

## HERBAGE PRODUCTION AND COMPOSITION FLUCTUATIONS OF NATURAL PLANT COMMUNITIES AS RELATED TO CLIMATE AND SOIL TAXONOMIC UNITS

H. B. Passey, V. K. Hugie, and Erasmus W. Williams<sup>1</sup>

Range vegetation is commonly measured in terms of total herbage and species composition. These measurements, when applied to natural plant communities, are the criteria by which rangelands are separated into range sites. One of the problems related to the use of such measurements is the fluctuation of herbage yield and species composition from year to year or over a period of years.

A number of publications discuss changes in herbage yield, and species composition of native plant communities caused by improper grazing and other disturbances resulting from man's activities. A few publications are concerned with the changes in herbage production and species composition that occur naturally in relict areas of range vegetation. Dyksterhius (4) states "interplay of populations continues in the climax, but these fluctuations tend to be around an average." Blaisdell (3) in his 13-year study of natural vegetation near Dubois, Idaho, found that herbage production in the best years was more than twice that in low years. He also noted that certain environmental conditions were favorable to one species but unfavorable to another. The close relationship of specific natural plant communities to soil types and phases of types has been reported by Heerwagen and Aandahl (5) and Passey and Hugie (8).

It is the purpose of this paper to report the results of a 5-year study of herbage production and species composition of three natural plant communities on three soils in the Carey

Kipuka area, Idaho. This study is a part of the soil-climate-plant investigations presently being conducted by the Soil Conservation Service.

Descriptions of the Carey Kipuka and the three soils used in this study; Tetonia silt loam, deep over basalt; Goodington silt loam; and Bancroft silt loam, deep over basalt cinders, are presented in the preceding paper of this symposium. Schematic profile descriptions are presented in Figures 1, 2, and 3.

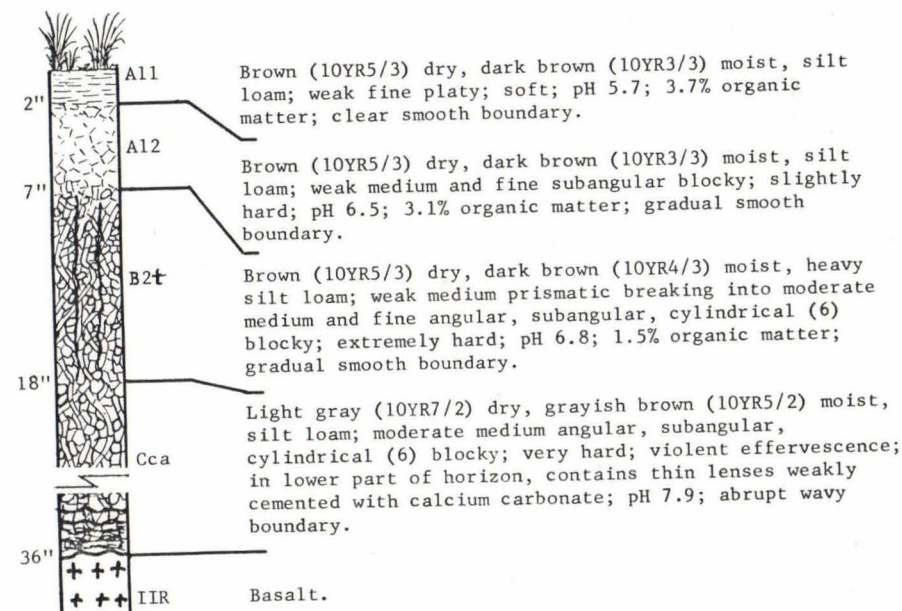


Fig. 1. Schematic profile description - Tetonia silt loam, deep over basalt (tentative). This soil occupies a 2% east slope and is formed in loess over basalt.

<sup>1</sup> Range Conservationist, Soil Scientist, and Range Conservationist, Soil Conservation Service, Salt Lake City, Utah.

