YARD SCALE VS. MILL RECOVERY

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OVERVIEW

- Millar Western Forest Products

- Alberta scaling system review

- Scaling process flow chart

- Scaling for cut control and mill consumption

- Volume variances and why

- What we did at MWFP to show why the differences

Millar Western Forest Products Ltd

- Sawmill and Pulp Mill complex at Whitecourt
- 1.2 MM M3 of softwood and 650,000 M3 of aspen
- FMA agreement with province of Alberta

Why Do We Scale
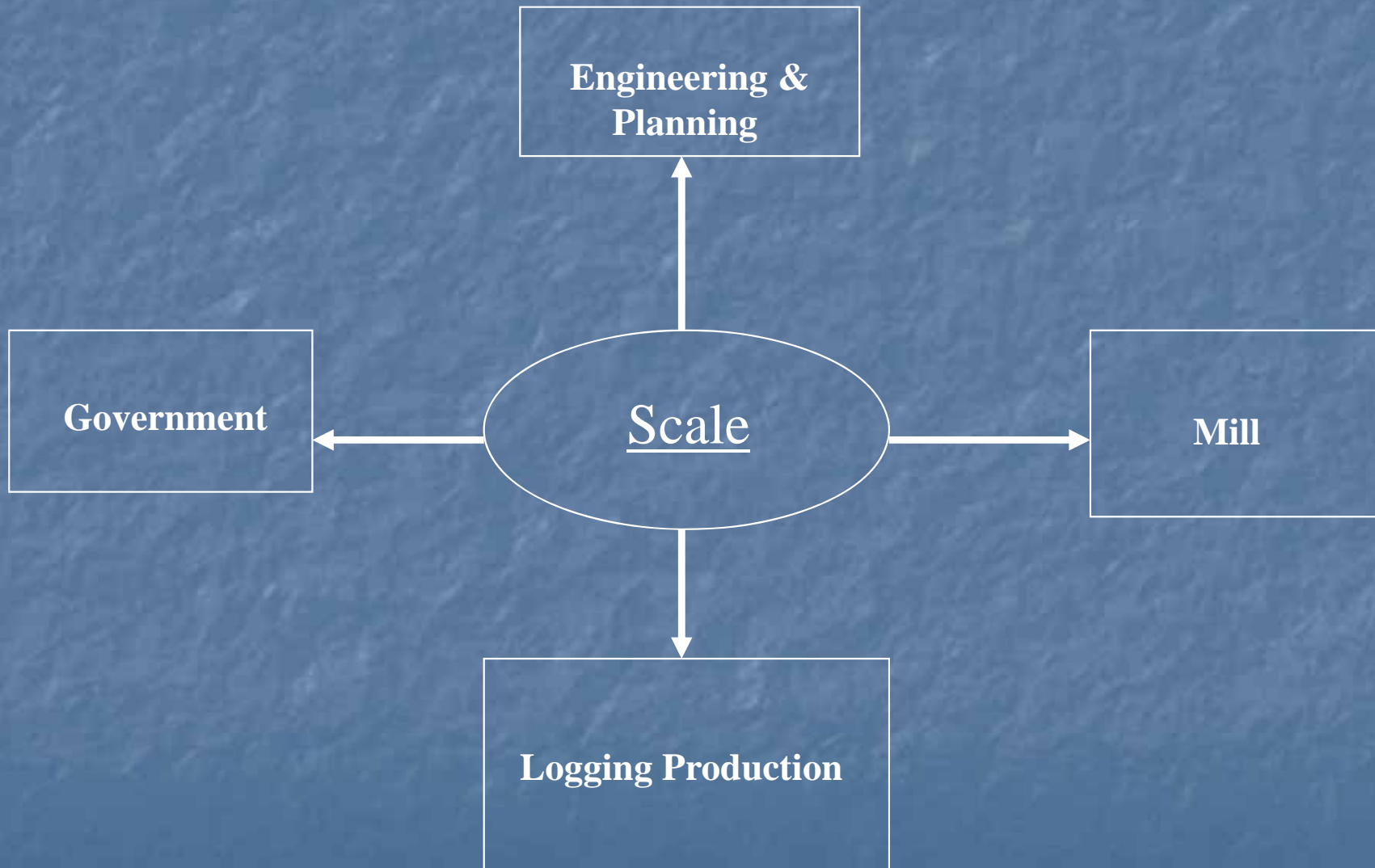
Yard Inventory

- 280,000 M3 TL Conifer
- 315,000 M3 CTL conifer
- 310,000 M3 aspen

Scaling Program

- MWFP hauls over 40,000 loads in a year
- Impractical to measure every load
- Mass scaling allows us to stratify and sample
- Scale data will give information for
  - Crown dues
  - Contractor pay
  - Mill yard inventory
  - Cut control records - AAC

Year End Cut Out Comparisons

- Conifer log deck inventory based on scale volumes
- Scale versus consumption variance
- Why

Manual Scale to Electronic Scale

- Comparison on 371 logs
- Stick scaled in Smalian
- Load run thru mill and scanner volumes calculated

Mill Studies

- Sample run thru mill
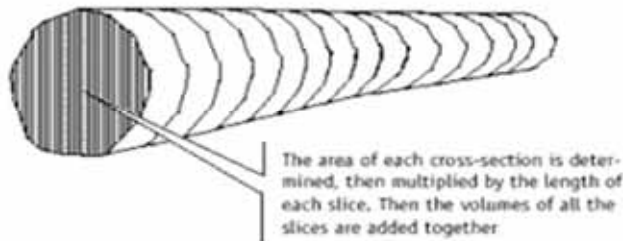- Scanner compared to stick scale

Detailed Methodology For the two volume calculations

Electronic

True volume

The True volume method calculates the area of the log by:

1. Dividing the log into a set of lengthwise segments
2. Calculating the polygonal area of each segment
3. Multiplying the polygonal area by the length of each segment, and then
4. Adding the volumes of all the segments together

The area of each cross-section is determined, then multiplied by the length of each slice. Then the volumes of all the slices are added together

