Cruising & Inventory

Follow the 4 P's

And

Avoid Mistakes

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Stolen From the 4 P's of Marketing

- **Product** – what?
- **Practices** – how?
- **Placement** – where?
- **Precision** – what is measured & how?

#1 - Product

- An inventory or cruise should relate directly to products of an enterprise.
  - Log lengths: if your market prefers a 40’ log and then variable lengths, why would you inventory in 32’ logs.
  - Quality: if your market differentiates log quality by pricing, your inventory or cruise should show product sorts.

* A Good Inventory Represents a Value Not a Cost

- Make more efficient, not lowest cost

- Keep up to date by a continuous inventory process rather than 10 year cycle
- Lower intensity on younger stands
- Higher intensity sample on stands close to harvest

Forest Inventory

- Should represent what will likely be harvested
  - What good is an inventory that does not mesh with what products come from your timberlands?

  Don't waste time & money

  A 32 foot log inventory when your product mix is variable length logs according to cutting specifications

  "Theoretical Volume" what "should" be there for harvest

#2 – Practice

- My focus will be on variable plots as those are most commonly used….

#2 – Practice

- **Cruise & Inventory rules should make sense and take account of real conditions**
  - Using a 10 BAF for all “eastside” forests
  - Focus on DBH measurements
  - Estimate total height on broken/forked trees
  - Edge plots
  - Limiting Distance
  - Sampling Design
  - Deductions are *per log* not taken from the whole

Limiting Distance

- Nice theory, but trees are not round.
- Variable plots are ***visual***; trees are in or out as viewed from plot center.

With the tools we have, RD 1000 is the most reasonable to measure, **IF** you have to.

- Provides measurement of visible face from plot center (like a caliper)

Is it in or out: it depends

- If measured with a diameter tape and limiting distance calculated, is it in or out?

- By fussing with limiting distance you are adding time, complexity and cost…..
- In a variable plot sample, trees are in or out visually…..check BAF calibration on Relaskops!

If a percent deduction is taken from the whole inventory, you are:

- Taking a deduction in all logs
- Including your most valuable logs

- Deductions are taken per log using scaling rules!
- Breakage is taken per tree depending on topography, height and defect!

Log Value
(that's what we cruise for!)

- 40 ft log = $650/M
- 30 – 38 ft log = $600/M

Take 40 ft to 5 inches or 32 ft to 6 inches???

40' x 5" = 40bdft = $650 x 40 = $26
32' x 6" = 50bdft = $600 x 50 = $30

Less physical wood, but more $$

Good Practice Includes Maintaining & Checking Equipment

- Relaskop scale is true
- Patched tapes or paint worn off
- Have increment borers in good condition
- Training & qualifications

Check Cruising

- Should always be “opportunities for improvement”. Its about quality control.
- To train and correct, not to punish. Training cruisers to do it right.
- Provides a benefit to cruisers, feedback, benchmarks. Improving productivity, fostering confidence and pride.
- *Should not encumber cruise production by excessive flagging or notes, etc.*

✓ If you have to do a lot of check cruising….

- ➢ Your upfront training needs to be better
- ➢ You got what you paid for with “lowest bid”.

#3 - Placement

- GIS pre-made maps with plots
  - Plot maps in handheld w/real-time GPS location
- GPS is your friend
  - Helps ensure correct stands are sampled
  - Can substantially reduce road travel time
  - Reduces between plot effort (use easiest path)
  - Eliminates out of type plots