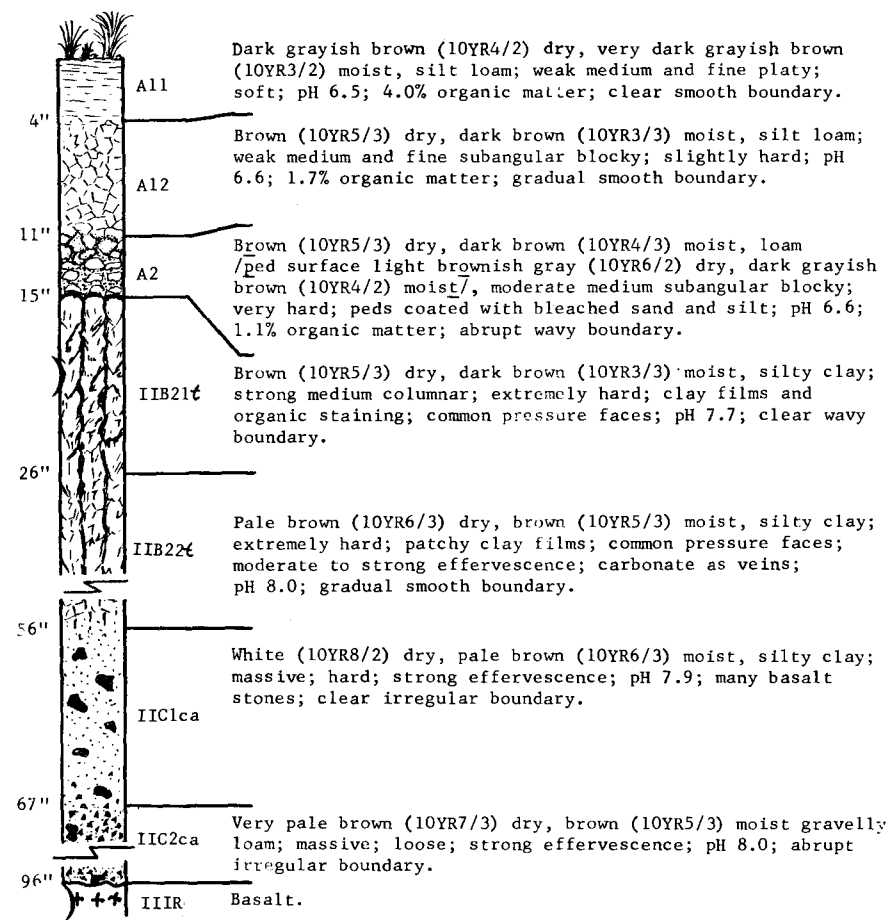


Fig. 2. Schematic profile description - Goodington silt loam (tentative). This soil is nearly level and is formed principally in basaltic ash and cinders.

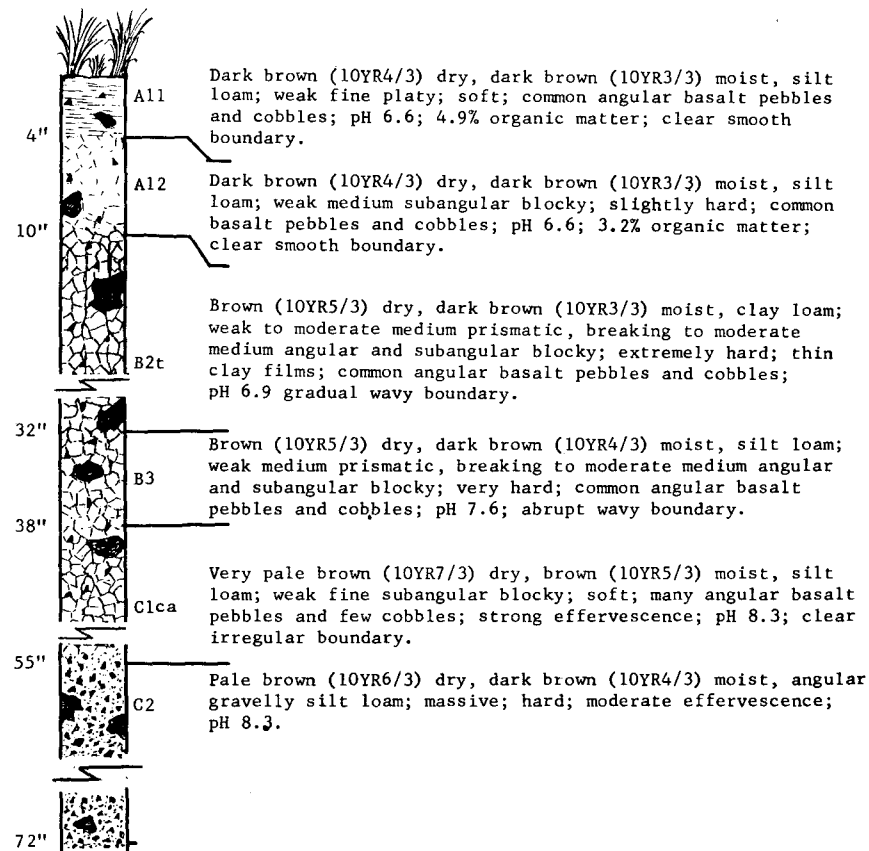


Fig. 3. Schematic profile description - Bancroft silt loam, deep over basalt cinders (tentative). This soil occupies a 19% north facing slope and is formed in loess and basaltic cinder and ash materials.

Climatic data for the 5-year period 1959-1963 at Craters of the Moon National Monument are presented in Table 1. Total precipitation from October 1 to March 31 is recorded as a single entry. Average temperature and recorded precipitation are given for the period April 1 to mid-July. Precipitation from mid-July to September 30 is not included in this table because it has little effect on plant growth and herbage production.

Common and botanical names of plant species mentioned will be found in the Appendix of the preceding paper.