The formula is:

$$\sum_{n=0}^{N} A_n \times L_n$$

where:

- A_n = true shape area of n cross-section
- L_n = length of n segment
- N = number of segments

Manual

- Standard scaling method endorsed by CSA
- Formula
  - V=a1+a2/2 X L

Results from Both Methods

Manual Scale		(Smalian)		
Logs	Gross	Cull	Net	
	Vol (m3)	Vol (m3)	Vol (m3)	
371	50.319 m3	0.209	50.11 m3	

Electronic Scale		(True volume)		
Logs	True volume		Converted using	
	Vol (m3)		Smalian method	
371	52.293 m3		50.039 m3	

Current Sawmill 2012 adjustment of -1.5% to Scanned volume				
	51.51 m3			

- SED & LED Measurements put into diameter classes
- Uses trim for log length

- Uses actual SED & LED Measurements (Inches)
- Log length taken at total lengths (Inches)

Analysis Procedure

- Stratification of the various cutting areas into a sampling population
- Statistical analysis on each population
- Summary stats on each pop
- Contracted out to mensuration professor at U of A

Report Summary

- Analysis of populations

- Are we meeting acceptable error levels - CV % within 8% as prescribed by government

- If so why the difference to mill consumption

Populations

Conifer

Population	Load	AESRD	Weight	Volume	Scaling
	Count	Conversion	Kgs	m3	Sample Size
159	649	668.59	24,545,880	36,713	3
154	3,625	722.31	142,072,300	196,692	24
154	2,639	722.31	105,242,010	145,702	
153	2,448	743.24	95,720,700	128,789	13
156	479	775.31	16,101,980	20,769	14
136	183	658.87	6,686,750	10,149	6
134	531	681.71	19,226,480	28,203	12
133	146	678.16	5,653,450	8,336	10
130	967	695.20	36,015,600	51,806	14
132	207	720.26	7,479,890	10,385	13
102	2,173	766.50	80,531,220	105,064	21
144	1,662	768.86	65,858,460	85,658	13
103	2,021	788.21	82,073,500	104,126	
103	1,442	788.21	67,133,820	85,173	26
Totals	19,172		754,342,040	1,017,564	169

