

Report of Study of Grassland Areas
of Badlands National Monument, South Dakota;
Fort Robinson Military Reservation in Nebraska;
North and South Units of
Theodore Roosevelt National Memorial Park, North Dakota;
and Wind Cave National Park, South Dakota

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by

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GENERAL RECOMMENDATIONS

I. Badlands National Monument

The White River Badlands constitute ¹one of the most famous deposits of the kind in the world. The fact that some 600,000 people visit the Badlands each year is sufficient evidence that the public is greatly interested in this area. Recommendations contained herein are based on the assumption that there is great interest in this area and that, first of all, this public interest should be protected and preserved wherever possible.

1. Public interest in the magnificence and beauty of the Badlands themselves should be continuously encouraged, but also, added points of attraction should be made available. It is suggested that areas of vegetation near the highways should be preserved and labeled in such a manner that the interested traveler may profitably stop for a look at the various plants (grasses and so called wild flowers) that catch his interest.

2. Erosion Control. Natural erosion is apparently very rapid, therefore, without a cover of vegetation, accelerated erosion on gentle slopes would be intense, indeed. It is recommended, therefore, that climax vegetation above and below the Great Wall be preserved in such a way as to allow vigorous growth and accumulation of mulch on the soil surface.

3. Foreground and Background. As the Badlands are approached, it would seem abrupt if there were no blanket of vegetation below and above the Great Wall to serve as a foreground or background. It is recommended that an area of grassland at least one mile in width from the badlands be preserved where possible.

4. Scientific Value. Interest in extensive scientific study of grasslands is relatively new. Great progress in this field has been made during the past 20 years and just now various national and state organizations are seeking ways

of having ungrazed grassland areas set aside so that long time studies could be initiated in order to gather more information on grassland potentials in respect to density, composition and yield.

It seems wise, therefore, to preserve good sized areas of each range site found on the Monument. These areas have been found and were given consideration in recommending a boundary for the Monument. Size could vary with possibilities. Large areas, however, have less border effect, therefore an area of 60 acres is better than one of 10 acres, for example.

If certain areas on various sites could be cut for hay and other areas grazed moderately to lightly, the results could be compared with similar areas that were ungrazed or heavily grazed.

5. Value to Livestock Production. The areas referred to in No. 4 could be used to determine proper stocking rates on various range sites. Unfortunately many of our rangelands are badly damaged through heavy grazing. There is much evidence to indicate that yield can easily be reduced to half potential by overuse. It would seem more helpful to livestock production if, rather than having more areas overgrazed, we might use a small portion of these areas on which to collect information that would be of value in working out a program of better range management. The proposed boundary has within it all the range sites found on the Monument.

6. Accessibility. Areas of good grassland were found in various locations on the Monument. Some, however, were potentially accessible to human travel but not to livestock utilization due to lack of water supply or other causes. This fact was given consideration in setting the proposed boundary.

7. Proposed Boundary (See red lines on map).

A. Sheep Mountain. The proposed extension is made for the following reasons:

1. Some of the most beautiful parts of the Badlands are found on Sheep Mountain Peak.
 2. Sheep Mountain has a good sized area of ungrazed inaccessible upland that is nearly climax. This is the best climax upland area found on the Monument.
 3. Sheep Mountain Table has a large area of ordinary upland site.
 4. The only sandy site found was on Sheep Mountain Table--it should be preserved.
 5. Sheep Mountain is relatively inaccessible to livestock.
- B. The north end of the Sand Site located in S26 T3S R16E has been heavily used in past years and, today, is quite disclimax. Farther south, however, range condition is considerably better. It is recommended, therefore, that sections 35 and 36 be included within the boundary of the Monument. NORTHWEST OF CASTELL
- C. Sage Creek Basin. This large basin has mostly clay and thin clay sites. It is felt that sufficient amount of these and other sites will be preserved within the proposed boundary.
- D. East end of Monument. If the boundary is set midway in Sections 8, 9, and 30 the badlands will be pretty well preserved and the vegetation given up seems not to be important to the Monument.

II. Fort Robinson Military Reservation.

The type of vegetation on this Reservation is fairly common to this section of the country. Proportionately, there is more sandy site and less ordinary upland site than is found on surrounding areas. These grasslands are important, however, and should be preserved so that they may be used for scientific and instructional purposes in the future.

It seems desirable to exclude grazing from areas representing each range site common in this section of the state. The remainder could be grazed and comparisons made with the ungrazed areas.

The areas excluded from grazing should be selected from locations most inaccessible to livestock utilisation. For example, west of Crawford, above the golf course is a sandy site which reportedly is not being used at this time. This would be a good sandy range site.

It was reported also that an ungrazed ordinary upland site is located on top of one of the buttes. This area would be a good one to keep ungrazed. Other sites could, doubtless, be found where their inaccessibility to livestock makes them more valuable as grassland preserves.

