

# The Effect of Ground Cover on the Soil Moisture Regime in a Mixed Mesophytic Woods

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## *Abstract*

A 25-acre mixed mesophytic woods in southwestern Delaware County was used to study the effect on soil moisture regime by presence or absence of ground cover. Four sites were selected within the woods, a Brookston silty clay loam with cover, a Brookston silty clay loam without cover, a Crosby silty clay loam with cover and a Crosby silty clay loam without cover. Bouyoucos soil moisture blocks were permanently installed at 5, 10, 25, and 50 cm. depths at each site. Available soil moisture was monitored daily for a period of thirteen months. Significant differences were found in rate and amount of loss and gain of available moisture content at the different depths for both soil types and for both cover situations.

## Introduction

A 25-acre mixed mesophytic woods in southwestern Delaware County was selected to study the effect of presence or absence of ground cover on soil moisture. Stewart Woods, the area chosen, met several predetermined requisites. These requisites included: a woods bisected by a fence, one side undisturbed, the other side lightly grazed and also at least two soil types, the latter oriented perpendicular to the fence line. These simple specifications quickly excluded most of the wooded areas in east central Indiana.

## Methods

Within the woods, four study sites were established. These sites were located on a Brookston silty clay loam with ground cover, a Brookston silty clay loam without cover, a Crosby silty clay loam with cover and a Crosby without cover. Soil moisture and soil temperature probes were permanently installed, with a minimum of disturbance to the soil structure and profile, at 5, 10, 25, and 50 cm. depths at each of the four sites. Taylor maximum-minimum thermometers and rain gages were mounted on posts one meter above the surface at each site. Air and soil temperatures, precipitation and available soil moisture were monitored daily for thirteen months.

A complete census was made of the 24.25-acre woods by species and diameter. The phytosociological parameters of relative and absolute density and basal area were determined as well as importance value (Table 1). This was done to compare the grazed and ungrazed areas on the basis of relative importance of represented species and to evaluate the difference exerted by a 12-year period of light grazing (one calf per 4 acres).

Sampling of ground cover was accomplished by establishing four one-meter square plots near each site. These plots were located 10 meters

