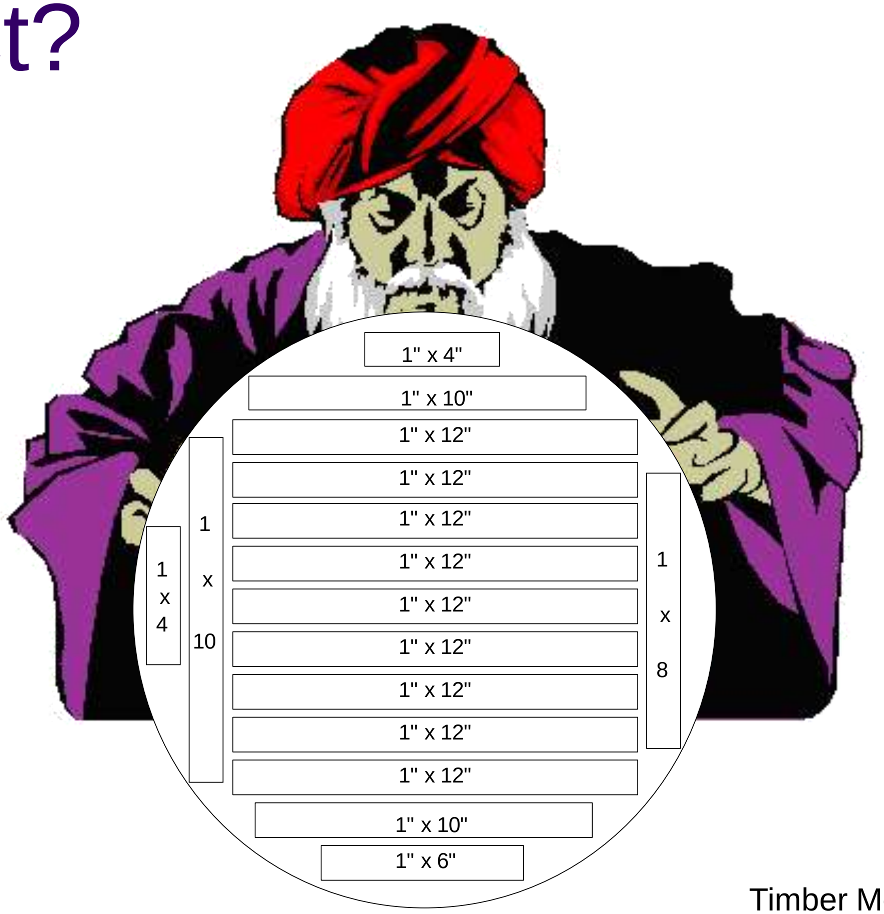
# Overrun and LRF: what do they mean and why are they so difficult to predict?




Timber Measurements Society meeting
9 April 2015 Coeur d’Alene, Idaho

# Variation in recovery

**<u>Log Characteristics</u>**
- diameter
- length
- taper
- defect

**Method of <u>measurement</u>**
- Scribner
- Cubic

**<u>Mill characteristics</u>**
- lumber type
- optimization
- strategy $ or BF

# Overrun and LRF examples

Volume US: **16.5’-14”-15.5”; BC: 5.0m-$18^R$-$20^R$**

110 BF east-side, 110 BF west-side

19.7 $ft^3$ USFS, 0.569 $m^3$ BC

**Overrun: 1.65 east-side, 1.65 west-side**

**LRF: 9.2 USFS, 318 BC**

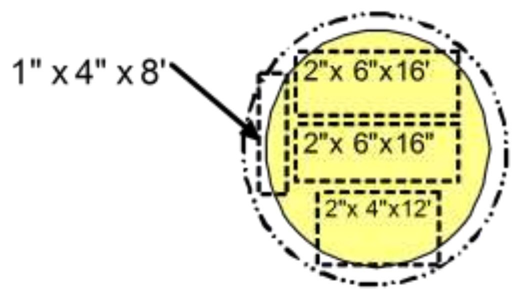
Volume **US: 16.5’-6.9”-8.5”; BC: 5.0m-$9^R$-$11^R$**

30 BF east-side, 20 BF west-side

5.7 $ft^3$ USFS, 0.159 $m^3$ BC

**Overrun: 1.42 east-side, 2.13 west-side**

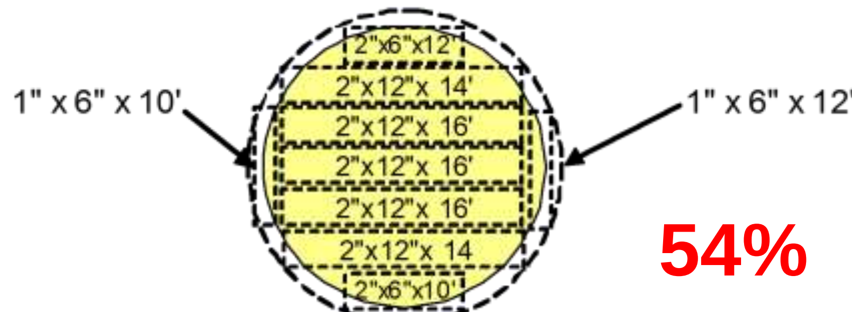
**LRF: 7.5 USFS, 268 BC**




**43%**

**Lumber Yield**

| Length | Thick | Width | BF |
|---|---|---|---|
| 8 | 1 | 4 | 2.67 |
| 16 | 2 | 6 | 16 |
| 16 | 2 | 6 | 16 |
| 12 | 2 | 4 | 8 |
| | | BF lumber | **42.67** |




**54%**

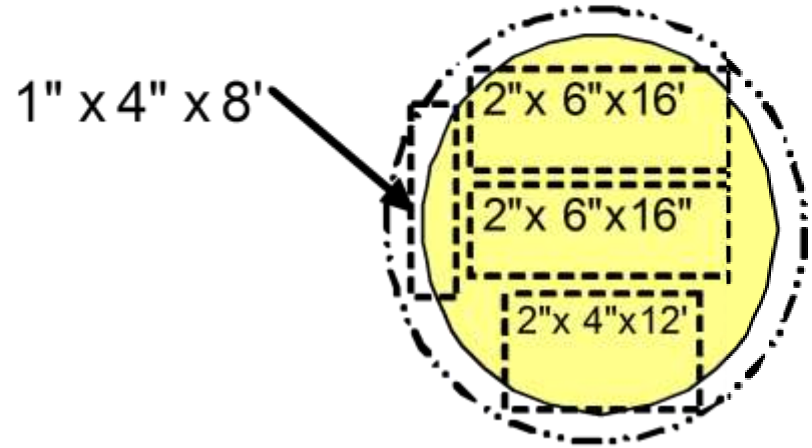
**Lumber Yield**

| Length | Thick | Width | BF |
|---|---|---|---|
| 12 | 2 | 6 | 12 |
| 14 | 2 | 12 | 28 |
| 16 | 2 | 12 | 32 |
| 16 | 2 | 12 | 32 |
| 16 | 2 | 12 | 32 |
| 12 | 2 | 12 | 24 |
| 10 | 2 | 6 | 10 |
| 10 | 1 | 6 | 5 |
| 12 | 1 | 6 | 6 |
| | | BF lumber | **181.00** |

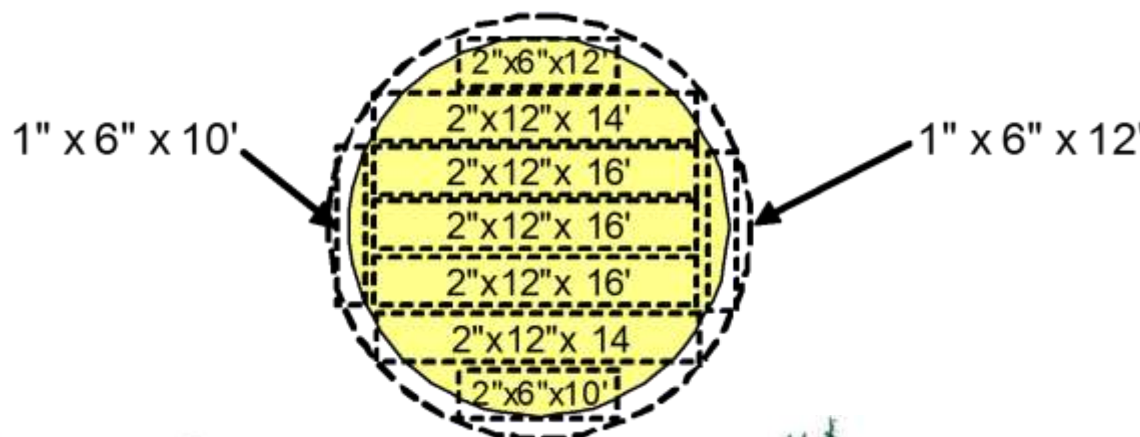
# Diameter

- Slab loss is greater for small logs than for large logs
- Less options to maximize yield in small logs (2” width increments)
- Related; volume in taper more for small logs vs. large logs

