TRAIL TRANSECT:

A Method for Documenting Trail Changes

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ABSTRACT

A trail transect system that documents trail conditions and changes in trails has been used successfully over the past 3 years to measure soil loss, and changes in trail width and vegetation. The system also can be used to study the relationship between trail degradation and the physical characteristics of a site. Data from trail transects can be useful in determining the physical conditions favorable for trail construction.

INTRODUCTION

DURING A STUDY of the impact of hikers on trails in the high-peaks region of the Adirondack Mountains in New York, Ketchledge and Leonard (1970) established trail transects to document trail conditions and to monitor physical changes on hiking trails. Work to date has resulted in a transect system that has been used successfully over the past 3 years to measure soil loss, and changes in trail width and vegetation (Fig. 1).

In this paper we describe how to set up a series of permanent benchmarks along a trail (ground control), choose sites for study, set up transects, and collect and compare information from the transects accurately. However it should be noted that this system does not attempt to point out the "whys" and "hows" of trail degradation.

TRAIL TRANSECT SYSTEM

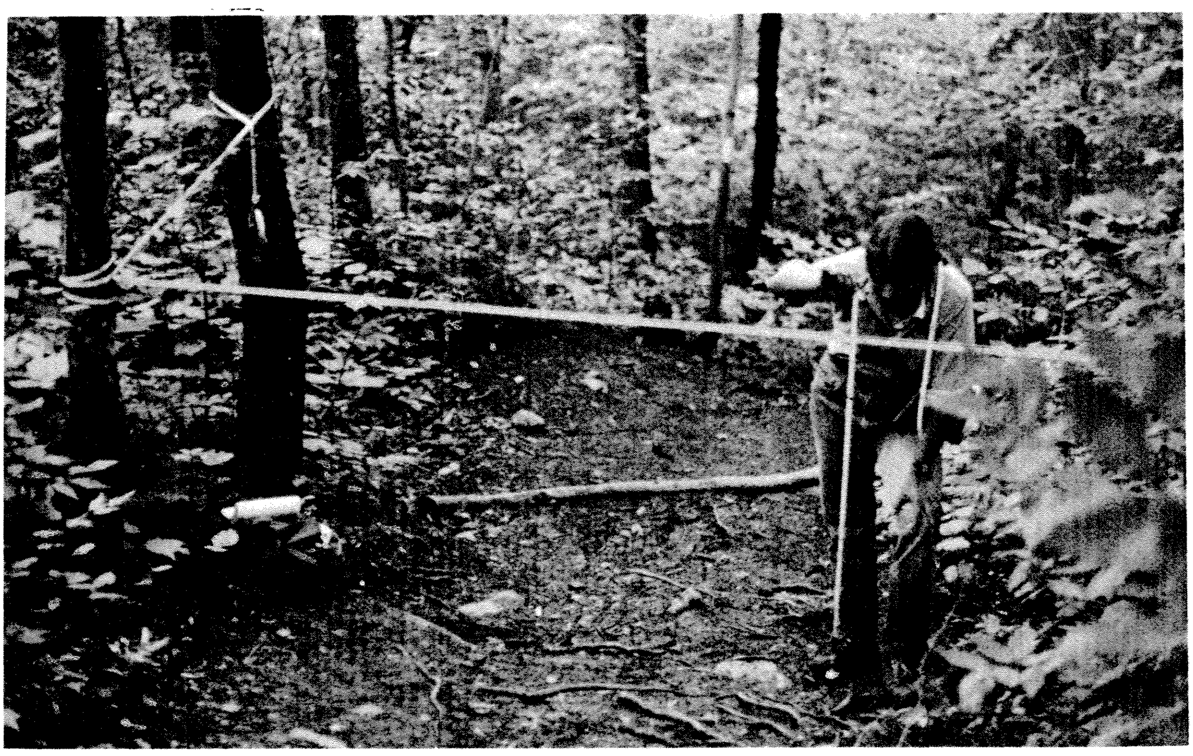
The system is a series of transects, located selectively along a trail. Transect locations should reflect the physical characteristics of the trail. At each transect, soil movement and changes in trail width and vegetation are monitored. The system is designed to facilitate accurate resampling of each transect, yearly or biyearly (spring and fall).

