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Reestablishing Understory Plants in Overused Wooded Areas of Maryland State Parks

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Abstract

In four overused areas, the treatments of small plots were fencing, scarifying the soil, and mulching; fencing and mulching plus planting of shrubs, herbaceous plants, or greenbrier with shrubs or holly. After 3 years, soil compaction was two to four times as great in check plots as in treated plots. Understory cover varied with conditions, but because of volunteer growth, planting was not nearly so important as mulching and eliminating use in reestablishing an understory.

Common and scientific names of plants referred to in this study:

Arrowwood	*Viburnum dentatum*
Ash	*Fraxinus* sp.
Aster	*Aster* sp.
Aster, white wood	*A. divaricatus*
Azalea	*Rhododendron* sp.
Barberry	*Berberis thunbergii*
Beech	*Fagus grandifolia*
Bentgrass	*Agrostis* sp.
Birch, river	*Betula nigra*
Blackgum	*Nyssa sylvatica*
Blueberry	*Vaccinium* sp.
Bluegrass	*Poa* sp.
Cherry, black	*Prunus serotina*
Clover	*Trifolium* sp.
Dogwood	*Cornus* sp.
Elm	*Ulmus* sp.
Fern, Christmas	*Polystichum acrostichoides*
Fern, cinnamon	*Osmunda cinnamomea*
Fern, netted chain-	*Woodwardia areolata*
Fern, royal	*Osmunda regalis*
Fescue	*Festuca* sp.
Fetterbush	*Leucothoe racemosa*
Fleabane	*Erigeron* sp.
Goldenrod	*Solidago* sp.
Greenbrier	*Smilax rotundifolia*
Hickory	*Carya* sp.
Holly	*Ilex opaca*
Inkberry	*I. glabra*
Jewelweed	*Impatiens* sp.
Locust, black	*Robinia pseudoacacia*
Maleberry	*Lyonia ligustrina*
Maple, red	*Acer rubrum*
Maple, sugar	*A. saccharum*
Mountain-laurel	*Kalmia latifolia*
Oak	*Quercus* sp.
Pepperbush, sweet	*Clethra alnifolia*
Pigweed	*Chenopodium* sp.
Pine, loblolly	*Pinus taeda*
Pine, Virginia	*P. virginiana*
Plantain	*Plantago* sp.
Rhododendron	*Rhododendron* sp.
Sassafras	*Sassafras albidum*
Selfheal	*Prunella vulgaris*
Shadbush	*Amelanchier* sp.
Smartweed	*Polygonum* sp.
Spicebush	*Lindera benzoin*
Strawberry	*Fragaria* sp.
Sweetgum	*Liquidambar styraciflua*
Tick-trefoil	*Desmodium* sp.
Violet	*Viola* sp.
Winterberry	*Ilex laevigata*
Wintergreen, spotted	*Chimaphila maculata*
Yellow-poplar	*Liriodendron tulipifera*

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INTRODUCTION

THE USE OF forested recreation areas has increased greatly in the last 30 years in the Northeast. These areas can become so overused that site problems arise, especially near metropolitan centers: Understory vegetation is eliminated, the forest floor may disappear—especially under hardwood stands on slopes—and surface soils become compacted; on slopes, sheet and gully erosion expose the surface roots of overstory trees. These changed site conditions can result in crown dieback or the death of entire stems.

Such problems can be greatly alleviated by limiting the use of areas, restricting visitors to the less critical areas during periods of low use, following a program of rotating use of recreational areas, and channeling visitors to prepared paths, camping pads, or pads for picnic tables. Paths and pads can be covered with wood chips, blacktop, crushed stone, or other materials that reduce erosion and prevent further compaction of the soil. Terraces and steps can be constructed for those portions of paths that are on steep slopes. Paths can be constructed to angle down the slopes, thereby preventing the paths from becoming water courses during wet periods. Barriers of fencing (e.g., snow fencing) or of thorny shrubs and vines might be used to channel visitors to the prepared paths.

Even with restrictions on foot and vehicular traffic, there still remains the problem of restoring understory vegetation in much of the wooded area that will no longer be subject to heavy use. Will the mere exclusion of such traffic be sufficient to allow the invasion of many understory plants, and on what types of sites will this occur? Should soils be broken up by disking, and then mulched? Will planting of suitable vegetation be necessary? If it is needed on some sites, can wildlings (wild plants) be successfully moved from nearby areas not used for intensive recreation?