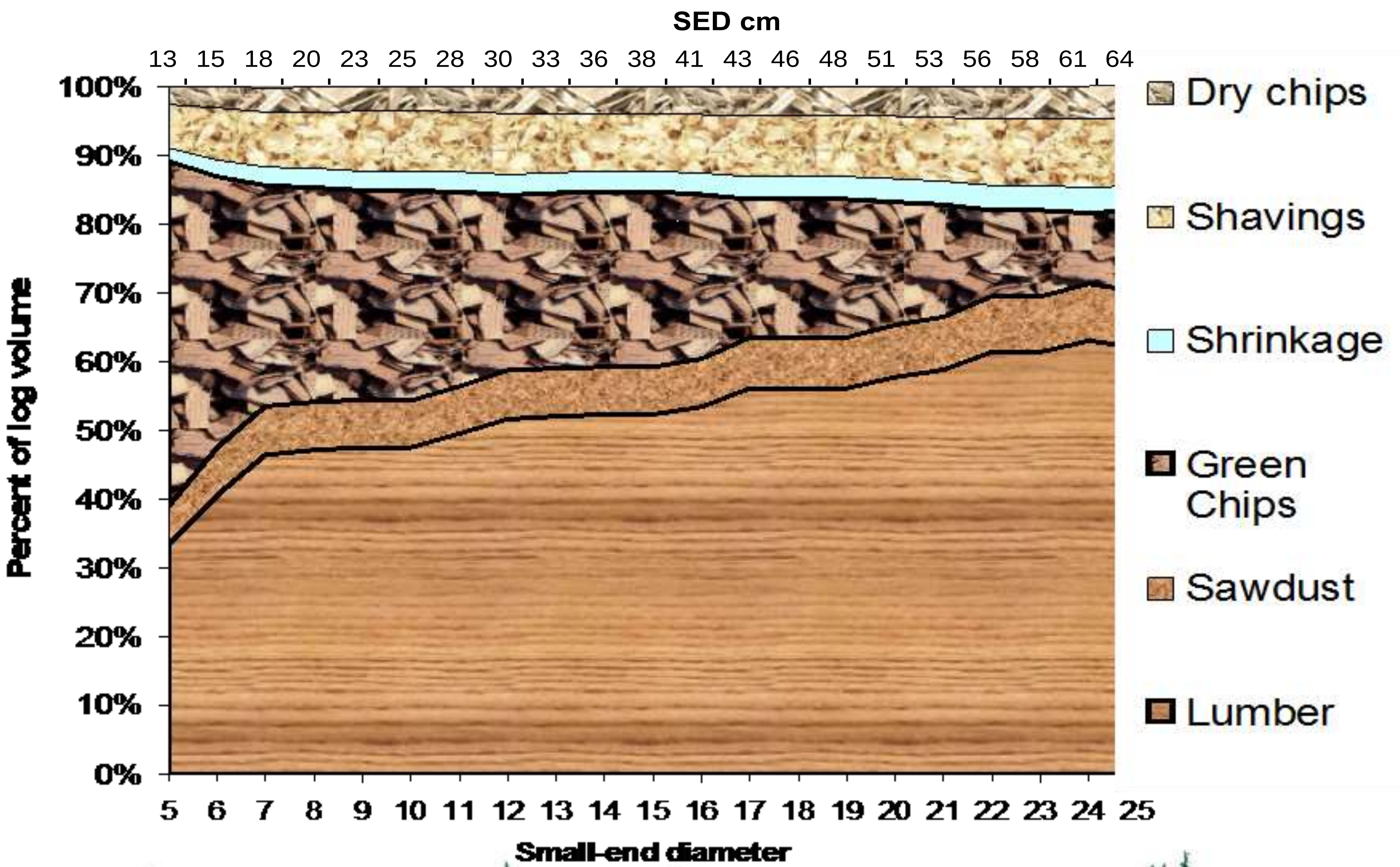
7” dia log



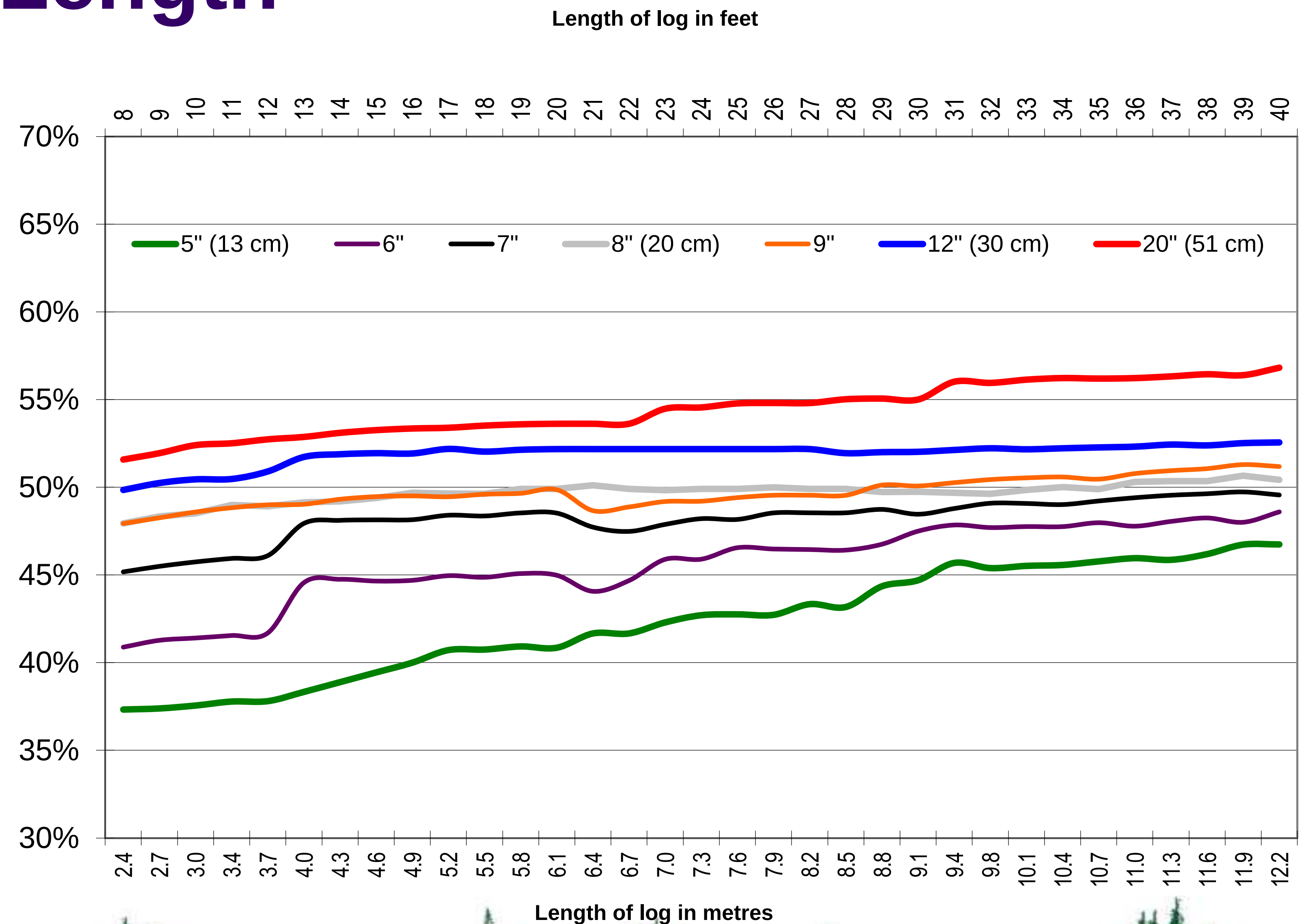

14” dia log



# Percent recovery (dimension mill)



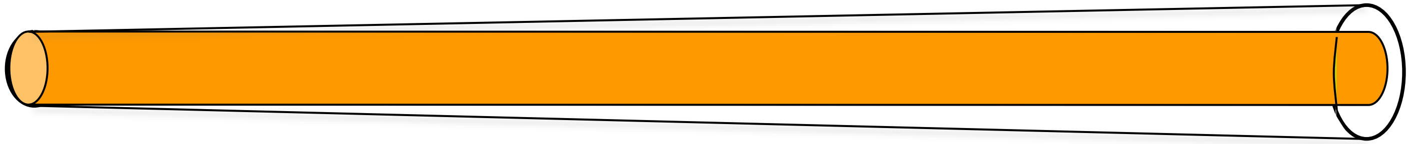
# Length


Length of log in feet
8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
70%
65%
60%
55%
50%
45%
40%
35%
30%
5" (13 cm)
6"
7"
8" (20 cm)
9"
12" (30 cm)
20" (51 cm)
2.4 2.7 3.0 3.4 3.7 4.0 4.3 4.6 4.9 5.2 5.5 5.8 6.1 6.4 6.7 7.0 7.3 7.6 7.9 8.2 8.5 8.8 9.1 9.4 9.8 10.1 10.4 10.7 11.0 11.3 11.6 11.9 12.2
Length of log in metres

# Slab volume from taper

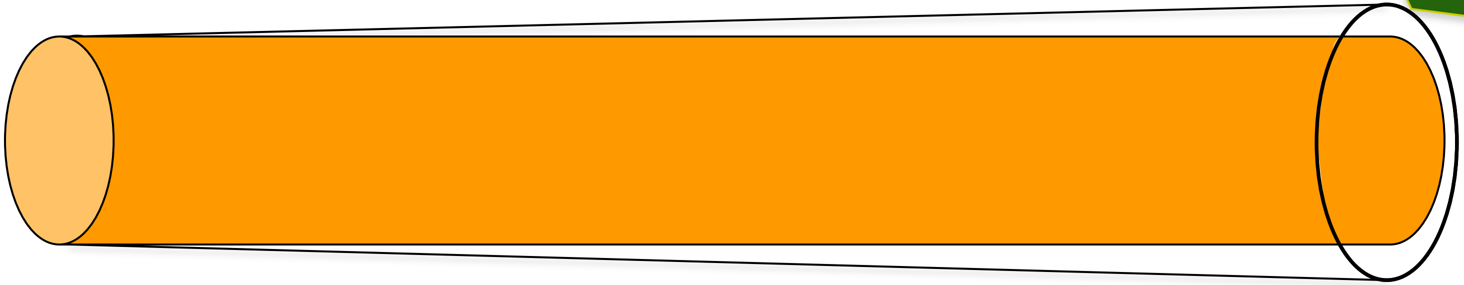
Generally, logs taper at same rate regardless of size

Log: 16’ – 7” - 9” = 5.7 ft$^3$
Cylinder: 16’ – 7” = 4.3 ft$^3$
Volume of taper: (5.7 – 4.3) = 1.3 or **23%**