Ground control

Basic to most field measurements is a reliable system of ground control for relocating sample points. Our ground control method provides a series of permanent benchmarks that can be used to locate the transects.

Begin by placing a permanent marker on a single tree at the trailhead. A lagbolt screwed

Figure 1.—A trail transect being used in the field.



into the tree at a height of about 4-1/2 feet (breast height) works well. In a field notebook record the tree species, diameter at 4-1/2 feet (dbh), and the tree's location in relation to the trailhead.

Using this marker as the origin of the ground control system, run a highway-distance measuring wheel (cyclometer) up the center of the trail, nailing numbered aluminum tags to trees at intervals of approximately 100 meters. Walking slowly with the wheel produces the best results. At each 100-meter point, nail a numbered tag to the trailside base of the nearest tree on the left side of the trail. At each point record the tag number, the tree species, the dbh, and the distance from the tree to the trail center. It also is useful to determine the elevation at each point; we found that a simple, hand-held altimeter is usually sufficient for documentation.

Repeat this process with the consecutively numbered tags; at the end of the trail, establish a final permanent marker (lagbolt). It is wise to record the location of this marker by identifying the tree species, dbh, and distance from the tree to the previous aluminum tag.

The following is an example of field notes on the location of ground control tags:

Site selection

To monitor a trail system effectively, select transect sites that reflect a range of physical characteristics, including slope, elevation, soil, water, and degree of damage encountered on the trail.

Transect sites also should have a significant degree of remeasurability. Points of extreme irregularity, such as the brink of a trench, a steep ledge, or deep-standing water, should be avoided. Moving the transect line to either side of these obstacles will provide a more accurate sampling of the site by partially eliminating ambiguities in measurements; for example, was the top or the bottom of the trench sampled last year?

However do not select an unreasonably large number of transect sites in an effort to represent all trail conditions; this system was developed only to indicate critical trail conditions and changes. In one of our investigations we used a total of 35 transects on a two-mile trail in New England; conditions ranged from poorly drained (wet) soil to exposed bedrock, hardwood forest to subalpine spruce, and 1,000- to 3,000-foot elevations.

Point	*Elevation (feet)*	*Side of trail*	*Species*	*Dbh (inches)*	*Remarks*
1	1,950	Left	Spruce	6	On a tree with an arrow pointing to the trailhead. About 15 meters from the first "Y" in the trail.
2	1,980	Left	Maple	10	On the opposite side of the trail is a tree with a WMNF sign.
3	2,020	Right	Maple	10	There is a large boulder on the opposite side of the trail.
4	2,070	Left	Maple	8	This is at the beginning of a steep incline.

Establishing trail transects

To set up a trail transect, a second set of numbered aluminum tags is needed. Select two trees, one on each side of the trail (but preferably a short distance from the trail edge), so that the line between the trees crosses the trail roughly perpendicularly. Place a numbered tag on the left-hand tree (facing upslope) 4-1/2 feet from the base. Record the distance in meters from the tree to the nearest ground control tag. Drive a galvanized nail into the downslope side of the tree, about waist high. Then tie a string to the nail and extend it across the trail to the right-hand tree, adjusting the line so that it is roughly parallel to the trail. At this point, drive a nail into the tree on the right; record the species and dbh of both trees. Also note the elevation and the distance from the trees to manmade structures, such as waterbars or steps, that are upslope of the transect (Fig. 2). (See the Appendix for a list of transect equipment).

Measurement procedures

Two fiberglass metric tape measures are required at a transect site. One is extended between the two trees and serves as a horizontal measure across the trail. The second tape, equipped with a plumb bob suspended from the end, is used for vertical measurements along the horizontal axis.

Before taking measurements, it is important to record the distance between the "O" point, or beginning of calibration, and the end of the tape. For the vertical tape, record the distance between the "O" point and the end of the plumb bob (Fig. 3). These distances should be the true distances; this step will ensure that future readings are comparable, even if different tapes are used.

