Forest Management
Tech Tips

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RANGEFINDER COMPARISON

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INTRODUCTION

Rangefinders are used to measure distance in a variety of applications for various resource needs in the Forest Service. There are many different types of rangefinders commercially available. In addition, there have been recent advances in rangefinder technology.

The cost of rangefinders varies from $60 to $12,000. Performance varies as much as cost. Significant factors in evaluating performance are range, accuracy, ease of use under field conditions, size and weight.

The required accuracy will vary depending on the application or the task being performed. Typical applications include determining the distance to surrounding trees from a plot center, the distances from one fixed point to another as in traversing, and calculating tree heights. In addition, rangefinders can be used to help determine the volume of a specific tree or stands of timber. The current trend, in the USDA Forest Service and other agencies, is to use more tree measurement sales with lump sum payments. Consequently, it is imperative that the volumes stated in the contracts be very accurate.

Some rangefinders are very accurate, lightweight and compact. Others are quite heavy and cumbersome. The size and weight of equipment carried in the field vest is a consideration for applications which entail walking long distances or on steep terrain.

OBJECTIVE

The objective of this test was to evaluate the performance of various rangefinder devices. The range, accuracy, size and weight of these devices were compared. In addition, test workers were surveyed for their opinion regarding ease of use. Comments were solicited on what effect the weather or other field conditions appeared to have on the readings. Additional performance features were noted. The project goal was to provide information to the field on the performance of various laser, ultrasonic and other current rangefinder devices. There is potential for considerable cost savings for field personnel using this information when selecting the appropriate rangefinder for the application.

RANGEFINDER TECHNOLOGIES

Ultrasonic

Ultrasonic distance measuring devices use a wide band frequency from a transducer, sending out narrow beams of sound waves which “bounce” off an object. The return signal is picked up by a hand held receiver. Accuracy is effected by the position of the receiver, outside sound waves, and noise. Noise generated by wind through the trees or brush, streams, rain, crew talking, road traffic or birds chirping can effect readings. When a horizontal distance measurement is being taken, the inclination or horizontal position of the receiver is critical. An outgoing wide band signal will be scattered, increasing the error, if the transducer is not positioned as close to horizontal as possible.

Optical

Optical distance measuring devices typically use the coincidence method of determining distance. This incorporates the use of a series of lenses and mirrors to produce a double image. The double images on mirrors are brought together by rotating a dial until both images merge into one. The dial has a distance indicator, when the two images merge, the distance to the target is read directly off the dial.

Laser

Pulse lasers determine distance by measuring the amount of time required for a pulse of infrared light to travel to the target and back. The speed of light is constant, so this amount of time is directly proportional to the distance. Many pulses are sent out and returned for each shot, improving the accuracy of the calculated value. Laser instruments are narrow band and require the operator to aim with some

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accuracy. The accuracy and maximum range of some laser instruments are dependent on the reflectivity of the target. Some laser instruments are effected by the power level of the batteries.

RANGEFINDER SELECTION CRITERIA

The rangefinders selected for testing were identified as representing the majority of rangefinders commercially available. In addition, rangefinder test devices were screened as meeting specific minimum criteria, appropriate for current typical applications. The minimum criteria for this test included size, weight, cost below $4000 and no need for the placement of reflective target in order to obtain a measurement. The test devices were assembled and calibrated in accordance with manufacturers recommendations.

INSTRUMENT DESCRIPTIONS

All ranges listed within the following product descriptions are manufacturer rated ranges.

Sonin 60 (figure 1)

- An ultrasonic device with a range of 1 to 60 feet (0.3 to 18 m).
- Smallest unit of measure is 1 inch (25.4 mm).
- Computes areas, volumes and adds, subtracts same.
- Has a walking measurement mode and limited data storage.
- Can switch from measuring feet to inches, meters to centimeters and deca feet to yards.
- Has a carrying case.
- Requires a 9 volt battery.
- Has an automatic shutoff.

Figure 1. Sonin 60 rangefinder.

Power Disto (figure 2)

- A laser device with a range of 1 to 90 feet (0.3 to 28 m), without use of reflective target and 1 to 300 feet (0.3 to 91.5 m) with a target.
- The smallest unit of measure is 0.001 foot (0.31 mm).
- There is a method provided for data storage and retrieval.
- Computes areas, volumes and adds, subtracts same. •Rainproof to IP52 with IEC 529.
- Includes battery charger, adapter to charge off car battery
- Has a arrying case.
- Requires specific NiCad batteries.
- Approximately 400 measurements can be taken per charge, with a charging time of 1 hour
- Has a low battery indicator and an automatic shutoff.
- Can switch from measuring feet to meters.