Deciduous

Population	Load	AESRD	Weight	Volume	Scaling
	Count	Conversion	Kgs	m3	Sample Size
151	657	815.18	24,945,640	30,601	32
157	773	903.80	26,333,970	29,137	25
152	1,130	886.40	43,726,620	49,331	16
125	1,939	920.45	71,359,630	77,527	6
141	2,033	927.53	71,109,380	76,665	16
180	1,905	884.16	66,928,030	75,697	14
109	66	883.17	2,472,080	2,799	6
115	534	910.02	21,264,350	23,367	22
108	1,477	931.97	54,243,520	58,203	24
Totals	10,514		382,383,220	423,328	161

Millar Conifer Populations

Population	Load Count	AESRD Conversion	Weight Kgs	Volume m3	Mean Conversion	Scaling Sample Size	Conv Lower CI	Conv Upper CI	Estimated Volume m3	Volume Lower CI	Volume Upper CI	Volume Range
159	649	668.59	24,545,880	36,713	668.84	3	632.27	705.42	36,713	34,796	38,822	4,026
154	3625	722.31	142,072,300	196,692	725.55	24	707.29	743.81	196,692	191,007	200,868	9,861
154	2639	722.31	105,242,010	145,702	725.55	24	707.29	743.81	145,702	141,491	148,795	7,304
153	2448	743.24	95,720,700	128,789	761.35	13	736.20	786.50	128,789	121,705	130,020	8,315
156	479	775.31	16,101,980	20,769	762.13	14	722.11	802.16	20,769	20,073	22,298	2,225
136	183	658.87	6,686,750	10,149	662.89	6	592.31	733.47	10,149	9,117	11,289	2,173
134	531	681.71	19,226,480	28,203	680.68	12	652.53	708.84	28,203	27,124	29,465	2,341
133	146	678.16	5,653,450	8,336	681.24	10	652.24	710.24	8,336	7,960	8,668	708
130	967	695.20	36,015,600	51,806	698.44	14	675.72	721.17	51,806	49,941	53,300	3,359
132	207	720.26	7,479,890	10,385	721.70	13	697.37	746.03	10,385	10,026	10,726	700
102	2173	766.50	80,531,220	105,064	767.88	21	749.82	785.94	105,064	102,465	107,401	4,937
144	1662	768.86	65,858,460	85,658	769.11	13	751.36	786.85	85,658	83,699	87,652	3,953
103	2021	788.21	82,073,500	104,126	790.91	26	777.14	804.69	104,126	101,994	105,610	3,616
103	1442	788.21	67,133,820	85,173	790.91	26	777.14	804.69	85,173	83,428	86,386	2,958
									1,017,564.60			

Population 144

Population Description

POPULATIONID	POP_DESCRIPTION	LOAD Count	KGS	M3	CONV
144	CTLS200001 LMR DRP	1662	65,858,460	85,657.73	768.856

Scaling Results

Population Sample	144
Variable - Conversion	
Mean Conversion	769.106
Standard Deviation	29.36311666
Sample Variance	862.19262
Count	13
Standard Error	8.143863287
Minimum	727.759
Maximum	818.566
Q3	782.332
Q1	750.254
AE	17.74
Confidence Interval (.05)	[751.4,786.8]

AESRD – Scaling Results

Mean Volume m3	53.665
Ratio – Conversion	768.856
Coefficient of Variation	4%

Load Conversions by sample
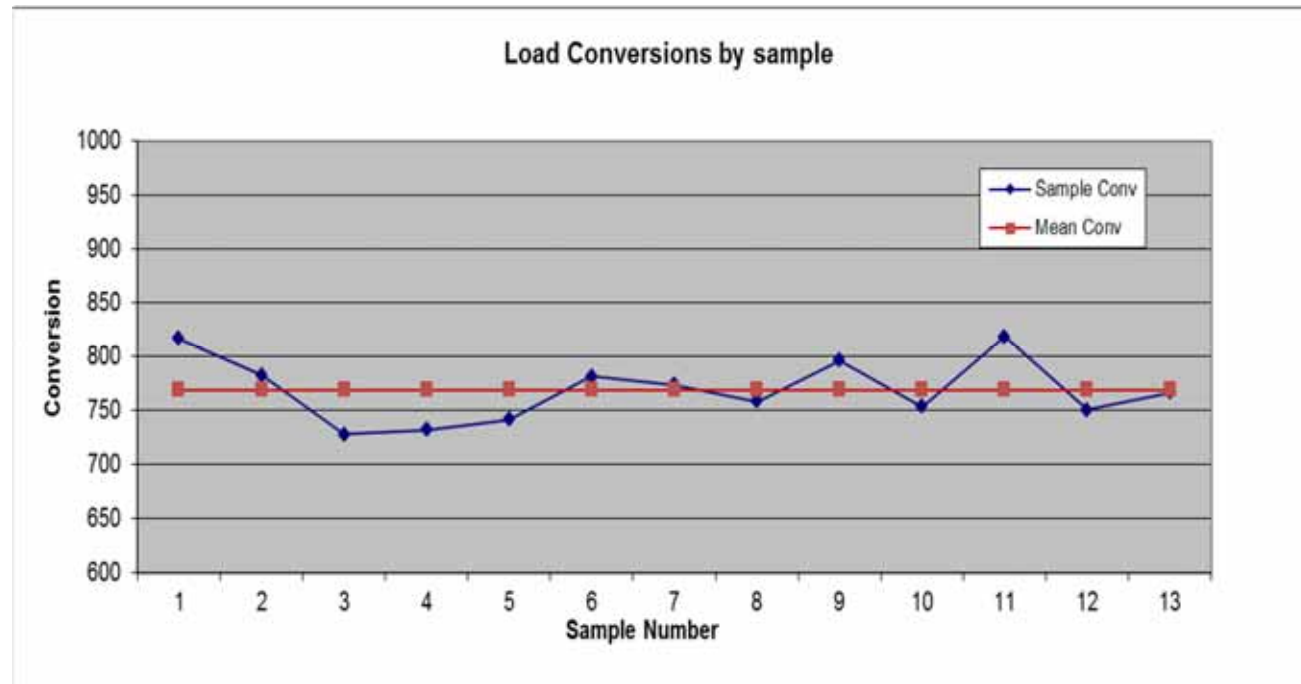
Population 144 - Population Estimates

Population Description

POPULATIONID	POP_DESCRIPTION	LOAD_CNT	KGS	M3	CONV
144	CTLS200001 LMR DRP	1662	65858460	85657.73045	768.856

Sample Statistics

| Population Sample	144
Variable - Conversion	
Mean Conversion	769.106
Standard Deviation	29.36311666
Sample Variance	862.19262
Count	13
Standard Error	8.143863287
Minimum	727.759
Maximum	818.566
Q3	782.332
Q1	750.254
AE	17.74
Confidence Interval (.05)	[751.4,786.8]

