Measuring Pulp Logs and Biomass:
results of log studies

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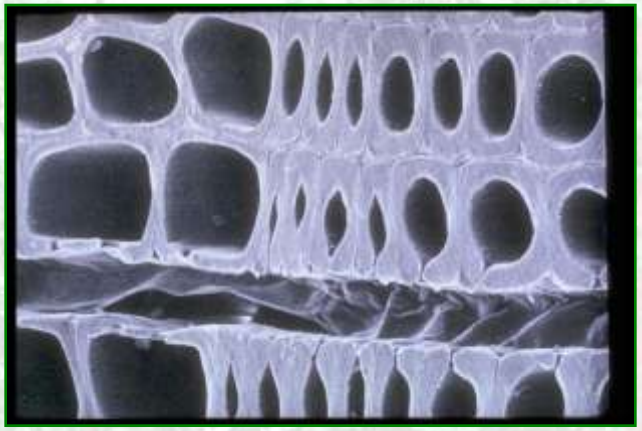
Timber Measurements Society
Coeur d'Alene Idaho, April 11-13, 2012

Measuring pulp logs and biomass

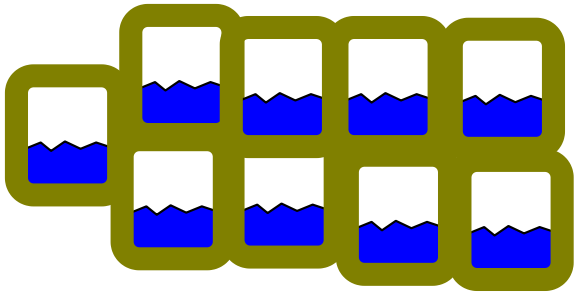
- What does the purchaser want?
  - An accurate predictor of useable fiber

- What are our options for measuring?
  - Green weight
  - Dry weight
  - Solid volume
  - Bulk volume
    - o Chips (units or loose volume)
    - o Logs (stacked volume, e.g., cords)
  - Board feet

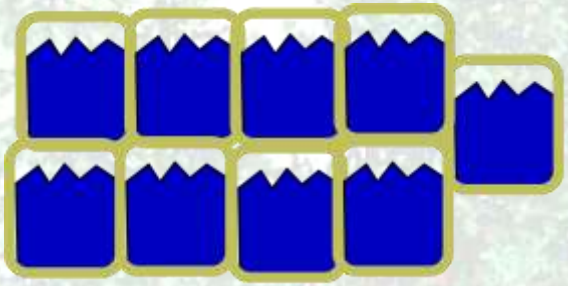


Dry weight review (purchaser's favorite)

- Bone-dry weight
  - The weight of fiber with all of the moisture removed
  - Normal procedure is to establish the weight in the green-state; take a representative sample of fiber, weight it green, dry it in an oven at (+ or –) 217 degrees until weight stabilizes; divide bone-dry weight by green weight and multiply ratio times total weight.



Douglas fir

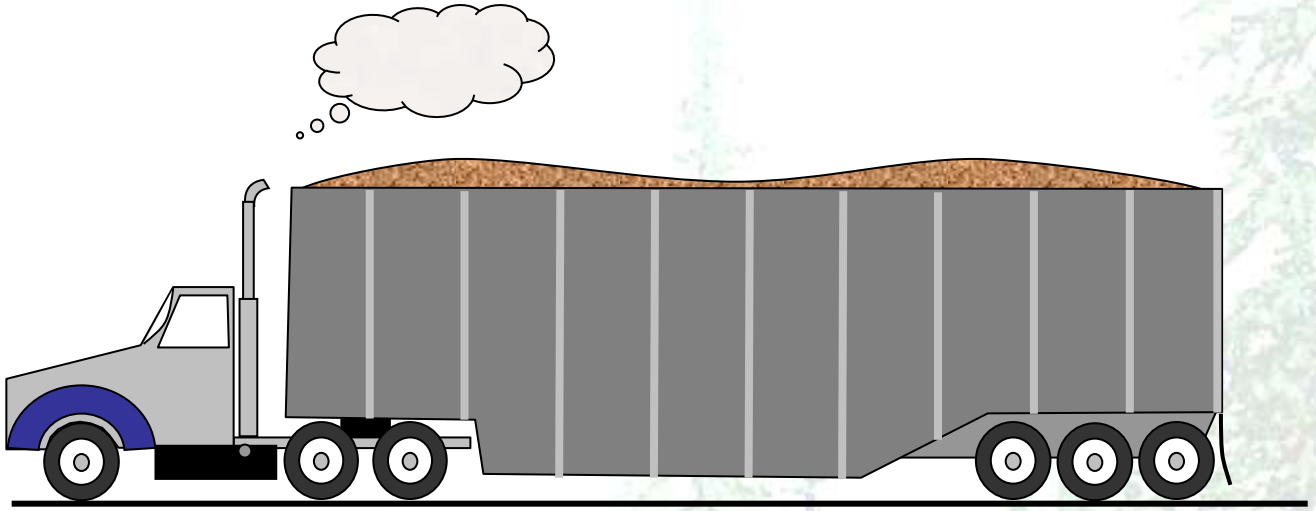


Grand fir

Units of measure for biomass

- Bone dry unit (BDU) = 2,400 lbs dry or 1088.4 kg
- Bone dry tonne (BDMT) = 2,205 lbs dry or 1,000 kg
- Bone dry ton (BDT) = 2,000 lbs dry or 907 kg

Dry weight review (example)