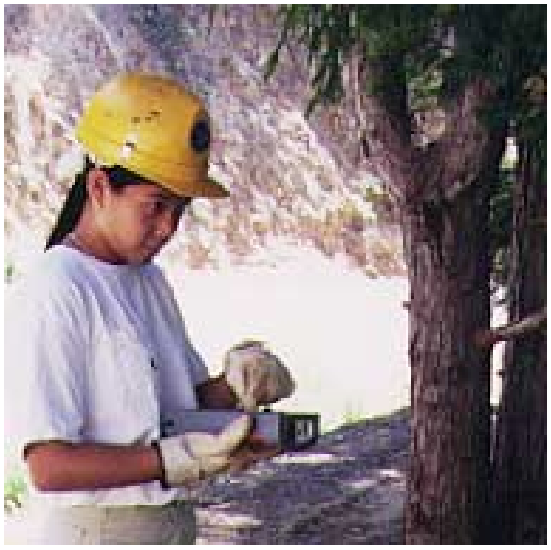

Figure 2. Power Disto rangefinder.

DME 70 (figure 3)

- A laser device with a range of 10 to 225 feet (3.1 to 68.6 m).
- The smallest unit of measure is 1 yard (0.9 m).
- Has light and audio indicators for locking onto target.
- Switches from measuring yards to meters.
- Has a carrying case.
- A 9 volt battery is required.
- Has a low battery indicator.
- Has an automatic shutoff.

Figure 3. DME 70 rangefinder.

Lytespeed 400 (figure 4)

- A laser infrared device with a monocular to assist in locating the target.
- Has a range of 400 yards (366 m) without the use of a reflective target, and up to 999 yards (913 m) with a target.
- The smallest unit of measure is 1 yard (0.9 m).
- This rangefinder has the ability to scan a target and has a target quality gage. This is used to scan across a target that may be difficult to lock onto, so as to find the most reflective point.
- A Rain Mode feature allows measurements to be taken in light precipitation, with a range of 65 to 400 yards (59 to 366 m).
- A Brush Mode filter allows targeting an object through light brush with a range of 115 to 400 yards (105 to 366 m).
- Water and shock resistant.
- Carrying case and straps are provided.
- A 9 volt battery is required.
- Switches from measuring yards to meters.
- Has a low battery indicator
- Has an automatic shutoff.

Impulse 200 (figure 5)

- A laser device with a range of up to 1640 feet (500 m) with the use of a reflective target.
- The smallest unit of measure is 0.01 foot (3.1 mm). •Calculates height, horizontal, vertical, and slope distances, cumulative and difference distances and inclination.

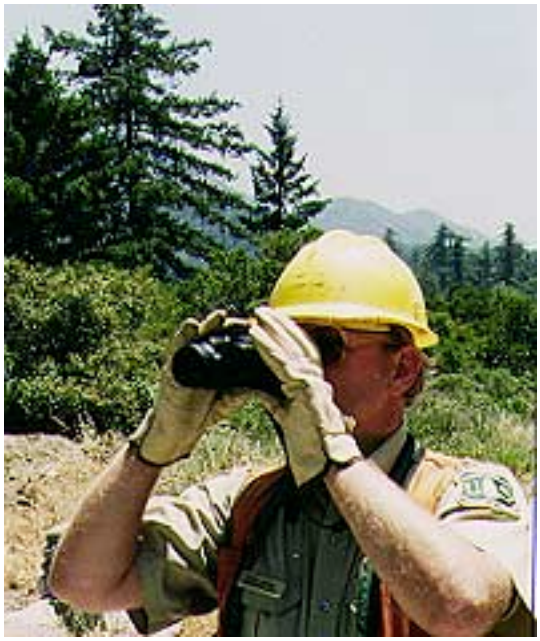

Figure 4. Lytespeed 400 rangefinder.

Figure 5. Impulse 200 rangefinder.

- Data storage and retrieval is via serial interface using an RS-232 port, accessed with a LEMO 4-pin to DB 9-pin cable or LEMO 4-pin to HP 200/48 10-pin cable.
- Optional mechanical compass and mount, monopod, tripod yoke and mount.
- Available data collection software includes LTI Map, LTI Face Profiler, and Traverse Handheld.
- Interfaces available for GPS mapping systems include Ashtech Reliance, Trimble Pathfinder and CMT MC-PS.