Table 1. Precipitation and Temperature-Craters of the Moon National Monument. October-March and April-July (by weeks).

| Date          |      | 1958-1959    |              | 1959-1960    |              | 1960-1961    |              | 1961-1962    |              | 1962-1963    |              |
|---------------|------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|--------------|
| Month         | Week | Pptn.<br>in. | Temp.<br>°F. | Pptn.<br>in. | Temp.<br>°F. | Pptn.<br>in. | Temp.<br>°F. | Pptn.<br>in. | Temp.<br>°F. | Pptn.<br>in. | Temp.<br>°F. |
| October-March |      | 5.03*        | --           | 6.87         | --           | 4.63         | --           | 8.84         | --           | 7.27         | --           |
| April         | 1st  | 0.00         | 38           | 0.00         | 51           | 0.00         | 40           | 0.00         | 39           | 1.03         | 37           |
|               | 2nd  | 0.04         | 39           | 0.00         | 41           | 0.05         | 37           | 0.00         | 43           | 0.48         | 38           |
|               | 3rd  | 0.10         | 42           | 0.18         | 40           | 0.58         | 41           | 0.00         | 51           | 0.39         | 35           |
| May           | 4th  | 0.79         | 45           | 0.68         | 38           | 0.04         | 40           | 0.52         | 45           | 1.15         | 37           |
|               | 5th  | 0.30         | 43           | 0.12         | 45           | 0.04         | 44           | 0.02         | 48           | 0.12         | 47           |
|               | 6th  | 0.15         | 51           | 0.00         | 56           | 0.03         | 46           | 0.02         | 51           | 0.72         | 49           |
|               | 7th  | 0.71         | 42           | 0.05         | 44           | 0.76         | 48           | 2.31         | 44           | 0.26         | 48           |
|               | 8th  | 0.25         | 44           | 0.01         | 45           | 0.03         | 60           | 0.78         | 46           | 0.81         | 57           |
| June          | 9th  | 0.00         | 57           | 0.00         | 61           | 0.91         | 58           | 1.03         | 51           | 0.79         | 56           |
|               | 10th | 0.16         | 57           | 0.33         | 58           | 0.15         | 61           | 0.03         | 49           | 1.02         | 48           |
|               | 11th | 0.05         | 67           | 0.00         | 61           | 0.04         | 65           | 0.34         | 58           | 2.35         | 56           |
|               | 12th | 0.29         | 65           | 0.00         | 61           | 0.00         | 72           | 0.03         | 65           | 0.58         | 57           |
| July          | 13th | 0.61         | 57           | 0.02         | 63           | 0.00         | 68           | 0.10         | 66           | 0.13         | 56           |
|               | 14th | 0.00         | 63           | 0.00         | 67           | 0.59         | 68           | 0.00         | 64           | 0.00         | 67           |
| Total & aver. |      | 8.48         | 51           | 8.26         | 52           | 7.80         | 53           | 14.02        | 51           | 17.10        | 49.1         |

\* Precipitation data available only since December 1958.

## METHODS

The methods and techniques used in this study are presented by Passey and Hugie (7).

## RESULTS

Total yields of air-dry herbage in pounds per acre and species composition, by percent of weight for 5 years on Tetonia silt loam, deep over basalt; Goodington silt loam; and Bancroft silt loam, deep over basalt cinders, are presented in Tables 2, 3, and 4 and Figures 4, 8, 9, and 10.

Table 2. Total Yield (Weight Air-Dry Herbage Per Acre) and Species Composition for 5-year Period 1959-1963\*, Tetonia silt loam, deep over basalt.

| Plant species               | 1959 |     | 1960 |     | 1961 |     | 1962 |     | 1963 |     | Average |     |
|-----------------------------|------|-----|------|-----|------|-----|------|-----|------|-----|---------|-----|
|                             | lb.  | %   | lb.  | %   | lb.  | %   | lb.  | %   | lb.  | %   | lb.     | %   |
| Idaho fescue                | 295  | 37  | 387  | 39  | 218  | 30  | 408  | 29  | 242  | 17  | 309     | 30  |
| Bluebunch wheatgrass        | 93   | 12  | 130  | 13  | 111  | 16  | 124  | 8   | 181  | 13  | 128     | 12  |
| Sandberg & Nevada bluegrass | 46   | 6   | 86   | 9   | 53   | 7   | 263  | 19  | 222  | 16  | 134     | 12  |
| Prairie junegrass           | 53   | 7   | 44   | 4   | 38   | 5   | 90   | 6   | 108  | 8   | 67      | 6   |
| Bottlebrush squirreltail    | --   | --  | 2    | T†  | --   | --  | 7    | T   | 12   | 1   | 5       | T   |
| Total grasses               | 489  | 62  | 649  | 65  | 420  | 58  | 892  | 62  | 765  | 55  | 643     | 60  |
| Tapertip hawksbeard         | 41   | 5   | 63   | 6   | 43   | 6   | 82   | 6   | 27   | 2   | 50      | 5   |
| Arrowleaf balsamroot        | 34   | 4   | 4    | T   | 9    | 1   | 13   | 1   | --   | --  | 12      | 1   |
| Narrowleaf milkvetch        | 30   | 4   | 50   | 5   | 20   | 3   | 85   | 6   | 231  | 16  | 83      | 8   |
| Longleaf and Hoods phlox    | 12   | 1   | 18   | 2   | 18   | 3   | 32   | 2   | 52   | 4   | 26      | 2   |
| Other forbs                 | 37   | 5   | 60   | 7   | 74   | 10  | 115  | 8   | 73   | 5   | 73      | 7   |
| Total forbs                 | 154  | 19  | 195  | 20  | 164  | 23  | 327  | 23  | 383  | 27  | 244     | 23  |
| Threetip sagebrush          | 135  | 17  | 142  | 14  | 126  | 18  | 173  | 12  | 188  | 13  | 153     | 14  |
| Douglas rabbitbrush         | 5    | 1   | 6    | 1   | 10   | 1   | 24   | 2   | 24   | 2   | 14      | 1   |
| Total shrubs                | 140  | 18  | 148  | 15  | 136  | 19  | 197  | 14  | 212  | 15  | 167     | 16  |
| Cheatgrass                  | 2    | T   | --   | --  | 2    | T   | 6    | T   | 25   | 2   | 7       | T   |
| Other annuals               | 5    | 1   | 4    | T   | 3    | T   | 8    | 1   | 15   | 1   | 7       | T   |
| Total annuals               | 7    | 1   | 4    | T   | 5    | T   | 14   | 1   | 40   | 3   | 14      | 1   |
| Total yield                 | 790  | 100 | 996  | 100 | 725  | 100 | 1430 | 100 | 1400 | 100 | 1068    | 100 |