Net weight = 71,000 lbs or 32,200 kg

Green chip sample = 922 g	Bone-dry sample = 497 g

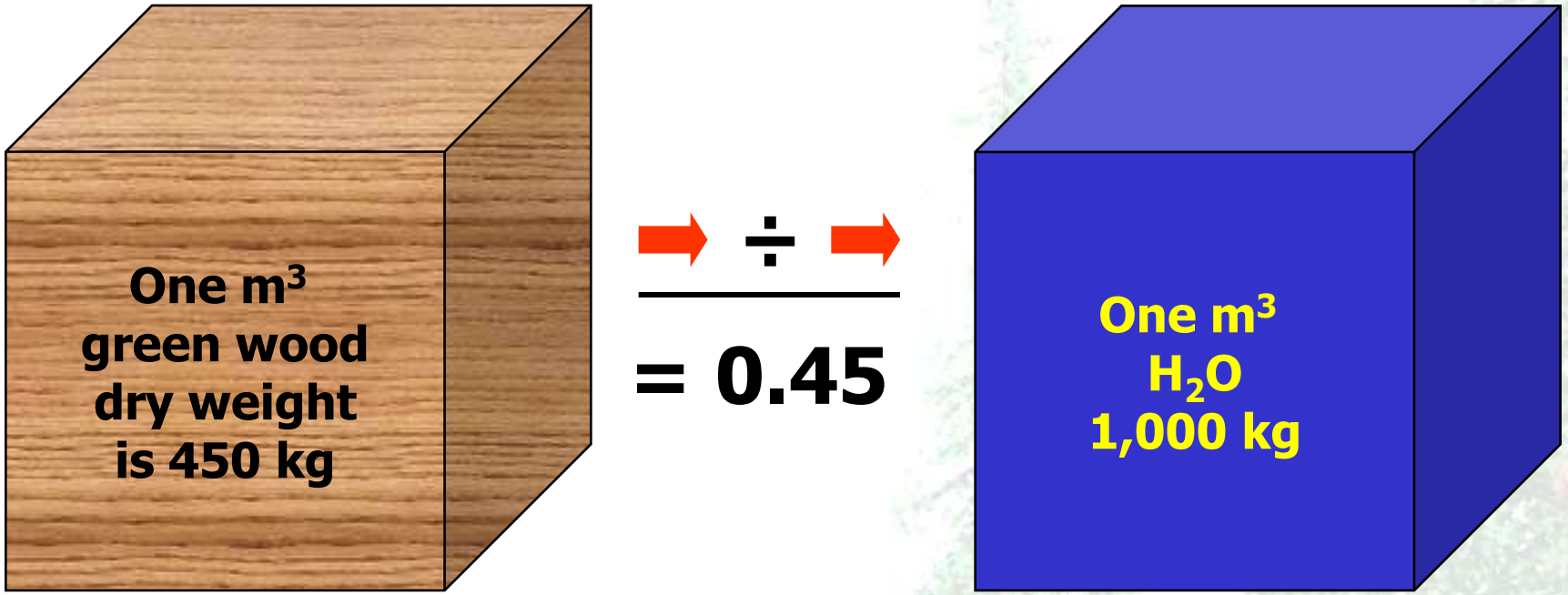
497 ÷ 922 = 53.9% fiber .539 x 71,000 = 38,269 lbs
or x 32,200 kg = 17,356 kg

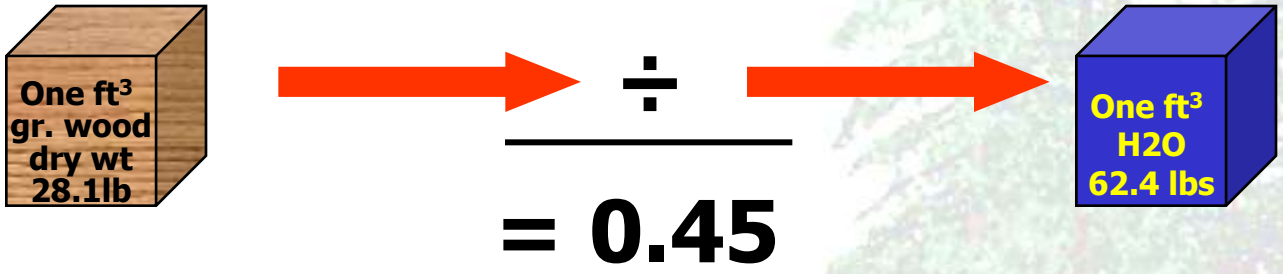
- **Bone dry Unit: 38,269 ÷ 2,400 = 15.945 BDU**
- **Bone-dry ton: 38,269 ÷ 2,000 = 19.135 BDT**

Specific gravity and basic density

- Specific gravity = the ratio of weight of a given volume relative to the weight of the same volume of water
- For our purposes here, SG always refers to green volume (before shrinkage) and dry weight
- Water weighs 62.4 lbs/ft^3 (1,000 kg/m^3)
- Basic density is the weight for a cubic meter (for our purposes, always dry), i.e., SG x 1,000
- Example: wood or bark with an SG of 0.50 would have 31.2 lbs/ft^3 or 500 kg/m^3 of dry fiber

Example of 0.45 SG and basic density of 450 kg





Western Species wood and bark properties

Common name **Conifers**	Latin name	Wood lbs/ft^3	Wood Specific Gravity (green m^3)	Wood heating value BTU/lb	Wood gigajoules per tonne	Bark % log weight (bark & wood)	Bark % log wood volume	Bark lbs/ft^3	Bark Specific Gravity (green m^3)	Bark heating value BTU/lb
Grand fir	*Abies grandis*	48.8	0.35	8150	18.99	11.7	14.3	45.1	0.54	--
Subalpine fir	*Abies lasiocarpa*	39.9	0.31	--	--	15.5	15.7	46.7	--	--
Western larch	*Larix occidentalis*	51.7	0.48	--	--	10.1	19.5	29.9	0.44	8750
Engelmann spruce	*Picea engelmannii*	51.5	0.33	--	--	11.0	13.0	48.8	0.48	8820
White spruce	*Picea Glauca*	46.2	0.37	--	--	7.3	10.0	36.0	0.29	8530
Lodgepole pine	*Pinus contorta*	53.5	0.38	8600	20.04	5.4	6.0	50.7	0.46	9382
Western white pine	*Pinus monticola*	46.1	0.35	9610	22.39	12.4	0.0	43.5	0.49	--
Ponderosa pine	*Pinus ponderosa*	56.0	0.38	9120	21.25	11.7	20.3	33.6	0.34	9616
Douglas fir	*Pseudotsuga menziesii*	51.2	0.45	8910	20.76	13.7	20.1	40.5	0.44	9962
Western red cedar	*Thuja plicata*	34.2	0.31	9700	22.60	11.8	12.6	36.2	0.37	8700
Western hemlock	*Tsuga heterophylla*	53.5	0.42	--	--	9.2	10.3	52.6	0.50	9297
Mountain hemlock	*Tsuga mertensiana*	56.9	0.42	--	--	15.0	25.1	40.0	--	--