- Has a filter mode for shooting through foliage.
- Carrying case, with hand strap and belt clip are provided.
- Waterproof to IP 67 and NEMA 6.
- Requires 2 AA batteries for a power supply of up to 20 hours of continuous use.
- Has low battery and battery voltage indicators, i•ndicators for multiple error conditions
- Has an automatic shutoff.
- Switches from measuring feet to meters and degrees to grads to percent slope.
- Controls can easily switch for left or right handed use.
- Allows for aligning and calibrating the tilt sensor and realigning the scope by the user.

Laser Atlanta Advantage (figure 6)

- A laser device with a range of 5 to 32,000 feet (1.5 to 9760 m) with the use of a reflective target.
- The smallest unit of measure is 0.1 foot (31 mm).
- Compatible with GPS, Pen Computer and Data Logger software.
- Contains an integrated digital compass/inclinometer in the C/I version.

Figure 6. Laser Atlanta Advantage rangefinder.

- Compass is a strapped down magnetometer.
- Calculates the missing line distance, inscribed, right triangular and rectangular areas based on two or more points.
- Data storage and retrieval via configurable RS-232 port and via PCMCIA Type II SRAM Cards.
- Optional 8x monoscope for distant viewing, monopod and tripod for mounting.
- Includes a battery charger, adapter to charge off car battery,
- Has water resistant carrying case
- Has an additional battery pack.
- Requires 6 volt NiCad batteries.
- Each battery pack provides power for 5 hours of continuous use.
- Battery charging time is 10 to 12 hours.
- Has a low battery indicator and an automatic shutoff.
- Switches from measuring feet to meters.

Swarovski Optik RF-1 (figure 7)

- A laser device with a range of 22 to 1100 yards (20 to 1005 m), without the use of a reflective target.
- This rangefinder has a 6x monocular viewer, with an integrated 6x24 telescope with focusing capabilities.

Figure 7. Swarovski Optik RF-1 rangefinder.

- The smallest unit of measure is 1 yard (0.9 m).
- Protective lens cap and carrying case provided.
- Requires 6 AA batteries.
- Each battery pack lasts up to 2000 measurements.
- Has a low battery indicator.

Ranging 400 (figure 8)

- An optical device which uses the coincidence method of determining distance, with a range of 20 to 400 yards (18 to 366 m).
- Includes a 3x monocular to assist in locating the target.
- The smallest unit of measure varies from 0.5 to 1 yard (0.5 to 0.9 m) on a dial indicator.
- Allows for a calibration adjustment and image adjustment by the user.
- Optional carrying case.
- No battery required.

Figure 8. Ranging 400 rangefinder.

RANGEFINDER TESTING

Testing was conducted on the Mount Baldy Ranger District of the Angeles National Forest. The same target was used for all devices, so the measurements could be compared with statistical validity. Flagging was placed on the target at diameter breast height (4 feet 8 inches)(4.3 m).

An Electronic Distance Measuring (EDM) infrared rangefinder was designated as the reference device used to measure the true distance (i.e. standard measurement). A professional land surveyor team used the EDM to measure all data points from the target, forward and backward. The range of distance was 500 feet (153 m). All devices were tested at 10 foot (3 m) increments, up to 100 feet (31 m), then continuing at 25 foot (8 m) increments up to 110% of the maximum manufacturers rated range, or 500 feet (153 m), whichever was greater.

Three operators were selected to participate in testing, all of similar height. Two operators were experienced in taking slope distance measurements.

STATISTICAL METHODS AND RESULTS

Accuracy denotes the absolute nearness to the truth. In contrast, precision denotes degree of repeatability in the taking of a measurement. The range of percent differences is an indicator of precision. The data reduction results are presented in table 1.

Percent Inaccuracy

The percent inaccuracy is the inaccuracy specification that could be met at the 95 percent confidence level. Assumptions are made that the data here was not a 1-in-20 or rarer anomaly and that the test measurements follow a normal distribution with the mean equal to the standard measurement. From these results, the smallest inaccuracy standard is met by the Laser Atlanta Advantage, followed closely by the Impulse 200.

Percent Bias

Percent bias indicates if the tool consistently over or under measures values. Bias can be used as a correction factor for measured values to obtain the true value. This correction factor is specific for each tool and may vary across the range of measured values. The percent bias values in table 1 were averaged across the range of values. From these results, the smallest bias standard is met by the Laser Atlanta Advantage, followed closely by the Impulse 200.

