

In forest assessment of timber strength

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Objective

Find objective site variables influencing grade yield in strength grading of Norway spruce

-Must be easily accessible from forest inventories or harvester measurements

Background

- **1 mill out of a total of 2,4 mill m³ produced of the sawn timber in Norway is strength graded**
- **No pre grading is done before dry sorting saw falling timber**
- **Yield is accepted, but varies significantly**

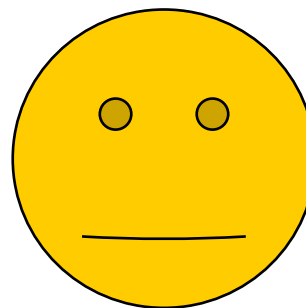
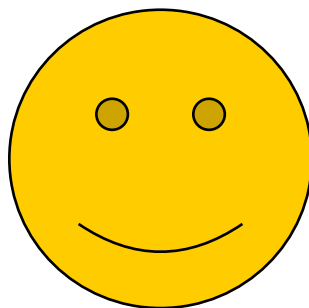
Who benefits?

- Producers of higher strength classes (>C24)

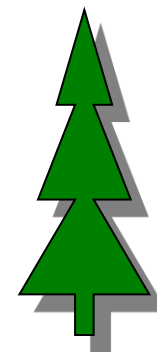
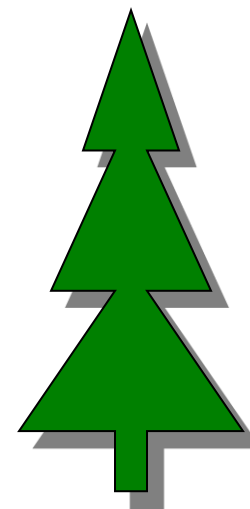
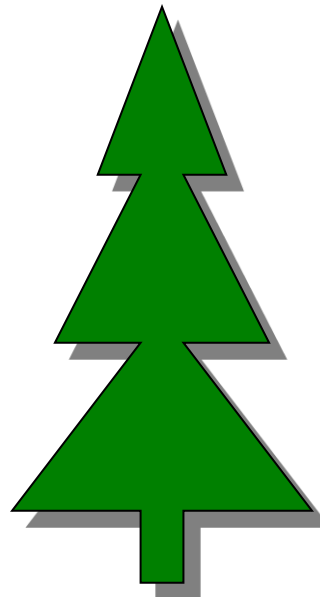


Sampling variation

Site level



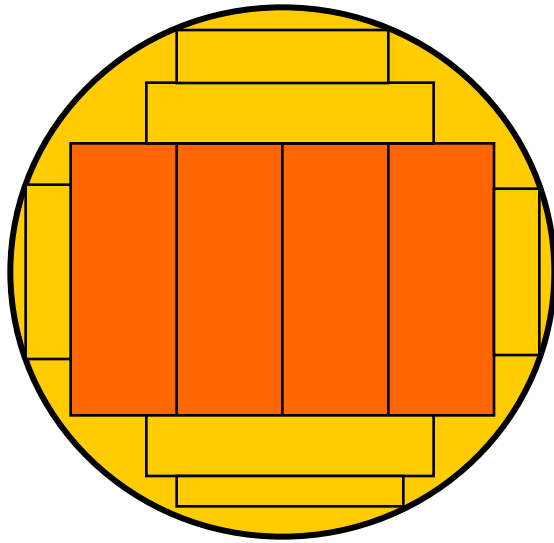
Tree level



Sampling

- **6 sites of varying forest quality**
- **3 tree sizes**
- **3 replicates from each group**
- **85 trees**
- **155 logs**
- **406 boards strength graded**

Cross-cutting and sawing



- All trees were cross-cut in fixed lengths of 4 or 6 m
- All sawing was done as heart-splitting
- Only the center yield was strength-graded
- Dimensions ranged from 38 x 100 mm to 50 x 225 mm
- Kiln dried to MC of 18 %