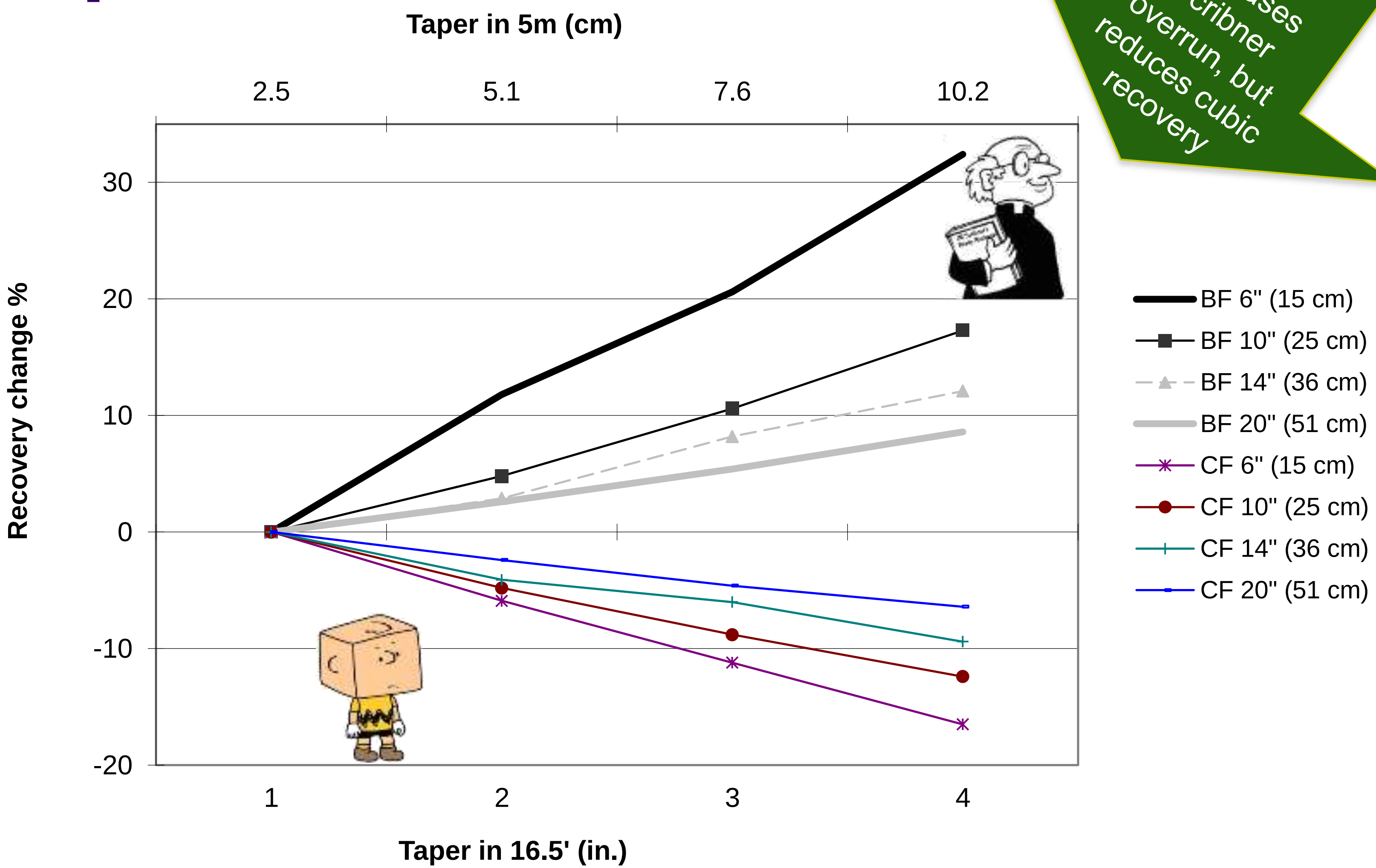
Geometry favors recovery in slab of bigger log

16’ – 14” - 16” = 19.7 ft$^3$
Cylinder: 16’ – 14” = 17.1ft$^3$
Volume of taper: 19.7 – 17.1 = 2.6 or **13%**



# Taper

Taper increases Scribner overrun, but reduces cubic recovery



# Defect effects on recovery












# Defect effects on recovery

Example of loss in recovery from a cant with sweep

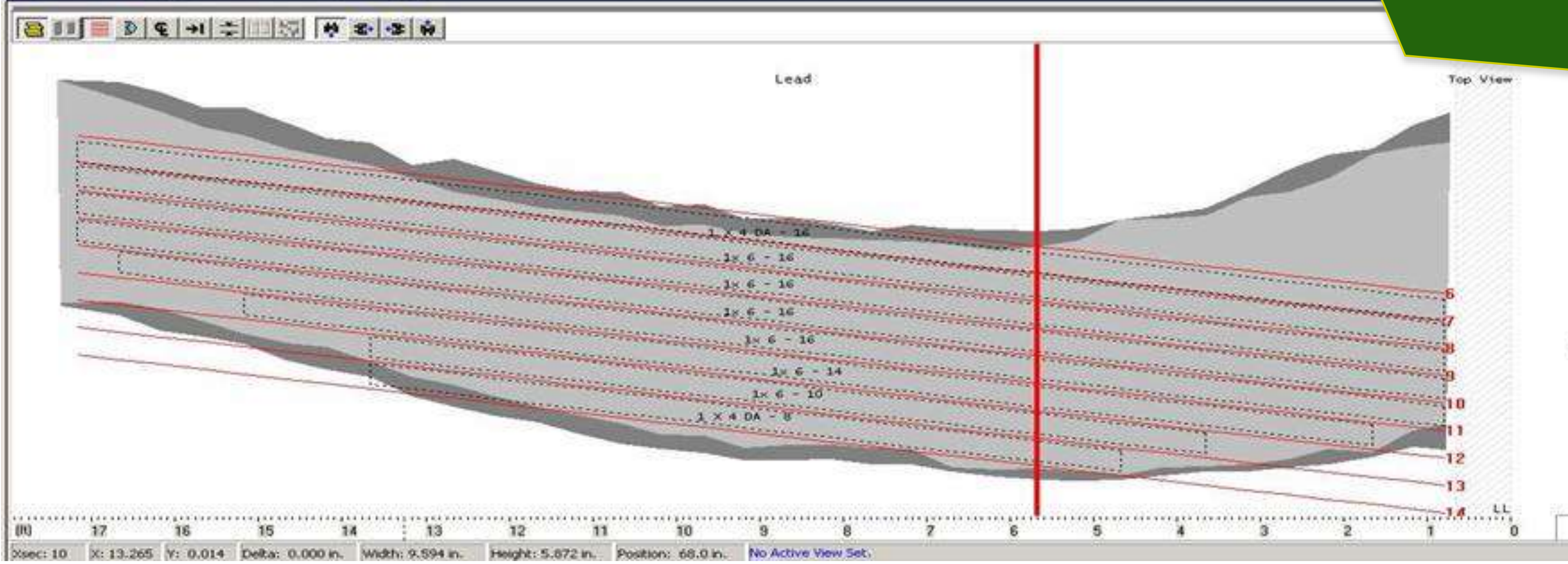
Straight sawn cant

Recovery = 63.9%

| Piece # | Spec. | Thickness (A) | Width (A) | Length (M) | Volume | Boards | Value | Solution | Timestamp | LRF | % Rec | Net Rec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 CANT | Default | 3.885 | 6.840 | 179.000 | 4460.0 | 5 | 6.35 | Curve | 2007/01/23 10:28:19 | 275 | 64.91 | 20.1 |
| 24+ CANT | Default | 5.907 | 9.786 | 200.000 | 10637.0 | 8 | 14.30 | Curve | 2007/01/23 14:04:22 | 302 | 71.22 | 52.6 |
| 24 CANT | Default | 5.907 | 9.786 | 200.000 | 10637.0 | 8 | 14.30 | Curve | 2007/01/23 14:15:02 | 302 | 71.22 | 52.6 |
| 24 CANT | Default | 5.907 | 9.786 | 200.000 | 10637.0 | 8 | 14.30 | Curve | 2007/01/23 14:15:18 | 302 | 71.22 | 52.6 |
| 24 CANT | Default | 5.907 | 9.786 | 200.000 | 10637.0 | 8 | 14.30 | Curve | 2007/01/23 14:17:08 | 302 | 71.22 | 52.6 |
| 24 CANT | Default | 5.907 | 9.786 | 200.000 | 10637.0 | 8 | 14.30 | Curve | 2007/01/23 14:20:28 | 302 | 71.22 | 52.6 |
| 24 CANT | Default | 5.907 | 9.786 | 200.000 | 10637.0 | 8 | 12.80 | Straight | 2007/01/23 14:22:16 | 271 | 63.88 | 47.2 |

| Product | Spec | Length | Value |
|---|---|---|---|
| 1 X 4 DA | Default | 16 | 1.07 |
| 1x 6 | Default | 16 | 2.05 |
| 1x 6 | Default | 16 | 2.05 |

We will come back to this example again

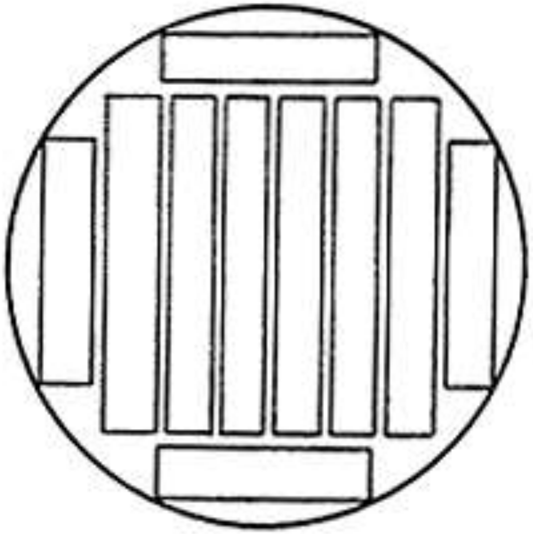


# Defect effects on recovery

- Effects of defect depend greatly on type of defect, scaling method, mill configuration and strategy
- Scaling defects don’t always correlate with defects in the mill
- Many defects (sweep, shake, checks, twist, big knots) end up in lumber, thus increasing recovery when deducted, or reducing recovery when accounted for only by grade
- Statistically, gross volume (both Scribner and cubic) is as good or better than net volume at predicting recovery, but falls short on predicting value (deduction or degrade needed)