The horizontal tape is set up from the tree on the left to the tree on the right. Slip the hook of the tape over the left nail and wrap the tape around the tree counterclockwise; then pass the tape under the nail and extend it over to the other tree. Again, pass the tape under the nail and draw it taut; then wrap it repeatedly around the tree and tie it off. Record the points where the tape passes under the nails; they are important in realigning the tape for future measurement (Fig. 4). Since the tape tends to sag, loop a length of carpet string over the nails and draw it taut. All vertical measurements should be taken from the top of the string (Fig. 5).

Figure 2.—An illustration of a trail transect.

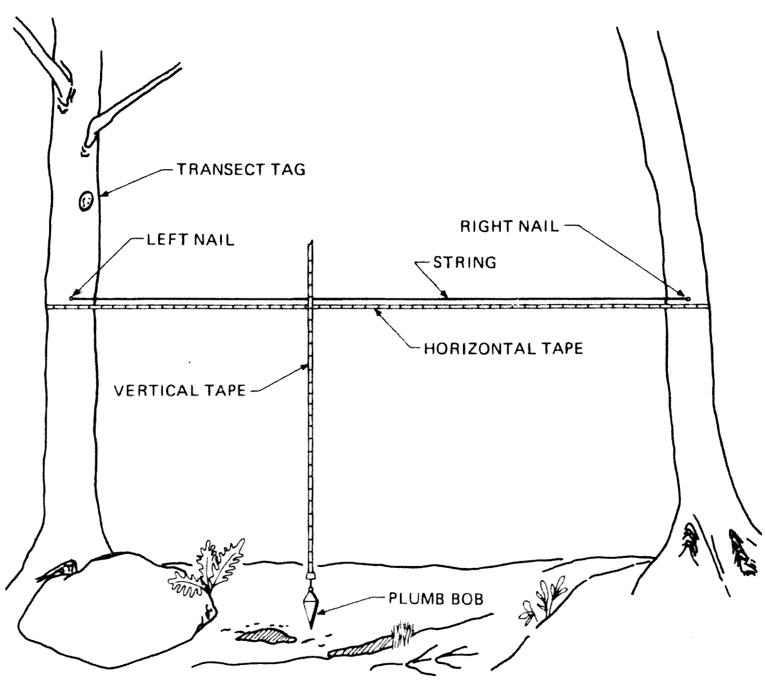


Figure 3.—It is important to record the distances between the "O" points and the ends of the horizontal and vertical tapes.

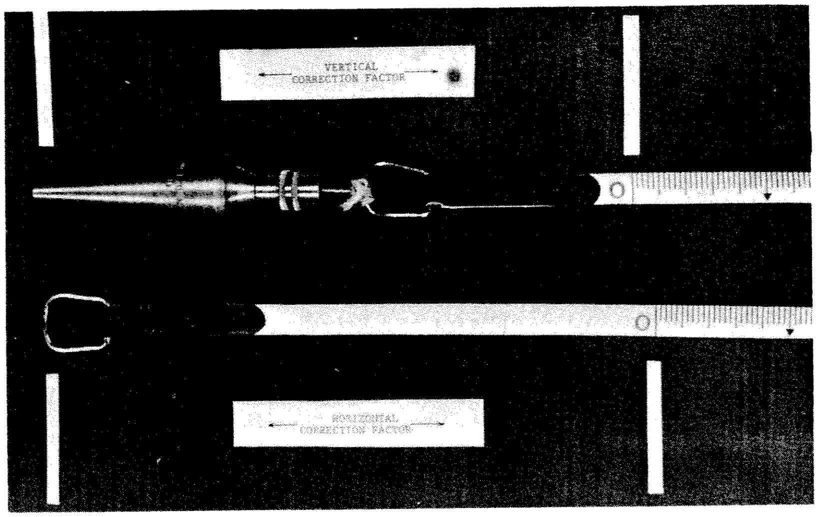


Figure 4.—An example of left nail reading of 34.6 cm.