\* Based on 20 random 9.6 square foot plots. † Pounds per acre and % composition.

† Trace.

Yields of herbage varied considerably from year to year on the same soils and also between the soils. Tetonia silt loam, deep over basalt, had the highest average yield, and Goodington silt loam the lowest. Total yield of air-dry forage per acre was highest in 1962 and amounted to 1,430 pounds on Tetonia, 1,130 pounds on Goodington, and 1,463 pounds on Bancroft. Lowest annual production on Tetonia and Goodington was in 1961 when Tetonia yielded 725 pounds per acre and Goodington 486 pounds. Bancroft produced its lowest yield in 1959, 648 pounds. The trend in herbage yield, though interrupted, appears to be slightly upward during the period of this study.

Changes in annual production of the grasses closely paralleled the total herbage production during the 5-year study. The highest yield of grasses on all 3 soils occurred in 1962 and the lowest in 1961. On Tetonia silt loam, deep over basalt, the 1962 yield of grass was slightly more than double the 1961 yield. Production of grass on Goodington silt loam and Bancroft silt loam, deep over

Table 3. Total Yield (Weight Air-Dry Herbage per Acre) and Species Composition for 5-Year Period 1959-1963\* Goodington silt loam.

| Plant species               | 1959  |     | 1960 |     | 1961 |     | 1962 |     | 1963 |     | Average |     |
|-----------------------------|-------|-----|------|-----|------|-----|------|-----|------|-----|---------|-----|
|                             | lb. † | %   | lb.  | %   | lb.  | %   | lb.  | %   | lb.  | %   | lb.     | %   |
| Idaho fescue                | 130   | 25  | 193  | 29  | 96   | 20  | 199  | 17  | 108  | 11  | 145     | 19  |
| Bluebunch wheatgrass        | 49    | 9   | 45   | 7   | 36   | 7   | 83   | 7   | 78   | 8   | 58      | 8   |
| Sandberg & Nevada bluegrass | 58    | 11  | 99   | 15  | 58   | 12  | 325  | 28  | 260  | 26  | 160     | 21  |
| Prairie junegrass           | 7     | 1   | 7    | 1   | 10   | 2   | 28   | 2   | 30   | 3   | 16      | 2   |
| Bottlebrush squirreltail    | 37    | 7   | 52   | 8   | 45   | 9   | 114  | 10  | 197  | 20  | 89      | 12  |
| Thurber needlegrass         | --    | T†  | 2    | T   | 4    | 1   | 16   | 1   | 10   | 1   | 7       | 1   |
| Total grasses               | 281   | 53  | 398  | 60  | 249  | 51  | 765  | 66  | 683  | 69  | 475     | 63  |
| Pussytoes                   | 18    | 3   | 43   | 7   | 42   | 9   | 52   | 5   | 66   | 7   | 44      | 6   |
| Lambstongue groundsel       | 2     | T   | 22   | 3   | 15   | 3   | 14   | 1   | 1    | T   | 11      | 1   |
| Longleaf & Hoods phlox      | 26    | 5   | 22   | 3   | 26   | 5   | 47   | 4   | 55   | 6   | 35      | 5   |
| Other forbs                 | 117   | 23  | 118  | 18  | 114  | 23  | 219  | 19  | 143  | 14  | 142     | 18  |
| Total forbs                 | 163   | 31  | 205  | 31  | 197  | 40  | 332  | 29  | 265  | 27  | 232     | 30  |
| Big sagebrush               | 33    | 6   | 27   | 4   | 19   | 4   | 23   | 2   | 10   | 1   | 22      | 3   |
| Threetip sagebrush          | 22    | 4   | 13   | 2   | 8    | 2   | 2    | T   | 1    | T   | 9       | 1   |
| Douglas rabbitbrush         | 19    | 4   | 9    | 1   | 8    | 2   | 6    | 1   | 14   | 1   | 11      | 1   |
| Total shrub yield           | 74    | 14  | 49   | 7   | 35   | 8   | 31   | 3   | 25   | 2   | 42      | 5   |
| Cheatgrass                  | --    | --  | --   | --  | --   | --  | 10   | 1   | 7    | 1   | 3       | T   |
| Other annuals               | 12    | 2   | 12   | 2   | 5    | 1   | 18   | 1   | 9    | 1   | 15      | 2   |
| Total annual yield          | 12    | 2   | 12   | 2   | 5    | 1   | 28   | 2   | 16   | 2   | 18      | 2   |
| Total yield                 | 530   | 100 | 664  | 100 | 486  | 100 | 1160 | 100 | 989  | 100 | 766     | 100 |

\* Based on 20 random 9.6 square foot plots. † Pounds per acre and % composition.

