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ACCURACY OF THE TOPOGRAPHIC ABNEY IN LONG-DISTANCE SIGHTING

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The topographic abney has long been a favorite instrument of foresters. It is considered one of the most accurate instruments for measuring tree heights, and for many years has been the official hand level for timber-survey work in the Forest Service. In land surveying, where the greater accuracy of the transit is not required, the staff compass and topographic abney used in conjunction with the topographic trailer tape do a faster, less expensive, and equally efficient job.

The accuracy of the abney in measuring horizontal distances and obtaining elevation differences depends, of course, on topography, methods employed, and experience of the crew. Using a single abney and considering cumulative errors, the accepted deviations for precision work should not exceed 30 feet per mile in distance nor 10 feet per mile in elevation.

A question arises, however, as to the effect of distance on elevation accuracy for abney readings. No reference was found in the literature regarding this matter, but a widely used "rule-of-thumb" has been to consider six chains the maximum distance for taking accurate abney shots, thereby limiting the length of the legs of a traverse.

Is the six-chain maximum a good rule or not? The primary purpose of this investigation was to ascertain the effect of distance on abney readings when the instrument is used to determine elevation differences.

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The study was conducted on the Lubrecht Experimental Forest, 30 miles northeast of Missoula. Five observers[2] took abney readings on each of seven ground points set exactly two chains apart at 2, 4, 6, 8, 10, 12, and 14 chains from the observers. The precise elevation of each point had been previously determined with a Y-level and Philadelphia rod. (The study area is for the most part gently rolling and open; a steep slope covered with patches of fir and pine starts at the 10-chain mark.) The same abney was used by all observers. It was adjusted and tested just prior to use. Readings were taken in the morning of a spring day; skies were generally sunny, with large scattered clouds.

All measurements were taken in the same manner: Sightings were made on another man[3] acting as the target on each distance point, with special care taken to sight on the exact plane at which the abney was held. The observers took turns using the abney, and each one obtained two readings on each distance point. After each sighting, the measured angle on the instrument was read by the same person (not one of the observers) and the topographic units were interpreted to the nearest half unit. Between sightings, the scale was set back to zero.

The average abney readings for the seven distance points are given in Table 1. The sets of readings are in agreement for each observer excepting those for

[2]Forestry students C. Johanningmeir, G. Knudsen, D. Oman, E. Reed, and N. Ringhand.

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the eight-chain distance point, in which the observations differ by half of a topographic unit, or four feet.

Table 1. Average Topographic Abney Measurements

Distance	A	B	C	D	E	All
			Observers			
Chains			Topographic Units			
2	−1.5	−1.5	−1.5	−1.5	−1.5	−1.5
4	−1.5	−1.5	−1.5	−1.5	−1.5	−1.5
6	−1.0	−1.0	−1.0	−1.0	−1.0	−1.0
8	− .75	−1.0	−1.0	− .75	− .5	− .8
10	0	0	0	0	0	0
12	+1.0	+1.0	+1.0	+1.0	+1.0	+1.0
14	+2.0	+2.0	+2.0	+2.0	+2.0	+2.0

Comparison of the computed abney elevations with the true elevations (Table 2) shows the differences to be only a foot or less for all distance points, again with the exception of the eight-chain point. No valid reason could be found to explain the variations at this particular distance point. It is interesting to note, however, that one observer (E) did measure the correct eight-chain elevation.

Table 2.

Elevation Error Between True and Computed Elevation

Distance	True Elevation*	A	B	C	D	E	All
				Observers			
Chains				Feet			
2	997	0	0	0	0	0	0
4	995	−1	−1	−1	−1	−1	−1
6	994	0	0	0	0	0	0
8	996	−2	−4	−4	−2	0	−2
10	1001	−1	−1	−1	−1	−1	−1
12	1011	+1	+1	+1	+1	+1	+1
14	1027	+1	+1	+1	+1	+1	+1

*Rounded off to nearest foot.

The results of this study indicate that distance does not necessarily affect the accuracy of an abney measurement. If the instrument is properly adjusted and used, and if the observer has an unobstructed view of the target, long-distance abney shots (14 chains in this study) should cause no greater elevation differences than short-distance sightings. However, there are several points to consider in choosing between long- or short-distance abney measurements.

First, in long sights the number of necessary measurements is reduced and there is therefore less chance of error. But since elevation error increases in the same ratio as the distance between the observer and the target, any mistake in sighting can cause a large elevation discrepancy in one direction. Error compensation may not offset mistakes of this magnitude unless all shots are equally long. Even then, serious elevation discrepancies could exist at individual points, although the cumulative error might equal zero.

Second, despite the fact that short-distance shots increase the possibility of elevation error, the compensating factor in such cases would probably prevent accumulation of a large error in one elevation direction.

Finally, there is the matter of cost. Long-distance shots save time and expense, not only in field work but in plotting the data after the survey is completed.

All things considered, long-distance abney sightings are recommended when an experienced crew is employed and when there is a clear view of the target.