INTRODUCTION

The purposes of study at Badlands National Monument were:

(1) Concluding whether there are grassland areas within the Monument that are unique and sufficiently significant from a national interest viewpoint to warrant continued preservation in a national monument as well as to protect the foreground and background of the badlands wall and adjacent eroded slopes, and

(2) Assessing the grasslands in the National Monument from the standpoint of their importance to the economy of the over-all local livestock industry.

At Fort Robinson, the main objective was to conduct a study of grasslands in the Reservation to conclude whether the grasslands in this area or portions thereof are unique and sufficiently important to warrant their preservation.

The plan for study at Theodore Roosevelt Park and at Wind Cave Park was to make reconnaissance observations of grasslands in these areas and then compare the vegetation with the grassland types in the Badlands Monument to determine the general extent to which significant grass species in either or both of the parks duplicates those found in the national monument and, conversely, the extent to which significant grass species in Badlands National Monument are not found in Theodore Roosevelt National Memorial Park or Wind Cave National Park.

In order to accomplish the objectives of this study, it seemed desirable to make a fairly intensive analysis of the vegetation of Badlands Monument to determine

(1) What range sites are found on the Monument,

(2) Where, in general, the range sites are located on the Monument.

(3) Density, composition and recommended carrying capacities of each site.

(h) Accessibility and water supply for each general area in order to more accurately evaluate for Park or livestock purposes.

The study at Badlands Monument was carried out along the following lines:

- (1) Numerous square-foot areas were examined on each site to determine density and composition of vegetation.
- (2) Reconnaissance surveys were made on each site studied to determine
 - a. Pattern of growth of vegetation on each site.
 - b. Soil conditions on each site.
 - c. Relative abundance of main species of forbs.
- (3) Photographs were taken to show general vegetative features of range sites studied.

A reconnaissance survey of the Badlands Monument was made by Mr. Albertson during the week of July 20 to set up plans of procedure for the later visit. During the first week of August G. W. Tomasek and F. W. Albertson, both of the Botany Department, Fort Hays Kansas State College, Hays, Kansas, made intensive quantitative studies of the different range sites on Badlands Monument. Further work was done by Mr. Albertson during the second week in August and well into the third week on Badlands Monument and on other areas included in the study.

Mr. John Rutter, Superintendent of Badlands Monument, was most helpful in providing transportation and in helping collect data. Without his generous help, the study could not have been completed.

George F. Ingalls furnished transportation to Roosevelt and Wind Cave Parks and gave encouragement and suggestions generously.

Local personnel at each park were most willing to render assistance wherever possible.

VEGETATION ON THE BADLANDS NATIONAL MONUMENT

The approach to the Badlands from the north is on rolling upland with good cover of ordinary upland vegetation. Due to erosion, the topography breaks sharply to a depth of several hundred feet and then, the terrain levels off into slightly undulating flats (Fig. 1). Where the earth was protected with erosion-resistant material, precipitous, color banded, pinnacle-like structures were left standing alone in front of which are badly eroded dome-like hillocks (Figs. 2 and 3). Most of the actual badlands are nearly barren of vegetation. However, lower slopes and small tributary ravines are occupied by open or closed covers of grasses and forbs (Fig. 4). Here size of the area of vegetation is comparatively small.

Below the Great Wall and foothills lies a broad expanse of slightly undulating alluvial flatlands comprised mostly of clay and thin clay range sites. In some places on these flat areas where Tertiary deposits are great the soil is shallow (Fig. 5). Cover is open and the areas are designated as shallow or very shallow.

Carrying capacity for all range sites on Badlands Monument may be found by referring to tables 1, 2, or 3.

Ordinary Upland Sites

This range site is most typical on the higher land. Occasionally, however, it was found on the undulating flats below the wall where soil is sufficiently open to permit growth of mixed species of grass common to uplands (Fig. 6).

One area of upland vegetation on S12 T15 R16E was found on a series of isolated buttes extending out from the wall. Being inaccessible to

livestock; the vegetation on the buttes had not been utilized to any extent for many years (Fig. 7). There were no signs of grazing; there was, however, an old wagon trail clothed with vegetation, that crossed the buttes lengthwise. A layer of mulch 2-3 inches deep covered much of the area.

The higher locations (Basal cover 39 percent) and gentle slopes and flats (cover 20 percent), on this undulating upland, were each occupied by nearly the same species of grass but relative abundance was quite different. For example, on the former location blue grama (Bouteloua gracilis) and needle-and-thread (Stipa comata) formed over 60 percent of the grass cover and western wheat grass (Agropyron smithii) only 2.7 percent (Table 1). On the gentle slopes and clay flats, however, total of blue grama, and needle-and-thread was only 11.8 percent whereas wheatgrass constituted 61.5 percent. Buffalo grass (Buchloe dactyloides) and the grass-like threadleaved sedge (Carex filifolia) were also important constituents of the upland site. Green needlegrass (Stipa viridula) was widely scattered and was usually most abundant on the heavier soil. Small plants of sand dropseed (Sporobolus cryptandrus) were found in small open places on higher locations.