† Trace.

basalt, in 1962 was more than 3 times their yield in 1961. Over the 5-year period, grasses accounted for 60% of the total yield on Tetonia, 63% on Goodington, and 78% on Bancroft.

During the 5-year period the percent of Idaho fescue generally decreased on all 3 soils. The highest yield of Idaho fescue was produced on Bancroft silt loam. On this soil it makes up 33% of the total herbage yield. The year 1962 was the highest production year on all 3 soils for Idaho fescue. Bancroft silt loam produced 369 pounds of air-dry herbage in both 1960 and 1962. The average production of Idaho fescue was the lowest on Goodington silt loam and the greatest fluctuation in percentage of annual yield occurred on this soil. In 1962 the yield of this grass was twice the amount produced in 1961.

Fluctuation in yield and percent composition of bluebunch wheatgrass was less than that of Idaho fescue and was erratic without any definite trend. Tetonia silt loam was the highest producer of this grass and Goodington silt loam the lowest.

Table 4. Total Yield (Weight Air-Dry Herbage Per Acre) and Species Composition for 5-Year Period 1959-1963\* Bancroft silt loam, deep over basalt cinders.

| Plant species               | 1959  |     | 1960 |     | 1961 |     | 1962 |     | 1963 |     | Average |     |
|-----------------------------|-------|-----|------|-----|------|-----|------|-----|------|-----|---------|-----|
|                             | lb. † | %   | lb.  | %   | lb.  | %   | lb.  | %   | lb.  | %   | lb.     | %   |
| Idaho fescue                | 297   | 46  | 369  | 41  | 255  | 37  | 369  | 26  | 300  | 28  | 318     | 33  |
| Bluebunch wheatgrass        | 101   | 16  | 111  | 12  | 84   | 12  | 191  | 13  | 149  | 14  | 127     | 13  |
| Sandberg & Nevada bluegrass | 92    | 14  | 164  | 18  | 86   | 13  | 617  | 43  | 309  | 29  | 254     | 27  |
| Prairie junegrass           | 28    | 4   | 30   | 3   | 29   | 4   | 32   | 2   | 63   | 6   | 36      | 4   |
| Great Basin wildrye         | 6     | 1   | 16   | 2   | 12   | 2   | 21   | 1   | 6    | T†  | 12      | 1   |
| Total grasses               | 524   | 81  | 690  | 76  | 466  | 68  | 1230 | 85  | 827  | 77  | 747     | 78  |
| Tapertip hawksbeard         | 42    | 7   | 55   | 6   | 54   | 8   | 61   | 4   | 110  | 10  | 64      | 7   |
| Longleaf & Hoods phlox      | 9     | 1   | 15   | 2   | 15   | 2   | 11   | 1   | 15   | 1   | 13      | 1   |
| Other forbs                 | 34    | 5   | 83   | 9   | 97   | 14  | 99   | 7   | 81   | 8   | 79      | 8   |
| Total forbs                 | 85    | 13  | 153  | 17  | 166  | 24  | 171  | 12  | 206  | 19  | 156     | 16  |
| Big sagebrush               | --    | --  | 5    | T   | 6    | 1   | 7    | T   | --   | --  | 4       | T   |
| Threetip sagebrush          | 18    | 3   | 19   | 2   | 13   | 2   | 18   | 1   | 8    | 1   | 15      | 2   |
| Douglas rabbitbrush         | 18    | 3   | 20   | 2   | 12   | 2   | 20   | 1   | 15   | 1   | 17      | 2   |
| Total shrubs                | 36    | 6   | 44   | 5   | 31   | 5   | 45   | 2   | 23   | 2   | 36      | 4   |
| Cheatgrass                  | --    | --  | 10   | 1   | 12   | 2   | 12   | 1   | 10   | 1   | 9       | 1   |
| Other annuals               | 3     | T†  | 6    | 1   | 9    | 1   | 5    | T   | 11   | 1   | 7       | 1   |
| Total annuals               | 3     | T   | 16   | 2   | 21   | 3   | 17   | 1   | 21   | 2   | 16      | 2   |
| Total yield                 | 648   | 100 | 903  | 100 | 684  | 100 | 1469 | 100 | 1077 | 100 | 955     | 100 |

\* Based on 20 random 9.6 square foot plots. † Pounds per acre and % composition.

† Trace.

The yield of Sandberg and Nevada bluegrass fluctuates more widely than that of any other grass species studied. Average was highest on Bancroft silt loam where the combined yield of the 2 grasses was 254 pounds of air-dry herbage per acre or 27% of the total. The highest production year for these 2 grasses was 1962. On Tetonia, Goodington and Bancroft soils, they produced 263, 325, and 617 pounds of herbage, respectively. On Bancroft silt loam the herbage yield of Nevada and Sandberg bluegrass in 1962 was 7 times higher than it was in 1961, the lowest production year.

Prairie junegrass contributed a small amount of herbage on all three soils. Thurber needlegrass contributed some herbage on Goodington silt loam. Great Basin wildrye also contributed a small amount of herbage on Bancroft silt loam.