TABLE 1. *Stewart Woods: Phytosociological Parameters.*

| Species      | Ungrazed Area |           |           |            | Grazed Area |           |           |            | Total Area |           |            |  |
|--------------|---------------|-----------|-----------|------------|-------------|-----------|-----------|------------|------------|-----------|------------|--|
|              | No.           | Rel. Den. | Rel. B.A. | Imp. Value | No.         | Rel. Den. | Rel. B.A. | Imp. Value | Rel. Den.  | Rel. B.A. | Imp. Value |  |
|              |               |           |           |            |             |           |           |            |            |           |            |  |
| Ash          | 100           | 14.10     | 15.89     | 15.00      | 307         | 18.98     | 17.55     | 18.27      | 17.49      | 17.12     | 17.31      |  |
| Aspen        |               |           |           |            | 2           | 0.12      | 0.08      | 0.10       | 0.08       | 0.57      | 0.33       |  |
| Basswood     |               |           |           |            | 4           | 0.24      | 0.30      | 0.27       | 0.17       | 0.22      | 0.19       |  |
| Beech        | 26            | 3.66      | 2.84      | 3.25       | 76          | 4.70      | 4.49      | 4.60       | 4.34       | 4.07      | 4.21       |  |
| Black gum    |               |           |           |            | 7           | 0.43      | 0.11      | 0.27       | 0.30       | 0.08      | 0.19       |  |
| Black oak    |               |           |           |            | 2           | 0.12      | 0.13      | 0.13       | 0.08       | 0.09      | 0.09       |  |
| Black walnut | 21            | 2.96      | 15.34     | 9.15       | 27          | 1.66      | 1.76      | 1.71       | 2.06       | 5.26      | 3.66       |  |
| Blue beech   | 21            | 2.96      | 0.43      | 1.70       | 7           | 0.43      | 0.05      | 0.24       | 1.20       | 0.14      | 0.67       |  |
| Bur oak      | 7             | 0.98      | 4.16      | 2.57       | 31          | 1.91      | 3.56      | 2.74       | 1.63       | 3.72      | 2.68       |  |
| Cherry       | 13            | 1.83      | 1.69      | 1.76       | 23          | 1.42      | 2.09      | 1.76       | 1.54       | 1.99      | 1.77       |  |
| Coffeetree   |               |           |           |            | 1           | 0.06      | 0.02      | 0.04       | 0.04       | 0.01      | 0.03       |  |
| Dogwood      | 8             | 1.12      | 0.12      | 0.62       | 1           | 0.06      | 0.00      | 0.04       | 0.38       | 0.03      | 0.21       |  |
| Elm          | 65            | 9.16      | 2.02      | 5.59       | 52          | 3.21      | 1.00      | 2.11       | 5.03       | 1.26      | 3.28       |  |
| Hackberry    | 27            | 3.80      | 0.97      | 2.39       | 41          | 2.53      | 0.84      | 1.69       | 2.92       | 0.88      | 1.90       |  |
| Haw          | 1             | 0.14      | 0.03      | 0.09       | 11          | 0.68      | 0.10      | 0.39       | 0.51       | 0.08      | 0.30       |  |
| Hickory      | 66            | 9.30      | 4.16      | 6.73       | 307         | 18.98     | 10.26     | 14.62      | 16.03      | 8.69      | 12.36      |  |
| Ironwood     |               |           |           |            | 11          | 0.68      | 0.11      | 0.40       | 0.47       | 0.08      | 0.28       |  |
| Redbud       | 10            | 1.41      | 0.24      | 0.83       |             |           |           |            | 0.42       | 0.06      | 0.24       |  |
| Red oak      | 76            | 10.71     | 26.32     | 18.25      | 256         | 15.83     | 33.48     | 24.91      | 14.27      | 32.01     | 23.14      |  |
| Sassafras    | 27            | 3.80      | 1.45      | 2.63       | 48          | 2.96      | 0.60      | 1.78       | 3.22       | 0.82      | 2.02       |  |
| Shingle oak  |               |           |           |            | 1           | 0.06      | 0.15      | 0.11       | 0.04       | 0.11      | 0.08       |  |
| Silver maple | 15            | 2.11      | 2.48      | 2.30       | 23          | 1.42      | 1.88      | 1.65       | 1.63       | 2.03      | 1.83       |  |
| Sugar maple  | 151           | 21.29     | 7.26      | 14.28      | 174         | 10.76     | 6.37      | 8.57       | 13.97      | 6.60      | 10.29      |  |
| White oak    | 75            | 10.57     | 14.52     | 12.55      | 205         | 12.67     | 14.46     | 13.57      | 12.03      | 14.48     | 13.26      |  |

TABLE 2. *Weekly Averages of Percentage of Available Moisture Content of Soils in Stewart Woods in 1966-67.*