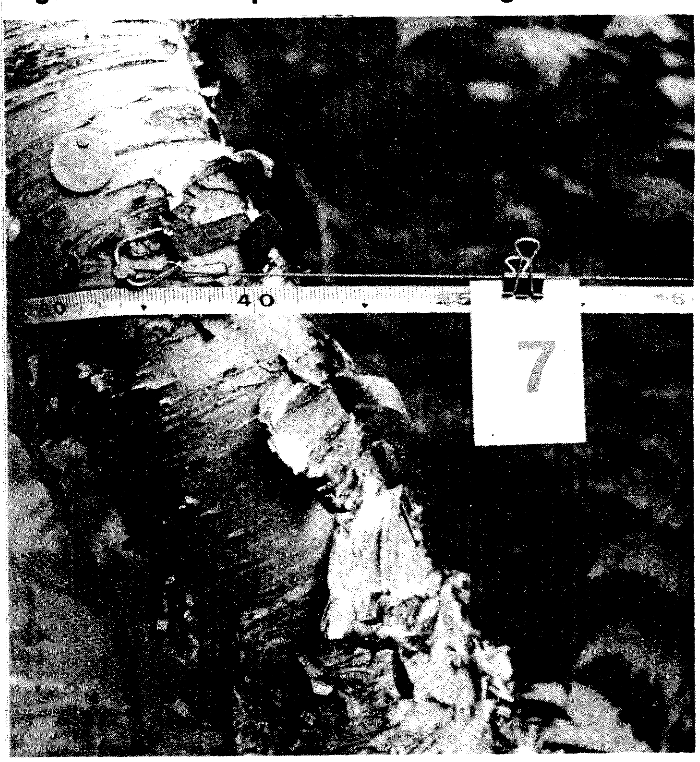
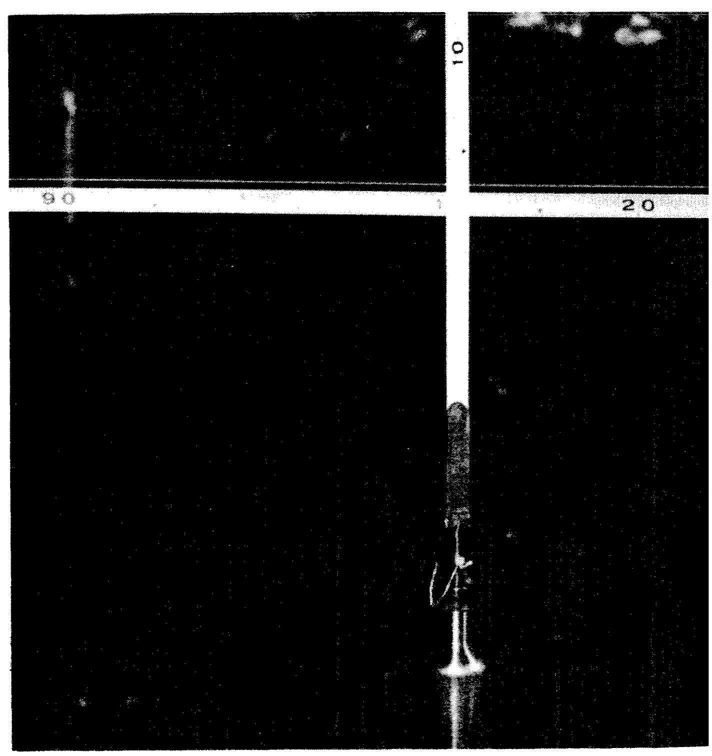


Figure 5.—An example of vertical measurement of 3.4 cm.



Trail boundaries

The first measurements establish the horizontal position of the trail edges. Suspend the plumb bob along the horizontal tape so that its point lies directly over the trail edge. The trail edge boundary is the point between the exposed soil or bedrock, which may be more accurately described as the immediate treadway, and the trailside vegetation. Record the two readings on the horizontal tape where it is intersected by the plumb bob string to indicate the position of the edges. We usually begin the remaining readings 20 to 40 cm outside the trail edges to allow for future widening.

Trail profile

After selecting the total horizontal distance to be measured, take vertical measurements at intervals of 5 or 10 cm along the horizontal tape. These measurements, taken from the ground surface to the carpet string, provide a rough profile, or cross section, of the trail. We have found that considerable practice is required to suspend the plumb bob on the surface of the ground, hold it at a known horizontal, and then read the vertical distance. The most consistent results probably are obtained when the eyes are at the level of the string, though this is not the most comfortable position.