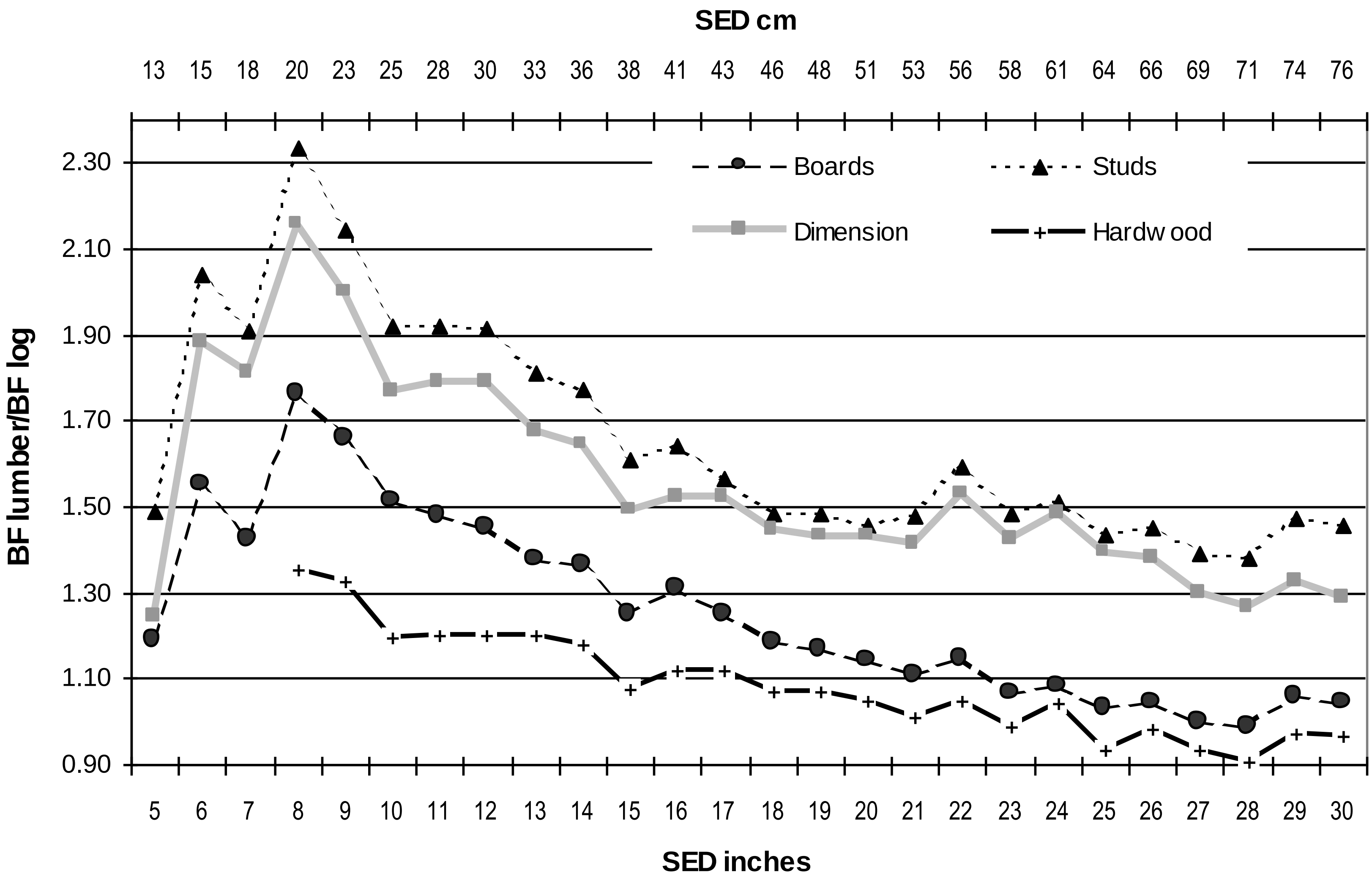
  - i.e., many firm- and some soft- wood defects produce lumber or veneer products that are below cost in value but have a tally

# Method of log measurement

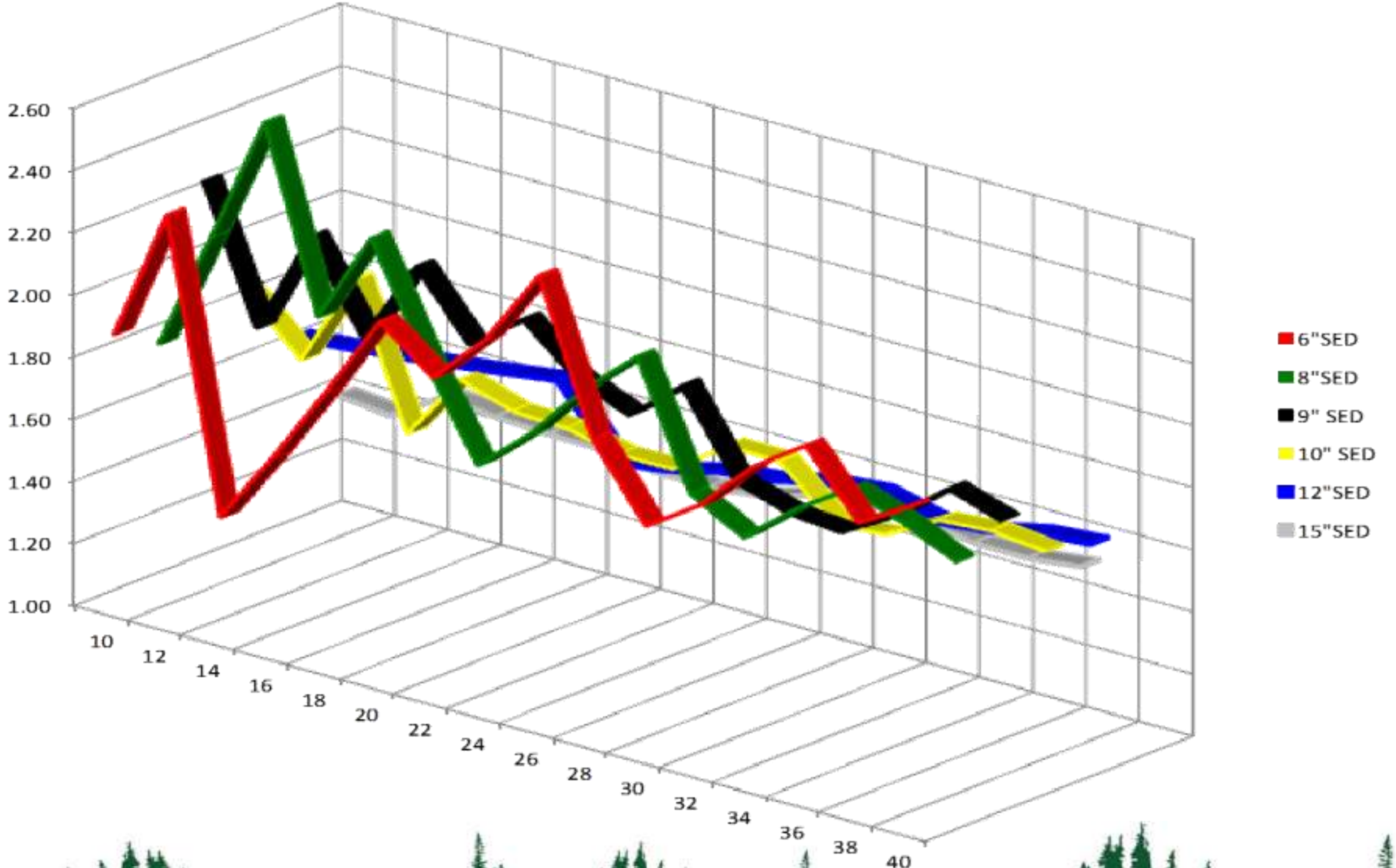


- Scribner attempts to predict output volume via diagrams based on assumptions from mid 19$^{th}$ century
  - Full size lumber in 2” width increments
  - No wane, 0.25” saw-kerf
  - No allowance for taper
  - Rounded in units of 10 BF (step function)
  - Several flavors: long, short, revised
- Cubic attempts to determine useable log volume only
  - Several flavors: USFS, NWLRAG, BC, Alberta, etc.

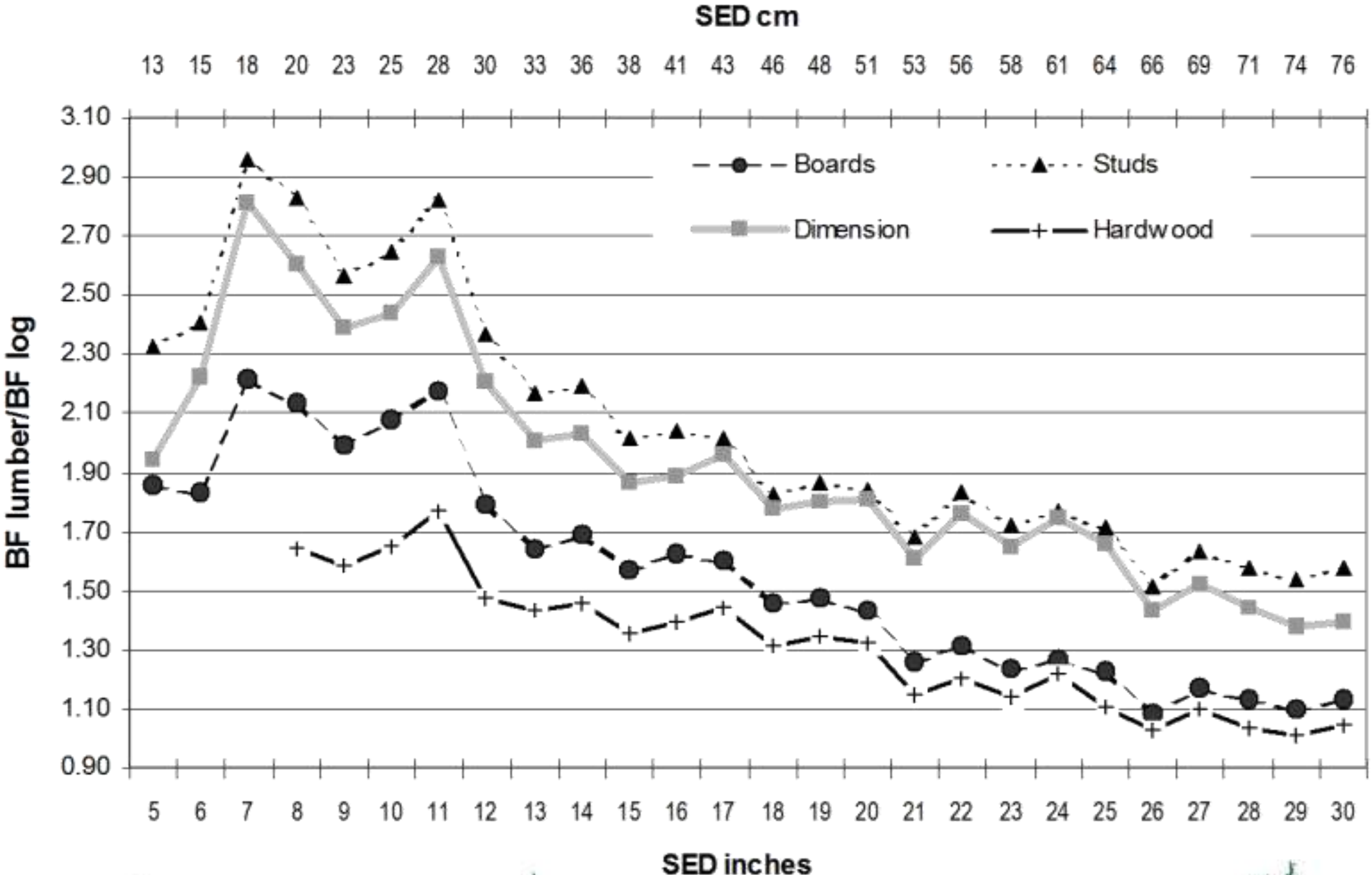
# Scribner short log recovery by diameter



