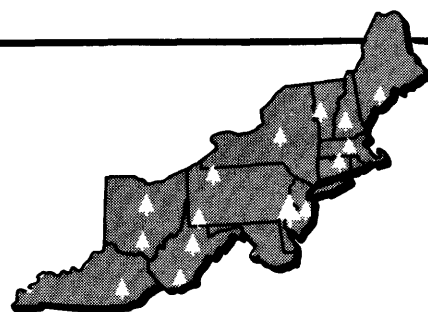


Northeastern Forest Experiment Station



FOREST SERVICE, U.S. DEPT. OF AGRICULTURE, 6816 MARKET STREET, UPPER DARBY, PA. 19082

GROUND-COVER VEGETATION MANAGEMENT AT BACKCOUNTRY RECREATION SITES

—STEPHEN FAY

USDA Forest Service
Northeastern Forest Experiment Station
Forestry Sciences Laboratory
Durham, N. H.

Abstract.—Increasing use of remote backcountry recreation sites in the Northeast is resulting in a loss of the thin soil mantle and destruction of the ground-cover vegetation. Fencing, fertilization and liming and a combination of fencing, fertilization, and liming were tested as means of reestablishing ground-cover vegetation on bare mineral soils of the Tuckerman Ravine shelter site on Mount Washington in New Hampshire. Results indicate that fencing would be a slow means of reestablishing ground-cover vegetation. Fertilization and liming were not very effective in producing an increase in the area covered by ground vegetation.

Increasing use of remote backcountry recreation sites in the Northeast, where soils in many places are shallow and plant communities fragile, is causing erosion of the thin soil mantle and destruction of the ground-cover vegetation. The situation has become serious enough that backcountry managers now express the need for management techniques that will enable them to reestablish ground-cover vegetation and maintain biologically and physically stable site conditions. In the past, management of the ground-cover vegetation in these areas has been limited, although grass seeding and fertilization have

been used successfully in the Adirondack Mountains of New York (*Ketchledge and Leonard 1971*).

The Study

A study was made to investigate cultural methods for reestablishing ground-cover vegetation on the heavily trampled mineral soils of the Tuckerman Ravine shelter site on Mount Washington in the White Mountains of New Hampshire. These areas now have a sparse covering of ground vegetation, ranging up to 30 percent coverage.

The study was designed to obtain a general idea of the potential of various vegetation-management methods. It was assumed that, because of the variety in site conditions and plant-community composition, and because the amount of ground vegetation is limited due to human impact, a study design with good replicates would not be possible. Consequently, it was decided to work with a range of natural and people-induced conditions and rely on generalizations rather than specific comparisons. It was also assumed that some management constraints might be placed on the study. In this case, grass seeding was not permitted, and fertilization had to be limited.

Related research has been done primarily in the Adirondack Mountains of New York by Ketchledge and Leonard (1971). They recommended application of a 50-50 mixture of red fescue (*Festuca rubra* L.) and Kentucky bluegrass (*Poa pratensis* L.), with a fertilizer treatment of nitrogen and phosphorus in the forms of urea and triple superphosphate, as the most promising method of reestablishing ground-cover vegetation on the summits of these mountains. Further investigations indicated that if the treatment of fertilizer and seed were stopped after a few years of application, native species would begin to reinvade the site (Ketchledge and Leonard 1972).

Other work indicated that losses in the area coverage of ground vegetation can be expected on both new (LaPage 1967) and old campsites (Frissell et al. 1965; Magill 1970). Moreover, shifts in species composition to more compaction- and drought-resistant species were noted in the second and third years of operation of a newly opened campground (LaPage 1967).

The Study Site

The Tuckerman Ravine shelter area is a 40-year-old overnight and day-use back-country recreation site on the southeastern slope of Mount Washington. It is at an elevation of 3,800 feet, and access to the area is primarily by the 2.5-mile-long Tuckerman Ravine Trail that originates at the Pinkham Notch Camp of the Appalachian Mountain Club. This area is in the White Mountain

National Forest and is administered by the U. S. Forest Service.

Spring skiers are the primary users of the area, although backpackers and day-hikers are also frequent visitors. Skiers come to enjoy the late spring skiing in Tuckerman Ravine, while hikers use the area as a gateway to the system of trails in the Presidential Range. It is estimated by personnel of the White Mountain National Forest that nearly 40,000 people visited the area between 1 January and 1 July 1972.

The shelter area is approximately 4 acres in size. It is surrounded by a dense old-growth balsam fir forest, which extends into the site in irregular patterns. In the central portion of the area, as well as along the main trails leading through the site, there are relatively large areas of bare mineral soil with a minimum of ground-cover vegetation. These areas total about 1 acre in size.

