03%	0.91%	0.89%	0.81%	0.85%	0.86%	0.86%	0.90%	0.64%
Choice to Prime	0.16%	0.16%	0.13%	0.10%	0.09%	0.11%	0.06%	0.10%	0.08%	0.08%	0.09%	0.06%	0.05%	0.03%
Select to Choice	0.15%	0.12%	0.09%	0.08%	0.12%	0.11%	0.06%	0.07%	0.07%	0.10%	0.08%	0.07%	0.07%	0.05%
Ungraded to Select	0.03%	0.02%	0.02%	0.02%	0.02%	0.03%	0.03%	0.01%	0.02%	0.03%	0.03%	0.03%	0.02%	0.01%
Total	0.35%	0.30%	0.24%	0.20%	0.23%	0.24%	0.15%	0.18%	0.18%	0.22%	0.20%	0.15%	0.14%	0.09%
Total Grade Changes	1.63%	1.22%	1.23%	1.01%	1.15%	1.27%	1.07%	1.07%	0.98%	1.07%	1.06%	1.01%	1.03%	0.73%

Grade Change	1/3	1/10	1/17	1/24	1/31	2/7	2/14	2/21	2/28	3/6	3/13	3/20	3/27	Total All
Prime to Choice	0.11%	0.14%	0.14%	0.17%	0.13%	0.12%	0.11%	0.10%	0.09%	0.11%	0.15%	0.13%	0.12%	0.13%
Choice to Select	0.42%	0.42%	0.51%	0.47%	0.42%	0.41%	0.45%	0.38%	0.43%	0.46%	0.40%	0.44%	0.44%	0.54%
Choice to Ungraded	0.01%	0.06%	0.00%	0.01%	0.02%	0.00%	0.00%	0.01%	0.00%	0.00%	0.01%	0.00%	0.02%	0.01%
Select to Ungraded	0.10%	0.07%	0.09%	0.08%	0.08%	0.05%	0.07%	0.05%	0.08%	0.08%	0.08%	0.07%	0.09%	0.09%
Total	0.64%	0.69%	0.75%	0.72%	0.64%	0.59%	0.64%	0.55%	0.60%	0.65%	0.64%	0.64%	0.67%	0.77%
Choice to Prime	0.05%	0.09%	0.05%	0.06%	0.07%	0.04%	0.05%	0.04%	0.06%	0.05%	0.04%	0.04%	0.05%	0.07%
Select to Choice	0.08%	0.06%	0.07%	0.07%	0.10%	0.06%	0.08%	0.05%	0.09%	0.08%	0.06%	0.05%	0.07%	0.08%
Ungraded to Select	0.03%	0.02%	0.02%	0.01%	0.04%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.01%	0.02%	0.02%
Total	0.16%	0.18%	0.14%	0.14%	0.21%	0.11%	0.13%	0.10%	0.16%	0.14%	0.12%	0.10%	0.14%	0.17%
Total Grade Changes	0.80%	0.86%	0.88%	0.86%	0.85%	0.70%	0.77%	0.65%	0.76%	0.80%	0.75%	0.74%	0.81%	0.94%

Table 2. Instrument marbling score overrides by grade change as a percentage of final quality grade (n=4,364,011)