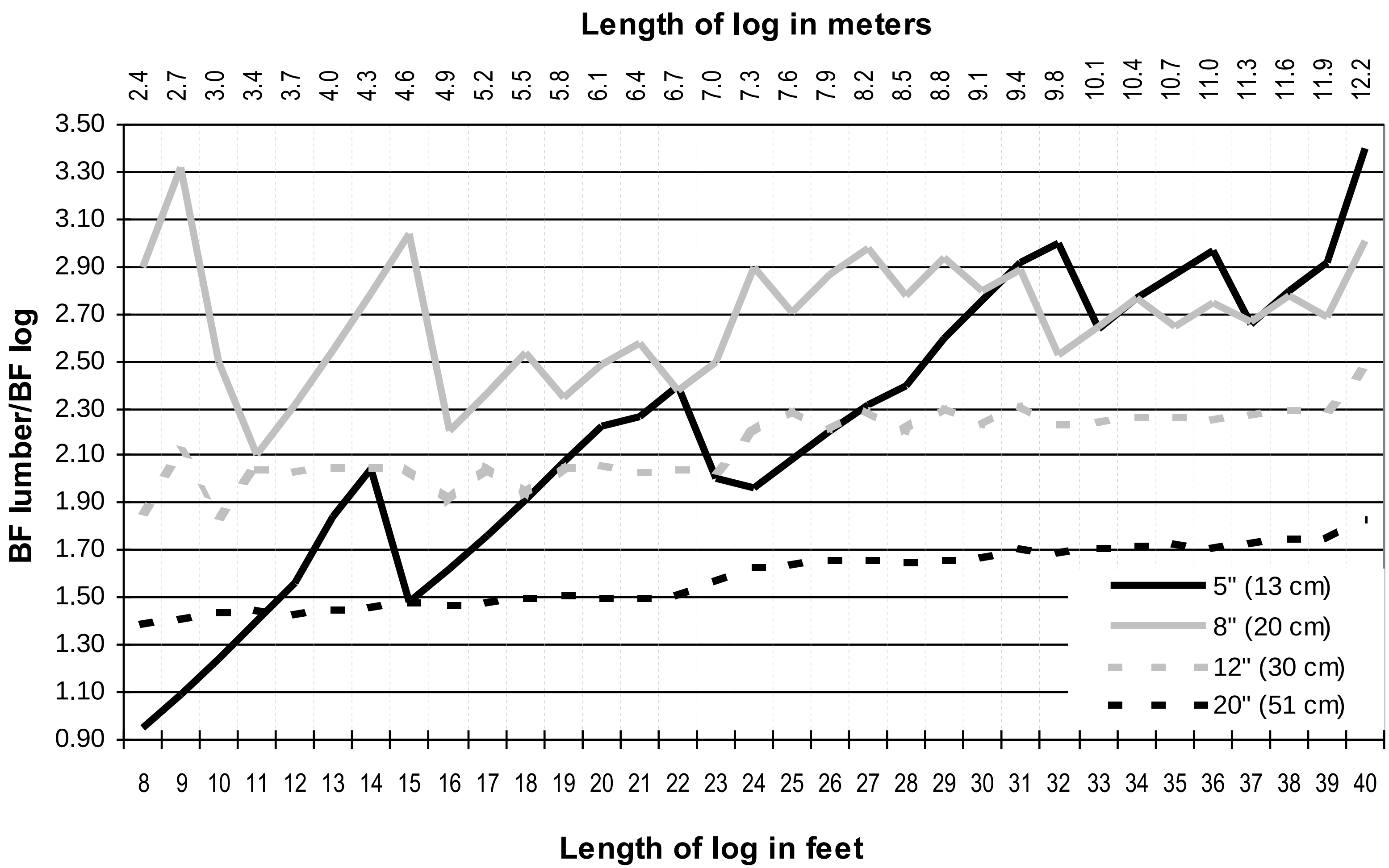
# Scribner short log recovery by length and diameter



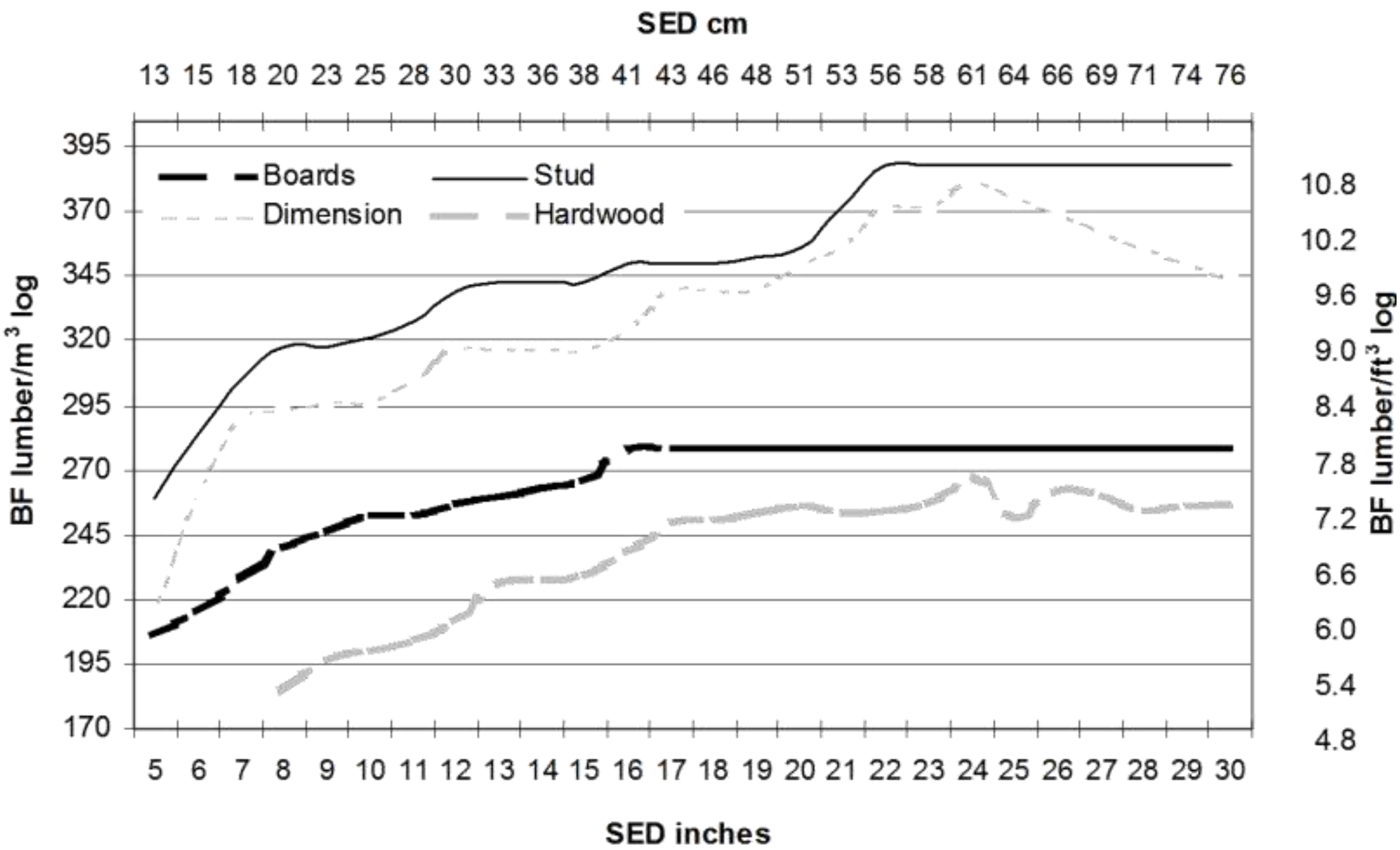
# Scribner long log recovery by mill diameter