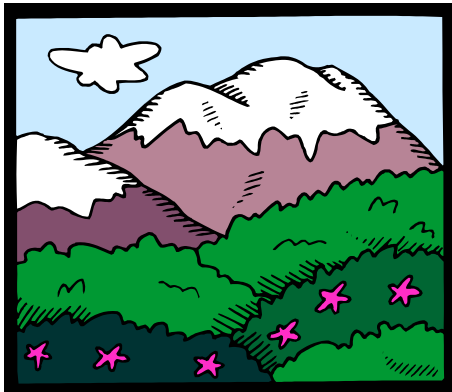
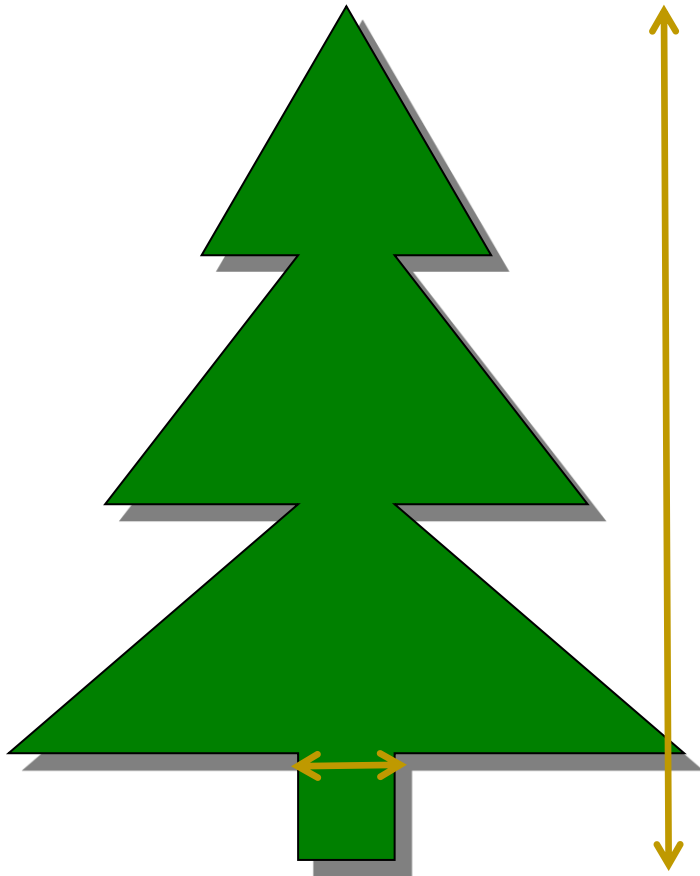
Strength grading



- By Dynagrade
- Finds the dynamic MOE
- Gives an Indicating Parameter (IP) from measuring the impact from a hammer and the length of a piece
- Most common strength grading machine in Norway

Results

Stand	Site index	Altitude [m]	Age [yrs.]	DBH [cm]	H [dm]	H/DBH	No of boards	E_{dyn}
1	G17	450	99	28.4	201	7.2	76	5 986 053
2	G14	470	117	26	213	8.4	84	6 559 405
3	G14	620	106	24.1	194	8.2	45	6 015 111
4	G11	630	100	24.9	160	6.5	32	5 196 563
5	G20	350	102	29.0	252	9.1	128	6 715 078
6	G11	770	119	27.5	154	5.8	41	5 508 049
Total			107	26.6	196	7.6	406	6 227 241