Aerial Photo of Row Thinned Plantation

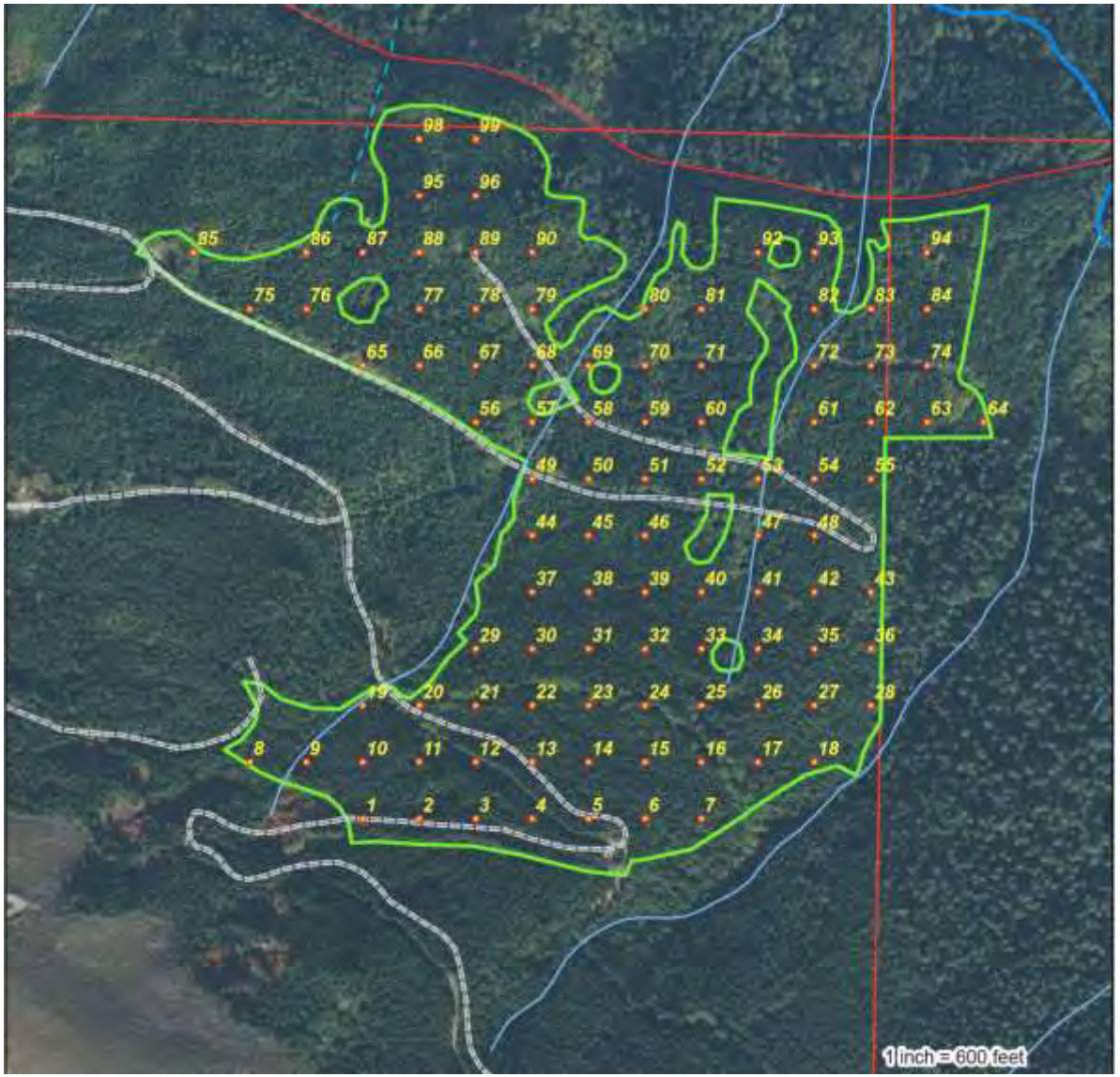
- Loblolly Pine in Georgia – Photo Courtesy of Weyerhaeuser Company

Planted at a Known Trees per Acre

Using a variable plot makes TPA very dependent on placement

- using a rectangular fixed area plot measures TPA directly and reduces variability

What happens when a portion of an inventory type is harvested?



Inventory should be PLOT based

- Likely to harvest highest or most valuable area first
- Remaining acreage gets the volume for whole type