Bottlebrush squirreltail grew on both the Goodington and Tetonia soils but was important as a producer of herbage only on the Goodington soil. Highest production year for this grass on Goodington silt loam was in 1963 when it produced 127 pounds of herbage or 20% of the total.

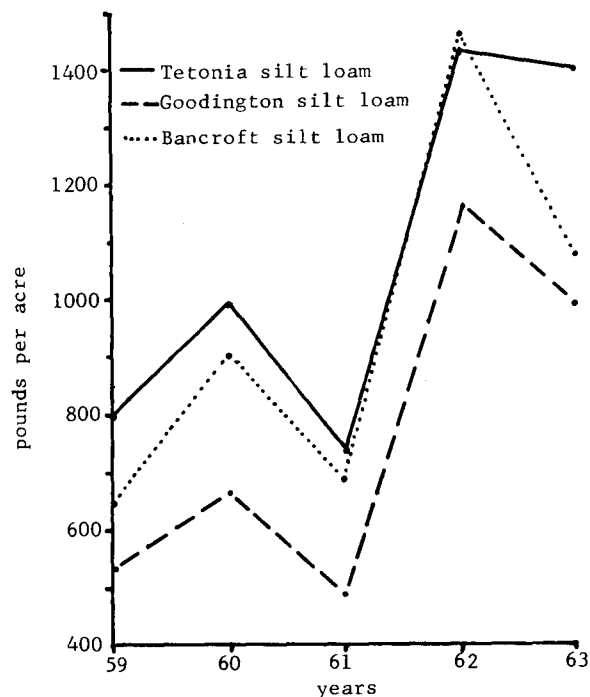


Fig. 4. Total air-dry herbage yield per acre 1959-1963.

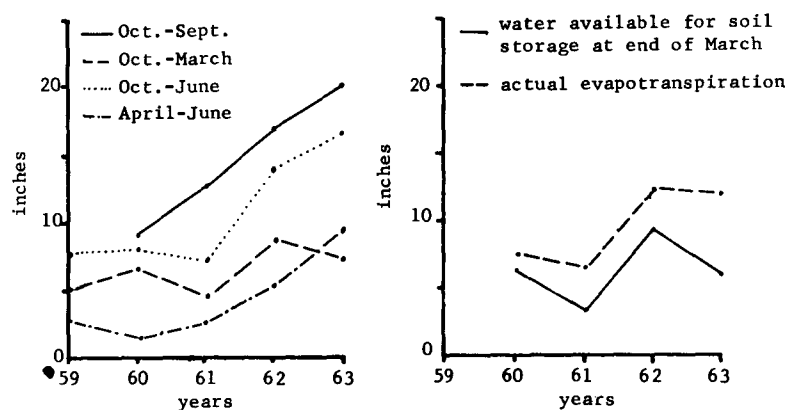


Fig. 5. Precipitation, Craters of the Moon National Monument, 1959-1963.

The yields of forbs during the five-year period fluctuated less than the yields of grasses. During the study period, forbs increased slightly, both in absolute yield and in percentage of composition. The forbs on Goodington silt loam were mainly low, mat forming, early growing species. On Tetonia and Bancroft soils, the principal forbs were erect and later growing species.

The forage yield of shrubby species fluctuated least during the 5-year period. Shrubs were an important component of the plant community only on Tetonia silt loam, deep over basalt. On this soil, threetip sagebrush and Douglas rabbitbrush produced an average yield of 167 pounds per acre or 16% of the total production. Highest yield during the study period was 212 pounds in 1963 and the lowest was 136 pounds in 1961. During the 5-year period, forage yield of shrubs increased slightly on Tetonia, was constant on Bancroft and decreased slightly on Goodington.

Herbage production from annuals on the three soils was minor. In the high moisture years of 1962 and 1963, there was a marked increase in cheatgrass.

The distribution of precipitation, calculated water balance, evapotranspiration, and soil moisture were studied to assist in the understanding of composition and yield fluctuations of the plant communities.

As an aid to further analysis of the climate, yearly weather records at the Craters of the Moon National Monument were subjected to calculations as outlined by Arkley and Ulrich (1). The actual and potential evapotranspiration and water balance (water available for soil storage) were calculated (Figure 6).



Fig. 6. Calculated weather data Craters of the Moon National Monument 1960-1963.

Soil moisture samples were collected twice each year from each horizon of the three soils studied. The soils were sampled at the beginning of the growing season in the first part of April, and again during the last part of June or early part of July at the end of the growing season. With these data and the volume weight of the various soils horizons, the amount of water removed from the soil during the growing season was determined (Figure 7).