Grasses found in this area but not appearing in table were squirreltail (Sitanion hystrix), purple three awn (Aristida purpurea), prairie sandreed grass (Calamovilfa longifolia) and Indian rice grass (Oryzopsis hymenoides). The last two species were found only close to the breaks where there was considerable disturbance.

Blue grama often grew in bunches 6-8 inches in diameter. It was not uncommon to find bunches completely dead or dead in the center with live growth on the border of the bunch. Buffalo grass was often in pure stands 2-4 feet in diameter. Threadleaved sedge was widely scattered mostly in small tufts 2 to 6 inches in diameter.

Forbs (broad leaved herbaceous plants) most common to this upland area are given in Table 4. The exponent (1 to 5) at the right of the name indicates its abundance. For example the exponent "1" indicates the forb is very common, while at the other extreme, the rarely found species are given a number "5" rating. Exponents of "2", "3", and "4" apply to forbs with abundance between the two extremes of "1" and "5".

The area had a slightly weedy appearance due to a fairly wide distribution of Lactuca ludoviciana, Chenopodium lanceolatum, Lappula occidentalis, Bryonia japonica, Chamaesyce spp., Leontodon canadense, and Cryptantha crassicaulis.

Another ungrazed area located on S29 T43N R12E (Sheep Mountain) was sampled in a manner similar to the one just described. This area sloped gently to the south and east. It was bordered by an open stand of Juniperus scopulorum and J. virginiana which occupied the upper breaks (Fig. 8).

Amount of mulch (2-3 inches) was approximately the same as on the butte upland previously described. The growth of grass was vigorous. Basal cover of 25 percent was intermediate between that on the rolling upland and upland flats (Table 1). Over the whole area, blue grama grass averaged somewhat higher and western wheat and buffalo grass somewhat lower than on the former area. Carex pennsylvanica made up 5.2 percent of the grassy vegetation on this location. It was, perhaps, significant that the grasses were well mixed together on the Sheep Mountain area rather than growing in fairly pure stands as was found on the butte area. Little bluestem (Andropogon scoparius) was present in small amounts. Forbs found are given in Table 4. Weeds were common and of nearly the same species as given for the butte upland. Sheep Mountain Table, the upland approach to Sheep Mountain, was largely ordinary upland. This rather large area was grazed lightly and occupied by nearly the same species of grass as on Sheep Mountain (Fig. 9).

In order to more accurately evaluate these ungrazed areas, comparisons were made with similar sites with considerable utilization by livestock. One upland area, for example, north of the rim road on S2 T2S R15E had rolling topography very similar to that of the butte upland. Species composition of grass was nearly the same in both areas but relative abundance was vastly different (Fig. 10). In the first place cover on the rolling upland was increased from 39.2 percent on ungrazed areas, to 46 percent on the grazed locations (Table 1). Wheatgrass and blue grama held their own but needle-and-thread and threadleaved sedge disappeared almost completely. The other significant change was the increase of buffalo grass from 20.9 percent of composition in the ungrazed area to 62.6 percent in the one utilized by livestock. On the clay flats wheatgrass suffered considerably from grazing (Fig. 11). Here the amount of this species of grass was reduced from 61.5 percent composition on the ungrazed flat to only 21.9 percent on the utilized area. Blue grama grass nearly doubled its percent composition when utilized. Buffalo grass increased from 7.9 percent to 64.8 percent.

By comparing these data it can be seen that needle-and-thread is reduced greatly and western wheat grass slightly when grazed fairly heavily. Conversely the two short grasses, and particularly buffalo grass, increased significantly in percent composition when put under grazing pressure.

Number and variety of forbs were greatly decreased on this area in comparison to the butte upland.

A lightly utilized upland prairie lies northeast of Dillon Pass. On the higher places grasses range in the direction of the shorter species, but on the lower flat areas, wheatgrass again is dominant (Fig. 12).

Another rolling upland area was studied in Sage Creek Basin where there was evidence of heavy use in years past but more recently grazing had been

relatively light (Fig. 13). Here basal cover was only 28.0 percent (Table 1). Western wheatgrass comprised 16.6 percent of the grass cover. Blue grama was most abundant with 25.9 percent and buffalo grass only 14.5 percent. The slightly open textured soil apparently favored blue grama. Most significant was the return of needle-and-thread (4.5 percent) and threadleaved sedge (14.5 percent) from nearly complete absence on the grazed rim road upland. Further evidence of disturbance was found in the presence of 2.5 percent of false buffalo grass (Hesperis squarrosa).

Other upland areas were found where there was considerable sand (sandy site) to mostly sand (sand site). Both sites occurred on steep rolling topography.

Sandy Site

The ungrazed prairie was located on Sheep Mountain Table--528 Th3N R12E--a short distance east of Sheep Mountain prairie and at a slightly lower altitude.