| Site          | Crosby Silty<br>Clay Loam—<br>Grazed |    |    |     |     | Brookston Silty<br>Clay Loam—<br>Grazed |     |     |    |     | Brookston Silty<br>Clay Loam—<br>Ungrazed |    |     |    |    | Crosby Silty<br>Clay Loam—<br>Ungrazed |    |    |    |  |
|---------------|--------------------------------------|----|----|-----|-----|-----------------------------------------|-----|-----|----|-----|-------------------------------------------|----|-----|----|----|----------------------------------------|----|----|----|--|
|               | 5                                    | 10 | 25 | 50  |     | 5                                       | 10  | 25  | 50 |     | 5                                         | 10 | 25  | 50 |    | 5                                      | 10 | 25 | 50 |  |
| Depth, cm.    |                                      |    |    |     |     |                                         |     |     |    |     |                                           |    |     |    |    |                                        |    |    |    |  |
| Oct.<br>1966  | 90                                   | 82 | 86 | 24  | 96  | 96                                      | 96  | 97  | 23 | 67  | 41                                        | 27 | 24  | 89 | 75 | 50                                     | 21 |    |    |  |
|               | 69                                   | 77 | 73 | 21  | 100 | 100                                     | 100 | 100 | 22 | 56  | 27                                        | 25 | 24  | 84 | 64 | 45                                     | 21 |    |    |  |
|               | 77                                   | 69 | 70 | 15  | 96  | 93                                      | 97  | 97  | 12 | 86  | 83                                        | 15 | 6   | 80 | 81 | 46                                     | 1  |    |    |  |
|               | 67                                   | 67 | 65 | 10  | 95  | 95                                      | 95  | 11  |    | 82  | 79                                        | 13 | 3   | 83 | 72 | 38                                     | 7  |    |    |  |
| Nov.<br>1966  | 66                                   | 67 | 64 | 25  | 86  | 87                                      | 81  | 34  |    | 79  | 74                                        | 27 | 14  | 67 | 66 | 54                                     | 10 |    |    |  |
|               | 87                                   | 86 | 89 | 91  | 95  | 97                                      | 94  | 91  |    | 90  | 72                                        | 68 | 26  | 67 | 77 | 66                                     | 32 |    |    |  |
|               | 94                                   | 87 | 84 | 93  | 94  | 96                                      | 94  | 91  |    | 90  | 84                                        | 85 | 0   | 81 | 81 | 78                                     | 79 |    |    |  |
|               | 94                                   | 93 | 87 | 81  | 100 | 90                                      | 91  | 86  |    | 96  | 87                                        | 86 | 0   | 83 | 91 | 89                                     | 70 |    |    |  |
| Dec.<br>1966  | 83                                   | 85 | 81 | 81  | 88  | 90                                      | 88  | 83  |    | 87  | 85                                        | 87 | 82  | 82 | 84 | 81                                     | 75 |    |    |  |
|               | 89                                   | 90 | 88 | 97  | 94  | 95                                      | 94  | 95  |    | 93  | 92                                        | 93 | 88  | 87 | 88 | 89                                     | 90 |    |    |  |
|               | 88                                   | 90 | 86 | 96  | 87  | 90                                      | 91  | 93  |    | 91  | 89                                        | 90 | 90  | 89 | 91 | 91                                     | 92 |    |    |  |
|               | 85                                   | 89 | 86 | 98  | 87  | 89                                      | 89  | 87  |    | 88  | 87                                        | 89 | 89  | 87 | 89 | 91                                     | 91 |    |    |  |
| Jan.<br>1967  | 83                                   | 87 | 81 | 93  | 87  | 89                                      | 89  | 94  |    | 88  | 87                                        | 91 | 93  | 84 | 84 | 87                                     | 89 |    |    |  |
|               | 84                                   | 87 | 84 | 91  | 87  | 86                                      | 86  | 91  |    | 88  | 88                                        | 88 | 90  | 85 | 86 | 88                                     | 90 |    |    |  |
|               | 83                                   | 87 | 82 | 94  | 84  | 87                                      | 88  | 94  |    | 87  | 87                                        | 89 | 90  | 84 | 84 | 89                                     | 90 |    |    |  |
|               | 87                                   | 89 | 86 | 98  | 89  | 90                                      | 89  | 97  |    | 90  | 90                                        | 90 | 94  | 88 | 88 | 90                                     | 92 |    |    |  |
| Feb.<br>1967  | 86                                   | 90 | 87 | 97  | 88  | 90                                      | 91  | 98  |    | 91  | 92                                        | 92 | 96  | 87 | 88 | 90                                     | 92 |    |    |  |
|               | 84                                   | 86 | 84 | 95  | 87  | 88                                      | 88  | 96  |    | 88  | 89                                        | 91 | 97  | 84 | 85 | 89                                     | 90 |    |    |  |
|               | 85                                   | 89 | 84 | 96  | 87  | 89                                      | 88  | 93  |    | 90  | 90                                        | 90 | 95  | 88 | 84 | 86                                     | 88 |    |    |  |
|               | 82                                   | 88 | 81 | 94  | 83  | 85                                      | 86  | 91  |    | 85  | 86                                        | 87 | 91  | 84 | 83 | 85                                     | 88 |    |    |  |
| March<br>1967 | 83                                   | 87 | 83 | 96  | 86  | 87                                      | 89  | 94  |    | 89  | 90                                        | 91 | 95  | 93 | 86 | 90                                     | 92 |    |    |  |
|               | 89                                   | 91 | 88 | 97  | 91  | 92                                      | 93  | 97  |    | 97  | 94                                        | 95 | 97  | 79 | 89 | 91                                     | 94 |    |    |  |
|               | 90                                   | 91 | 90 | 99  | 92  | 94                                      | 97  | 100 |    | 95  | 96                                        | 98 | 100 | 78 | 91 | 94                                     | 95 |    |    |  |
|               | 96                                   | 97 | 95 | 100 | 98  | 98                                      | 97  | 100 |    | 100 | 98                                        | 99 | 100 | 90 | 98 | 99                                     | 98 |    |    |  |