Because the answers to such questions were not known, the Maryland Park Service and the Northeastern Forest Experiment Station cooperated in a study that was started in 1974. The areas chosen for the study differed in degree of overuse, site conditions, and in the length of time they had been intensively used for recreation. This report summarizes the information obtained in a 3-year period.

LITERATURE REVIEW

Most of the previous attempts to establish a ground cover on the bare soil of overused recreational areas have relied on seeding grasses, often exotic species, and usually on supplemental fertilization. For example, in the Shenandoah National Park no attempt was made to reestablish mountain-laurel, azalea, and other native plants. Instead, gullies were filled with soil, fertilizer was applied and worked into the soil, the area was seeded to K-31 fescue, Merion bluegrass, and common Kentucky bluegrass, and then mulched (Lindsay 1971). Beardsley and Wagar (1971, and with Herrington 1974) also relied on and recommend seeding grasses and clovers.

Sutton (1975) pointed out that exotic plants increase maintenance costs because frequent fertilizing, watering, or pruning may be needed. He thought that the greatest obstacle to the use of native plants was the lack of adequate supplies. Cordell and James (1971) tried to supplement existing vegetation on southern Appalachian recreational sites by planting small, bare-root trees and shrubs. In their study such stock was so susceptible to competition, dry weather and soil, trampling, maintenance mowing, and theft that 83 percent was lost in 3 years, and the average survivor was 23 percent shorter than when planted. Cordell and James thought that planting techniques were not the cause of their poor results. In contrast, Magill and Leiser (1972) considered faulty planting techniques, insufficient or poorly timed maintenance, and lack of protection the chief causes for failure. In New Hampshire, fencing, fertilizing, and liming were not effec-

Figure 1.—A picnicking area near the lake, Greenbrier State Park. Note the absence of both understory vegetation and forest floor. Sheet erosion has occurred and gully erosion has started. Note, too, the occasional stumps left after cutting trees that died.

tive in reestablishing ground cover in heavily used Tuckerman Ravine during a 2-year period (Fay 1975).

Some of the native or introduced species in recreation areas are more resistant. Often these are certain old-field species such as LaPage (1967) studied, or the ones that Bates (1935) and others found were able to survive trampling in England—such as bentgrass, bluegrass, plantain, and clover. Ripley (1962) studied primarily tree species in the southern Appalachians, but did note that mountain-laurel was less tolerant of heavy recreational use than rhododendron and deciduous azalea.

Vegetative deterioration as a result of recreational use varies with edaphic conditions. Settergren and Cole (1970) found that recreation effects were greater on relatively shallow soils with low amounts of moisture than on alluvial or other deep soils. In their opinion, the number and travel of recreationists should be restricted on sites that provide delicate balances for vegetation. Chubb and Ashton (1969) suggested that several factors affect the resistance of vegetation to recreational use: geology and soils (including soil fertility); topography and aspect that affect slope, soil erosion, and the microclimate for flora and fauna; and species, because some are more resistant than others.

In recreational areas, much of the impact on soils may occur in the first 2 years, according to the study by Merriam and Smith (1974). Because Thorud and Frissell (1969) indicated that a compacted forest soil may require up to 6 years to return to its original condition, Merriam and Smith suggested that sites be made resistant to use because rotating sites is not usually feasible in shoreline areas, the most attractive for recreation. Legg and Schneider (1977) found that soil deterioration varied with the intensity of use—there was partial recovery during the winter, but that recovery was less than the amount of deterioration during the previous summer. In urban areas with trees, Patterson (1976) recommended mulching compacted soil with wood chips and other materials; though in urban areas that were grass-covered, lightweight aggregates rotary-tilled into the soil reduced compaction even where soil was under continued recreational use.

STUDY AREAS AND METHODS

Four Maryland areas were selected for our study:

One was in Greenbrier State Park, Washington County, between the turf area near the lake and the uphill parking lots that serve the swimming-picnicking area (Fig. 1). The overstory trees are chiefly yellow-poplar on the lower elevations and oak and hickory on the slope. Soils are in the Edgemont and Hazel series. Since 1968 when the area was opened for recreation, use has been so heavy that by 1974 both forest floor and understory plants had mostly disappeared, and some sheet erosion on the slopes had exposed surface roots of the trees.

A second area was in the Manor Area of the Cunningham Falls State Park, Frederick County, and has been used for picnicking since 1961. Much of the area is in a cove, and soils are deeper than in Greenbrier State Park, but they are in the Edgemont or Edgemont-Chandler series. For the most part, this area had been so heavily used that there was no understory vegetation. However, in most portions there is little or no slope, so soil erosion has not been common.