Percent Differences

Percent differences were calculated between the standard measurement and the test device measurement. The smaller the range of percent difference the better. The smallest range of percent differences is met by the Impulse 200, followed closely by the Laser Atlanta Advantage.

Table 1. Rangefinder Data Reduction Results.

	Sonin 60	Power Disto	DME 70	Lytespeed 400	Impulse 200	Laser Atlanta Advtg.	Swarovski Optik RF-1	Ranging 400
Percent Inaccuracy								
Operator 1	11.62	0.36	4.32	1.43	0.35	0.21	1.22	3.28
Operator 2	9.76	1.36	4.55	1.47	0.43	0.20	1.15	3.65
Operator 3	11.11	0.73	3.01	1.51	0.31	0.19	1.40	4.59
All Operators	10.83	0.82	4.00	1.47	0.36	0.20	1.26	3.74
Percent Bias								
Operator 1	-11.59	0.12	-4.16	1.11	-0.32	-0.06	-1.15	3.58
Operator 2	-11.11	1.35	-4.48	1.13	-0.42	0.01	-1.00	-3.93
Operator 3	-11.11	1.17	-2.72	1.21	-0.26	-0.01	-1.14	-5.80
All Operators	-11.30	0.88	-3.79	1.15	-0.34	-0.02	-1.14	-2.16
Range of Percent Differences for all Operators								
Minimum	-13.0	-0.63	-8.9	-1.03	-0.95	-0.88	-3.79	-40
Maximum	-7.7	1.67	-1.0	5.98	0.30	0.94	0.68	13
Total Range	5.3	2.30	7.9	7.01	1.25	1.82	4.47	53

DISCUSSION

All rangefinder devices were tested to the minimum and maximum manufacturer ranges up to 500 feet (153 m). Several of these devices did not measure the minimum or maximum manufacturers range of values as listed in the operator manuals. Reference the **Instrument Descriptions** starting on page 2 and Table 4. This may be due to the field conditions encountered in our forestry applications.

There was minimal difference in measured values, percent inaccuracy, percent bias and percent differences between inexperienced and experienced operators.

The same target, a market section of bark, was used for all operators. No reflective targets were used in the testing. Surface finish, color, size, and shape of the bark effect reflectivity and range. All readings were taken at the same height and on the same tree surface. No optional monoscopes for distant viewing were used, only built in monoscopes. No monopods or tripods were used for mounting. These test conditions were the same for all operators.

As recommended by laser rangefinder manufacturers all testing was conducted with fresh batteries for each operator in order to avoid varying performance as the battery decays.

It was noted by the operators, rangefinders are much easier to carry through the workday with the use of a neck strap or shoulder yoke. Some of the rangefinders did not provide either. Both neck straps and shoulder yokes are readily available commercially and easily adaptable to the rangefinders used in this study.

User manuals were supplied with all rangefinders and were available to all operators before testing. Brief verbal instructions were also give to all operators.

An attempt was made to shoot through light, medium and dense foliage with the test rangefinders. Only the rangefinders with a filter were able to shoot through brush and only on a limited basis.

In addition to accuracy testing, each operator was asked to subjectively rate the instruments on a scale of 1 to 8 with 1 being the most favorable. The ratings are as indicated in table 2.

Table 2. Operator Rating of Test Instruments.

	Targets Ease to Locate	Ease of Use	Readings Dependable	Easy to Learn	Better than Log Tape or Survey Chain	Overall Rank
Sonin 60	8	5	8	7	7	7
Power Disto	6	1	6	5	6	6
DME 70	5	3	5	1	5	5
Lytespeed 400	2	5	3	3	2	4
Impulse 200	3	3	1	5	1	1
Laser Atlanta Advtg	4	2	1	4	2	1
Swarovski Optik RF-1	1	5	4	2	2	3
Ranging 400	7	8	7	8	7	8

Test operators were asked for comments regarding the rangefinders immediately after testing was completed. Their comments are as indicated in table 3.

Table 3. Comments on Rangefinder Test Units by Operators Immediately After Testing.