|               |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |     |
|---------------|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|-----|
| April<br>1967 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
|               | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
|               | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
|               | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
|               | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| May<br>1967   | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
|               | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
|               | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
|               | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
|               | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| June<br>1967  | 88  | 100 | 93  | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
|               | 42  | 74  | 59  | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
|               | 19  | 30  | 24  | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
|               | 22  | 23  | 39  | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
|               | 12  | 15  | 23  | 99  | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
| July<br>1967  | 0   | 1   | 3   | 85  | 40  | 34  | 79  | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 | 100 |
|               | 0   | 0   | 0   | 49  | 32  | 22  | 43  | 95  | 67  | 51  | 84  | 91  | 80  | 97  | 100 | 100 | 100 | 100 | 100 | 100 |
|               | 0   | 0   | 0   | 24  | 22  | 19  | 27  | 82  | 74  | 34  | 66  | 77  | 88  | 98  | 100 | 99  | 98  | 100 | 97  | 100 |
|               | 0   | 0   | 0   | 16  | 18  | 16  | 20  | 64  | 63  | 23  | 49  | 63  | 42  | 79  | 79  | 45  | 43  | 46  | 42  | 68  |
|               | 19  | 0   | 0   | 0   | 0   | 2   | 16  | 44  | 19  | 2   | 34  | 52  | 41  | 41  | 36  | 27  | 0   | 0   | 0   | 0   |
| Aug.<br>1967  | 0   | 0   | 0   | 0   | 0   | 0   | 6   | 22  | 27  | 42  | 21  | 41  | 41  | 36  | 27  | 0   | 0   | 0   | 0   | 0   |
|               | 0   | 0   | 0   | 0   | 2   | 0   | 0   | 6   | 37  | 16  | 6   | 21  | 21  | 20  | 10  | 0   | 0   | 0   | 0   | 0   |
|               | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 22  | 0   | 0   | 12  | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   |
|               | 1   | 0   | 0   | 0   | 2   | 1   | 0   | 0   | 54  | 11  | 0   | 0   | 0   | 54  | 13  | 0   | 0   | 0   | 0   | 0   |
|               | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 37  | 8   | 0   | 0   | 0   | 61  | 2   | 0   | 0   | 0   | 0   | 0   |
| Sept.<br>1967 | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 0   | 29  | 18  | 0   | 0   | 0   | 60  | 0   | 0   | 0   | 0   | 0   | 0   |
|               | 2   | 2   | 0   | 0   | 30  | 17  | 0   | 0   | 50  | 26  | 0   | 0   | 0   | 50  | 7   | 0   | 0   | 0   | 0   | 0   |
|               | 49  | 27  | 68  | 0   | 75  | 46  | 0   | 0   | 79  | 68  | 2   | 0   | 0   | 74  | 60  | 0   | 0   | 0   | 0   | 0   |
|               | 70  | 41  | 74  | 0   | 82  | 76  | 0   | 0   | 85  | 79  | 4   | 0   | 0   | 80  | 76  | 5   | 0   | 0   | 0   | 0   |
|               | 83  | 80  | 84  | 0   | 87  | 88  | 50  | 0   | 92  | 92  | 74  | 0   | 0   | 82  | 85  | 52  | 0   | 0   | 0   | 0   |
| Oct.<br>1967  | 2   | 2   | 0   | 0   | 30  | 17  | 0   | 0   | 50  | 26  | 0   | 0   | 0   | 50  | 7   | 0   | 0   | 0   | 0   | 0   |
|               | 49  | 27  | 68  | 0   | 75  | 46  | 0   | 0   | 79  | 68  | 2   | 0   | 0   | 74  | 60  | 0   | 0   | 0   | 0   | 0   |
|               | 70  | 41  | 74  | 0   | 82  | 76  | 0   | 0   | 85  | 79  | 4   | 0   | 0   | 80  | 76  | 5   | 0   | 0   | 0   | 0   |
|               | 83  | 80  | 84  | 0   | 87  | 88  | 50  | 0   | 92  | 92  | 74  | 0   | 0   | 82  | 85  | 52  | 0   | 0   | 0   | 0   |
|               | 2   | 2   | 0   | 0   | 30  | 17  | 0   | 0   | 50  | 26  | 0   | 0   | 0   | 50  | 7   | 0   | 0   | 0   | 0   | 0   |
| Nov.<br>1967  | 87  | 89  | 88  | 91  | 91  | 92  | 86  | 11  | 94  | 94  | 91  | 0   | 0   | 86  | 92  | 89  | 15  | 89  | 15  | 89  |
|               | 88  | 90  | 88  | 94  | 91  | 92  | 88  | 66  | 94  | 94  | 94  | 14  | 0   | 86  | 93  | 92  | 80  | 93  | 80  | 93  |
|               | 88  | 90  | 88  | 96  | 89  | 91  | 89  | 88  | 92  | 94  | 95  | 66  | 0   | 85  | 93  | 94  | 88  | 94  | 88  | 94  |
|               | 87  | 90  | 87  | 97  | 88  | 89  | 89  | 92  | 91  | 93  | 94  | 97  | 0   | 84  | 92  | 95  | 92  | 95  | 92  | 95  |
|               | 87  | 89  | 86  | 97  | 87  | 88  | 88  | 91  | 89  | 93  | 94  | 96  | 0   | 83  | 91  | 92  | 90  | 92  | 90  | 90  |
| Dec.<br>1967  | 87  | 89  | 86  | 97  | 87  | 88  | 88  | 91  | 89  | 93  | 94  | 96  | 0   | 83  | 91  | 92  | 90  | 92  | 90  | 90  |