At each point where a vertical measurement is taken, record the vegetation (ground cover species) and surface soil characteristics within 5 cm of the plumb bob point. Also record, once for each transect, the forest stand surrounding the transect site. In our example of the fieldbook notes (Fig. 6), the forest stand has been recorded as hardwood; the ground vegetation at this par-

Figure 6.—Example of trail transect fieldbook notes.

SAMPLING NO. 1	MONTH 6	YEAR 1976	TRANSECT NO. 12
FIELD NOTEKEEPER		TRANSCRIBER	

DESCRIPTION

LEFT TREE: Sugar Maple - 10" NAIL READING: 45 cm

RIGHT TREE : Paper Birch - 6" NAIL READING: 530 cm

LEFT TRAIL EDGE: 180 cm

RIGHT TRAIL EDGE: 330 cm

STAND: *Hardwood*

HORIZONTAL	VERTICAL	REMARKS
200 cm	50 cm	M/L, F, RF, common plantain

ticular spot (horizontal: 200 cm; vertical: 50 cm), is represented by common plantain. A more detailed description might be developed, but this system is sufficient for documentation.

To document surface soil characteristics, we have developed a simplified system that is based on the exposure of mineral soil versus soil covered with organic matter (leaf litter), the extent to which the organic matter is visibly decomposed, and the physical nature of the rock that might be present. As with the system for recording vegetation, this is a qualitative method, but it can be used with minimum training. In the example of fieldbook notes, the surface soil on the site is a mixture of mineral soil and litter (M/L), the litter is fractured (F), and there are rock fragments (RF) (Fig. 6).

The following criteria should be used for documenting the forest stand, surface soil characteristics, and rock on a transect site:

Forest Stand

Hardwood (H)	Minimum of 90% trees hardwood species.
Softwood (S)	Minimum of 90% trees softwood species.
Mixed (H/S)	Less than 90% hardwood and less than 90% softwood.

Surface Soil

Mineral (M)	Minimum of 90% area exposed mineral soil.
Mixed (M/L)	Less than 90% mineral soil and less than 90% litter.
Litter (L)	Minimum of 90% area covered by organic matter (leaves, twigs, needles).
Unfractured (UF)	Minimum 95% entire, not broken, origin recognizable.
Fractured (F)	Minimum 75% not entire, broken, but origin still recognizable.
Finely ground (FG)	Minimum 95% finely divided, origin no longer recognizable.

Rock

Rock fragment (RF)	Loose rock, easily disturbed.
Embedded rock (ER)	Held in place by soil, not easily disturbed.
Bedrock/ledge (B/L)	Portion of underlying rock formation.

DATA EVALUATION

The data obtained from a transect may be compiled on a desk calculator (Fig. 7).

Trail width

The change in trail width is monitored by the horizontal readings. In a given transect, the tread might extend from 220 cm to 350 cm one year, then expand to extend from 190 cm to 380 cm the next. If care is taken in resetting the horizontal tape, this method graphically records any change in width. Where there is no clearly defined transition point, or where subjective differences arise between individuals sampling, the recorded descriptions of surface soil conditions are usually sufficient for documentation.

Soil loss

The vertical measurements are used to monitor soil loss. Once these measurements are adjusted for any change in plumb bob position from year to year, they can be inserted into the following equation to calculate the area (A) from the string to the ground surface within the zone measured:

$$A = \frac{V_1 + V_2}{2} + \frac{V_2 + V_3}{2} + \frac{V_n + V_{n+1}}{2} \times D$$

Where: A = area in square centimeters

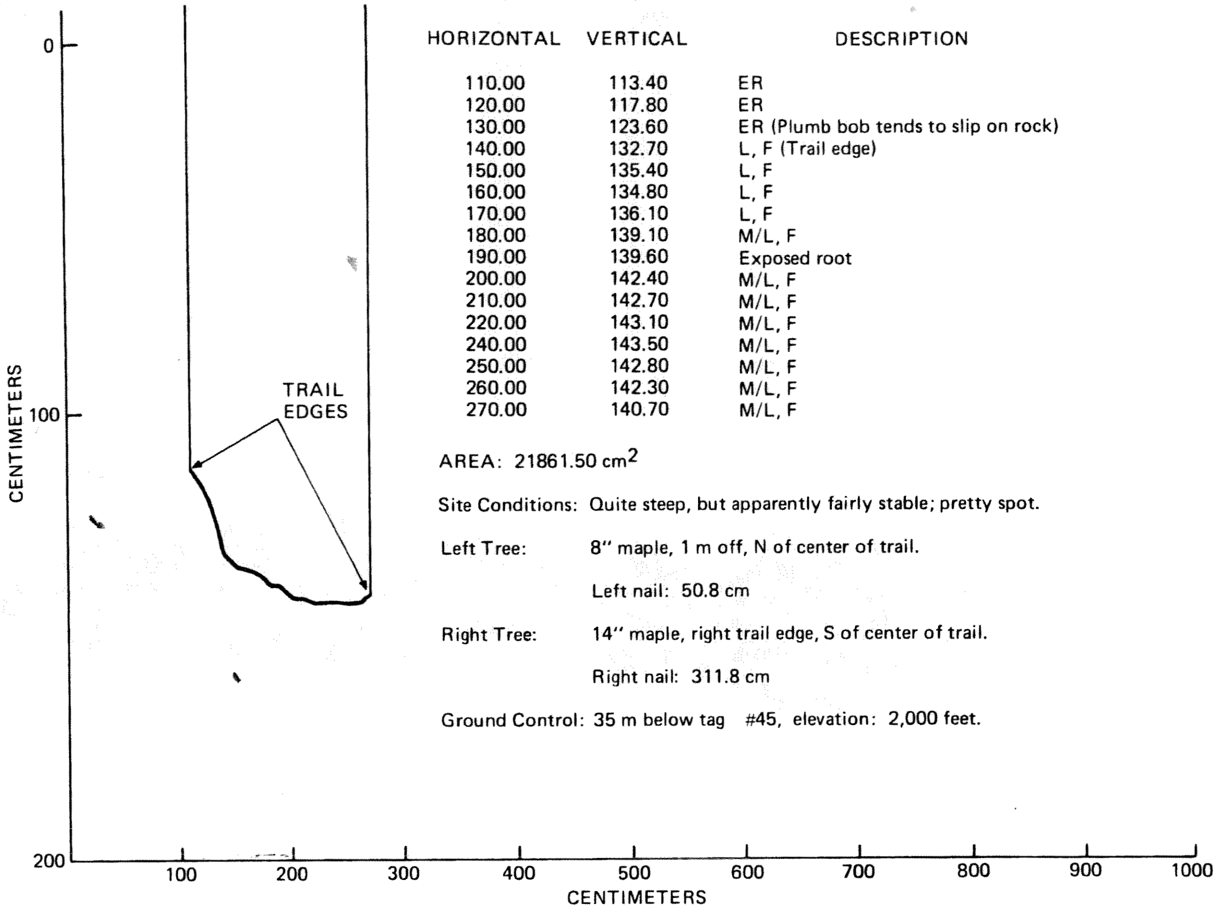
V_n = vertical distance measurements (cm)

D = interval on horizontal axis (5 or 10 cm).

An increase in area from one year to the next at an individual site indicates soil loss (Fig. 8).

To evaluate erosion in a transect, area calculations from seasonal or yearly samplings are compared. However, two figures for area can be compared only when the same horizontal readings are used for both area calculations (to ensure that the same horizontal span, or trail width, is being compared). As the characteristics of the tread change, comparisons can be made using a new horizontal span. So vertical measurements taken initially outside

Figure 7.—An example of compilation of trail transect data.



HORIZONTAL	VERTICAL	DESCRIPTION
110.00	113.40	ER
120.00	117.80	ER
130.00	123.60	ER (Plumb bob tends to slip on rock)
140.00	132.70	L, F (Trail edge)
150.00	135.40	L, F
160.00	134.80	L, F
170.00	136.10	L, F
180.00	139.10	M/L, F
190.00	139.60	Exposed root
200.00	142.40	M/L, F
210.00	142.70	M/L, F
220.00	143.10	M/L, F
240.00	143.50	M/L, F
250.00	142.80	M/L, F
260.00	142.30	M/L, F
270.00	140.70	M/L, F

AREA: 21861.50 cm^2

Site Conditions: Quite steep, but apparently fairly stable; pretty spot.