- SHOULD use only volumes of plots within remaining type

- Causes higher than actual inventory drift

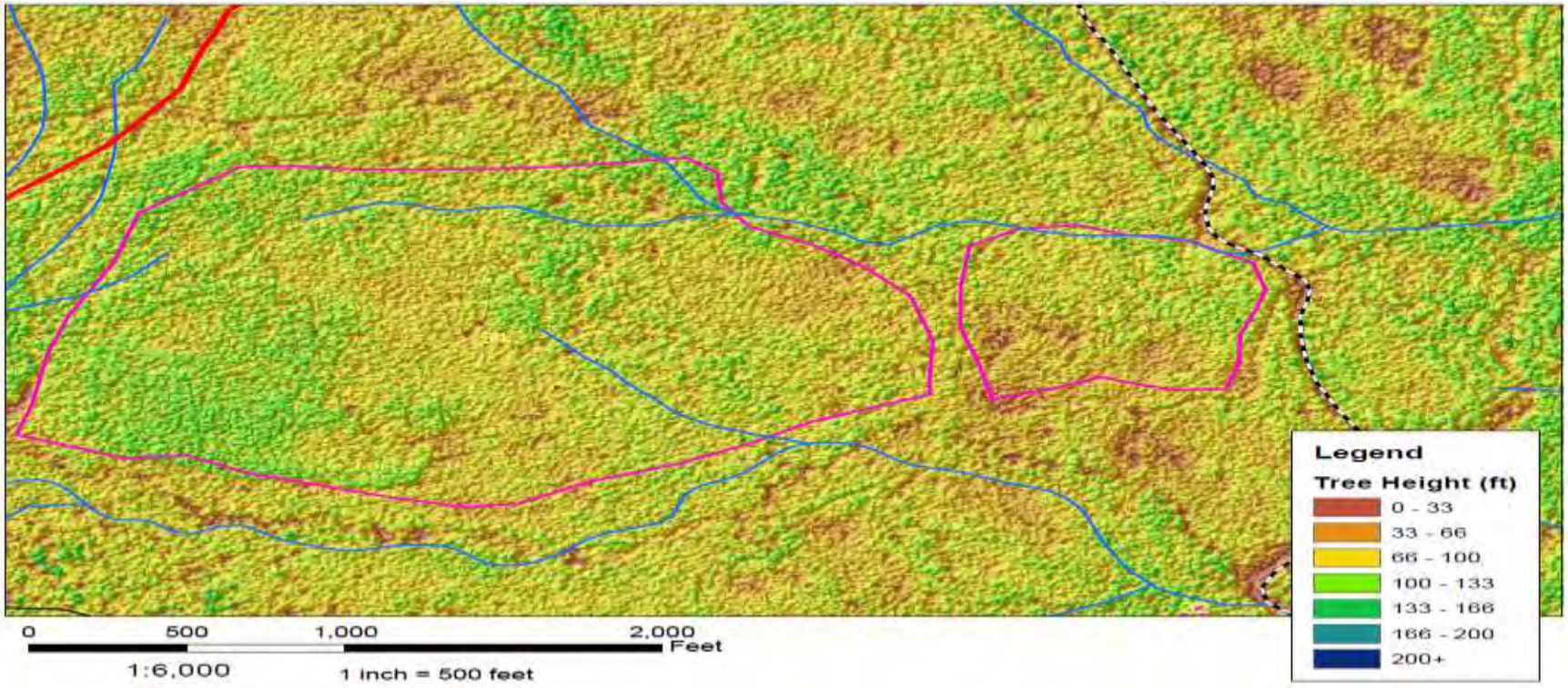
Plots vary from 48M/acre to 4M/acre

Plot No.	Plot Acres	Age	SI	Maj Spc	S T	Trees Me.	Trees Ct.	DBH	16' FF	Tot Ht.	Nor Stk	BA /Ac.	Trees /Ac.	Logs /Ac.	Net CuFt/Ac.	Net BdFt/Ac.	Total CUNITS	Total MBF
0001	1.44	40	117	WH		8		11.4	84	63	91	222.3	311.30	350.1	5,057	16,125	73	23
0002	1.44	40	117	DF		7		10.2	86	57	80	189.9	334.44	334.4	3,604	11,581	52	17
0003	1.44	40	115	SF		4		10.3	88	60	37	103.4	177.78	177.8	2,176	7,503	31	11
0004	1.44	40	115	SF		3		9.2	87	70	28	78.1	170.34	170.3	1,824	7,885	26	11
0005	1.44	40	115	WH		6		11.4	88	71	78	212.0	297.81	384.6	5,169	20,759	74	30
0006	1.44	40	115	WH		2		8.5	86	41	27	74.3	189.40	189.4	1,112	4,830	16	7
0007	1.44	40	120	DF		4		10.6	84	68	74	155.8	256.35	256.4	2,575	9,403	37	13
0008	1.44	40	115	SF		5		14.3	77	61	62	168.8	150.82	168.0	3,816	8,797	55	13
0009	1.44	40	101	SF		13		10.1	88	69	126	333.6	600.98	733.5	8,213	33,349	118	48
0010	1.44	40	115	WH		4		11.0	86	61	54	147.9	225.04	261.1	3,442	11,084	49	16
0011	1.44	40	117	WH		3		10.2	83	53	49	120.4	212.74	212.7	2,207	7,999	32	11
0012	1.44	40					0											