Load Conversions by sample
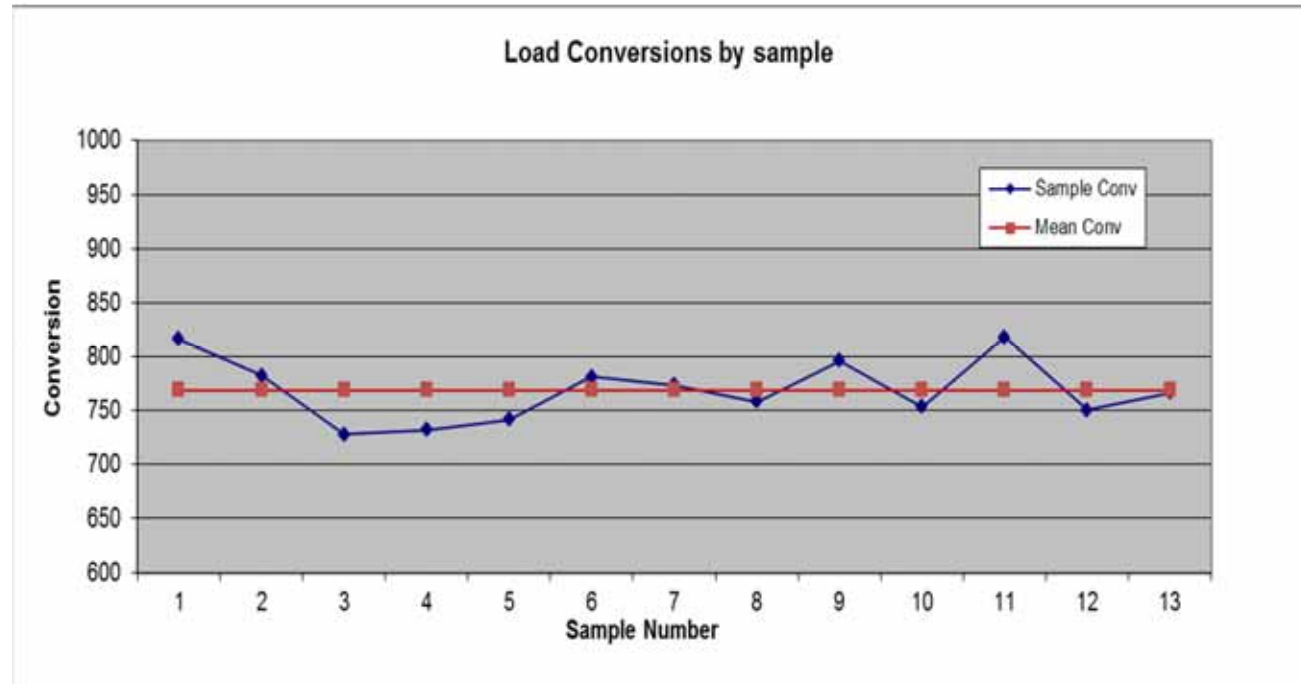
Population Estimates

Mean	Confidence Level(95.0%)	Ci Lower - conversion	CI Upper - conversion	Ci Lower - Volume	CI Upper - volume	Mean Volume
769.106	17.74	751.4	786.8	83,699	87,652	85,658