The removal of the forest vegetation and the loss of the forest humus layer from these parts of the shelter site were not the result of natural forces. The forest cover was removed through cutting fuelwood, clearing for buildings, and death of trees from the general impact of a large number of people visiting the site each year. The organic soil horizon was lost primarily through disturbance from human use, followed by erosion. The remaining mineral soil is now 10 to 25 centimeters in total depth, overlying large boulders, and is very compacted.

The undisturbed forest soil in the area surrounding the shelter site is 75 to 90 centimeters in total depth to the underlying large boulders. It is well drained. There is an organic horizon composed of an L (litter), F (fermented), and H (humus) layer, and this is 10 to 15 centimeters deep. The underlying mineral soil is distinctly separated from the organic horizon. There is a light gray A₂ horizon, a B horizon ranging from reddish-brown to yellowish-brown, and an olive-brown C horizon. The depth of these horizons is generally as follows: A₂—0 to 12 centimeters; B—12 to 50 centimeters; and C—50 to 90 centimeters. The mineral soil horizons are fine sandy loam.

The organic horizon is dark brown and has a

pH of 5. This is somewhat above the 3 to 4 pH reported for the same horizon in other parts of the White Mountains (Hoyle 1973). The pH of the mineral soil horizons ranges from 4 to 5.

The main source of nutrient elements in these soils, particularly nitrogen and phosphorus, is the forest humus layers (Hoyle 1973). The mineral soil is generally infertile.

The ground-cover vegetation, which was of primary interest in this study, is located in a zone between the edge of the forest surrounding the shelter site and the areas of bare mineral soil. This zone ranges from 0.5 to 1 meter in width up to a maximum of 6 meters. Grasses, common plantain, black sedge, and rushes were the predominate species in this zone. All the ground-cover species identified in this zone are listed in table 1.

There are eight Adirondack-type overnight lean-to's in the shelter area. They can accommodate 10 to 12 persons per night. Total capacity is 86. There are also latrines, storage sheds, and other service buildings at the site.

Study Design and Sampling

In June 1972, eight study plots were laid out in the zone of existing ground-cover vegetation. Each plot was 3.6 meters square. Plot locations were selected to encompass the range of site conditions and species composi-

tion. Four treatments were used in this study; each was applied to only two plots, as follows:

1. No treatment.
2. Fenced to exclude people.
3. Fertilized and limed.
4. Fenced, fertilized, and limed.

The fencing was established by a rope strung around four metal fence posts at each corner of the plot. This was installed at the beginning of the study and was not removed until September 1973. The fertilization was 1120 kg/ha of N-P-K (5-10-5) broadcast on the soil surface only once, in June 1972. Agricultural hydrated lime was applied at the same rate and time. It also was broadcast on the soil surface.

Samples were taken in the third weeks of June, July, and August 1972 and 1973 to determine the percentage of area covered by ground vegetation. An 0.09-square-meter sampling quadrat was systematically laid down 48 times on each plot per sampling. Each time the quadrat was laid down, the individual species inside the quadrat were identified, and the percentage of area covered was estimated visually. The data from the 48 samples on each plot were combined to represent the characteristics of that plot.

Table 1.—Ground-cover vegetation identified in the Tuckerman Ravine shelter area

Common name	Latin name
Boreal bentgrass	<i>Agrostis borealis</i> L.
Glaucous bluegrass	<i>Poa glauca</i> Vahl.
Redtop	<i>Agrostis alba</i> L.
Blue-joint	<i>Calamagrostis canadensis</i> Adans.
Red fescue	<i>Festuca rubra</i> L.
Rhode Island bentgrass	<i>Agrostis tenuis</i> L.
Common timothy	<i>Phleum pratensis</i> L.
Common plantain	<i>Plantago major</i> L.
Black sedge	<i>Carex nigra</i> L.
Short-tailed rush	<i>Juncus brevicaudatus</i> Fern.
Toad rush	<i>Juncus bufonius</i> L.
Sweet white violet	<i>Viola pallens</i> Brainerd
Pineapple weed	<i>Matricaria matricarioides</i> Less.
Knotweed	<i>Polygonum aviculare</i> L.
Yarrow	<i>Achillea millefolium</i> L.
White clover	<i>Trifolium repens</i> L.
Mountain cranberry	<i>Vaccinium Vitis-Idaeae</i> L.
Paper birch	<i>Betula papyrifera</i> Marsh.
Balsam fir	<i>Abies balsamea</i> L.

Results and Discussion

The data from July were selected as being fairly representative of the results in general (table 2).

The treatments applied in this study were not very effective in increasing the percentage of area covered by the most abundant ground-cover species in the shelter area between the summers of 1972 and 1973. The fenced-in plots showed small gains and losses in area coverage—less than 2 percent (table 2).

Time was probably one of the limiting factors of this treatment. If the fencing had been left up long enough to allow the existing ground vegetation to recover from trampling and to allow deposit of some organic matter on the soil surface, this would have contributed to a gradual improvement in the physical condition of the soil and would have provided better conditions for re-invasion by ground vegetation.