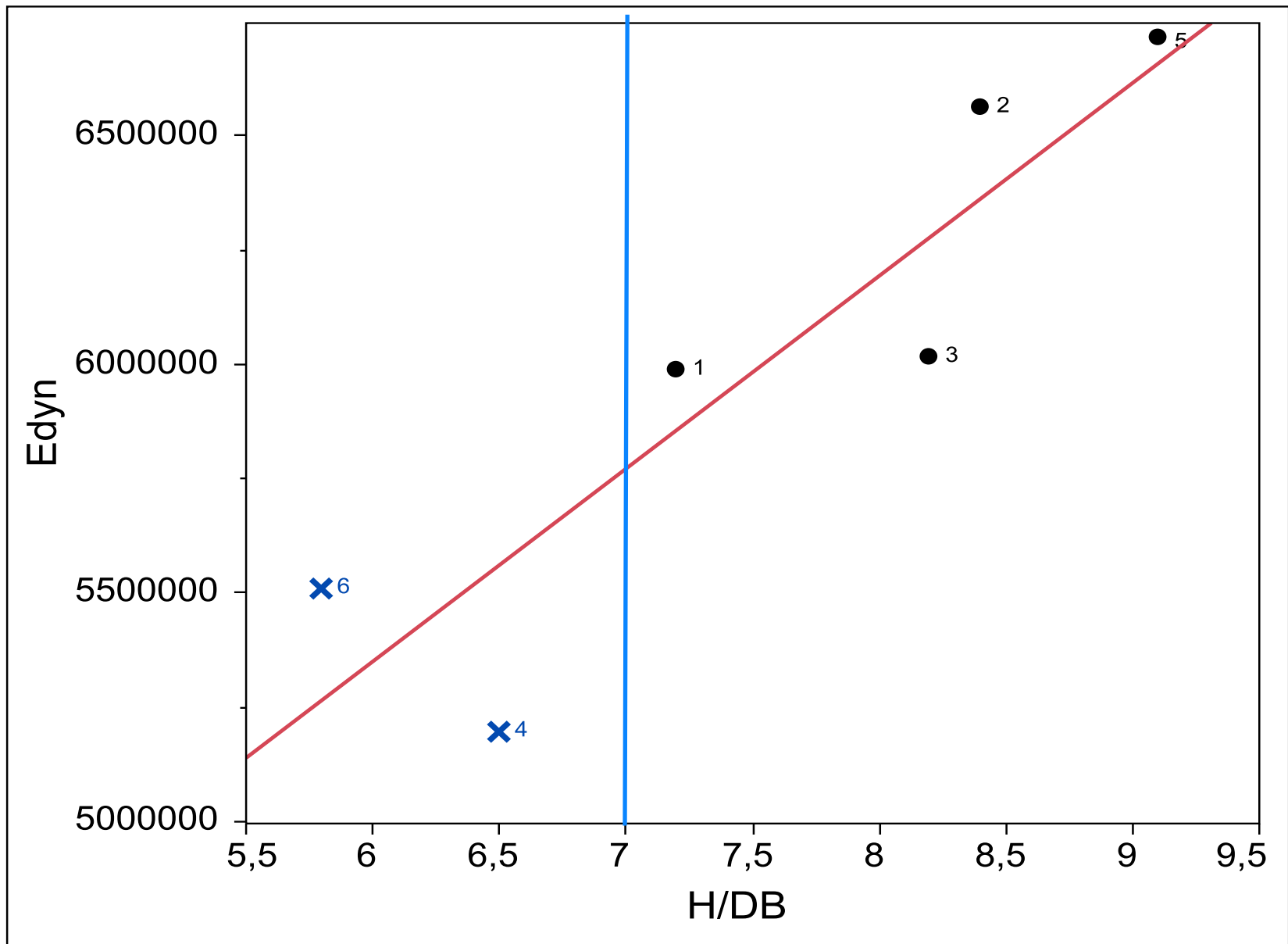


Predictors

- H = Tree height
- Diameter = DBH
- H/DBH
- Altitude
- Site index

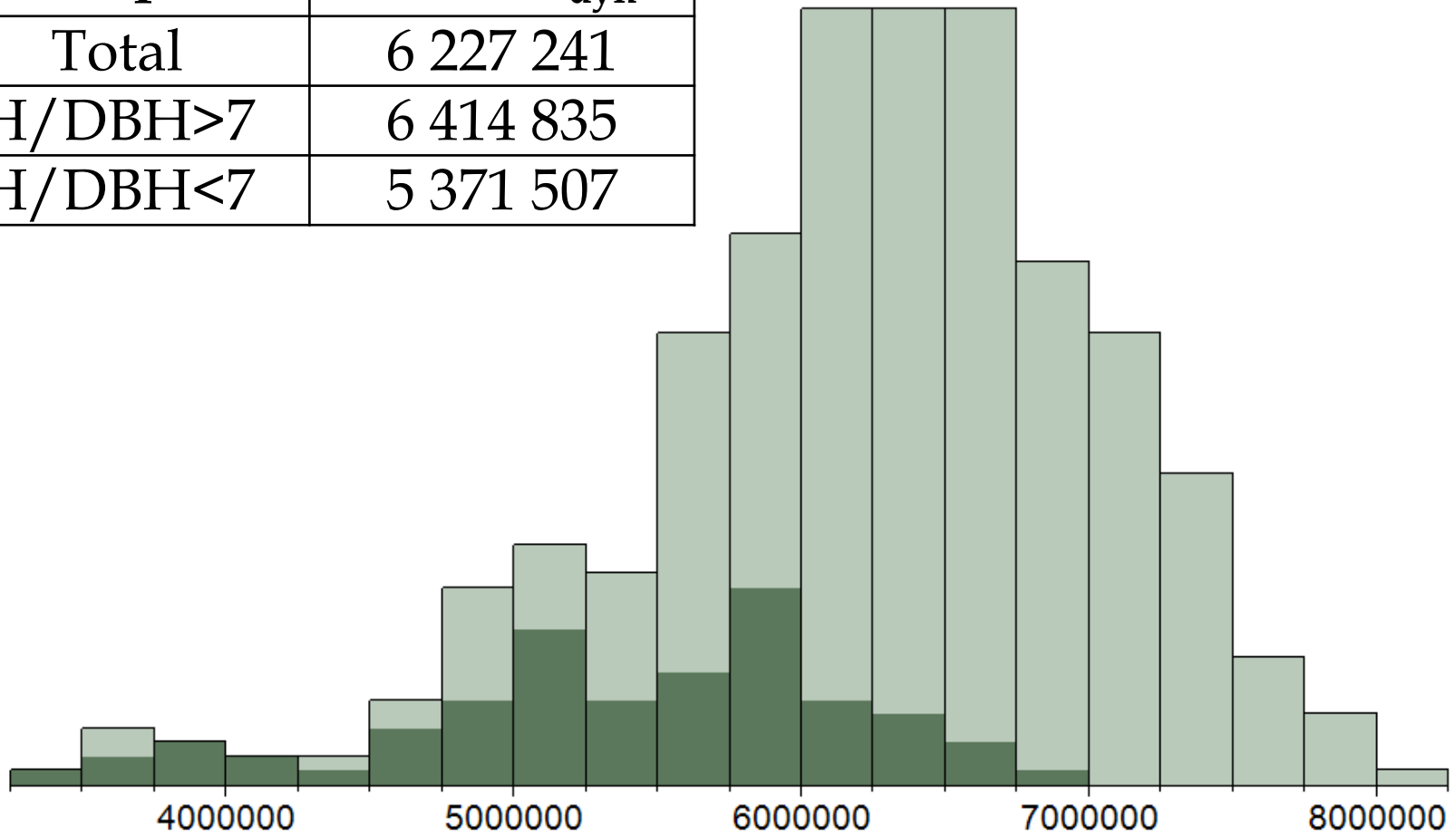
Regression analysis

	<i>Predictor</i>	<i>R²</i>	<i>RMSE</i>	<i>F-ratio</i>	<i>P-value</i>	<i>Equation</i>
1	H	0.878	228 146	28.9	0.006	3 030 379+15 154×H
	DBH	0.152	602 434	0.7	0.445	2 900 454+116 182×DBH
2	H/DBH	0.813	228 672	17.4	0.014	2 820 436+421 629×H/DBH
	SI	0.630	397 973	6.8	0.059	4 076 424+132 434×SI
	Alt	0.644	390 191	7.2	0.055	7 687 069+3083×Alt.

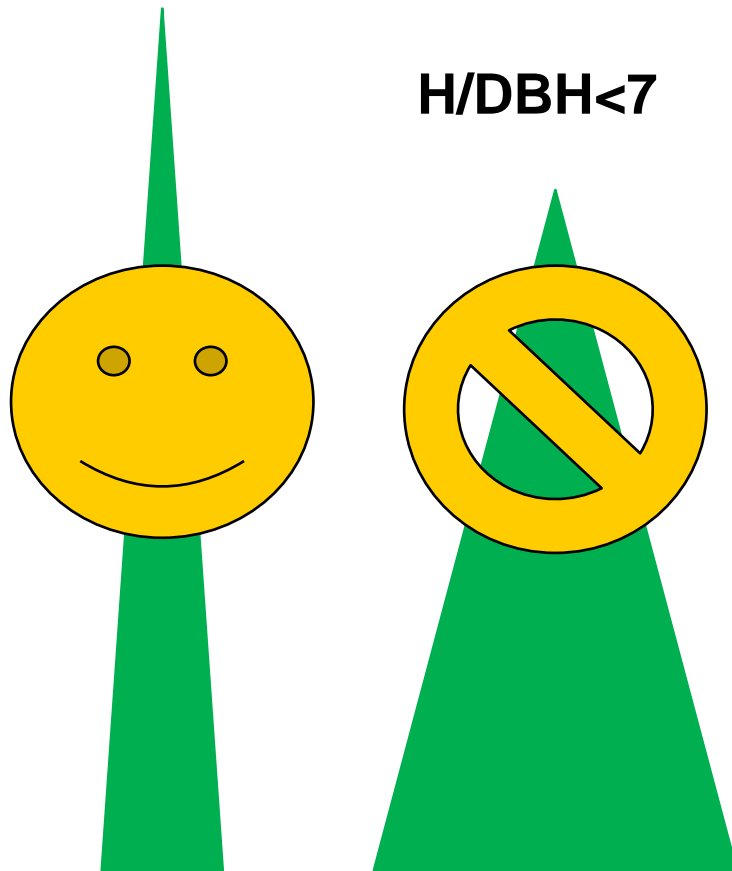


Distribution

Sample	Mean E_{dyn}
Total	6 227 241
H/DBH>7	6 414 835
H/DBH<7	5 371 507

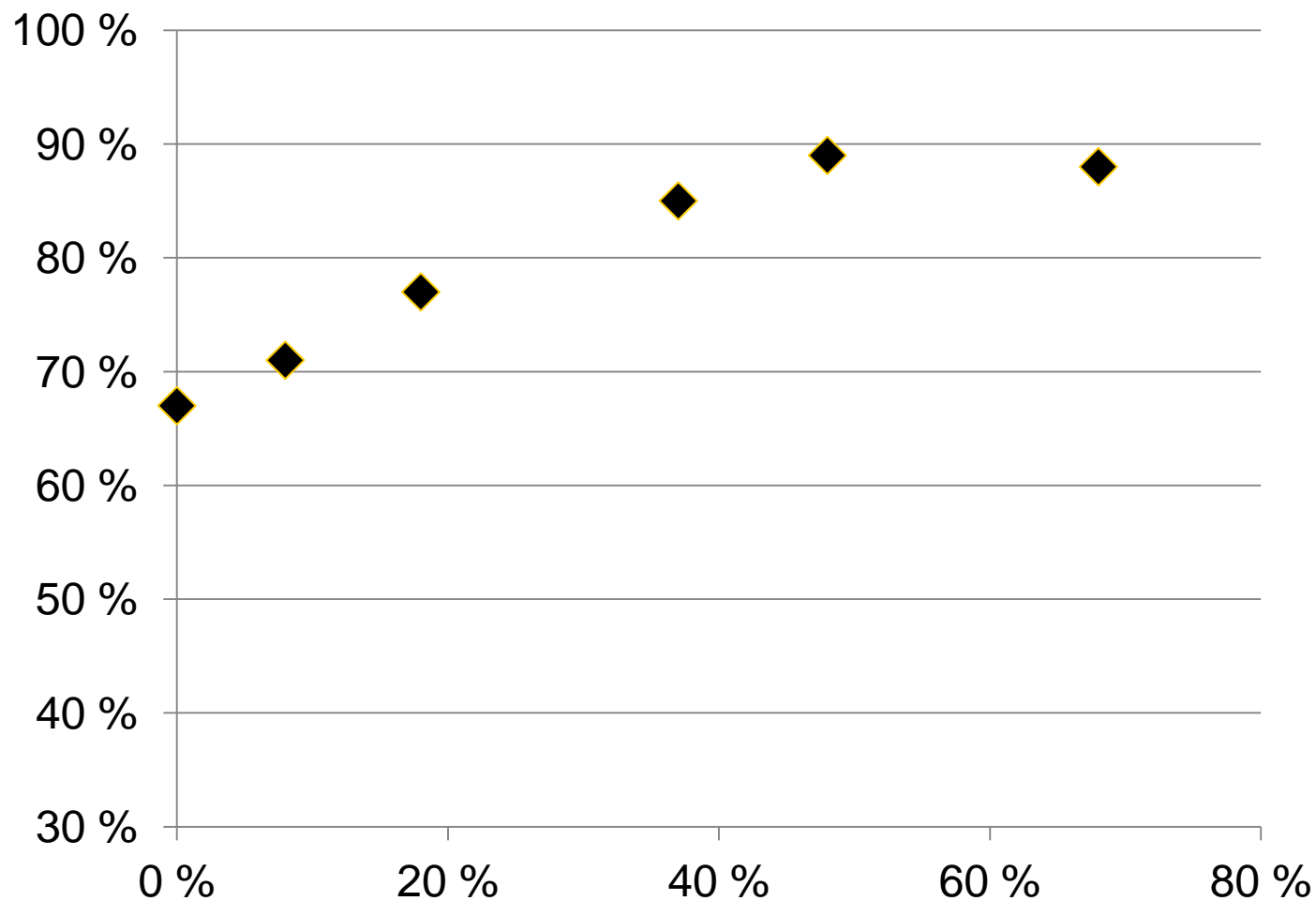


Effects of in forest grading



	Grade yield	
	Total batch	H/DBH > 7
C24	98.0	99.4
R	2.0	0.6
C30	66.7	76.9
R	33.3	23.1
C30	27.3	33.0
C24	62.8	62.8
R	9.8	4.2
C35	10.3	12.6
C24	76.7	81.1
R	13.1	6.3
LS22	53.2	62.2
LS15	43.8	36.9
R	3.0	0.9

C30 vs rejected timber



Conclusions

- **Mean taper of trees in a stand good predictor for timber strength**
- **Up to 10 % increase in C30**
- **Pre-sorting attractive for saw mills producing higher strength classes than C24**
- **Sorting algorithms must be validated for each saw mill**
- **Document actual strength**

Further work



Approx. 20 sites sampled
acc. latitude, altitude and
site index

Gradients

----- North → South

----- Coast → Mountain

----- Coast