Approximate raw material to product ratios

	Inputted wood units per one product output unit		
Composite panels	**ft^3/ft^3 (m^3/m^3)**	**BDU/msf 3/8”**	**$BDMT/m^3$**
Insulation board	0.66	0.21	0.26
Particleboard	1.32	0.43	0.53
MDF	1.73	0.56	0.69
OSB	1.7	0.55	0.68
Pulp yields	**Wood/pulp ft^3/BDT**	**Wood/pulp $m^3/BDMT$**	**Wood/pulp BDT/BDT**
Mechanical paper	84.3	2.63	1.05
Chemi-mechanical process	89	2.78	1.11
Kraft paper (bleached)	186.3	5.82	2.33
Kraft paper (unbleached)	157.1	4.9	1.96

Assumes inputted wood fiber SG of 0.40

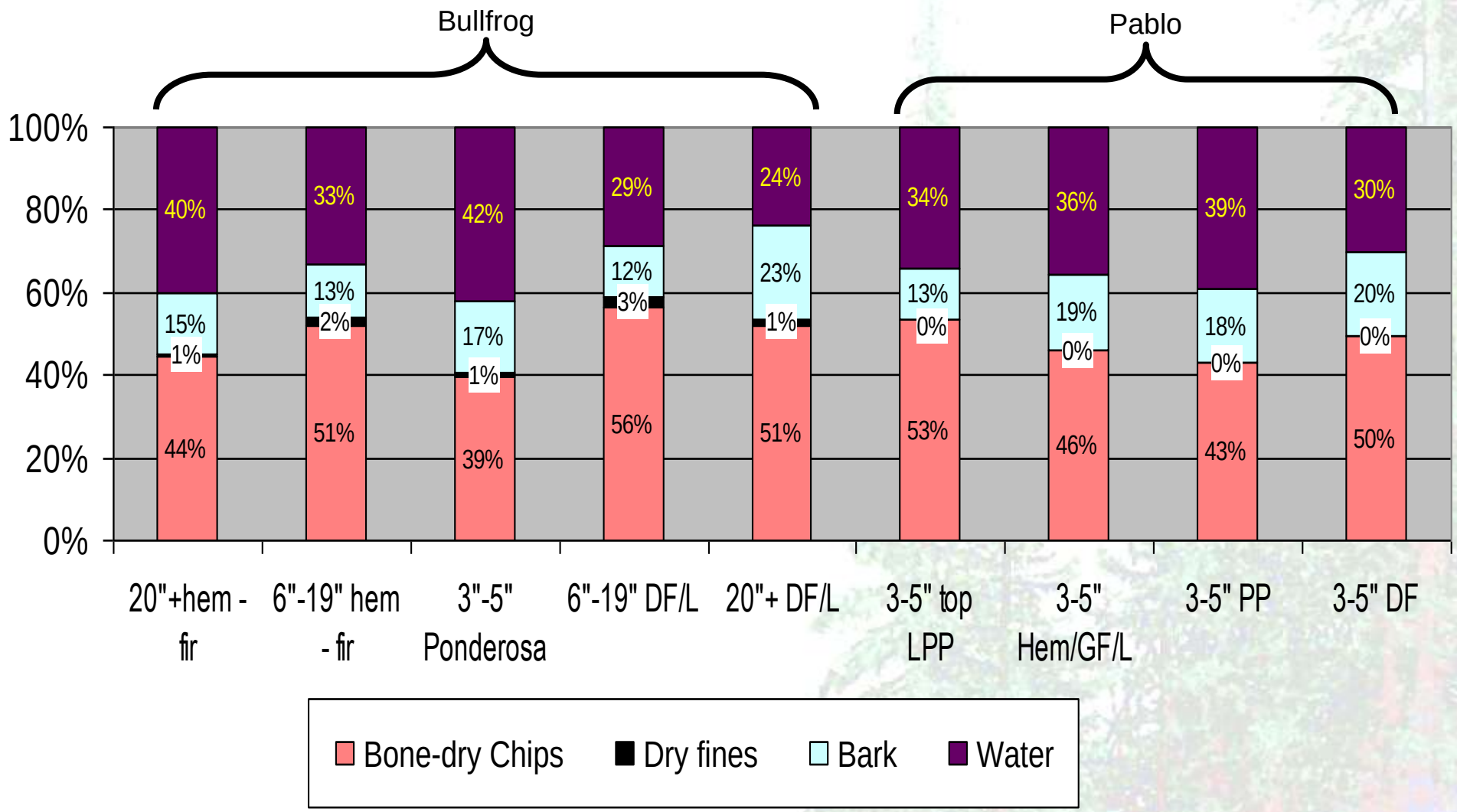
Log Tests

- Bull frog chip plant (Cle Elum WA, early Fall, 1991)
  - Stationary chipper
  - All chips screened
  - Mostly bigger logs not suitable for sawlogs (cull), except for ponderosa pine thinning sort
  - Logs, weighed, corded, scaled in Scribner (east-side and cubic)
- Pablo MT, Summer 1998
  - Portable chain flail chipper
  - No Screening of chips
  - All thinning logs and tops
  - Logs weighed and scaled cubic