Population Precision

Population 144	
Range	3955.79
1/2 CI	1977.90

Effect of Sample Size – Assume same mean and constant variance
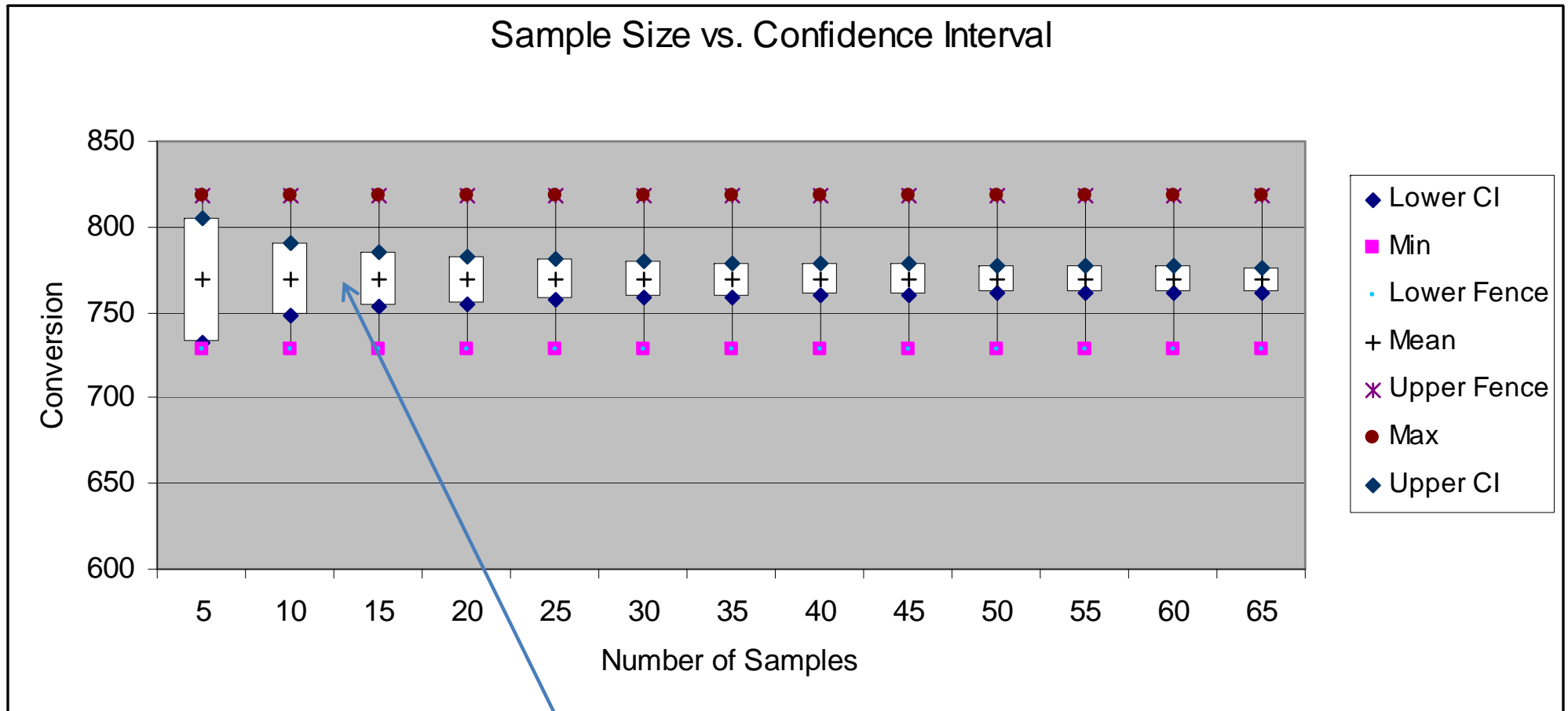
n	5	10	15	20	25	30	35	40
t	2.776445105	2.262157163	2.144786688	2.093024054	2.063898562	2.045229642	2.032244509	2.02269092
se	13.13158498	9.285432785	7.581524121	6.565792488	5.872623332	5.360947118	4.963272595	4.642716392
AE	36.45912483	21.00510828	16.26075201	13.74236161	12.12049885	10.96436796	10.08658348	9.390780291
2*AE	72.91824966	42.01021657	32.52150402	27.48472323	24.2409977	21.92873591	20.17316696	18.78156058
CI	[732.6,805.6]	[748.1,790.1]	[752.8,785.4]	[755.4,782.8]	[757,781.2]	[758.1,780.1]	[759,779.2]	[759.7,778.5]