Quality Grade & Up/Down Grades	9/27	10/4	10/11	10/18	10/25	11/1	11/8	11/15	11/22	11/29	12/6	12/13	12/20	12/27
										Week beginning				
Prime	4.91%	5.04%	5.73%	5.73%	5.55%	5.83%	6.60%	6.20%	5.92%	6.16%	6.21%	6.07%	6.09%	5.09%
Prime to Choice	3.06%	2.31%	2.01%	1.43%	1.88%	2.84%	2.75%	2.14%	2.96%	2.46%	2.18%	2.13%	3.23%	2.09%
Choice to Prime	3.37%	3.17%	2.26%	1.83%	1.63%	1.80%	0.90%	1.56%	1.36%	1.38%	1.52%	0.91%	0.77%	0.57%
Total Change	6.43%	5.48%	4.28%	3.26%	3.50%	4.65%	3.65%	3.71%	4.32%	3.84%	3.70%	3.05%	4.00%	2.66%
Total "Out"	3.06%	2.31%	2.01%	1.43%	1.88%	2.84%	2.75%	2.14%	2.96%	2.46%	2.18%	2.13%	3.23%	2.09%
Total "In"	3.37%	3.17%	2.26%	1.83%	1.63%	1.80%	0.90%	1.56%	1.36%	1.38%	1.52%	0.91%	0.77%	0.57%
Choice	76.34%	75.19%	75.21%	75.16%	75.26%	75.17%	75.39%	74.92%	76.09%	76.40%	75.77%	75.44%	76.25%	77.16%
Choice to Prime	0.22%	0.21%	0.17%	0.14%	0.12%	0.14%	0.08%	0.13%	0.11%	0.11%	0.12%	0.07%	0.06%	0.04%
Choice to Select	1.17%	0.91%	1.01%	0.82%	0.88%	1.01%	0.75%	0.86%	0.72%	0.78%	0.82%	0.82%	0.79%	0.61%
Choice to Ungraded	0.07%	0.03%	0.02%	0.02%	0.05%	0.01%	0.05%	0.03%	0.01%	0.03%	0.00%	0.01%	0.01%	0.02%
Prime to Choice	0.20%	0.15%	0.15%	0.11%	0.14%	0.22%	0.24%	0.18%	0.23%	0.20%	0.18%	0.17%	0.26%	0.14%
Select to Choice	0.20%	0.16%	0.12%	0.10%	0.16%	0.14%	0.08%	0.09%	0.10%	0.13%	0.11%	0.10%	0.09%	0.06%
Total Change	1.85%	1.46%	1.48%	1.20%	1.36%	1.53%	1.20%	1.28%	1.17%	1.24%	1.23%	1.17%	1.21%	0.87%
Total "Out"	1.46%	1.15%	1.20%	0.99%	1.06%	1.16%	0.88%	1.02%	0.84%	0.92%	0.95%	0.90%	0.86%	0.67%
Total "In"	0.40%	0.31%	0.27%	0.21%	0.30%	0.36%	0.32%	0.27%	0.33%	0.33%	0.29%	0.27%	0.35%	0.20%
Select	18.75%	19.77%	19.06%	19.12%	19.18%	18.99%	18.01%	18.88%	17.99%	17.44%	18.03%	18.49%	17.66%	17.74%
Choice to Select	4.76%	3.47%	3.99%	3.24%	3.47%	4.00%	3.15%	3.40%	3.06%	3.40%	3.45%	3.34%	3.42%	2.66%
Select to Choice	0.81%	0.60%	0.48%	0.40%	0.64%	0.57%	0.34%	0.36%	0.41%	0.56%	0.45%	0.39%	0.40%	0.28%
Select to Ungraded	0.98%	0.51%	0.52%	0.47%	0.57%	0.49%	0.72%	0.48%	0.41%	0.48%	0.56%	0.58%	0.51%	0.24%
Ungraded to Select	0.18%	0.12%	0.11%	0.11%	0.10%	0.14%	0.17%	0.08%	0.12%	0.20%	0.14%	0.15%	0.12%	0.07%
Total Change	6.72%	4.70%	5.10%	4.22%	4.78%	5.19%	4.38%	4.30%	4.00%	4.64%	4.60%	4.46%	4.45%	3.25%
Total "Out"	1.79%	1.11%	1.00%	0.87%	1.21%	1.05%	1.05%	0.83%	0.81%	1.03%	1.01%	0.97%	0.91%	0.52%
Total "In"	4.94%	3.59%	4.09%	3.35%	3.57%	4.14%	3.32%	3.47%	3.19%	3.60%	3.59%	3.49%	3.54%	2.73%

Total "Out" represents the total of the number of carcasses that were downgraded and upgraded out of the quality grade. Total "In" represents the total of the number of carcasses that were downgraded and upgraded into the quality grade. Using the Choice grade as an example, Total "Out" is the sum of Choice to Prime, Choice to Select and Choice to Ungraded. Total In is the sum of Prime to Choice and Select to Choice. Total Change is the sum of Total "Out" and Total "In."