Our third site was the Lake Area, Cunningham Falls State Park, which was opened to swimming and picnicking on July 4, 1974. Picnic tables were installed under an oak—yellow-poplar stand near the swimming area and under a yellow-poplar stand farther away. The understory vegetation was cut before the area was opened to the public, and most of the plants were severely trampled during the first season, especially in the stand closest to the swimming area. Recreation here is concentrated in areas that are somewhat flatter than those used at the Greenbrier site. Soils are in the Highfield series.

The fourth area was at Milburn Landing, Pocomoke River State Park, Worcester County. This area has been used for camping since 1955. It is a relatively flat, Coastal Plain site on soil of the Matapeake series. The understory of a pole stand of loblolly pine had been cut, allowing campers to drive vehicles between the trees in much of the area. The vehicular

and foot traffic had eliminated many understory plants, although close inspection showed that some small herbaceous plants and a few woody plants were still present, especially near overstory stems.

Within each of two blocks in each area, five 10-foot-square (3-meter) plots were established. Four plots in each block were treated and enclosed by a fence. One untreated plot was a check and was not fenced. The four treatments were:

(1) Native perennial, nonwoody plants were planted and lightly mulched. The plants were dug from nearby wooded areas, and 10 to 13 plants or clumps were set out in each plot. In all areas the plants included ferns, grasses, sedges, and forbs, but specific species varied among the areas. Wood chips were lightly sprinkled over the whole area of each central Maryland plot, while oak-bark chips were used in the Milburn Landing plots.

(2) Native shrubs were planted and lightly mulched. In each plot 10 to 12 clumps were transplanted from nearby wooded areas. The species were low-bush blueberry, mountain-laurel, azalea, and dogwood in the Greenbrier plots; mountain-laurel, azalea, and low-bush blueberry in the Manor plots; spicebush, mountain-laurel, and arrowwood in the Cunningham Falls lake plots; sweet pepperbush, winterberry, maleberry, mountain-laurel, inkberry, blueberry, shadbush, azalea, fetterbush, and arrowwood in the Milburn Landing plots. Mulching here (and in treatments 3 and 4) was similar to treatment 1.

(3) A mixture of greenbrier and shrubs or slow-growing trees were planted and lightly mulched. In each plot five or six clumps of greenbrier were planted, along with four to seven other woody plants. The latter were mountain-laurel, blueberry, and dogwood in the Greenbrier plots; barberry and mountain-laurel in the Manor plots; mountain-laurel, spicebush, and barberry in the Cunningham Falls lake plots; and holly in the Milburn Landing plots.

(4) Plots were scarified and lightly mulched. In this treatment the surface soil was broken up, usually with a fire rake.

Plots at Cunningham Falls and Greenbrier State Park were established in October 1974; the Milburn Landing plots, in November 1974.

The plots were examined in September or early October of each of the 3 subsequent years. The plot cover of woody, herbaceous, and all understory plants was estimated to the nearest 5 percent. The number of seedlings or clumps of each woody species was recorded by species, and an attempt was made, unsuccessfully in thick covers, to do the same for herbaceous plants.

In 1975, with a double-ring infiltrometer, an attempt was made to determine the rate of infiltration. However, the results were so variable that it appeared necessary to make a number of tests for valid comparisons, which would have greatly disturbed the conditions within the plots.

Hence, penetrometer readings were substituted, and several measurements, often 10, were made in each plot. The pocket penetrometer has a retracting piston that penetrates the topsoil under pressure, and the amount of pressure required to insert the piston is recorded in tons per square foot. Its range is from 0 to 4.5 tons. Ward and Berg (1973) used the pocket penetrometer to study soil compaction in Michigan's Waterloo Recreation Area. They reported that readings in excess of 3.0 tons denoted areas of heavily compacted soils.

RESULTS

Soil compaction

The exclusion of recreational use, mulching, and scarification were highly effective in improving surface soil conditions within 3 years. In 1977 penetrometer values showed that in all blocks the check plots had soils two to four times more compacted than the plots fenced, mulched, and scarified or planted in 1974 (Table 1).