Unfortunately, the soils on this site were so compacted from years of trampling that the improvement of soil conditions through the addition of small amounts of organic matter would be a slow process. Moreover, the infertility of the mineral soil in the White Mountains (Hoyle 1973) undoubtedly limited the growth of ground vegetation and hence the amount of organic matter deposited on the soil surface.

One possible means of improving the soil nutrient supply and providing better conditions for re-invasion by ground vegetation might be through application of fertilizer and lime. The fertilizer would add the nitrogen and phosphorus necessary for plant growth to these nutrient-deficient soils where the humus layer had been the previous source of these elements. Lime would be helpful in shifting the pH of this acid soil to more neutral conditions and therefore help prevent the phosphorus

Table 2.—Effect of four treatments on the percentage of area covered by important ground-cover species, July 1972 and July 1973

Species	Treatments							
	Control plot—		Fenced plot—		Fertilized and limed plot—		Fenced, fertilized, and limed plot—	
	1	2	3	4	5	6	7	8
Grasses: ¹								
1972	—	16	7	—	30	1	2	4
1973	—	13	6	—	7	2	5	9
Change	—	—3	—1	—	—23	+1	+3	+5
Common plantain:								
1972	1	1	—	—	7	2	16	4
1973	1	3	—	—	4	3	17	3
Change	0	+2	—	—	—3	+1	+1	—1
Black sedge:								
1972	9	—	—	—	—	—	—	—
1973	11	—	—	—	—	—	—	—
Change	+2	—	—	—	—	—	—	—
Short-tailed rush:								
1972	2	—	2	—	—	—	—	—
1973	1	—	—	—	—	—	—	—
Change	—1	—	—1	—	—	—	—	—
Mountain cranberry:								
1972	—	—	1	—	—	—	—	—
1973	—	—	2	—	—	—	—	—
Change	—	—	+1	—	—	—	—	—
White clover:								
1972	—	—	—	—	2	—	—	—
1973	—	—	—	—	1	—	—	—
Change	—	—	—	—	—1	—	—	—

¹ Glaucous bluegrass, Rhode Island bentgrass, redtop.
(—) Species not present.

from becoming fixed by the aluminum and iron in the soil.

The fertilizer and lime applied in the study were not very effective in increasing the percentage of area covered by ground vegetation. Some species showed a loss while others showed a slight gain (table 2). The loss was not due to the treatment. The plot where the loss occurred was on a hillside, which was washed over with rain water shortly after the treatment. The water may have removed the fertilizer and lime, along with some surface soil. The loss in percentage of area covered by ground vegetation was probably due to poor growing conditions on the study plot.

The limited effect of the fertilizer was probably the result of two factors. First, the rate of application was not sufficient to substantially improve the nutrient status of this infertile mineral soil. A heavier rate of application might have been more effective. A heavier rate could also be accomplished through the application of urea (N) and triple superphosphate (P). The main advantage of these two is that they are more concentrated than the 5-10-5 used in the study, and therefore less weight of fertilizer would have to be carried into the backcountry to apply the same amount of nitrogen and phosphorus.

The second factor is that the lime treatment was not sufficient to raise the pH of this acid mineral soil to the neutral range. Therefore the applied phosphorus was probably fixed by aluminum and iron in the soil and rendered unavailable to the plants. An application of 3500 to 4500 kg/ha of lime would have been more effective. In addition, it might be reasonable to use dolomitic limestone rather than the hydrated lime used in the study. Dolomitic limestone has a fertilizing effect through the addition of magnesium, which might have been helpful on this infertile soil.

The combination of fertilizer, lime, and fencing was the most effective of the treatments in encouraging an increase in the percentage of area covered by ground vegetation. The grasses on the plots receiving this treatment showed an increase from 1972 to 1973 of

3 to 5 percent. This indicates that the combined treatment is potentially useful.

Conclusions and Implications

The results of this study indicate that none of the treatments applied in the Tuckerman Ravine shelter area warrant use as the sole means of increasing the percentage of area covered by vegetation over a relatively short period of time. The infertile condition of the mineral soil and the absence of the forest humus layer (and its reserve of nitrogen and phosphorus) dictate the need for a substantial application of fertilizer to improve the nutrient status of the soil. Urea and triple superphosphate, possible sources of these elements, have been used successfully in the acid soils of the Adirondack Mountains of New York (Ketchledge and Leonard 1971).

A heavier rate of application of lime should be considered on these acid soils to ensure the availability of the applied phosphorus. A treatment of 3500 to 4500 kg/ha might be reasonable. Dolomitic limestone should be used rather than hydrated lime to take advantage of the fertilizing effect of its magnesium. Fencing areas off from human use without any other treatment will probably be a slow way to increase the regrowth of indigenous ground-cover vegetation on sites such as the one studied.

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