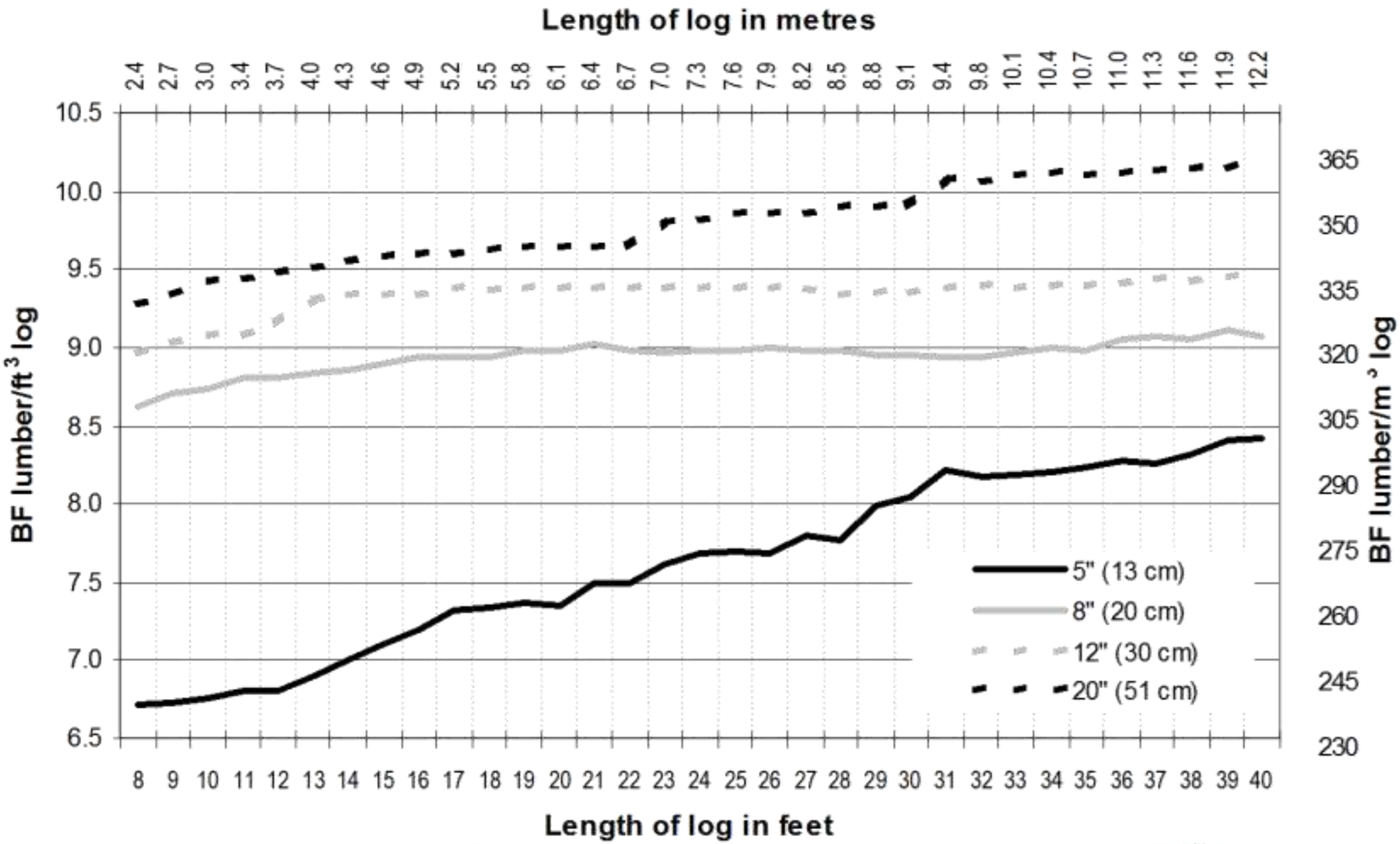
# Scribner long log recovery by length



# Cubic recovery by diameter and mill type



# Cubic recovery by length and SED



# Milling effects on recovery variability

# Value should trump volume in the mill

- It’s generally good business to trim away 2’ or rip 2” off to upgrade from a #3 to #2
- Sometimes mills worry too much about overrun/LRF and not enough as to why remanufacturers are buying their wood
- Optimization and scanning is a “game-changer” when used to its potential
- Recovery is often compromised to reduce manufacturing costs
- It is not uncommon for mills to neglect the effects of log storage, debarking and drying (e.g. compromising kiln schedules to accommodate two species)

# Loss from sweep

Straight sawn cant

Recovery = 63.9%

| Piece # | Spec. | Thickness (A) | Width (A) | Length (M) | Volume | Boards | Value | Solution | Timestamp | LRF | % Rec | Net Rec. |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 30 CANT | Default | 3.885 | 6.840 | 179.000 | 4460.0 | 5 | 6.35 | Curve | 2007/01/23 10:28:19 | 275 | 64.91 | 20.1 |
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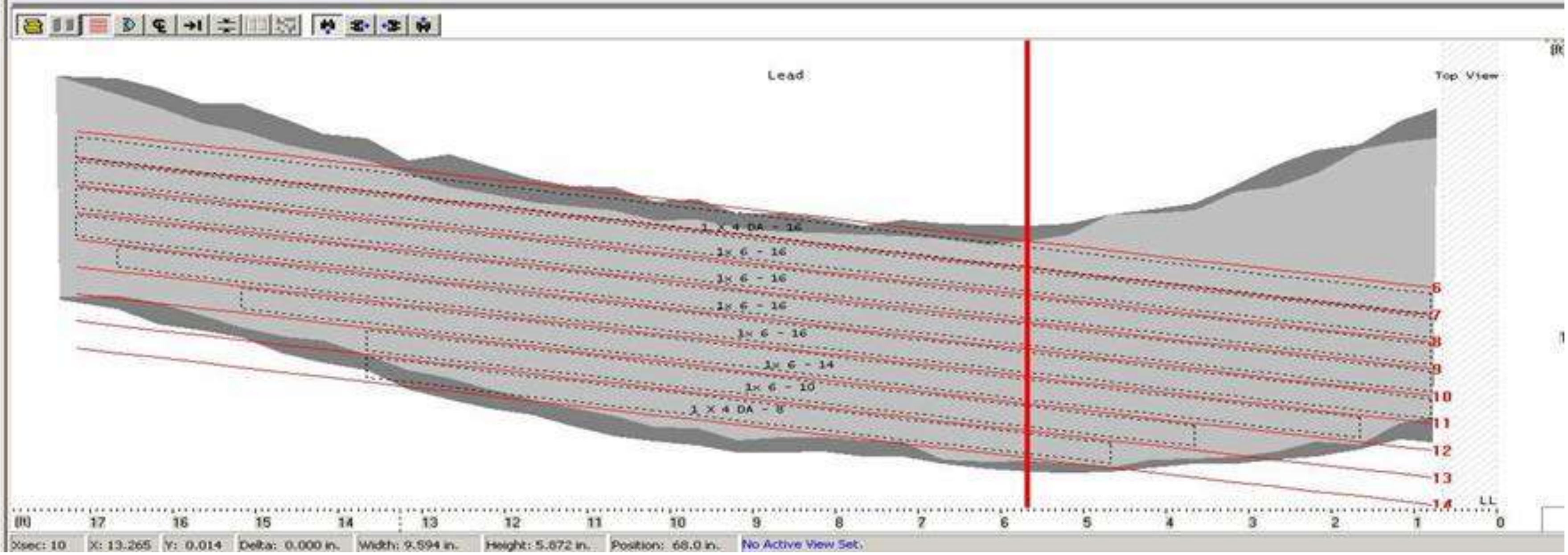


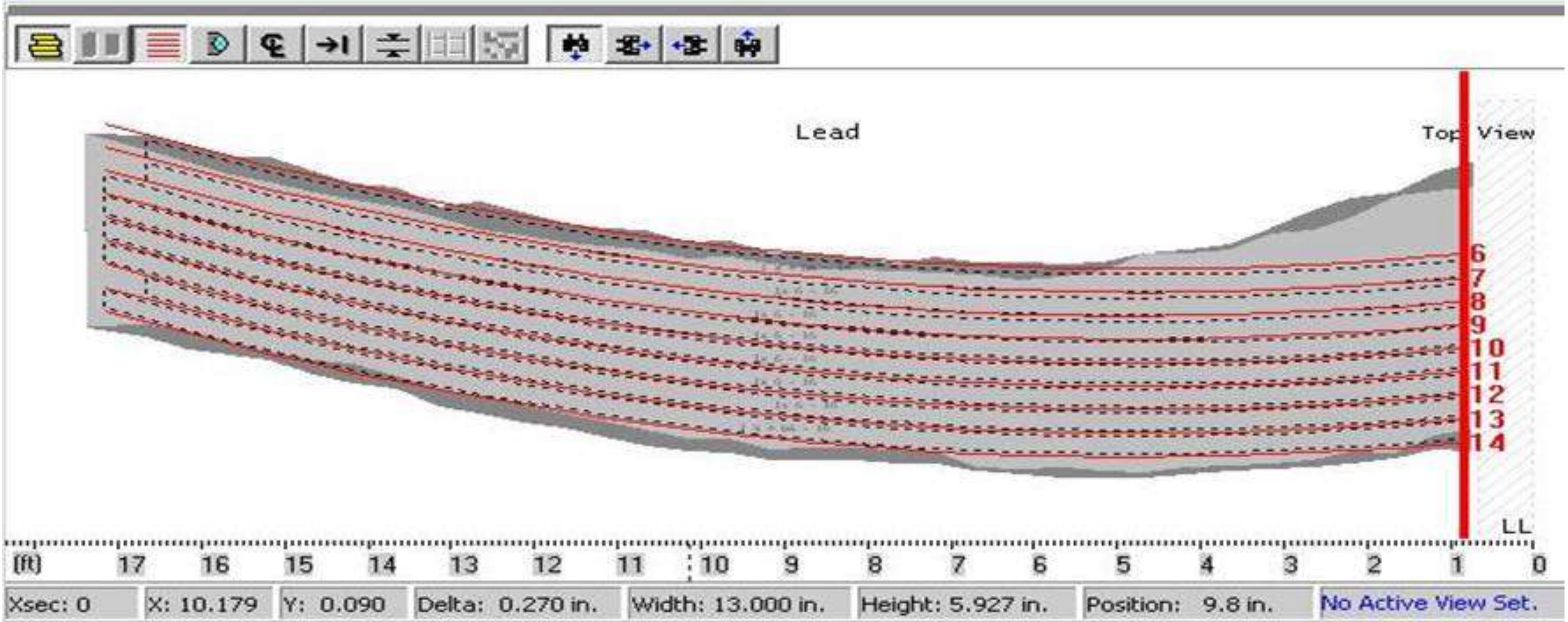
# Loss from sweep

Previous cant with curve sawn solution

Recovery = 71%

| | | | |
|---|---|---|---|
| 1x6 | Default | 16 | 2.05 |
| 1x6 | Default | 16 | 2.05 |
| 1x6 | Default | 16 | 2.05 |
| 1x6 | Default | 16 | 2.05 |
| 1X4 DA | Default | 16 | 1.07 |

8% increase over straight sawn and likely more after drying!!