Woody understory plants

Woody understory plants formed very little cover, usually about 0 percent, in check plots in 1977 (Table 2) and often only similar amounts in fenced plots with unfavorable conditions—heavy shade, relatively heavy deposits of soil or wood chips from washing, thick leaf litter from blowing or washing. In con-

Table 1.—Average penetrometer values in 1977 for check and treated plots by area and block (in tons/square foot)

Area	Block	Check plot	Treated plots
Pocomoke River			
Milburn Landing	A	3.70	1.19
	B	4.43	1.19
Cunningham Falls			
Manor Area	A	2.85	1.44
	B	1.35	0.33
Lake Area	A	2.75	0.77
	B	4.5	2.02
Greenbrier	A	4.5	1.38
	B	3.85	1.69

trast, woody plants provided covers of 20 to 40 percent in eight plots (four at Milburn Landing, three in one lake block at Cunningham Falls, and one at Greenbrier). In general, these covers developed in the most favorable conditions: deep soils under relatively light shade. Much of the cover here came from volunteer woody plants, as shown by the fact that two of these eight plots received no planted shrubs (Table 2).

The survival and growth of transplanted woody plants varied with species (Table 3). Again, area had an appreciable effect. Survival was 81 percent in both Milburn Landing blocks, 81 percent in one Cunningham Falls lake block, 81 and 91 percent in the Greenbrier blocks, but only 48 to 75 percent in the three other blocks. On the deep Coastal Plain soil and under the light shade at Milburn Landing, several of the transplanted shrubs (especially winterberry, sweet pepperbush, fetterbush, and azalea) were thriving in 1977, and one winterberry was 5.3 feet tall. In contrast, most of the shrubs moved into the Manor Area were placed under heavy shade, and those in one block were subjected to deposits of leaves, wood chips, and soil from washing. As a result, while six of the seven barberries planted there were still alive, only two were classed as thriving.

Tree reproduction increased in the fenced plots. In 1977 the average number of tree seedlings in treated plots was about 14 times that in the unfenced check plots (Table 4). However, there were great differences among plots. Nine treated plots had only 2 to 5 seedlings, while 11 plots had 21 to 46. Treated plots in one Milburn Landing, one Cunningham Falls, and one Greenbrier block tended to have a high number of tree seedlings (Table 4). Species varied greatly with area. At Milburn Landing the seedlings were red maple, sweetgum, yellow-poplar, loblolly pine, river birch, black cherry, oak, blackgum, and holly. In the other areas they often included yellow-poplar, red maple, black locust, oak, and sassafras, while black cherry, ash, Virginia pine, blackgum, elm, hickory, beech, and sugar maple seedlings were found in only one to three blocks.

Table 2.—Cover of woody understory plants in 1977 by area, block, and treatment (in percent)

Area	Block	Check	Fenced and:			
			Scarified, mulched	Herbs planted, mulched	Shrubs planted, mulched	Barrier plants planted, mulched
Pocomoke River						
Milburn Landing	A	0	5–10	25	40	10
	B	0	15	5	30	20
Cunningham Falls						
Manor Area	A	0	0+	0+	0–5	5–10
	B	0+	5	0+	5	10
Lake Area	A	0–5	5–10	5	15	15
	B	0	30	0+	20	40
Greenbrier	A	0	0+	0+	5	0–5
	B	0	0+	0	20	5

Table 3.—Survival of transplanted woody plants in study areas over 3 years

Species	Transplanted plants	
	Number	% survival
Shadbush, inkberry, winterberry	4	100
Spicebush	15	93
Fetterbush, maleberry, sweet pepperbush	12	92
Azalea	11	91
Barberry	8	88
Holly	8	88
Dogwood	7	86
Greenbrier	43	72
Mountain-laurel	41	63
Blueberry	16	56
Arrowwood	2	0

Table 4.—Number of tree seedlings per 10-foot-square plot in 1977 for check and fenced plots by area and block

Area	Block	Check	Fenced plots
Pocomoke River			
Milburn Landing	A	0	24
	B	0	13
Cunningham Falls			
Manor Area	A	2	11
	B	2	10
Lake Area	A	0	4
	B	2	27
Greenbrier	A	3	29
	B	0	6

Herbaceous plants

Herbaceous covers were more quickly favored than woody covers. By 1977 the herbaceous covers in 11 fenced plots, all with favorable growing conditions, were 50 to 80 percent (Table 5). Of these plots, only four were planted to herbaceous plants, so volunteer growth was responsible for much of the cover —even in plots where such plants were moved in. In contrast, under the adverse growing conditions, herbaceous covers were 0 to 15 percent in all plots at Greenbrier, in one Manor block, and in most check plots.