Table 2. *Continued*

Quality Grade & Up/Down Grades	1/3	1/10	1/17	1/24	1/31	2/7	2/14	2/21	2/28	3/6	3/13	3/20	3/27	Total All
						Week beginning								
Prime	5.55%	5.71%	5.19%	5.03%	4.87%	5.41%	4.81%	4.69%	4.87%	5.31%	5.04%	5.16%	4.97%	5.49%
Prime to Choice	2.05%	2.52%	2.71%	3.35%	2.62%	2.16%	2.28%	2.23%	1.94%	2.12%	2.94%	2.45%	2.48%	2.40%
Choice to Prime	0.86%	1.59%	0.93%	1.24%	1.41%	0.71%	0.95%	0.90%	1.18%	1.03%	0.81%	0.70%	1.09%	1.33%
Total Change	2.90%	4.11%	3.65%	4.59%	4.03%	2.87%	3.22%	3.13%	3.12%	3.15%	3.76%	3.14%	3.57%	3.73%
Total "Out"	2.05%	2.52%	2.71%	3.35%	2.62%	2.16%	2.28%	2.23%	1.94%	2.12%	2.94%	2.45%	2.48%	2.40%
Total "In"	0.86%	1.59%	0.93%	1.24%	1.41%	0.71%	0.95%	0.90%	1.18%	1.03%	0.81%	0.70%	1.09%	1.33%
Choice	77.64%	78.01%	76.82%	78.03%	78.63%	79.80%	80.15%	78.63%	78.87%	78.64%	78.85%	78.49%	78.57%	77.06%
Choice to Prime	0.06%	0.12%	0.06%	0.08%	0.09%	0.05%	0.06%	0.05%	0.07%	0.07%	0.05%	0.05%	0.07%	0.09%
Choice to Select	0.55%	0.54%	0.67%	0.60%	0.53%	0.52%	0.56%	0.49%	0.55%	0.59%	0.49%	0.56%	0.56%	0.70%
Choice to Ungraded	0.01%	0.07%	0.00%	0.01%	0.02%	0.00%	0.01%	0.02%	0.01%	0.00%	0.01%	0.00%	0.03%	0.02%
Prime to Choice	0.15%	0.18%	0.18%	0.22%	0.16%	0.15%	0.14%	0.13%	0.12%	0.14%	0.19%	0.16%	0.16%	0.17%
Select to Choice	0.10%	0.08%	0.09%	0.09%	0.13%	0.08%	0.10%	0.06%	0.11%	0.10%	0.08%	0.06%	0.09%	0.10%
Total Change	0.86%	0.99%	1.01%	0.99%	0.94%	0.79%	0.86%	0.75%	0.86%	0.90%	0.82%	0.83%	0.90%	1.09%
Total "Out"	0.62%	0.73%	0.73%	0.69%	0.64%	0.57%	0.62%	0.56%	0.62%	0.66%	0.55%	0.61%	0.65%	0.82%
Total "In"	0.25%	0.26%	0.28%	0.30%	0.29%	0.22%	0.23%	0.19%	0.23%	0.24%	0.27%	0.22%	0.24%	0.27%
Select	16.81%	16.28%	17.99%	16.94%	16.50%	14.79%	15.04%	16.68%	16.26%	16.05%	16.11%	16.35%	16.46%	17.45%
Choice to Select	2.52%	2.57%	2.86%	2.77%	2.54%	2.79%	2.99%	2.30%	2.65%	2.88%	2.39%	2.71%	2.66%	3.09%
Select to Choice	0.46%	0.37%	0.40%	0.39%	0.62%	0.41%	0.51%	0.28%	0.54%	0.47%	0.39%	0.29%	0.41%	0.45%
Select to Ungraded	0.59%	0.40%	0.50%	0.46%	0.46%	0.36%	0.47%	0.30%	0.46%	0.47%	0.49%	0.44%	0.55%	0.49%
Ungraded to Select	0.19%	0.15%	0.09%	0.08%	0.22%	0.09%	0.06%	0.06%	0.07%	0.08%	0.05%	0.08%	0.12%	0.12%
Total Change	3.75%	3.50%	3.85%	3.70%	3.84%	3.65%	4.03%	2.94%	3.72%	3.91%	3.33%	3.51%	3.74%	4.15%
Total "Out"	1.05%	0.78%	0.90%	0.85%	1.08%	0.77%	0.98%	0.58%	1.00%	0.94%	0.88%	0.72%	0.96%	0.94%
Total "In"	2.70%	2.73%	2.95%	2.85%	2.76%	2.88%	3.05%	2.36%	2.72%	2.97%	2.44%	2.79%	2.78%	3.21%