Test logs summary

			Scaled Log volume			
CATAGORY	Delivered Tons	CORDS	MBF	CF	m3	BDT Chips
20"+ hem - fir	169.74	76.40	46.93	6455.2	182.8	74.63
6"-19" hem - fir	227.35	111.50	49.21	8760.8	248.1	116.20
3"-5" Ponderosa	79.04	33.70	9.11	2359.0	66.8	30.98
6"-19" DF/L	174.98	87.90	35.43	6102.9	172.8	97.38
20"+ DF/L	47.35	23.10	11.66	1621.3	45.9	24.36
3-5" top LPP	28.17			1015.5	28.8	15.00
3-5" Hem/GF/L	25.97			842.8	23.9	11.93
3-5" PP	27.86			861.6	24.4	12.07
3-5" DF	23.83			707.5	20.0	11.80

Fiber yield related to delivered weight



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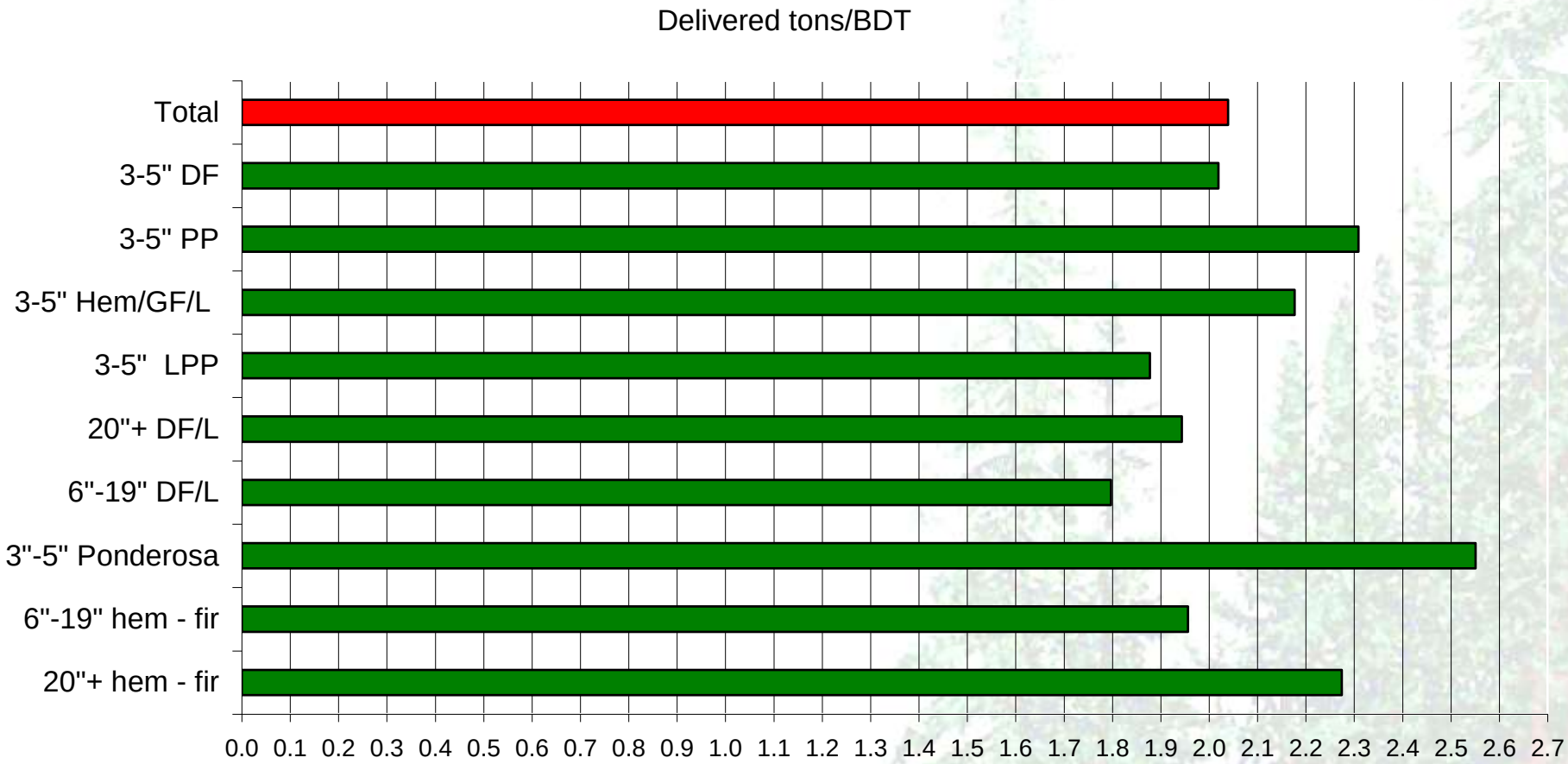
Delivered tons per BDT



CV = 12%

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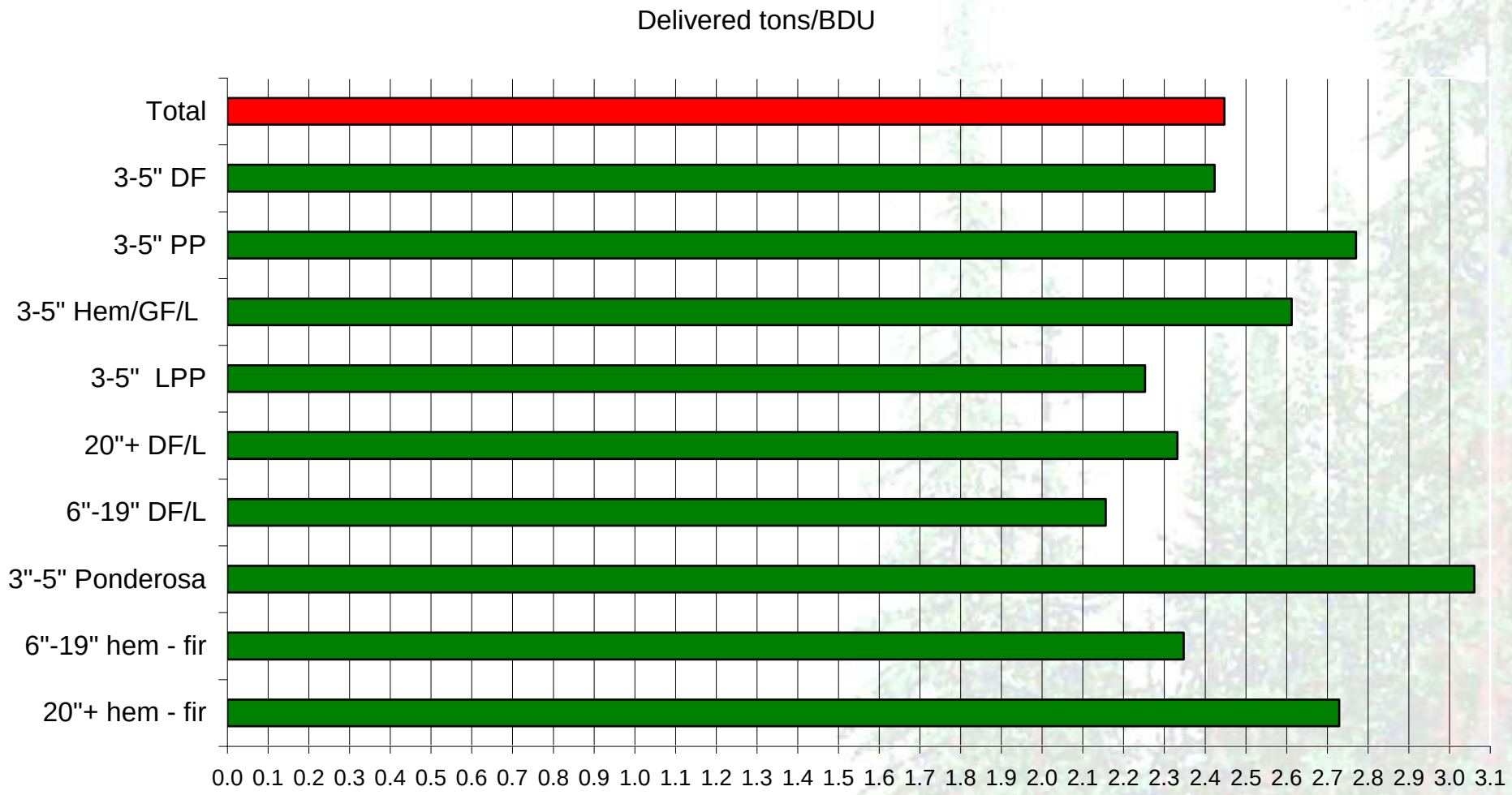
Delivered tons per BDU



CV = 12%

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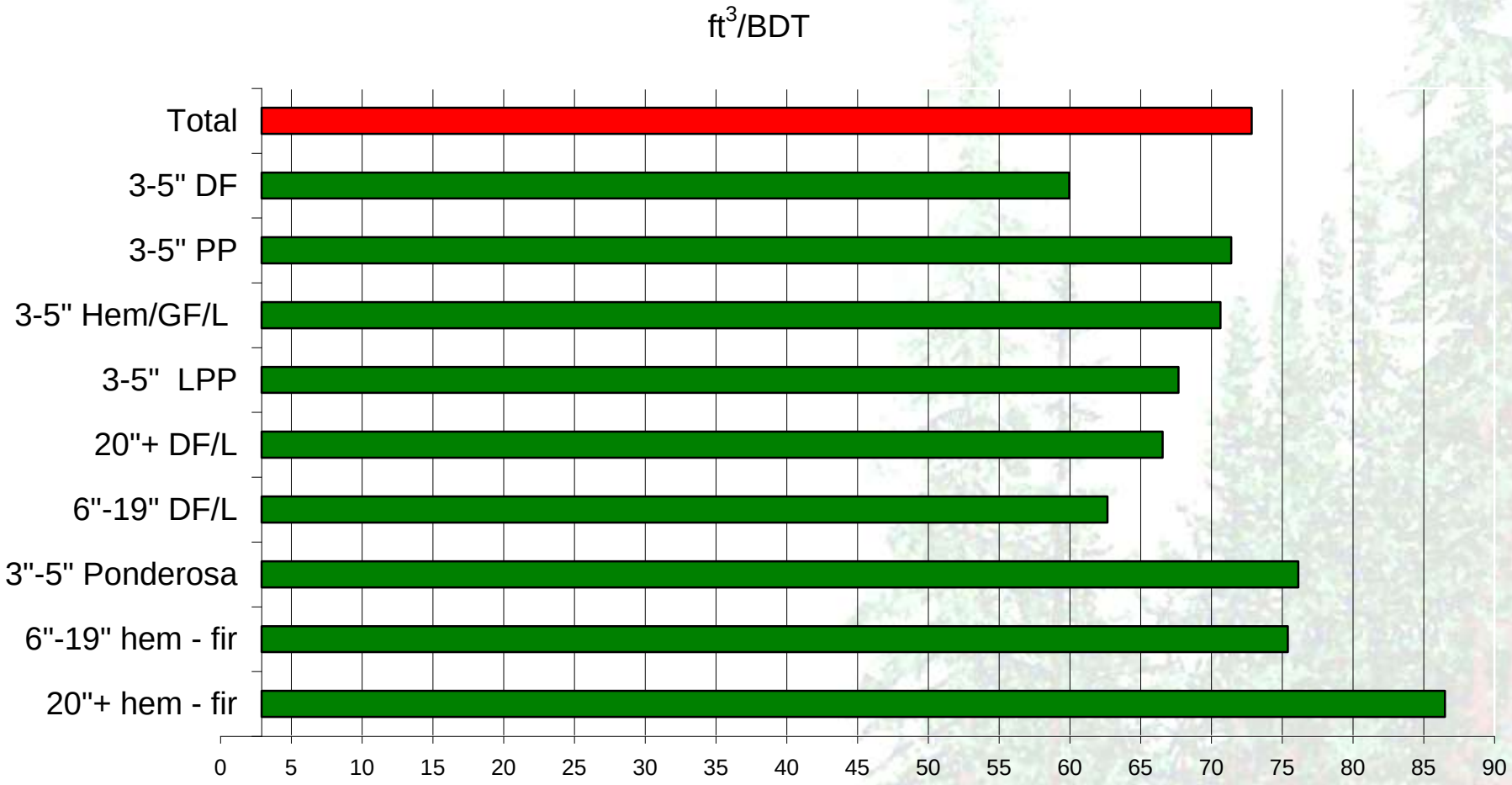
ft^3 log scale per BDT



CV = 11%

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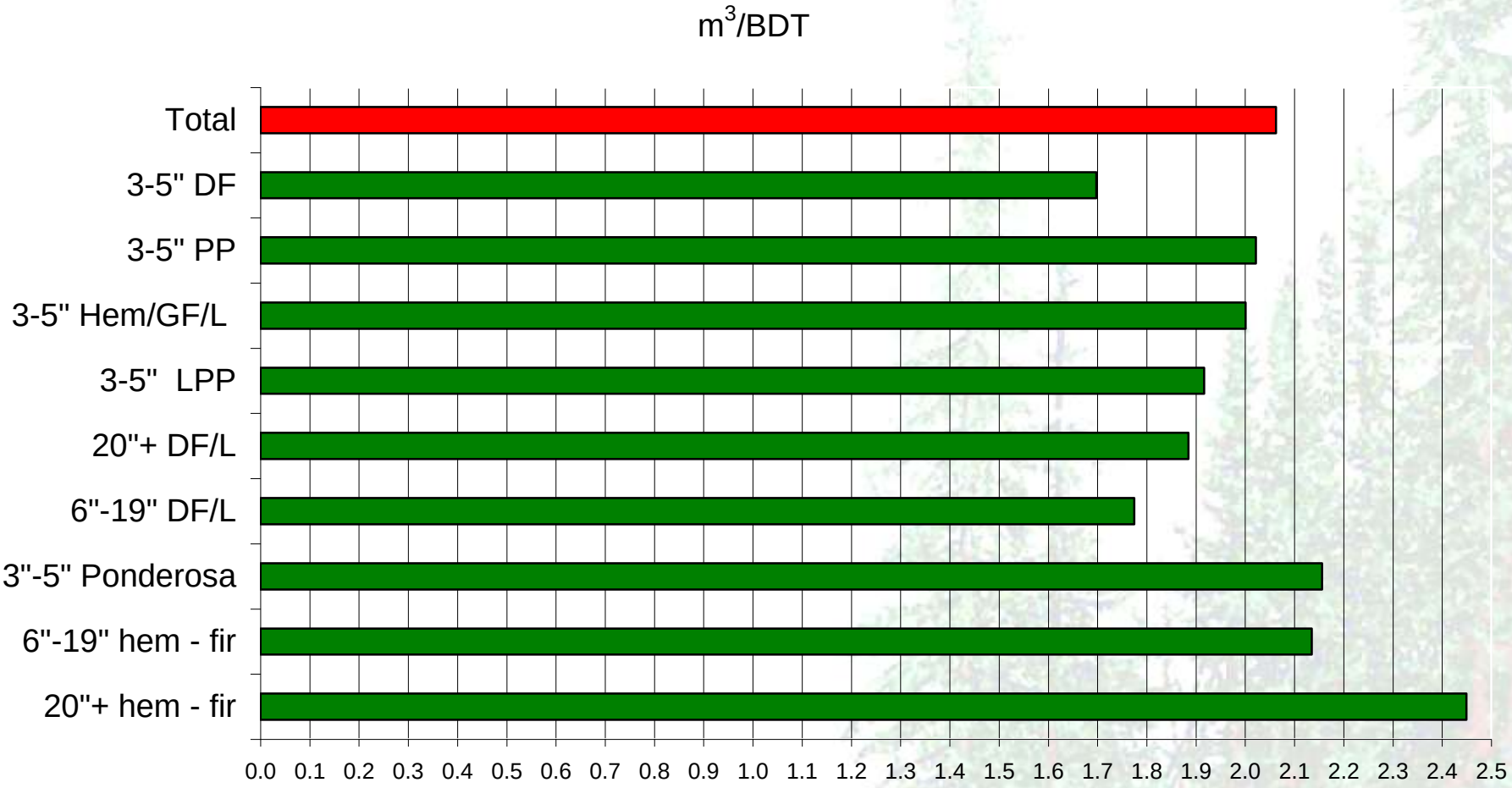
m^3 log scale per BDT



CV = 11%

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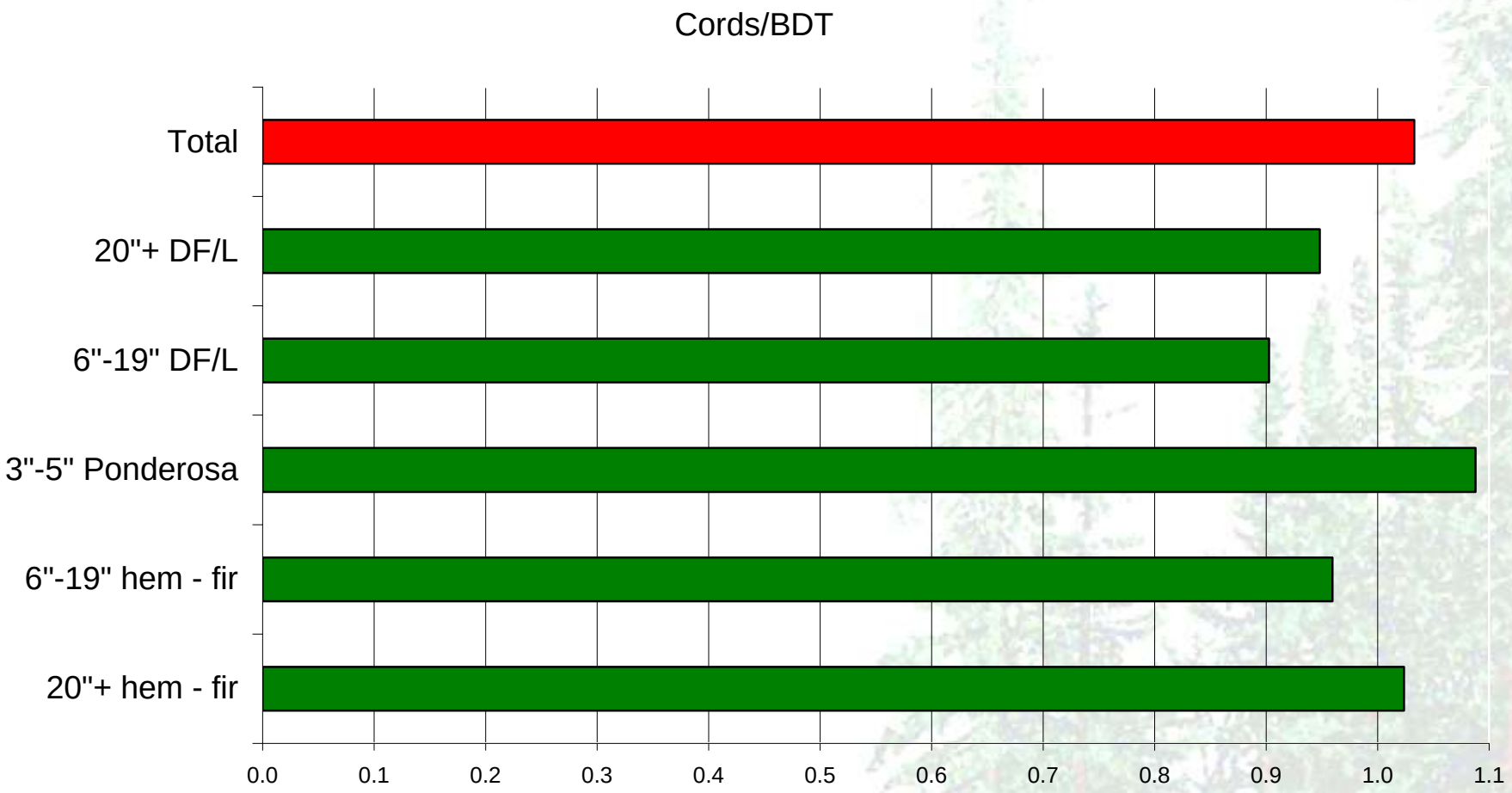
Cords per BDT



CV = 7%

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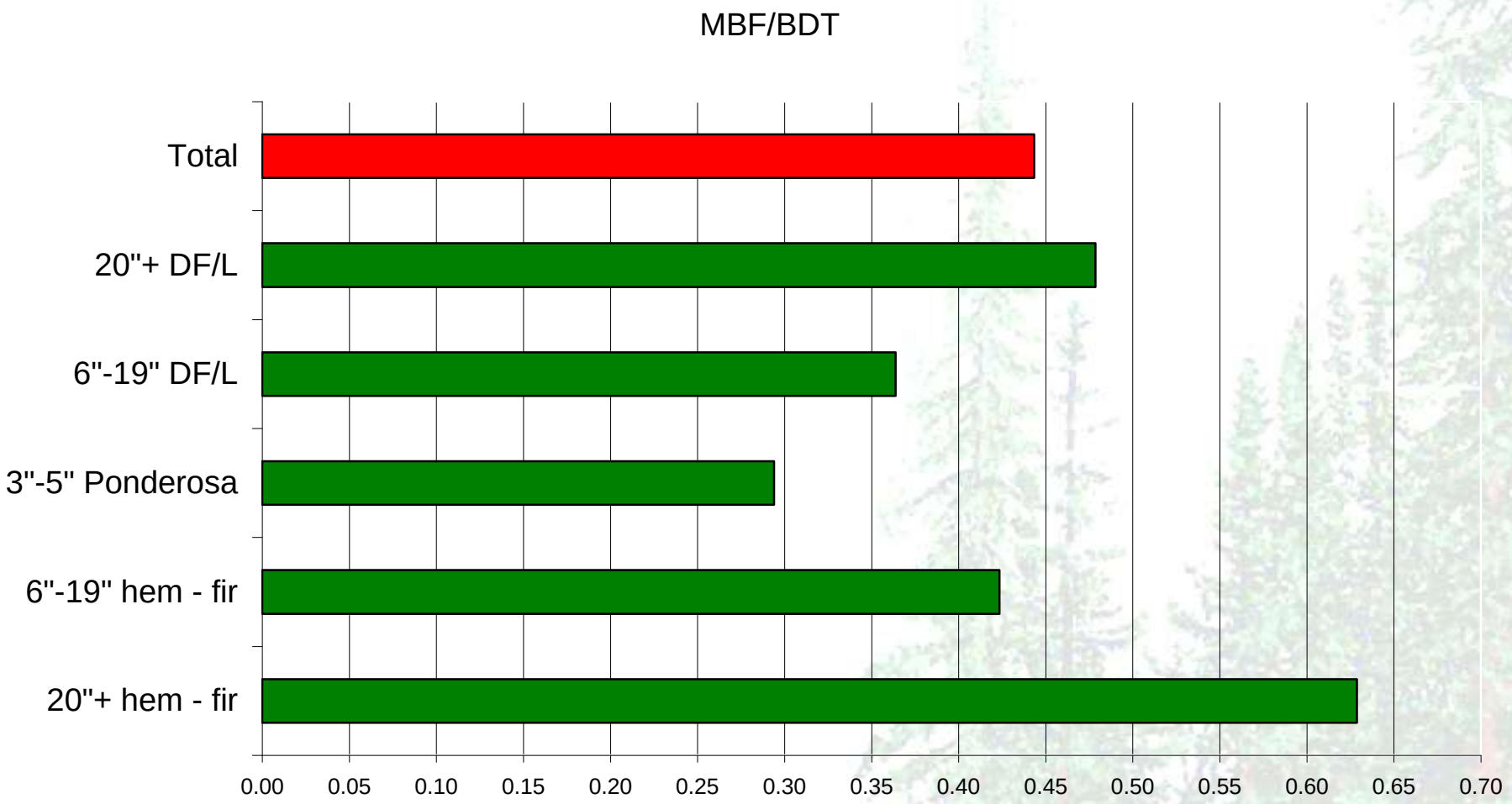
MBF (East-side) per BDT



CV = 29%

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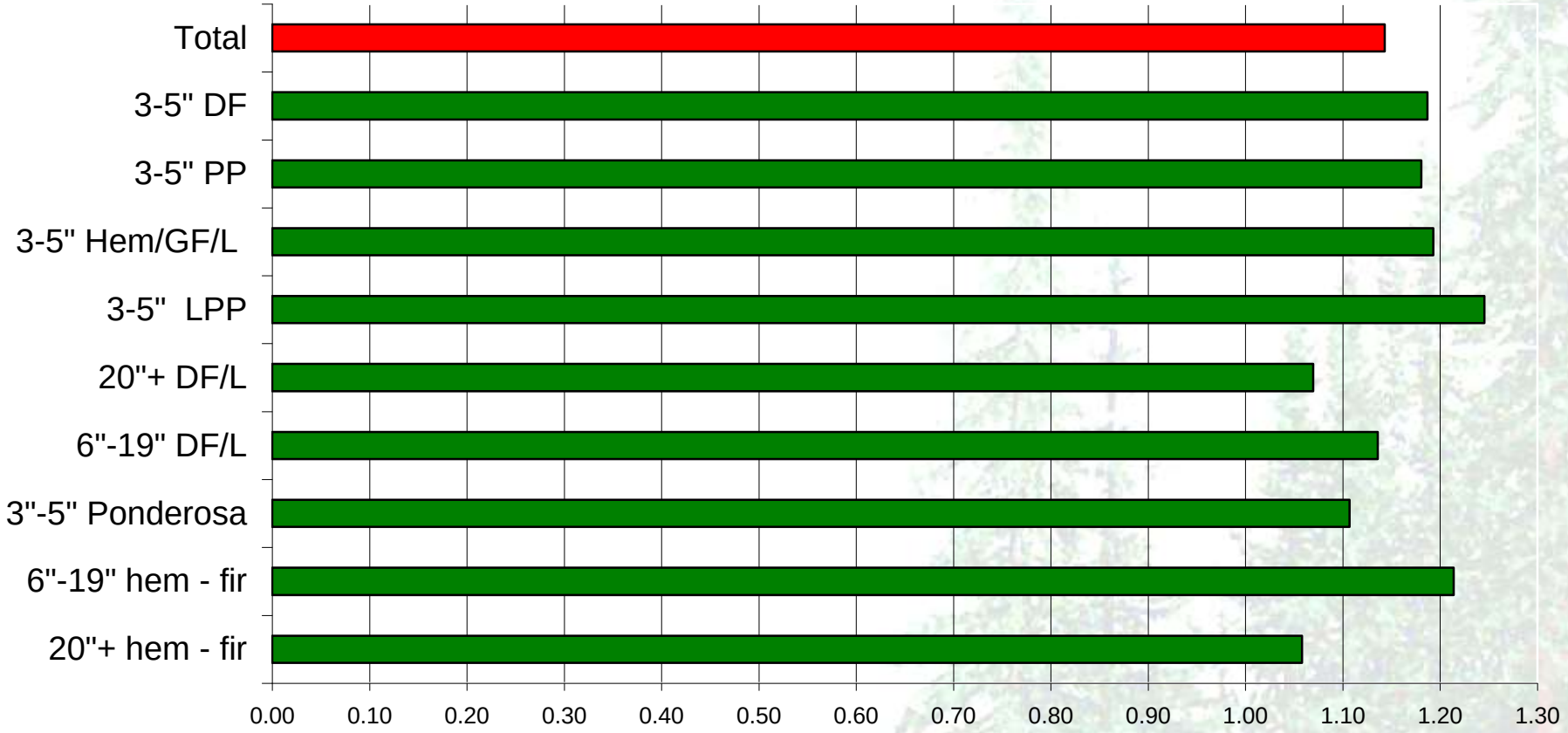
Cubic plus published SG by species

(Log volume in m^3 x published SG x (2205 ÷ 2000)) ÷ BDT actual chip yield



Note: SG used were: DF = 0.45, LPP and PP = 0.38, hem-fir = 0.35

CV = 6%

Log test conclusions

- Not advisable to use Scribner to measure pulp logs!
- Cords, cubic and green tons all are much better predictors of recovery
- Cubic coupled with average SG would be the best, e.g., 100 m^3 of DF logs (3,513 ft^3), (SG 0.45) = 45 BDT
- About 2 tons of logs = 1 BDT; 2.4 tons of logs = 1 BDU (+ or – for inland NW USA)
- A cord is roughly the equivalent of a BDT
- Roughly 15% of the delivered weight ends up as hogfuel (flails and debarkers also remove some wood with bark).

Is there another way? Ask the Austrians

Sample Taking

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- Lorry: 10 samples of truck vehicle and 10 samples of trailer
- Cutting along one line within the allowed sector
- Snow cover has to be removed in prior of sample taking

Half cross section

Chainsaw sampler

Chain saw with saw dust catching device

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