The volunteer growth that came in after plots were fenced obscured the survival and growth of some of the transplanted herbaceous plants because the locations of the latter were mapped, but not marked. Ferns were moved with a relatively high degree of success: 72 percent were living after 3 years. Under favorable conditions all ferns survived and were thriving in 1977, whereas in one Manor Area block survival was only 25 percent because washing covered the other ferns with leaves, wood chips and soil. However, in no area had the ferns spread. Such species as the cinnamon fern, royal fern, and netted chainfern were successfully transplanted at Milburn Landing, and the Christmas fern in the other areas.

The success of transplanting other herbaceous plants varied: it was sometimes good under favorable conditions, but always poor where the plants were subsequently covered

Table 5.—Herbaceous cover in 1977 by area, block, and treatment (in percent)

Area	Block	Check	Fenced and:			
			Scarified, mulched	Herbs planted, mulched	Shrubs planted, mulched	Barrier plants planted, mulched
Pocomoke River						
Milburn Landing	A	30	75	50	15	80
	B	10	35	75	50	50
Cunningham Falls						
Manor Area	A	0	0	10	0	0
	B	0	25	20	25	5
Lake Area	A	0	65	50	75	75
	B	0	25	80	45	35
Greenbrier	A	0	15	15	0–5	0+
	B	0	0	0+	0+	0+

with a thick layer of leaves, soil, or wood chips. For example, in one Manor Area block where washing was not a factor, both plants of spotted wintergreen survived; in the other block, neither plant survived because of the deposits from washing. However, certain subshrubs such as spotted wintergreen, some species of ferns, and some other herbaceous plants are better adapted to growing under moderate to heavy shade than many understory species.

Under favorable light conditions, sediment deposits favored certain volunteer herbaceous plants. As might be expected, these included smartweed, jewelweed, and pigweed.

Species of volunteer herbaceous plants were numerous and varied with area. Some of the forbs were weeds such as selfheal, plantain, and tick-trefoil. Other forbs of possible interest to recreationists included wild strawberries, violets, goldenrod, fleabane, and asters. In the fenced plots of the lake area of Cunningham Falls State Park, the white wood aster was the most common volunteer forb, and along with the goldenrod provided a show of contrasting color in September and October.

General understory conditions

By 1977, 3 years after treatment, the understory cover greatly increased in many of the fenced plots (Fig 2, Table 6). On the deep Coastal Plain soil of Milburn Landing, all treatments that included fencing then had covers of 65 to 77 percent, more than three times as much as in the checks. There were similar results at the lake area of Cunningham Falls State Park, while the effects of treatments were much less in the Manor Area and at Greenbrier (Table 6). Relatively dense shade in the Manor blocks, washing and deposits of wood chips or soil in one Manor block, and a heavy cover of leaves in one Greenbrier block were the apparent causes for the reduced cover.

Figure 2.—A 1977 view of one of the Milburn Landing blocks. Note the understory cover inside the fence, and lack of it outside.

Table 6.—Cover of understory plants by treatment and year for Pocomoke River, Cunningham Falls, and Greenbrier areas (in percent)

Treatment	Milburn Landing			Manor Area			Lake Area			Greenbrier		
	1975	76	77	75	76	77	75	76	77	75	76	77
Check (unfenced)	30	30	20	0	0	0	6	3	1	0	0	0
Scarified, mulched	38	65	65	2	2	13	25	42	62	3	5	10
Herbs planted, mulched	42	60	77	3	6	15	52	70	65	10	8	8
Shrubs planted, mulched	37	58	68	3	8	15	52	72	75	7	7	14
Barrier plants planted, mulched	52	68	75	5	8	11	50	63	82	7	6	5

CONCLUSIONS

In general, even though some wildlings were successfully moved, the emphasis in reestablishing understories in overused recreational areas should apparently be on confining recreational use to prepared paths and pads through the use of fencing or other barriers, and mulching portions outside of the paths and pads. Scarification before mulching seems questionable in wooded areas because it may damage tree roots—even though it would help to break up the compacted surface soil. Mulching and the exclusion of use allow the invasion of many volunteer plants under favorable growing conditions, hence transplanting seems desirable only where rapid establishment of understory plants is desired. If high survival is desired, transplanting should be restricted to favorable sites—those with light shade, deep and moist soils, and no washing. Also, transplanting should be limited to species that in our trial were moved with a high degree of success—such as spicebush and sweet pepperbush among the shrubs, or Christmas fern among the herbaceous plants.

The establishment of plants that might serve as barriers to foot traffic was sufficiently poor that fences seem to be the best solution until improved survival and growth are ensured. Holly, greenbrier, and barberry can be moved with a fair degree of success, but even under favorable conditions in our trials, their growth was so slow that they offer little promise of forming suitable living barriers within a reasonable time.

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