Vegetation on this area was characterized by numerous isolated orange-yellow tufts of threadleaved sedge, blue grama grass, the long, shiny stems of needle-and-thread grass, good sized communities of the cane-like prairie sandreed (Calamovilfa longifolia) and the dark green mound-like plants of bush morning glory (Ipomoea leptophylla). See figures 14 and 15.

Basal cover was 25.6 percent, due mostly to the abundance of needle-and-thread and threadleaved sedge, with 51. and 28.4 percent respectively for the two species (Table 2). A layer of mulch covered most of the area. Blue grama and buffalo grass were restricted to only slightly over 8 percent of total cover. Prairie sandreed and western wheatgrass each comprised approximately 5 percent of total cover.

Forbs on this site are scarce and limited to a few species as shown in Table 1.

Data were collected also on a grazed sandy site near Scenic. It was significant that percent composition of blue grama increased from 7.3 percent on the ungrazed area to 54.3 percent where grazing was practiced. Equally important was the decrease in needle-and-thread from 51 percent on the ungrazed site to 15.8 percent on the one fairly heavily grazed.

The open cover with no mulch allows erosion to continue, consequently many of the tufts of grass had 1 to 2 inches of soil removed from around them.

Vegetation on this area was making good growth but the presence of weeds such as Russian thistle, annual sunflowers, ragweed, and lamb quarters gave it a weedy appearance. Forbs were much more abundant here than on the ungrazed location.

Sand Site

The sand site was found on top of a long butte a few miles north of Inlay on S26 T3S R14E. Portions particularly the north end of this long narrow area show considerable disturbance some time in past years. Remnants of an old farmstead were still in evidence. South from the farmstead where data were collected the vegetation was in excellent condition. Soil on the ridgelines (Fig. 16) and hillsides (Fig. 17) was somewhat more sandy than on the lower slopes and lowlands. Separate measurements, therefore, were made on each portion of the site.

Cover was relatively low especially on the ridgelines. Here needle-and-thread, prairie sandreed and sand dropseed (Sporobolus cryptandrus) with 52.1, 13.8, and 9.5 percent composition, respectively, made up about 75 percent of the cover (Table 2). Sand bluestem (Andropogon hallii), blue grama, two species of sedges (Carex filifolia and C. pauciflorus) and prairie June grass (Eriaria cristata) were present in smaller amounts.

On the lowlands with a little heavier soil, needle-and-thread and prairie sandreed relinquished some space to western wheatgrass and small increases in blue grama and sand bluestem. Forbs and weeds were abundant as indicated in Table 4.

Below the wall, a broad nearly level area of grasslands extend for several miles away from the breaks toward White River. On the higher areas are found the clay sites while on the broad shallow lagoon-like locations, the thin clay sites occur.

Clay Site

On a broad flat in Sage Creek Basin measurements were made on a clay site (Fig. 18). Basal cover was 27.4 percent (Table 3). Western wheatgrass, blue grama and buffalo grass, together, comprised over 94 percent of the total cover. Threadleaved sedge and green needlegrass made up the remainder of the grass cover. Most of the forbs were of the weedy type such as Helianthus annuus, Euphorbia marginata, Bromus jaceoides and Leptilon canadense.

Another high grade clay site was studied in order to make comparisons with the clay site in Sage Creek Basin (Fig. 19). This area was located on Conata Road S14 T3S R16E. The grass cover was much the same in both areas except in the Sage Creek Basin area occurred a small amount (3.8 percent) of green needlegrass whereas on the Conata Road area there was no green needlegrass but instead there occurred 8.1 percent of side oats grama (Bouteloua curtipendula).

Further comparisons were made on a fairly heavily grazed site south of Seaside on S3 T4S R13E. Here grazing pressure had favored growth of the short grasses to such an extent that blue grama and buffalo grass formed 70 percent of total cover (Table 3). Western wheatgrass was reduced from over 40 percent in the two other areas to only 15.8 percent on the grazed area.

Forbs and weeds are found in Table 3.

Thin Clay Site

One area studied was in Sage Creek Basin adjacent to the clay site. There are slight undulations in topography on this site and on the lowest places there occurs a nearly pure stand of western wheatgrass. The slightly higher locations, however, are occupied by a scattered cover of blue grama, buffalo grass and green needlegrass. Here the stand of wheatgrass is somewhat less than on the lower flats.

The cover is open (8.0 percent) and, on many bare spaces 12 inches across, the soil surface has a network of numerous drought cracks. On the whole area, western wheatgrass averaged over 93 percent of the total cover. Blue grama, buffalo grass, and green needlegrass, each with approximately 2 percent, formed the remainder of the cover (Table 3). Forbs were sparse (Table 4).

Another area on S15 T38 R16E near the Conata Road was studied (Fig. 20). The cover of 12 percent was the result of a slight increase in the percentage of blue grama (16.5 percent) and a corresponding decrease in wheatgrass which was 81.4 percent in comparison to 93.3 percent on the Sage Creek area (Table 3).