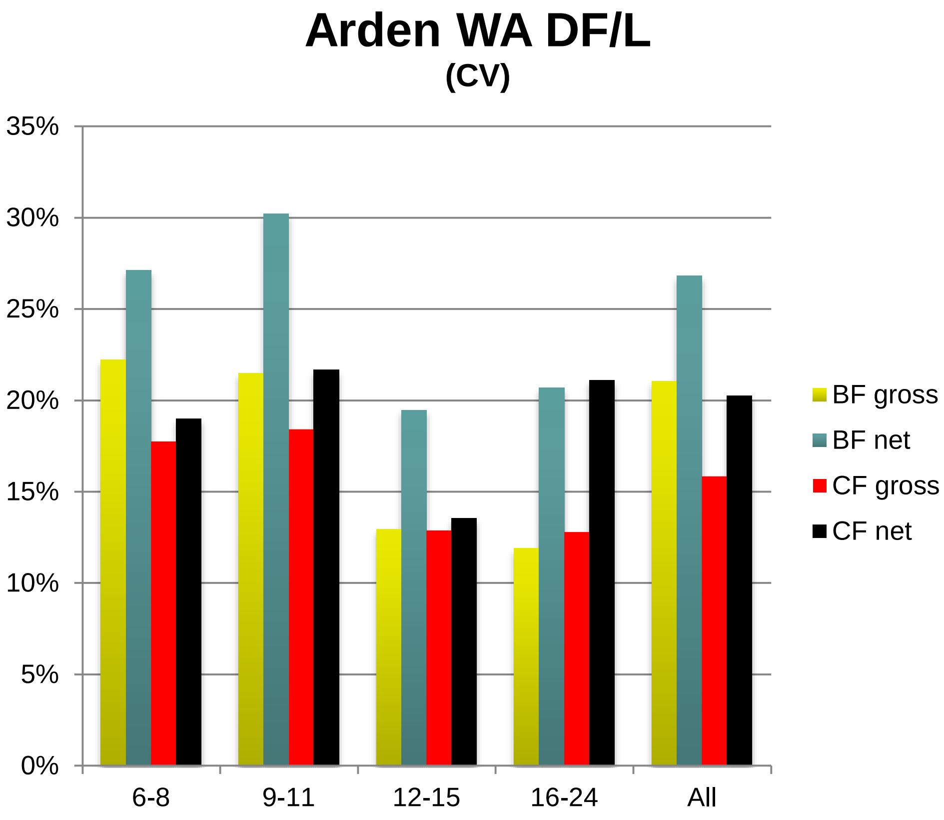
# Log test data to compare precision of recovery ratios

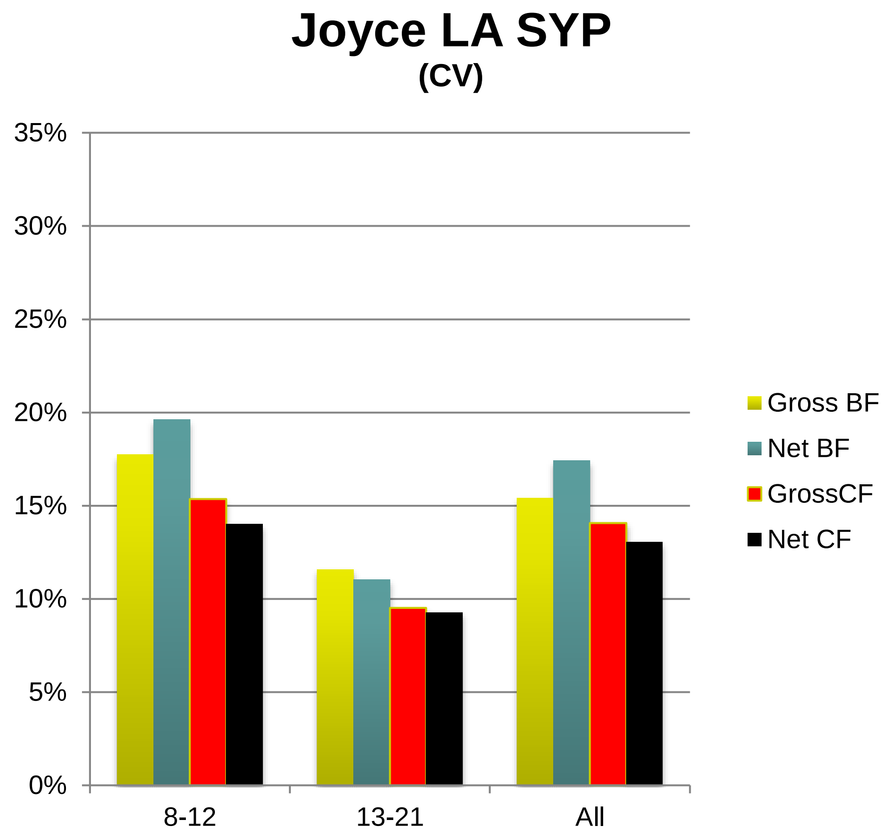
| Log Dia | No. Logs | GROSS | NET | % Def | BF Lbr | BF Recov | Gross CF | Net CF | Lbr CF | Lbr CF rec % | LRF |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 6 | 20 | 400 | 400 | 0% | 763 | 1.91 | 88 | 88 | 42 | 48% | 8.7 |
| 7 | 21 | 630 | 550 | 13% | 1008 | 1.83 | 113 | 108 | 56 | 52% | 9.4 |
| 8 | 21 | 630 | 570 | 10% | 1286 | 2.26 | 142 | 138 | 73 | 53% | 9.4 |
| 9 | 21 | 840 | 740 | 12% | 1610 | 2.18 | 177 | 163 | 91 | 56% | 10.1 |
| 10 | 11 | 660 | 620 | 6% | 1056 | 1.70 | 115 | 112 | 60 | 54% | 9.5 |
| 11 | 16 | 1120 | 1050 | 6% | 1895 | 1.80 | 199 | 193 | 107 | 55% | 9.8 |
| 12 | 11 | 880 | 770 | 13% | 1481 | 1.92 | 158 | 148 | 84 | 57% | 10.1 |
| 13 | 15 | 1500 | 1410 | 6% | 2435 | 1.73 | 253 | 243 | 139 | 57% | 10.1 |
| 14 | 14 | 1540 | 1490 | 3% | 2581 | 1.73 | 269 | 257 | 149 | 58% | 10.1 |
| 15 | 13 | 1820 | 1790 | 2% | 2836 | 1.58 | 287 | 283 | 165 | 58% | 10.0 |
| 16 | 16 | 2560 | 2420 | 5% | 3814 | 1.58 | 397 | 384 | 221 | 58% | 10.0 |
| 17 | 11 | 1980 | 1660 | 16% | 2758 | 1.66 | 311 | 263 | 160 | 61% | 11.4 |
| 18 | 11 | 2310 | 2110 | 9% | 3348 | 1.59 | 339 | 321 | 195 | 61% | 10.5 |
| 19 | 9 | 2160 | 1880 | 13% | 3121 | 1.66 | 308 | 287 | 180 | 63% | 10.9 |
| 20 | 5 | 1400 | 1230 | 12% | 1907 | 1.55 | 191 | 175 | 111 | 63% | 11.0 |
| 21 | 4 | 1200 | 1110 | 8% | 1766 | 1.59 | 165 | 159 | 102 | 64% | 11.2 |
| 22 | 5 | 1650 | 1140 | 31% | 2156 | 1.89 | 227 | 167 | 124 | 74% | 13.1 |
| 23 | 1 | 380 | 330 | 13% | 548 | 1.66 | 48 | 43 | 31 | 72% | 12.6 |
| 24 | 1 | 400 | 350 | 13% | 508 | 1.45 | 55 | 51 | 29 | 57% | 10.0 |
| 12.3 | 226 | 24060 | 21620 | 10% | 36876 | 1.71 | 3843 | 3584 | 2121 | 59% | 10.29 |