Table 3. Parameter estimates for the nonlinear models fitted to
<u>Total Grade Changes</u>, <u>Total Downgrades</u> and <u>Total Upgrades</u>

	b_2	b_1	b_0	$b_1 + b_2$
Downgrade	0.517%	0.624%	1.045%	1.141%
Upgrade	0.132%	0.240%	2.757%	0.372%
Total Grade Changes	0.676%	0.812%	1.365%	1.488%

Table 4. Percent overrides by one and two shift plants.

	One shift	Two Shifts	
Grade Change	**Day**	**Day**	**Night**
Prime to Choice	0.64%	0.02%	0.04%
Choice to Select	0.76%	0.42%	0.57%
Choice to Ungraded	0.02%	0.01%	0.02%
Select to Ungraded	0.10%	0.09%	0.08%
Total	*1.52%*	*0.54%*	*0.71%*
Choice to Prime	0.07%	0.07%	0.08%
Select to Choice	0.13%	0.07%	0.07%
Ungraded to Select	0.01%	0.02%	0.02%
Total	*0.21%*	*0.16%*	*0.17%*

Table 5. Means and standard deviations of differences from validation targets and percent overrides (n=464)

	Mean	Std Dev	Minimum	Maximum
Difference from Low Card Target	0.47	3.76	-11	18
Difference from Medium Card Target	-2.62	6.02	-20	12
Difference from High Card Target	1.55	5.49	-12	19
Difference from USDA Card Target	-2.68	6.44	-20	14
Percent Overrides	-0.35%	0.61%	-	-

Table 6. Correlations among differences from validation targets and percent overrides[1]

		1	2	3	4	5
1	Difference from Low Card Target		-0.11	-0.13	-0.09	-0.02
2	Difference from Medium Card Target	-0.11		-0.30	0.22	0.17
3	Difference from High Card Target	-0.13	-0.30		-0.08	-0.08
4	Difference from USDA Card Target	-0.09	0.22	-0.08		-0.01
5	Percent Overrides	-0.02	0.17	-0.08	-0.01	

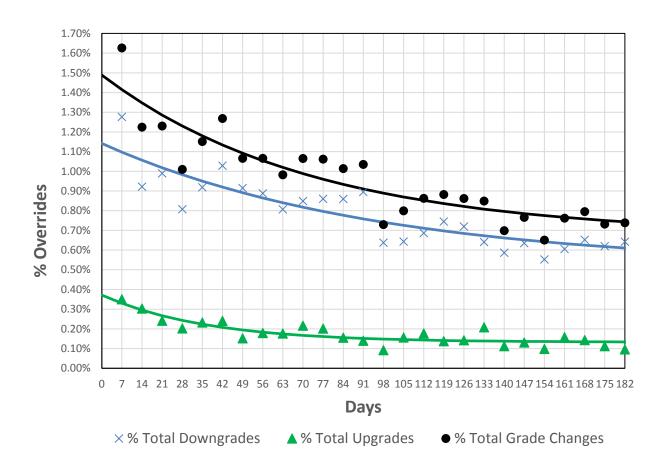[1]Coefficients ≥ 0.10 differ from 0 ($P<0.01$)

Figure 1. Mean instrument marbling score override as a function of trial day. Nonlinear regression models (% Override = $b_2 + b_1 \exp(-b_0 d)$) were fitted to the data points.