A more heavily grazed pasture on S35, T38, R 13E was sampled and compared with the other two lightly grazed areas. Basal cover was not changed significantly, but buffalo grass, with 1 and 2 percent composition on the lightly utilized areas, comprised 26 percent of total cover on this heavily grazed one (Table 3). Western wheatgrass decreased considerably when put under heavy grazing. No photo was taken in this area, but the one cited taken east of Balay is very similar (Fig. 21).

Lowland Site

Lowlands form a small amount of the vegetation in comparison to some of the other sites. One such area was studied on S26 T2S R15E (Fig. 22). Basal cover was 26.4 percent (Table 3). Greatest abundance was furnished by side oats grama (37.6 percent), little bluestem (23.4 percent), and western wheatgrass (11.0 percent). Blue grama with 8.7 percent composition, and buffalo grass (3.4 percent) occurred in local nearly pure stands. Prairie sandreed grass with 4.1 percent was fairly evenly scattered on the heaviest soils over the area. At the base of slopes there was a small amount of this species of grass.

Near this lowland sampled, on a slightly higher elevation, is a wide expanse of vegetation that lies between lowland and ordinary upland in composition. Cattle were found grazing on this area (Fig. 25). Another lowland area is shown in Fig. 26.

Forbs were fairly abundant as shown in Table 4.

Shallow Site

A shallow site located on S11: T2S R15E near Sage Creek Trail was studied (Figs. 23 and 24). The basal cover of 17.2 percent was somewhat patchy with fairly dense stands of blue grama and buffalo grass alternating with western wheatgrass (Table 2). Between are open spaces with little or no vegetation. The two short grasses comprised about 60 percent of the cover. Side oats grama, a sort of stranger on the Monument, was present with a percentage composition of 11.3. Western wheatgrass, needle-and-thread, threadleaved sedge, and prairie sandreed grass made up most of the remaining cover. It should be noted that little bluestem, found elsewhere only on Sheep Mountain upland and on the lowland, was present with 1.5 percent composition. Forbs were relatively abundant and represented by many species (Table 4).

Another area off the Monument on S35 T3S R17E was sampled for purposes of comparison. Basal cover and composition were very similar to the Sage Creek area except that needle-and-thread was present only in Sage Creek area and conversely sand dropseed was found only on the latter area.

Very Shallow Site

This site is found on relatively small areas with steep slopes and very low density of vegetation. Natural erosion is relatively high, leaving bunches of grass on mounds 2-4 inches high. The approximately 4 percent cover was comprised mostly of side oats grama and blue grama. Small amounts of sand dropseed also occurred.

FORT ROBINSON MILITARY RESERVATION

Most consideration was given to the east unit because of its large percentage of grassland composition in comparison to the west unit with a fairly dense stand of western yellow pine (Pinus ponderosa) and a few other evergreen and deciduous trees.

Sandy Site

By far the most extensive type on the east unit was the sandy site. One very lightly grazed area was found near Crawford just above the golf course (Figs. 27 and 28). Topography was gently rolling. Soil was fairly sandy with a nearly continuous thin layer of mulch. The most common grass found on this site was needle-and-thread which occurred in tufts 2 to 6 inches across. The tufts were 12 to 24 inches apart between which were numerous small bunches of blue grama, sand dropseed, and threadleaved sedge. Also, there were scattered bunches of red and purple three awn (Aristida longicoma and A. purpurea) on the gentle slopes. Buffalo grass was common on the ridgelines. The lower places on this site were occupied by western wheatgrass which shared dominance with needle-and-thread, sand dropseed, and big dropseed (Sporobolus asper).

Scattered plants of big bluestem (Andropogon gerardi), and sand bluestem (A. hallii) occurred in bunches 8 to 12 inches across many of which were dead in the center. Little bluestem dominated the ditches and sharp breaks and knolls. Prairie sandreed grass was also found in old ditches. Forbs as shown in Table 1 were similar to those found on the sandy site at the Badlands.

Two other sandy sites were examined and were found to be very similar to the one described above.

Ordinary Upland Site

This area lying southeast of headquarters, was on rolling topography with some places quite steep (Fig. 29). Soil was fairly coarse in texture with a relatively good cover of about 40 percent. The most important grasses were blue grama, needle-and-thread, buffalo grass in patches, and scattered stems of western wheatgrass.

Threadleaved sedge was very common in small tufts around which was considerable erosion. Purple three awn in occasional bunches was found. As upland grades off to the brow where terraces are formed, little bluestem becomes dominant. On the steeper slopes needle-and-thread grass becomes widely scattered. Even prairie sandreed grass is present in small amounts.

Forbs were common but inconspicuous. Those found are listed in Table 1.

Shallow and Very Shallow Sites

These sites occurred adjacent to each other (Fig. 30). Least rock outcrop and openness of cover was found on the shallow site. Here blue grama was most important with threadleaved sedge next in abundance. Needle-and-thread grass and purple three awn were common but widely spaced. None of the important grasses on the shallow site were found on the very shallow site. On the latter site, little bluestem was most common with occasional tufts of side oats grama, hairy grama (Bouteloua hirsuta), Fendler's, three awn

(*Aristida fendleriana*) and threadleaved sedge. Forbs were numerous especially in the very shallow soil.

Savannah Site

The west unit of Fort Robinson is occupied with a fairly heavy stand of western yellow pine (*Pinus ponderosa*) and other coniferous and broad leaved trees and shrubs (Fig. 31). In the open spaces between groups of trees was an open stand of grasses, chief among which were little bluestem, big bluestem, sand bluestem, side oats grama, *Carex* sp., and prairie sandreed grass. On the steep slopes very little mulch was allowed to accumulate due to fairly severe erosion. Away from the trees and on more level topography the grass cover was considerably greater than on the slopes and the soil was protected by a layer of mulch over much of the soil.

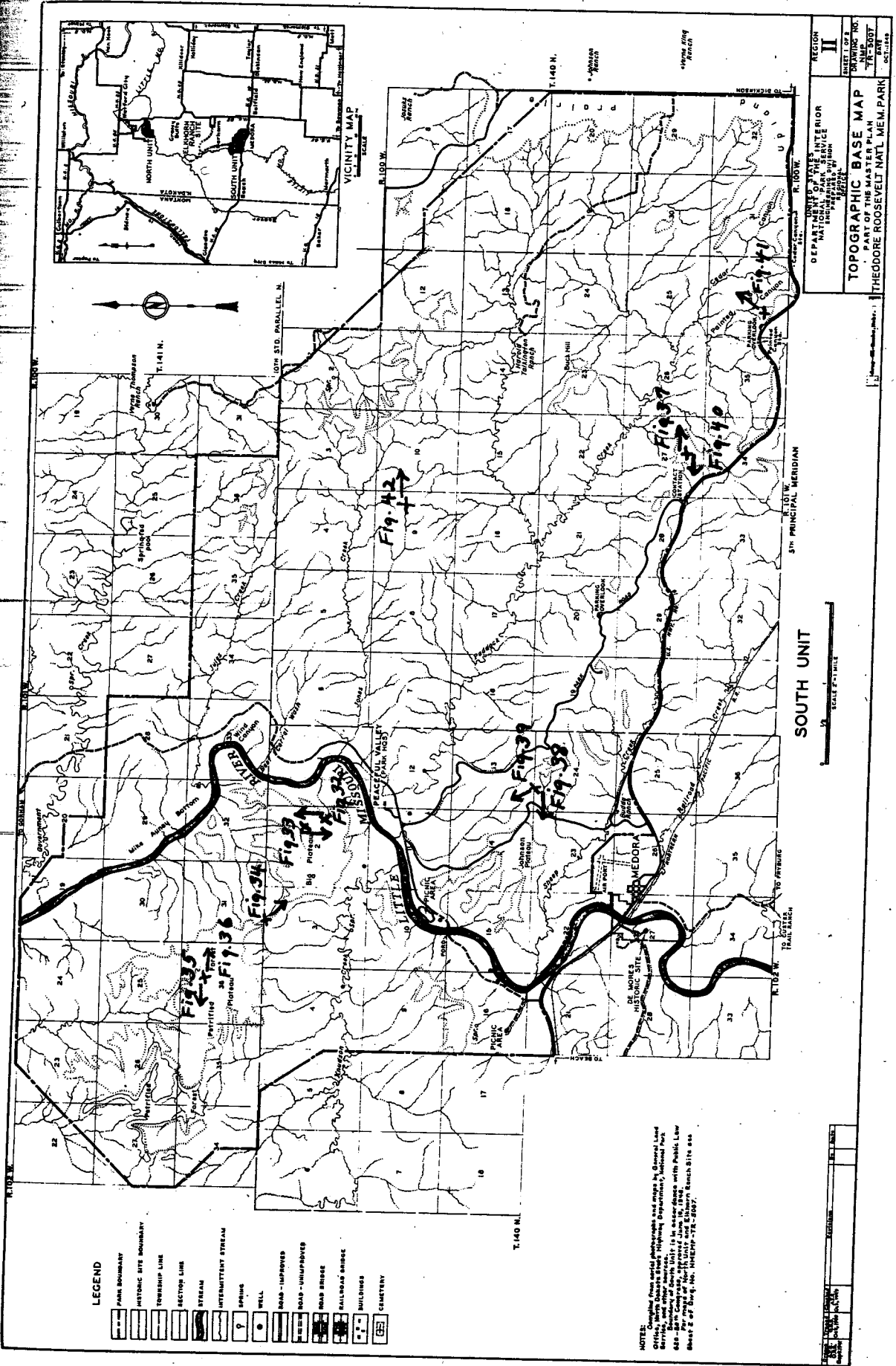
Where the stand of trees was greatest the understory of grasses and forbs was least. It was significant, however, that grasses formed a fairly continuous closed or open cover over much of the area.

The grassland area surrounding the Fort appeared to be mostly of the upland type and perhaps ordinary upland rather than sandy upland which formed most of the grasslands on the Fort. It should be noted that very little clay or thin clay was found on the Fort whereas they comprised the greatest area on the Monument.

THEODORE ROOSEVELT NATIONAL MEMORIAL PARK--SOUTH UNIT

Vegetation on Big Mountain Plateau and Petrified Forest Plateau, two fairly extensive uplands, was sampled and studied sufficiently to determine the cover and composition of grasslands away from the breaks.

The soil on Big Plateau was fairly sandy and the topography was slightly rolling (Figs. 32 and 33). Grasses were mostly needle-and-thread, green



LEGEND

- PARK BOUNDARY
- HISTORIC SITE BOUNDARY
- TOWNSHIP LINE
- SECTION LINE
- STREAM
- INTERMITTENT STREAM
- SPRING
- WELL
- ROAD - IMPROVED
- ROAD - UNIMPROVED
- RAILROAD BRIDGE
- MILLING
- CEMETERY

NOTE: Contour lines are based on topographic and maps by General Land Office, and other sources. The map is a reproduction of the 1907 map of the Theodore Roosevelt National Monument, which is in the public domain. The map is a reproduction of the 1907 map of the Theodore Roosevelt National Monument, which is in the public domain. The map is a reproduction of the 1907 map of the Theodore Roosevelt National Monument, which is in the public domain.

SOUTH UNIT



5th PRINCIPAL MERIDIAN

UNITED STATES	
DEPARTMENT OF THE INTERIOR	
BUREAU OF LAND MANAGEMENT	
TOPOGRAPHIC BASE MAP	
PART OF THE MASTER PLAN	
THEODORE ROOSEVELT NATL MEM. PARK	
REGION	II
SHEET 1 OF 2	
DRAWING NO.	
NAME	
DATE	OCT. 1948

needlegrass, blue grama and western wheatgrass. Threadleaved sedge was very common. Spot grazing was common and on the grazed areas blue grama and threadleaved sedge formed most of the cover. On lower places where soil was slightly heavier, western wheatgrass and green needlegrass were dominant.

Forbs as given in Table 4 were nearly the same on both areas.

On the slightly higher (than Big Plateau) Petrified Forest Plateau grazing was more intense (Fig. 34). The lower story was composed primarily of blue grama and threadleaved sedge. Needle-and-thread and western wheatgrass formed the upper story. Grazing pressure had increased the cover of 28.5 percent on Big Plateau to over 50 percent on the Petrified Forest area (Figs. 35 and 36). On another upland area with fairly open soil that had been very lightly grazed, needle-and-thread made up a fairly large portion of the grass cover (Fig. 37). Blue grama and threadleaved sedge formed a rather continuous understory.

Amount of vegetation on steep slopes varied considerably. On the more gently rolling topography, a fairly solid cover of grasses occurred (Fig. 38). Vegetative composition was not greatly different from that on the higher elevations. Often rather broad tributary ravines with gentle slopes were completely occupied with grasses (Fig. 39). Steep south-facing hillsides were sparsely populated with grasses and forbs, but slopes away from the sun were well clothed with a cover of blue grama, western wheat, both needlegrasses and small amounts of little bluestem, big bluestem, and wild rye grass (Elymus canadensis). It was also noted that mixed with the grasses on the north-facing slopes were numerous cedars (Fig. 40). The nearly solid cover of grasses on these rocky steep slopes was in sharp contrast to the nearly barren wall at Badlands National Monument. As the topography broke from the upland rather abruptly it extended into a series of foothills between which were broad, undulating valleys (Figs. 41 and 42).

Here the vegetation was formed of nearly the same species as on higher elevations, but there was generally less needle-and-thread and more western wheatgrass.

ROOSEVELT NATIONAL MEMORIAL PARK--NORTH UNIT

Topography at the north unit seemed to have steeper walls, fewer foot hills and a proportionately smaller amount of upland in comparison to the south unit (Fig. 43). Uplands were also more rolling than at south unit (Figs. 44 and 45). Much of the upland north of the Little Missouri River was in secondary succession after having been cultivated a number of years ago. South of the River, topography was steep and, to the west, the soil surface was covered with large rocks of glacial deposit (Figs. 46 and 47).

A basal cover of about 30 percent was comprised of blue grama, plains muhly (Muhlenbergia cuspidata), needle-and-thread, June grass (Koeleria cristata), prairie sandreed grass, little bluestem, big bluestem, western wheatgrass and threadleaved sedge. No buffalo grass was found on this park.

The steep walls were bare or sparsely clothed with vegetation (Figs. 48 and 49). Being relatively few foot hills, the cover of vegetation tended to stop at the top of the wall and begin again in the broad valley at the bottom of the wall. Where there are foot hills, the south-facing slopes are clothed with an open cover of grasses and forbs. The north-facing slopes, however, have an upper story of evergreens and an open understory of grasses (Fig. 50). There were some rolling clay flats in the foot hills with western wheatgrass as the dominant grass. Lowlands were fairly free of grazing, therefore, trees grew unmolested. Cottonwood, peach leaved willow and green ash were chief among the trees growing here.