All Populations

Conversion Factors by Company, Species and Population
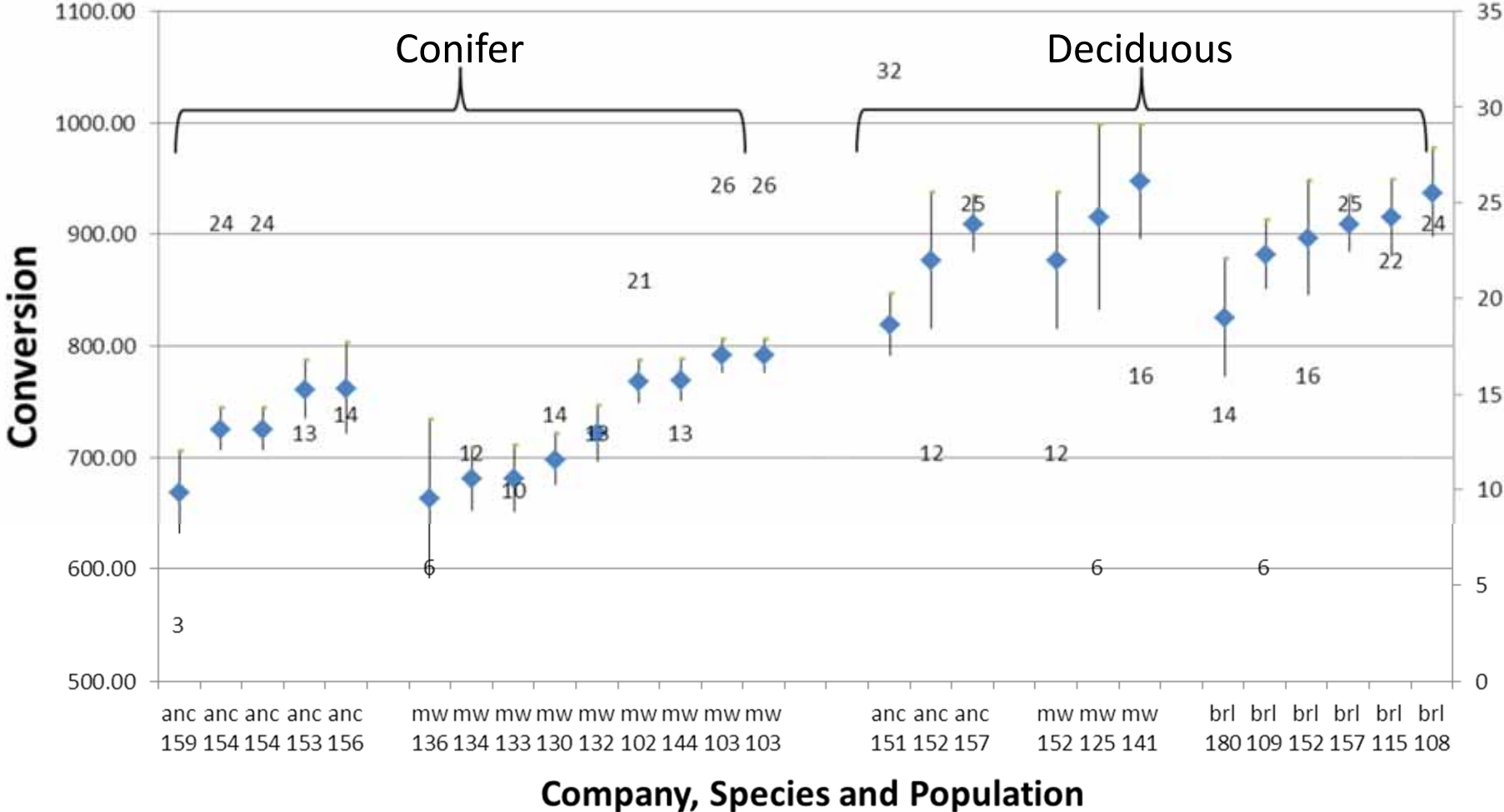
Overall Conifer Population Confidence Intervals

■ Weighted Confidence Interval (weighted by number of loads)

Weighted Conversion Factors			
Mean Conv	Lower CI	Upper CI	Range
741.98	735.88	748.08	12.20
Weighted Conifer Volume (m3)			
Mean Volume	Lower CI	Upper CI	Range
1,016,663.07	1,008,374.01	1,025,089.52	16,715.51

Discussion

- Current procedure – set sampling to a minimum of 15 samples to get a CV of 8%.

- Year end analysis – compare to government requirement.

- Sampling more does not always give a better result.

- There is a threshold where extra samples do not give a bang for the buck

Discussion

- Stratification is key to minimizing variations
- Factors
  - Age
  - Species
  - Form
  - Summer logging vs winter logging

Recommendations

- Thoughtful creation of populations
  - Minimize variation within population
- Monitor sampling results and adjust allocation of plots

Conclusions

- Because you sample, you cannot eliminate sampling error
    - Need to minimize within population variation by stratifying well
    - Sample enough to minimize sample size effect
- Current sampling approaches meet AESRD standards but could potentially be improved to narrow confidence intervals needed for population estimates
- Findings suggest that 20 samples is a good target