- Plots 50 – 99 = 14M/acre
- Plots 1 – 49 = 19M/acre
- **Total = 16.5M/acre**

LIDAR: tree heights

can help with typing; may show species change, clumps of older residual trees



#4 - Precision

- How much of a sample is enough?
  - Zero sampling may work in a known plantation situation (if you really need to save $)
- What should be measured?
  - Focus on tree heights, log lengths & values
- Instruments / tools & use
  - Use lasers for tree heights
  - GPS for navigation
  - Handheld for recording field data
    - Auto error checking, avoids transcription errors, scaling diameter calculations allow for value judgments on logs

Our Typical Forests Have High Variation

- Many commercial tree species: DF, WH, RC, RA, BM, CW, SF, GF, AF, WL, PP, LP, QA
- Many different products: export, poles, saw quality
- Wide diameter range: typical 60 year-old stand 30”DBH to 8” DBH
- Wide value range even within species

Cruise to Cut-Out

Acres	Cruise	Cut Out	% Diff	Cruise SE 1 SD	cruise DF	Cruise WH	Cruise RC	Cruise RA	Cruise CW	Cut DF	Cut WH	Cut RC	Cut RA	Cut CW	CV	# Plots	# Trees
73	2,641	2,851	-7.4%	5.7%	889	1,354	182	200	17	814	1,417	232	383	6	52.4%	85	447
76	2,899	2,871	1.0%	6.8%	2,248	346	59	245	-	2,087	386	87	312	0	61.6%	81	410
100	3,747	3,890	-3.7%	5.6%	2,228	1,104	100	283	33	2,564	907	75	325	19	52.5%	89	427
68	3,317	3,506	-5.4%	5.1%	1,931	959	290	50	87	2,055	1,042	251	59	98	42.8%	70	325
92	5,378	5,560	-3.3%	4.4%	4,155	831	357	23	12	4,194	808	489	43	26	42.5%	92	546
121	7,506	7,390	1.6%	5.8%	4,789	1,847	656	89	125	4,547	1,809	829	108	97	44.5%	113	623
33	2,016	1,884	7.0%	7.4%	1,383	115	202	317	-	1,280	111	207	276	11	63.1%	72	334
90	5,129	4,961	3.4%	4.0%	1,491	3,154	323	31	130	1,512	2,964	290	65	129	40.1%	99	587
56	1,984	2,227	-10.9%	15.0%	1,615	253	57	55	2	1,672	378	115	52	10	63.4%	71	297
91	4,172	4,102	1.7%	4.3%	104	3,799	239	6	25	106	3,617	295	8	75	41.7%	92	512
102	4,500	4,553	-1.2%	9.1%	2,422	1,069	706	225	78	2,404	1,120	707	235	87	45.7%	101	474
	43,289	43,795			23,255	14,831	3,171	1,524	509	23,235	14,559	3,577	1,866	558			
			-1.2%		0.1%	1.9%	-11.4%	-18.3%	-8.8%								

Timber Sale Cut-outs - Actual Data

			Douglas-fir Mbf			Hemlock Mbf			Red Cedar Mbf			Hardwoods Mbf			Sum Species		
Sale Name	Acres	Mbf per acre	Scale	Cruise	%	Scale	Cruise	%	Scale	Cruise	%	Scale	Cruise	%	Scale	Cruise	%
	38.3	42.891	1,362	1,481	8.0%	201	134	-50.0%	58	49	-18.4%	23	66	65.2%	1,644	1,730	5.0%
	199.3	33.688	5,045	4,768	-5.8%				632	621	-1.8%	1,037	902	-15.0%	6,714	6,291	-6.7%
	105.5	36.180	3,007	3,423	12.2%	251	288	12.8%	208	141	-47.5%	351	294	-19.4%	3,817	4,146	7.9%
	150.0	45.360	228	208	-9.6%	5,494	5,362	-2.5%	705	592	-19.1%	377	236	-59.7%	6,804	6,398	-6.3%
	71.9	39.708	2,116	1,885	-12.3%	547	431	-26.9%	69	66	-4.5%	123	92	-33.7%	2,855	2,474	-15.4%
	67.0	46.627	2,164	2,007	-7.8%	731	913	19.9%	193	202	4.5%	36	63	42.9%	3,124	3,185	1.9%
	86.7	40.877	2,070	1,992	-3.9%	982	921	-6.6%	477	482	1.0%	15	6	-150.0%	3,544	3,401	-4.2%
	122.0	40.484	793	784	-1.1%	3,774	3,402	-10.9%	137	142	3.5%	235	113	-108.0%	4,939	4,441	-11.2%
	86.0	52.465	3,147	2,483	-26.7%	1,123	986	-13.9%	111	97	-14.4%	132	276	52.2%	4,513	3,842	-17.5%
	110.9	50.045	3,668	4,332	15.3%	1,574	1,633	3.6%	156	189	17.5%	152	324	53.1%	5,550	6,478	14.3%
	139.8	40.129	2,621	3,005	12.8%	1,499	1,498	-0.1%	990	974	-1.6%	500	512	2.3%	5,610	5,989	6.3%
	72.4	42.129	2,299	2,208	-4.1%	318	422	24.6%	192	143	-34.3%	242	243	0.4%	3,051	3,016	-1.2%
Totals	**1,249.9**	41.736	**28,520**	**28,576**	**0.2%**	**16,494**	**15,990**	**-3.2%**	**3,928**	**3,698**	**-6.2%**	**3,223**	**3,127**	**-3.1%**	**52,165**	**51,391**	**-1.5%**
% of Totals			54.7%	55.6%		31.6%	31.1%		7.5%	7.2%		6.2%	6.1%		100.0%	100.0%	

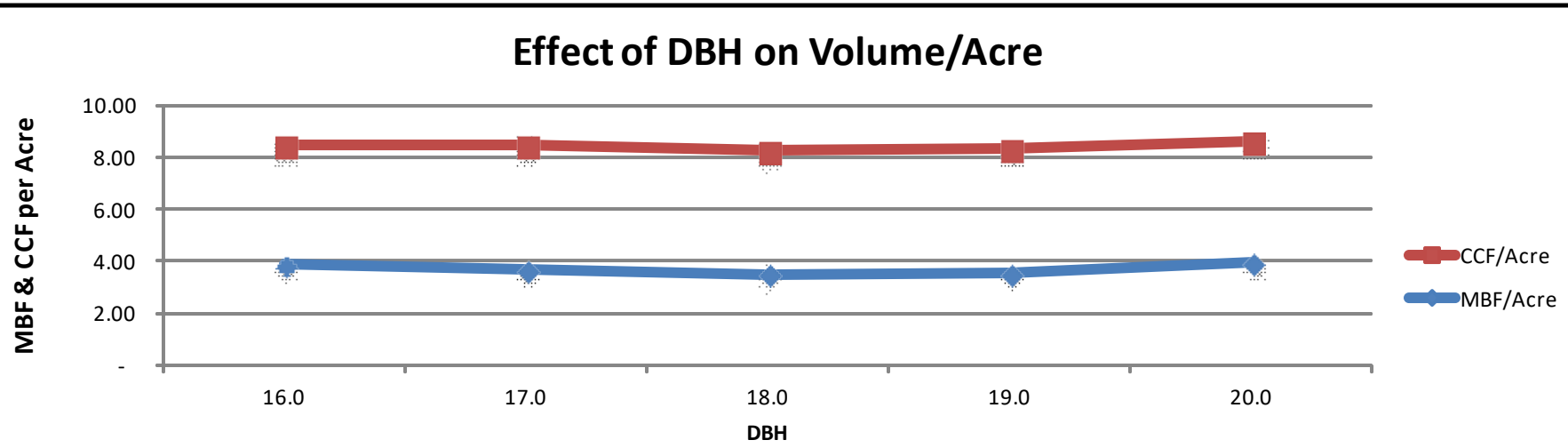
Where all of the sale cut the same year they were cruised? Should any growth be added?
The species don't add up to the totals in the document!
What was CV% by sale?
How many plots in each sale, statistics?
How many plots should have been taken to get the cruises to cut out closer?
What kind of cut-outs really make the user happy?
How much more money would it cost to get a better cut-out?

A Good Sample:
Measurements – Order of Importance

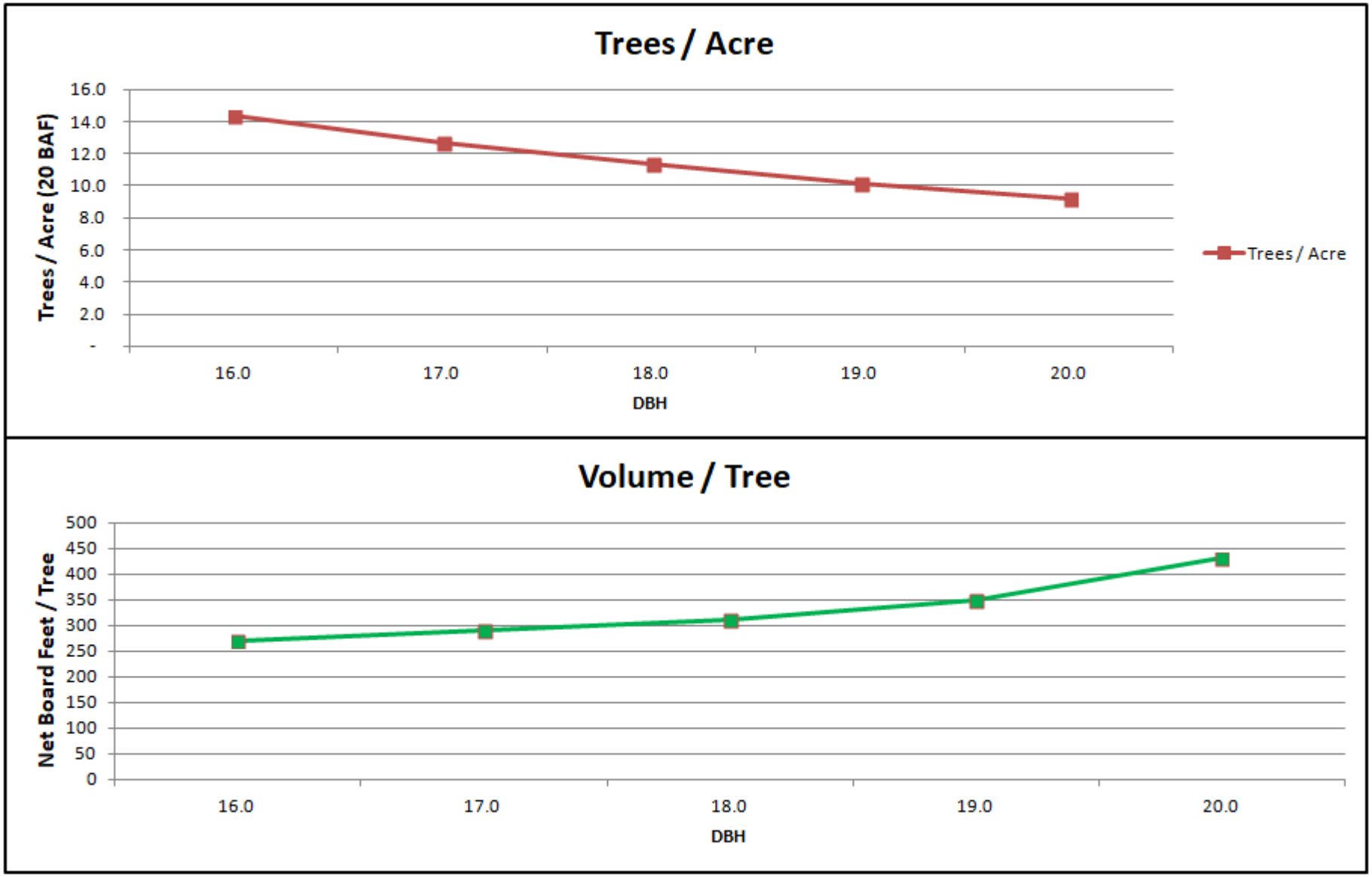
- Net timber acres
- Sampling system
- Tree Count
- Height
- Species
- Log lengths
- Log sorts
- DBH& taper

DBH Makes Little Difference in Volumes / Acre

Sensitivity of DBH to Volume per Acre with a BAF cruise													
Tree						Bole	Total	Per Acre		Net		per acre	
No.	BAF	DBH	FP	FF	TDF	Ht	Ht	BA	Trees	Net CuFt	Net BdFt	CCF	MBF
1	**20**	**16.0**	16	89	4	**95**	**116**	20.00	14.3	59	270	8.45	3.867
2	**20**	**17.0**	16	89	4	**95**	**116**	20.00	12.7	67	290	8.50	3.680
3	**20**	**18.0**	16	89	4	**95**	**116**	20.00	11.3	73	310	8.26	3.508
4	**20**	**19.0**	16	89	4	**95**	**116**	20.00	10.2	82	350	8.33	3.555
5	**20**	**20.0**	16	89	4	**95**	**116**	20.00	9.2	94	430	8.62	3.942



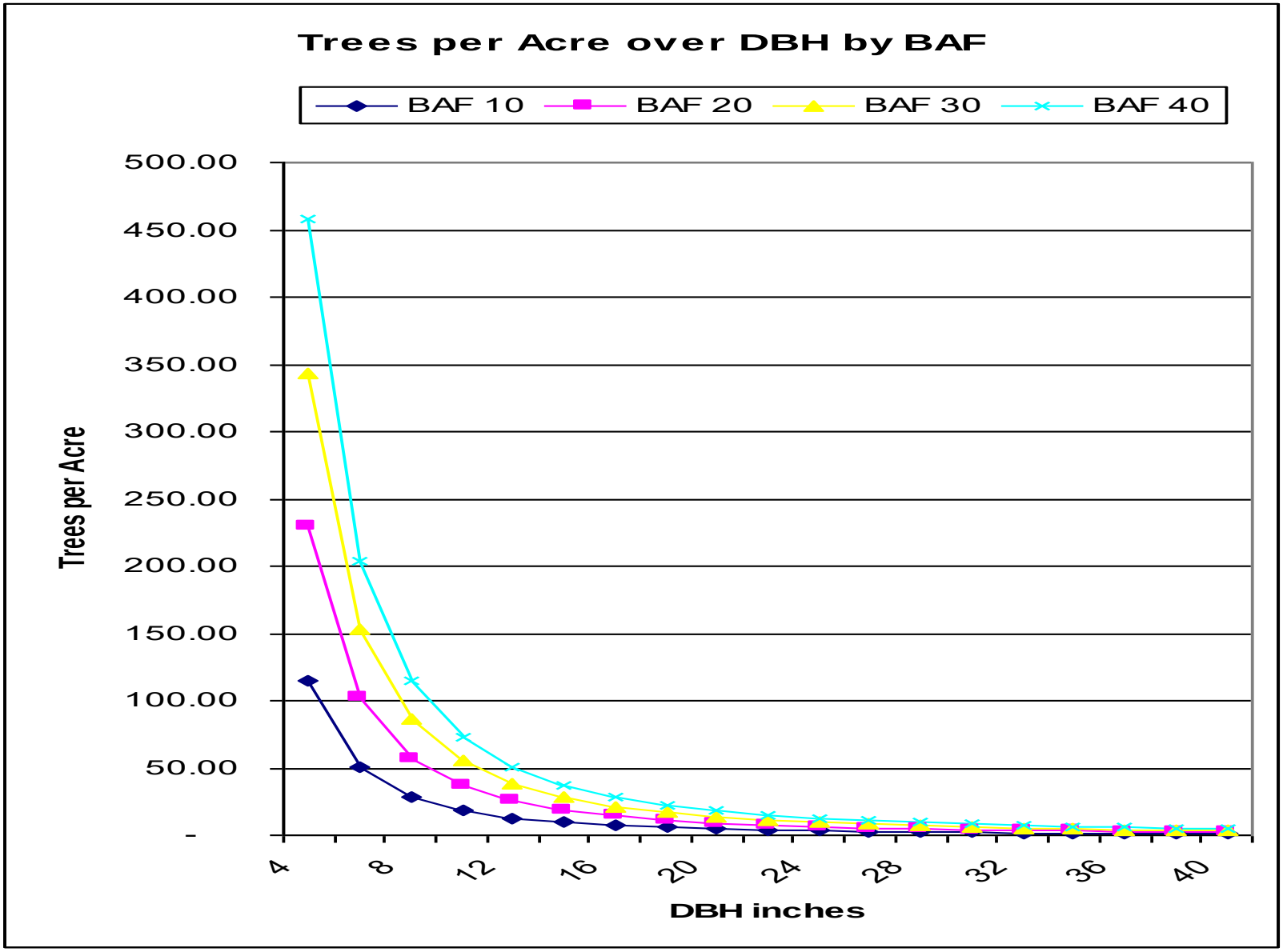
Fewer Trees/Acre Represented by the BAF & More Volume/Tree Provides Balancing



What happens when height is changed?