Rangefinder	Pros	Cons
Sonin 60	Fits easily into cruiser vest pocket. Inexpensive.	Measures for short distance only. Must shoot absolutely level to tree to get good reading.
Power Disto	Fits into cruiser vest back pocket.	Measures for short distance only.Must shoot absolutely level to tree. Not appropriate for outdoor use. Expensive.
DME 70	Very small. Shoots quick. Audio signal helpful. Inexpensive.	Not weather proof. No plastic case.Measures in yards and meters only. Does not magnify target. Hard to use with gloves on.
Lytespeed 400	Magnifies target. Reading inside the viewer.Neck strap. Soft rubbe reye-piece for comfort and is removable if wearing glasses. Inexpensive.	Measures in yards and meters only. Hard to push button with gloves on.
Impulse 200	Easy aim. Quick shot. Left or right handed use. Hand strap.	Confusing to operate. Does not look weather proof. More options and more complicated. For its weight should have a neck strap for easy transport. Does not magnify, so is hard to see the target at far distances.
Laser Atlanta Advantage	Shoots slope and horizontal distance quickly. Switches easily between feet/ yards/meters. Has data card; data re-corder adapter; rechargeable battery in the handle; backup battery. Gives reading in viewer.	Very heavy and bulky. Not something I would like to hike around with for a long distance. Reading given the viewer is less accurate (1 foot)(0.31 m) than the reading on the instrument face (0.1 foot)(0.31mm). To manually record readings must look up onto the instrument face.
Swarovski Optik RF-1	Magnifies target. Easy operation. One button only. Reading inside the viewer. Neck strap. Fits easily into cruiser vest pocket.	Measures in 2 yard (1.8 m) increments and have to find where values change between even yards to determine the 1 yard (0.9 m)measurement. Feels top heavy. Expensive.
Ranging 400	No batteries. Inexpensive.	Hard to focus. Takes longer to use. Hard plastic eyepiece. Small eyepiece. Difficult to operate.

Table 4 provides a comparison by range, price, weight and size.

Table 4. Comparison of Range, Price, Weight and Size of Test Instruments.

	Range capability noted in testing	Price	Weight incl. batteries	Size
	(Feet) (m)	($)	(Pounds) (Kg)	(Inch) (mm)
Sonin 60	5 to 15 (1.5 to 4.6)	70	0.4 (0.2)	5.6x2.7x1 (142x69x25)
Power Disto	10 to 60 (3 to 18)	1795	1.8 (0.8)	9.3x4x2.2 (236x102x56)
DME 70	10 to 250 (3 to 76)	290	0.6 (0.3)	5x1.75x4 (127x45x102)
Lytespeed 400	60 to 500* (18 to 152)	260	1.0 (0.5)	6x2.5x5 (152x64x127)
Impulse 200	10 to 500* (3 to 152)	2900	2.2 (1.0)	6x2.5x5 (152x64x127)
Laser Atlanta Advantage	10 to 500* (3 to 152)	3000	4.4 (2.0)	10x3x11 (254x76x279)
Swarovski Optik RF-1	60 to 500* (18 to 152)	3300	2.4 (1.1)	5.9x4.7x2.4 (150x119x61)
Ranging 400	60 to 500* (18 to 152)	70	1.3 (0.6)	10.5x2x4 (267x51x102)

Note* = Rangefinder was measured to the maximum test range. Distance/accuracy beyond the maximum test range, up to the maximum manufacturer range was not tested. See Instrument Descriptions.

CONCLUSION

This report includes information on rangefinder descriptions, percent inaccuracy, percent bias, user comments, user rankings, cost, weight and size. The user in the field has an in depth knowledge of what is required to get the job done. Consequently, with this knowledge base and the results of this comparison study, the user is in the position to determine the best instrument for the job.

For further information on these instruments, the test, or test data, please contact Lois Sicking at 909-599-1267 x294.

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Power Disto
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PROJECT PROPOSAL
USDA Forest Service
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SDTDC solicits input from the field for suggestions for future projects. Your suggestions are important to us, so please take a few moments to complete this form and return to the address provided.

Project Originator: Name _____ Date _____

Title _____

Unit _____

Mailing address_____

DG address _____ Telephone_____

Project Title: _____

Current Problem/Need
Describe how work is currently being done; current problem/need, location; why improvement is needed.

_____
_____
_____
_____
_____

Proposed Solution
Describe your concept of the end product, i.e., new equipment design, video production, handbook, etc.

_____
_____
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Potential Benefits
Describe how this product will improve safety, resource management; increase efficiency, customer satisfaction, productivity; reduce cost, time.

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User Feedback Survey

User Name (optional) _____
Title _____
Unit _____

Tech Tip—Rangefinder Comparison

Benefits	YES	NO	Amount
Improves safety	_____	_____	_____
Saves money	_____	_____	_____
Saves time	_____	_____	_____
Increases efficiency	_____	_____	_____
Other	_____		_____

How effective or relevant is this information?

What would you change?

General comments: