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Sources of bias in diameter growth data

by
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Differences in the growth predictions made using the growth models from increment core data (Wensel. Meerschaert, and Biging, 1987) compared to those from the difference of two measurements 5 years apart (Wensel and Robards, 1989) were significant enough to suggest that there could be bias introduced in either the measurements or the analysis.[2] To investigate this possibility, the process used for these estimates was examined in considerable detail and comparisons were made to assess the source of the differences observed.

This assessment was carried out in three stages. First, the validity of the increment data was examined. Second, a "period" effect was estimated to see how comparable the growth rates were on the same trees over the two periods used. Third, an overall bias is estimated.

Validity of data and previous analyses.

There were 82 trees available that had both remeasurements and increments available for the same period. Largely these were site index trees that had been bored to determine tree age; the 5-year increment was also determined, however. The discrepancy in the measurements led to a re-analysis of the algorithm used to backdate the initial DBH measurements. Here it was

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2 For CACTOS users. the 1987 and 1989 studies produced the coefficient files COFILE.31 and COFILE.4, respectively.

discovered that the increment core data used in the 1987 estimates failed to account for the growth in the bark. Since the bark factor estimated for the entire data set is about 0.89, this introduces a bias of about 12% (i.e., $(\frac{1}{0.89} - 1)100\%$). Thus the DBH growth estimates in the 1987 paper should be increased by 12%.

Period effects.

A period effect can be estimated for trees where remeasurement data are available for the two periods in question. For the data used in the 1987 estimates, over two thousand trees had measurements in the two periods in question: 5 to 10 years prior to the initial coop measurement in 1979 and 5 to 6 years after that date. These are referred to as period 0 and period 1. While there were 4 geographical regions recognized in the two studies, we had remeasurement data prior to 1979 from only 2 of these regions, the northern Sierra (region 1) and the Mendocino (region 4). The average growth rates for the two periods are shown by species and region in Table 1.

Table 1. Average 5-year diameter growth rates for periods 0 and 1.

species		region	obs	average by period per. 0	per. 1	diff	diff	std dev	std error
	(no.)	(no.)	(no.)	(in.)	(in.)	(in.)	%	(in.)	(in.)
PP	1	1	390	0.766	0.945	0.179	23.4	0.579	0.029
PP	1	4	212	0.542	0.604	0.063	11.6	0.254	0.017
SP	2	1	107	1.213	1.437	0.224	15.6	0.593	0.057
SP	2	4	86	0.834	0.865	0.031	3.7	0.249	0.027
JP	5	1	18	0.781	0.868	0.087	11.1	0.481	0.113
IC	12	1	366	0.706	0.767	0.061	8.6	0.654	0.034
IC	12	4	88	- 0.714	0.654	-0.060	-8.4	0.647	0.069
DF	14	1	53	1.124	1.346	0.222	19.8	0.406	0.056
DF	14	4	202	0.876	1.018	0.143	16.3	0.258	0.018
WF	21	1	344	1.046	1.208	0.162	15.5	0.563	0.030
WF	21	4	160	0.784	0.858	0.074	9.4	0.285	0.023
RF	22	1	3	1.305	1.455	0.151	11.6	0.249	0.144
RF	22	4	8	- 0.812	0.774	-0.038	-4.7	0.224	0.079
All		both	2037	0.826	0.942	0.116	14.0	0.514	0.011
All		1	1281	0.878	1.023	0.145	16.5	0.592	0.017
All		4	756	0.739	0.806	0.067	9.1	0.335	0.012

The differences varied some between species but all species showed faster growth in period 1 than in period 0 and faster growth in region 1 than in region 4. Thus the 1989 estimates include an average "period effect" of about 14%.

Overall bias.

Finally, all of the increment data were matched with the remeasurement data for period 1. Simply examining the average DBH growth across all 6 of the major species provides the result summarized in Table 2.

Table 2. Summary of sources of bias in growth predictions

	average DBH growth (inches)		
a.	remeasurement for period 1		0.96
b.	increment for period 0	0.68	
c.	period 0 adjusted for bark growth	0.76	
d.	adjustment for period 0 effect (14%)		0.87
e.	difference		0.09

This leaves an overall estimate of the differences between the two estimation data bases, 1987 corrected for both a bark and period effect and 1989, of 0.09 inches or 9%. Breaking the period adjustment out by species did not change the overall result.

Discussion

This simple analysis reduced the unexplained difference in the average DBH growth from 0.28 to 0.09 inches, a reduction of about two thirds. Other possible sources of the differences may be hypothesized. However, these results appear to suggest that either the 1987 estimates adjusted for bark growth and period effect or the 1989 models can be used to give similar estimates.

However, this does not touch the real problem in estimating tree growth with CACTOS (Wensel, Daugherty, and Meerschaert, 1986). All of the estimation and validation work has centered on growth estimates for 5-year intervals while planners are regularly using CACTOS to project for much longer periods. Trials with CACTOS coefficient file "cofile.410", which contain the growth estimates from Wensel and Robards (1989), can easily produce basal area stocking levels of 600 to 800 square feet per acre (or more!) within the projection period. The stocking in the data base do not extend much beyond 400 square feet per acre. Further, the growth rates do not appear to be retarded by the higher stocking levels. This is an appropriate topic to consider when analyzing the 1990 remeasurement data.

Literature Cited

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