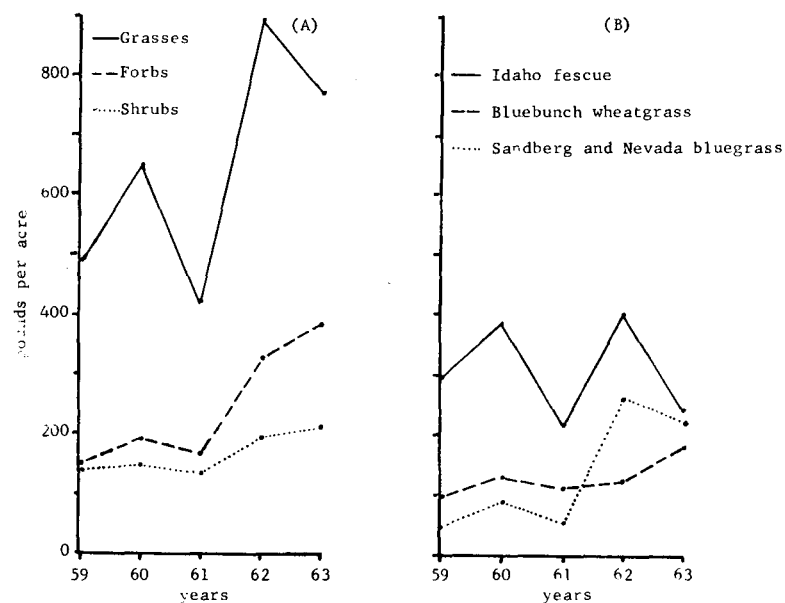


Fig. 7. Shaded area represents inches of water removed from the soil (1959-1963). Based on soil moisture samples taken at the beginning (solid line) and end of the growing season (dash line).

A rain gauge at the Carey Kipuka was used to measure the amount of precipitation received at the study site during the growing season. These combined measurements gave a fairly reliable measure of the water used by plants. These data indicate that the average production of air-dry herbage per inch of water used was 129 pounds per acre on Tetonia silt loam, deep over basalt; 94 pounds on Goodington silt loam; and 118 pounds on Bancroft silt loam, deep over basalt cinders.

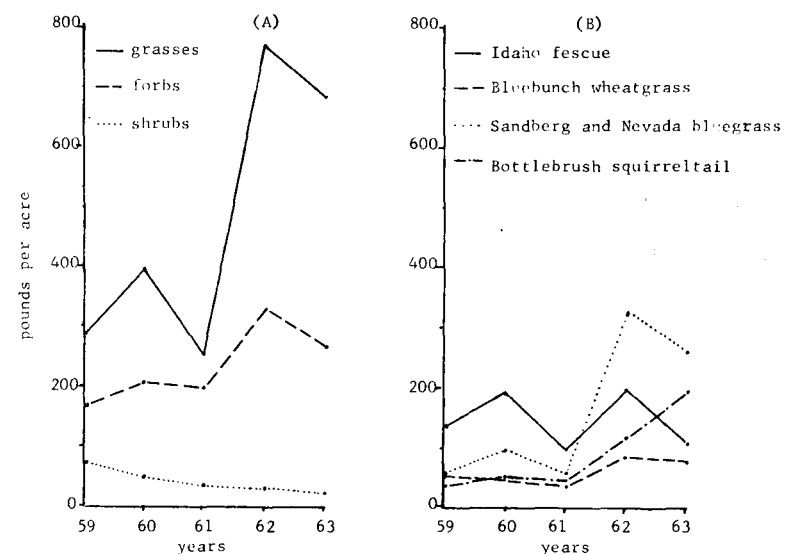


Fig. 8. Air-dry herbage production Tetonia silt loam (A) grasses, forbs, shrubs; (B) grass species.

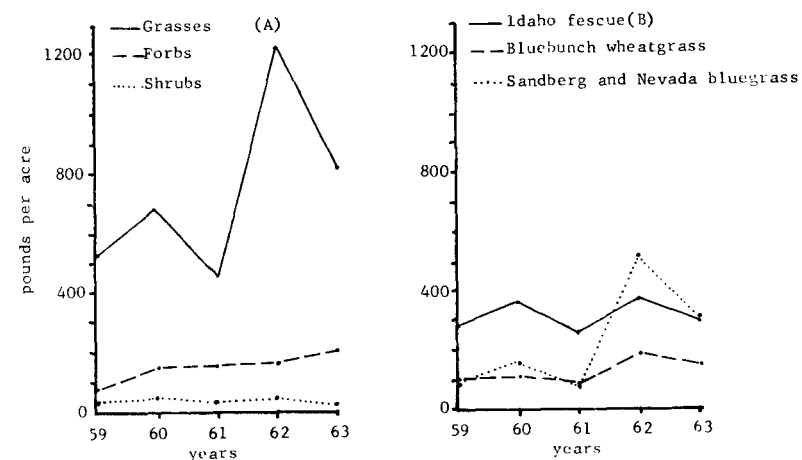


Fig. 9. Air-dry herbage production, Goodington silt loam (A) grasses, forbs, shrubs; (B) grass species.

Correlation coefficients of herbage production and various distribution periods of precipitation, calculated water balance and evapotranspiration and total water used in herbage production were calculated and are presented in Table 5. These coefficients are not conclusive because of the small sample and, therefore, their levels of significance were not determined.