in each cardinal direction from the instrument post. All shrubs, tree reproduction and herbaceous vegetation were tallied by species.

### Results and Discussion

Little significant difference was noted in a comparison of importance values between the grazed and ungrazed area. The grazed portion of the woods appeared to be more xeric with combined importance value for oaks and hickories of 53.1% as opposed to 37.8% for the ungrazed. Note that the importance for the ungrazed portion is distributed fairly evenly between five species, all rather mesic in their requirements.

Ground cover was very sparse on the grazed side even with the minimal grazing. No shrubs were tallied and very few forbs; 82.5% of all individuals in the grazed area were sedges and grasses.

An evaluation of the soil moisture data indicated that the two sites with relatively little ground cover reached field capacity earlier than sites with cover (Table 2). This difference increased with depth, i.e., the 50 cm. depth showed the greatest difference in moisture content between cover and non-cover. The 25 and 50 cm. depths, once they achieved field capacity, remained consistently higher in available moisture content than the shallower depths not only during the growing season, but all year. Fluctuations in available moisture at the 5 and 10 cm. depths were very wide during the summer as an effect of convectional rain and higher evaporation rates. The moisture regime did not actually stabilize at any depth until mid-March; at this time field capacity was constant and remained so until June and July.

Differences in soil moisture existed between the two soil types as well as in the presence or absence of cover. Available moisture content began decreasing sooner in the Crosby than in the Brookston and dropped to 15% available moisture content at an earlier date. The difference in time required to reach 15% available moisture was less marked between the Crosby and Brookstone as the soil depth increased. Fall rains caused a sharp and steady increase in available moisture content at the 50 cm. level. This occurred about two weeks earlier in the Crosby than in the Brookstone. Other depths in both soils evidenced an increase but with the increase occurring at the same time at each depth and at a less steady rate than 50 cm. Though the penetration was better on the Crosby, the Brookston had in general a higher moisture holding capacity through the year.

In summary, soil moisture reached field capacity earlier in the grazed portion of the woods on the Crosby soil, though penetration of moisture was greater in the ungrazed. Moisture retention was greater at all four depths on the grazed side, particularly on the Brookston soil. Apparently, grazing, if minimal to avoid compaction, has a favorable effect on the soil moisture regime.

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