Left Tree: 8" maple, 1 m off, N of center of trail.

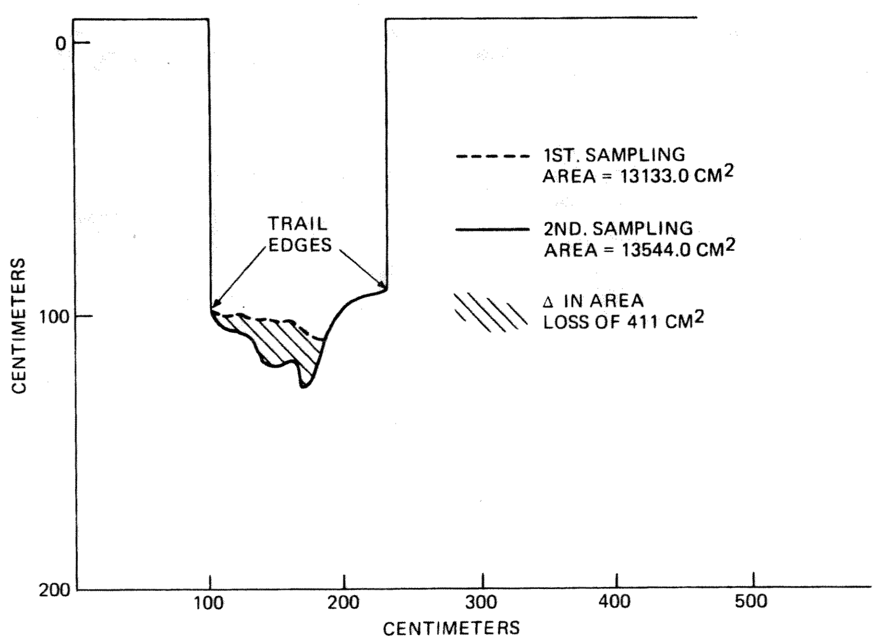
Left nail: 50.8 cm

Right Tree: 14" maple, right trail edge, S of center of trail.

Right nail: 311.8 cm

Ground Control: 35 m below tag #45, elevation: 2,000 feet.

Figure 8.—An example of calculation of soil loss on trails.



the tread can become important later when the tread has widened to encompass them.

A larger comparison of erosion along a trail can be obtained by a further breakdown of the area figure. Since the tread width measured for erosion depends on the nature of the transect site, the change in area (loss or gain) in cm^2 per horizontal span must be calculated for comparisons between transects. For our calculations, a 10-cm span is used. The trail width is divided into 10-cm intervals, and the change in area is divided by the number of intervals. The result is an average change in area in cm^2 per 10-cm interval.

Change in vegetation

The change in vegetation at a transect is evaluated by determining the presence or absence of plants or species from one sampling to the next.

This information is also helpful in monitoring trail widening, or shifts in the location of the tread. A new trail could be documented by observations of losses of vegetation and changes in surface soil within the transect but not on the immediate tread.

It should not be assumed that the species list collected from a transect represents all of the species on the mountain. Often, trails receive more sunlight than the adjacent land; this provides habitats for uncharacteristic species. Trails also are subjected to impact pressures that can keep common woodland species off them.

CONCLUSION

The application of information from transects does not stop with documentation of trail conditions and changes in trails; the data can be used to study the relationship between trail degradation and the physical characteristics of a site.

Data from the trail transect system—which can be used by individuals with little professional training—also can be useful in determining the physical conditions favorable for trail construction. This information could be used directly in the design and location of new trails, and the reconstruction of existing trails.

LITERATURE CITED

Ketchledge, E. H., and R. E. Leonard.
1970. **Impact of man on the Adirondack high country.** Conservationist 25(2):14-18.

APPENDIX

Equipment list for establishing trail transects

- 2 sets of numbered aluminum tags
- 2 lagbolts
- Highway distance-measuring wheel (cyclometer)
- Notebook
- Simple altimeter
- Carpet string
- 2 fiberglass metric tape measures
- Plumb bob
- Hammer