Table 5. Correlation Coefficients Between Precipitation Periods\*; Calculated Water Available for Storage and Actual Evapotranspiration\*; Total Water Used in Herbage Production; and Total Air-Dry Herbage Yield (1959-1963).

| Factors correlated with herbage production | Coefficients |            |          |           |
|--------------------------------------------|--------------|------------|----------|-----------|
|                                            | Tetonia      | Goodington | Bancroft | All soils |
| Precipitation*                             |              |            |          |           |
| October-September                          | 0.75         | 0.72       | 0.55     | 0.60      |
| October-March                              | 0.93         | 0.95       | 0.97     | 0.87      |
| October-June                               | 0.94         | 0.87       | 0.91     | 0.65      |
| April-June                                 | 0.76         | 0.68       | 0.50     | 0.59      |
| Calculated*                                |              |            |          |           |
| Water available for soil storage (March)   | 0.81         | 0.87       | 0.95     | 0.80      |
| Actual evapotranspiration                  | 0.99         | 0.98       | 0.89     | 0.86      |
| Total water used in production of herbage† | 0.92         | 0.99       | 0.95     | 0.88      |

\* Based on climatic data, Craters of the Moon National Monument, 1958-1963.

† Includes water removed from the soil during the growing season and precipitation, April through June, at the Carey Kipuka.

## DISCUSSION

The total herbage production and species composition as determined by weight, fluctuate widely from year to year and between soil taxonomic units in the same year. It appears, however, that these fluctuations are not cumulative in altering the composition and production of natural plant communities. These findings are in agreement with Blaisdell (3) who reported that production and composition of natural vegetation fluctuate widely from year to year and over a period of years.

Characteristic plant communities for each of the three soils included in this study have been described in our preceding paper "Soil taxonomic units and potential plant community relationships in a pristine range area of southern Idaho."

Tetonia silt loam was the most productive soil, Bancroft silt loam was second, and Goodington silt loam was the least.

Herbage production of grasses and forbs fluctuates more widely than the production of shrubs and annuals. This is to be expected because grasses and forbs contribute a large percentage of total herbage than do shrubs and annuals.

Herbage yields of individual plant species varied considerably in degree of fluctuation from year to year and between the soil units. The yield of 2 shallow-rooted, early-maturing grasses, Sandberg and Nevada bluegrass, was especially erratic. These 2 grasses produced 7 times as much herbage on Bancroft in 1962 as they did in 1961. Moderately deep-rooted, later-maturing grasses, such as Idaho fescue and bluebunch wheatgrass, fluctuated much less in their annual production than did Nevada and Sandberg bluegrass and, therefore, are more dependable producers of herbage than the shallow-rooted species. Variation in the yield of individual plant species was not always consistent with variations in total yield. Environmental conditions that are favorable to the growth of one plant species during a specific year may be less favorable to the growth of another. This agrees with Blaisdell (3) and Arnold (2) who reported that specific weather conditions may be favorable to the growth of one plant species but unfavorable to another.

Correlation coefficients between total annual yield and different periods of precipitation over the five-year period indicate that precipitation during October through March has greater influence on yield than in other periods of the year (Table 5). These data agree with the work of Blaisdell (3) who found that precipitation during the nine months prior to the growing season influenced herbage yield more than precipitation during the growing season. Total herbage yield also appears to be correlated closely with the water available for soil storage at the end of March and water evapotranspiration during the growing season. Precipitation during the late fall and winter is stored in the soil and used by plants during the growing season when precipitation is usually inadequate for their needs. As expected, total herbage yield was directly related to total water used.

Soil taxonomic units differ in their ability to absorb, retain, and release water. As indicated in Table 5, the correlation between herbage yield and moisture storage and use for individual soils is higher than correlation between herbage yield and moisture factors for all soils.

At Craters of the Moon National Monument the precipitation in 1963 prior to the growing season was 7.27 inches and during

the growing season was 9.77 inches. Moisture content of the soil at the end of the growing season indicated that evapotranspiration during the growing season slightly exceeded precipitation. The moisture deficiency, however, was not great enough to affect plant growth, yet herbage yields on all 3 soils were less in 1963 than in 1962. The reduction was greatest on Bancroft silt loam that is on a 15% northern slope. Yield and soil moisture data indicate that lower temperatures along with reduced solar radiation probably inhibited plant growth in 1963. High herbage yields coincident with high temperatures in 1962 are additional evidence that temperature is an important factor in annual fluctuations in plant growth on the Carey Kipuka.

### SUMMARY

This study was conducted on an undisturbed range area located 25 miles northeast of Carey, Idaho. Total herbage yield and species composition of three natural plant communities growing on different soil taxonomic units with the same general climate were studied over a 5-year period, 1959 to 1963. Herbage yield and species composition were determined on a weight basis.

Annual yields of herbage and species composition varied considerably from year to year and between soils in the same year. Fluctuations in production and composition apparently are not cumulative and, consequently, do not permanently alter the plant community. Yields of grasses, forbs, shrubs, and annuals vary widely over the years, but yields of grasses and forbs fluctuate more than shrubs and annuals.

The degree of fluctuation in plant species varied from year to year for soils and for the plant species. Sandberg and Nevada bluegrass herbage production fluctuated widely and was not dependable, but Idaho fescue and bluebunch wheatgrass fluctuated considerably less and consequently were more dependable producers.

In addition to weather conditions, soil characteristics such as depth to impervious basalt, presence of restrictive clay horizons, and direction of soil slope influence the production and composition of natural plant communities.

Herbage production is closely correlated to precipitation during the six months preceding the growing season, to available water in the soil at the end of March, to actual evapotranspiration, and to the total water used in herbage production.

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