Tree No.	Spp	St	DBH	16' FF	Bole Ht.	Tot Ht.	BA /Ac.	Trees /Ac.	Logs /Ac.	Net CuFt/Ac.	Net BdFt/Ac.	Total CUNITS	MBF	Tree Height % Difference	% MBF/Acre Difference
0001	DF		18.0	88	95	121	51.7	29.23	87.7	2,067	8,184	103	41		
0002	DF		18.0	88	90	114	51.7	29.23	87.7	1,996	7,892	100	39	5.6%	3.7%
0003	DF		18.0	88	85	107	51.7	29.23	87.7	1,955	7,600	98	38	5.9%	3.8%
0004	DF		18.0	88	80	101	51.7	29.23	87.7	1,919	7,015	96	35	6.3%	8.3%
0005	DF		18.0	88	75	94	51.7	29.23	87.7	1,726	6,431	86	32	6.7%	9.1%
0001	DF		22.0	88	110	141	51.7	19.57	58.7	2,405	11,349	120	57		
0002	DF		22.0	88	105	134	51.7	19.57	58.7	2,290	10,762	115	54	4.8%	5.5%
0003	DF		22.0	88	100	127	51.7	19.57	58.7	2,250	10,566	113	53	5.0%	1.9%
0004	DF		22.0	88	95	121	51.7	19.57	58.7	2,158	9,783	108	49	5.3%	8.0%
0005	DF		22.0	88	90	114	51.7	19.57	58.7	2,038	8,805	102	44	5.6%	11.1%

Erratic volume jumps due whether or not an extra short log fits on top


Trees per Acre over DBH by BAF
BAF 10
BAF 20
BAF 30
BAF 40
500.00
450.00
400.00
350.00
300.00
250.00
200.00
150.00
100.00
50.00
-
Trees per Acre
4
8
12
16
20
24
28
32
36
40
DBH inches

Count Plots

Count Plots

- Measure basal area only
- Volume/acre usually varies more than BA
- Provide a false precision by making statistics look better
- Get treated as “hurry up or make money” plots
- ✓ Can provide efficient, cost-effective way to have greater coverage with sample

Count Plots

- Use judgment
- Can you just take fewer plots?

✓1 or few species
✓Narrow range of tree size
✓Irregular, scattered openings or low stocked areas, i.e. BA variation is high and the area is large

These conditions can result from:

•Variable thinnings or partial cutting
•Harvest marking
•Root rot pockets

BAF	PLOT #	TREE #	DBH	BA/Acre	Original TPA	Adjusted TPA	Volume/ Tree	Net Vol/Acre	Adjusted Net Volume/Acre
20	1	1	26.1	20	5.8		820	4,756	
		2	12.1	20	25.0		140	3,500	
		3	22.0	20	7.6		520	3,952	
		4	26.0	20	7.0		810	5,670	
		5	27.7	20	4.8		1,120	5,376	
				100	50.2			23,254	
20	2	1	23.1	20	6.9		680	4,692	
		2	26.0	20	5.4		680	4,644	
				40	12.3			9,336	
Average/Plot (measure & grade only)				70	31.3			16,295	
Add Count Plots:									
20	3	4 count trees		80					
20	4	4 count trees		80					
Average/Plot (*ALL PLOTS*)				75		33.58			17,510

Count Plot Adjustment Calculations

The adjustment for volume is based on the difference between basal area on graded (measured) plots and count plots. In the above example, the graded plots had a basal area of 140 in total. The count plots had a basal area of 160. The adjustment from the count plots is done for each species. In the above example, all trees are Douglas-fir.

$$\text{Adjustment} = \frac{\text{Count BA + Graded BA}}{\text{Graded BA}} = \frac{160 + 140}{140} = 2.149$$

The adjusted trees/are is calculated by multiplying the total number of trees per acre times the adjustment factor, divided by the total number of plots

$$\text{Example:} \quad \frac{(50.2+12.3)\ \text{TPA X } 2.149}{4\ \text{plots}} = 33.53\ \text{TPA}$$

The volume per acre is adjusted in the same way as trees per acre

$$\text{Example:} \quad \frac{(23{,}254 + 9{,}336)\ \text{Vol/Acre X } 2.149}{4\ \text{plots}} = 17{,}510\ \text{BdFt/Acre}$$

- What happens if count plots are not done carefully or do not represent the whole stand?

Actual Example from harvest unit with patches of “dog hair”:

2 - 6 tree plots:

1=60mbf/acre, and 1=16mbf/acre

MBF/acre usually varies more than BA/acre!

Most of your time is spent getting to a site and then traveling between plots

Ultimately how many plots go into a stand is determined by:

- ***Time***
- ***Budget***
- ***Training & skill of cruisers***

The End

- Thank you

- Questions & Comments?