# Coefficient of variation by log measure (cubic vs. Scribner)

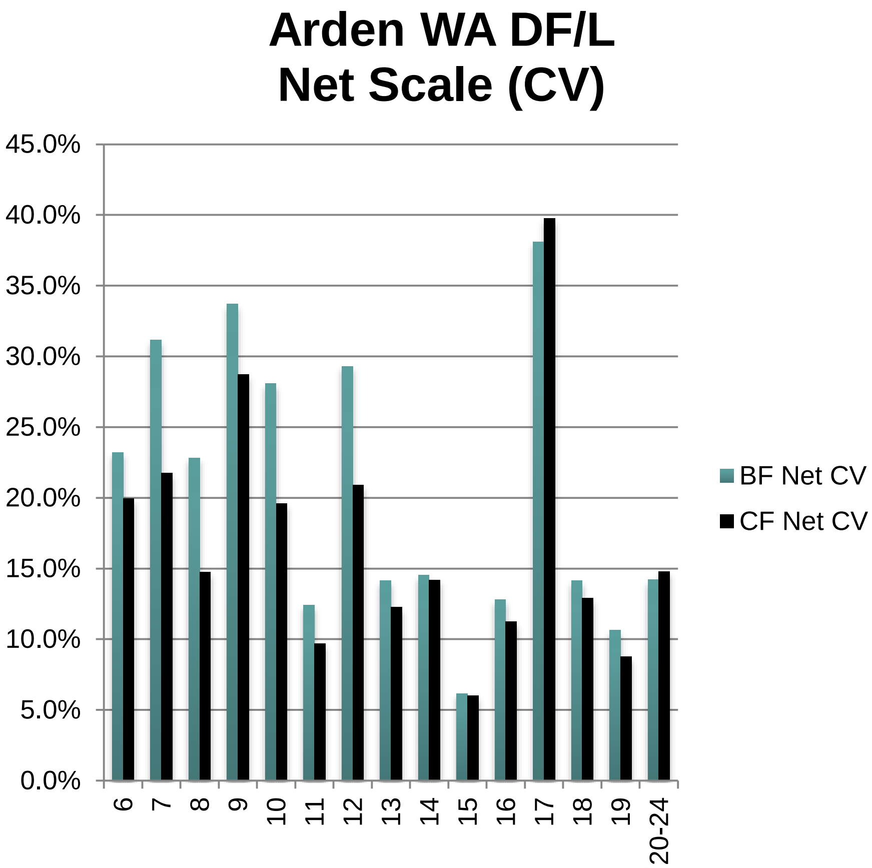
| log # | Grade | Length | Dia 1 | Dia 2 | Gross BF | Net BF | % Def | BF Lmbr | Net BF Rec | Gross BF Rec | Gr. Ft3 | Net ft3 | lum ft3 | % rec | Net LRF | Gross LRF |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 161 | 1 | 20 | 15 | 16 | 180 | 180 | 0% | 259.4 | 1.44 | 1.44 | 26.2 | 26.2 | 15.1 | 58% | 9.90 | 9.90 |
| 201 | 1 | 20 | 15 | 17 | 180 | 160 | 10% | 233.3 | 1.46 | 1.30 | 28 | 25.2 | 13.6 | 54% | 9.26 | 8.33 |
| 199 | 1 | 16 | 15 | 16 | 140 | 140 | 0% | 211.4 | 1.51 | 1.51 | 21 | 21 | 12.3 | 59% | 10.07 | 10.07 |
| 303 | 1 | 16 | 15 | 16 | 140 | 120 | 19% | 173.3 | 1.44 | 1.24 | 21 | 17.1 | 10.0 | 58% | 10.13 | 8.25 |
| 233 | 1 | 18 | 15 | 17 | 160 | 160 | 0% | 246.0 | 1.54 | 1.54 | 25.2 | 25.2 | 14.3 | 57% | 9.76 | 9.76 |
| 111 | 1 | 20 | 15 | 17 | 180 | 180 | 0% | 278.7 | 1.55 | 1.55 | 28 | 28 | 16.2 | 58% | 9.95 | 9.95 |
| 121 | 1 | 16 | 15 | 16 | 140 | 140 | 0% | 222.7 | 1.59 | 1.59 | 21 | 21 | 13.0 | 62% | 10.60 | 10.60 |
| 262 | 1 | 16 | 15 | 17 | 140 | 140 | 0% | 225.6 | 1.61 | 1.61 | 22.4 | 22.4 | 13.1 | 58% | 10.07 | 10.07 |
| 29 | 1 | 20 | 15 | 17 | 180 | 170 | 5% | 277.3 | 1.63 | 1.54 | 28 | 26.6 | 16.1 | 61% | 10.42 | 9.90 |
| 230 | 1 | 16 | 15 | 16 | 140 | 120 | 13% | 206.0 | 1.72 | 1.47 | 21 | 18.4 | 12.0 | 65% | 11.20 | 9.81 |
| 227 | 1 | 16 | 15 | 16 | 140 | 140 | 0% | 236.6 | 1.69 | 1.69 | 21 | 21 | 13.7 | 65% | 11.27 | 11.27 |
| 28 | 1 | 20 | 15 | 17 | 180 | 180 | 0% | 301.3 | 1.67 | 1.67 | 28 | 28 | 17.5 | 63% | 10.76 | 10.76 |
| 168 | 2 | 16 | 15 | 16 | 140 | 140 | 0% | 198.1 | 1.42 | 1.42 | 21 | 21 | 11.5 | 55% | 9.43 | 9.43 |
| 254 | 2 | 16 | 15 | 17 | 140 | 140 | 0% | 200.9 | 1.44 | 1.44 | 22.4 | 22.4 | 11.6 | 52% | 8.97 | 8.97 |
| 264 | 2 | 20 | 15 | 16 | 180 | 150 | 15% | 214 | 1.43 | 1.19 | 26.2 | 22.3 | 12.4 | 56% | 9.60 | 8.17 |
| 192 | 2 | 16 | 15 | 16 | 140 | 120 | 13% | 178.0 | 1.48 | 1.27 | 21 | 18.4 | 10.4 | 57% | 9.67 | 8.48 |
| 21 | 2 | 18 | 15 | 16 | 160 | 150 | 6% | 218 | 1.45 | 1.36 | 23.6 | 22.3 | 12.5 | 56% | 9.78 | 9.24 |
| 190 | 2 | 16 | 15 | 17 | 140 | 140 | 0% | 208.6 | 1.49 | 1.49 | 22.4 | 22.4 | 12.1 | 54% | 9.31 | 9.31 |
| 186 | 2 | 16 | 15 | 17 | 140 | 130 | 6% | 200.6 | 1.54 | 1.43 | 22.4 | 21 | 11.7 | 56% | 9.55 | 8.96 |
| 143 | 2 | 20 | 15 | 17 | 180 | 160 | 10% | 245.1 | 1.53 | 1.36 | 28 | 25.2 | 14.3 | 57% | 9.73 | 8.75 |
| 281 | 2 | 18 | 15 | 17 | 160 | 150 | 6% | 250.0 | 1.67 | 1.56 | 25.2 | 23.8 | 14.6 | 61% | 10.50 | 9.92 |
| 278 | 2 | 20 | 15 | 16 | 180 | 170 | 5% | 290.4 | 1.71 | 1.61 | 26.2 | 24.9 | 16.8 | 67% | 11.66 | 11.08 |
| 193 | 3 | 16 | 15 | 16 | 140 | 130 | 6% | 178.0 | 1.37 | 1.27 | 21 | 19.7 | 10.3 | 52% | 9.04 | 8.48 |
| 307 | 3 | 16 | 15 | 17 | 140 | 130 | 6% | 183.2 | 1.41 | 1.31 | 22.4 | 21 | 10.4 | 50% | 8.72 | 8.18 |
| 210 | 3 | 16 | 15 | 17 | 140 | 140 | 0% | 202.6 | 1.45 | 1.45 | 22.4 | 22.4 | 11.7 | 52% | 9.04 | 9.04 |
| 258 | 3 | 16 | 15 | 16 | 140 | 140 | 0% | 233.7 | 1.67 | 1.67 | 21 | 21 | 13.6 | 65% | 11.13 | 11.13 |
| 225 | 3 | 20 | 15 | 18 | 180 | 180 | 0% | 295.9 | 1.64 | 1.64 | 29.9 | 29.9 | 17.0 | 57% | 9.90 | 9.90 |
| 116 | 3 | 16 | 15 | 17 | 140 | 140 | 0% | 237.7 | 1.70 | 1.70 | 22.4 | 22.4 | 13.8 | 62% | 10.61 | 10.61 |
| 77 | 3 | 20 | 15 | 18 | 180 | 170 | 5% | 311.4 | 1.83 | 1.73 | 29.9 | 28.4 | 18.1 | 64% | 10.96 | 10.41 |
| | | | | | | | | Stdev | 0.12 | 0.15 | | | | | 0.76 | 0.93 |
| | | | | | | | | Avg | 1.55 | 1.48 | | | | | 10.03 | 9.61 |
| | | | | | | | | **CV** | **8%** | **10%** | | | | | **8%** | **10%** |

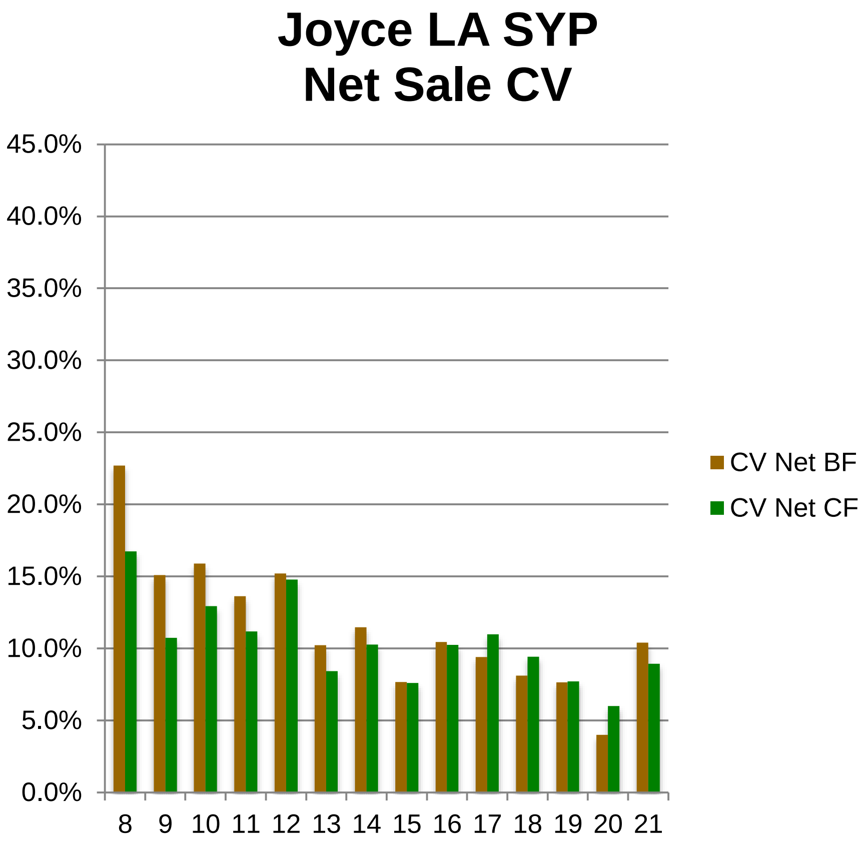
# Log scale for predicting recovery (grouped diameters)



# CV of recovery factor net scale



# Conclusions

- Recovery factors for BF and cubic have a CV of roughly: 15-25% for logs <12" (30 cm) and 10-20% for larger logs
- Cubic measure is a more precise predictor of recovery for both individual diameter groupings (1" class), grouped classes or camp-run (about 5-10% lower CV), however, Scribner is almost as good in bigger diameters
- Gross volume is generally a better predictor of recovery (not value) than net when mostly firmwood type defects
- Most variation is likely caused by the nature of logs (irregular shaped objects) and recovery of value trumping volume in the sawmill
- Higher CVs of small logs likely tied to some degree by big measurement units (inches and rads).

# Thank you for your attention

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