Forbs are given on Table 4.



NORTH UNIT

NOTES: Compiled from aerial photographs and maps by General Land Office, National Park Service, and other sources.
Boundary of North Unit is in accordance with Public Law 831-80, approved June 30, 1948.
Boundary of Elk River Ranch is in accordance with Public Law 830-80 in Congress, approved June 30, 1948.
For map of South Unit see Sheet 1 of Dist. No. NHEXP-TR-5007.

Section	Block	Number	Page
100	100	100	100

UNITED STATES DEPARTMENT OF THE INTERIOR NATIONAL ENGINEERING SERVICE OFFICE OF REGIONAL OFFICE	REGION II	DRAWING NO. MAP TN-5687 DATE
SHEET 2 OF 2		
SCALE 1" = 1 MILE		
TOPOGRAPHIC BASE MAP PART OF THE W/STER PLAN THEODORE ROOSEVELT NAT'L MEM PARK		

WIND CAVE NATIONAL PARK

This area with fairly rough topography had comparatively little bare ground (Fig. 51). Chief among the grasses on the ordinary upland sites were blue grama, buffalo grass, threadleaved sedge, prairie June grass, red three awn, little bluestem and plains muhly (on rocky knolls), needle-and-thread, and western wheatgrass (Fig. 52). Growth was good but, near headquarters, grazing was severe. On the heaviest soil locations blue grama, buffalo grass, and threadleaved sedge became most abundant while on the sandy or rocky locations, the midgrasses were in control.

Along fairly steep slopes near where western yellow pine becomes abundant, the soil is shallow and cover is open (Figs. 53 and 54). Here were found little bluestem, big bluestem, hairy grama (Bouteloua hirsuta), blue grama, western wheat, prairie June grass, and red three awn. Little bluestem was by far the most abundant on these steep slopes, and possibly the most abundant for the whole park. This was in sharp contrast to what was found in the other areas.

Several lowland areas were observed (Fig. 55). Near headquarters, a fairly heavily grazed lowland was found to have a good cover of blue grama on knolls with needle-and-thread and western wheat as an upper story.

Near the east side of the Park on red Permian soils, particularly on a broad lowland, western wheatgrass and green needlegrass are most common (Fig. 56). Bunches of blue grama occur in small amounts around which is a mat of buffalo grass. Where the red soils leave off there is a rapid rise in topography of Tertiary material clothed with a fairly open stand of little bluestem, hairy grama, blue grama, and needle-and-thread (Fig. 57).

A large portion of the Park is populated with western yellow pine (Fig. 58). Beneath the pines is an open cover of grasses. In open spaces between communities of pines, the cover of grass is continuous and furnishes excellent grazing, particularly for elk. Conditions in these pine communities are much

the same as those found in the west unit at Fort Robinson area.

Forbs were quite common particularly on the ungrazed shallow site. It was interesting to note here the abundance of lead plant (Amorpha canescens) while elsewhere this palatable woody forb was greatly reduced in size and abundance by grazing. Other forbs are given in Table h.

COMPARISONS

Generally speaking, the most important grasses of the Badlands Monument were found also on all other areas studied. However, their relative importance and other conditions under which they grew varied considerably from one area to another (Table 5). Western wheat grass, blue grama, needle-and-thread grass and threadleaved sedge were all given a number "1" rating in every park but even so, the heavy soil on the extensive clay flats at Badlands Monument was so favorable to western wheatgrass, and blue grama that these grasses were much more common at Badlands than elsewhere. Conversely, the open soils at Roosevelt Parks and at Fort Robinson were ideal for dense stands of needle-and-thread grass.

Even the less common, though important, ones varied considerably. For example, buffalo grass rated a number "1" at Badlands, a number "2" at Wind Cave and at Fort Robinson but only a "4" and "5" respectively, at south and north Roosevelt Parks. In fact, buffalo grass was not found at North Roosevelt. Much the same could be said of little bluestem for at Wind Cave Park it was by far the most common grass whereas a "3" or "5" was the highest rating at other locations.

Some species of grass such as prairie sandreed were scattered widely though never abundant.

Differences in parent materials at Badlands Monument in comparison to those at other areas have resulted in great differences in topography and type of soil. For example, the soils at Badlands Monument were formed from an

unconsolidated highly-erodible clay-like material whereas at the other locations parent material was mostly some form of rock.

Rapid erosion on the Monument has left steep cliffs with sharp or dome-shaped tops that stand at considerable distance from where erosion began. As the cliffs move back they leave before them nearly level areas that now form the important clay and thin clay sites.

On the other areas, soil-forming processes and erosion have evidently proceeded more slowly; consequently, topography is less steep and the soil is proportionately more sandy than on the Monument. These variations have resulted in considerable differences in growing conditions for the various species of grass.

Relative importance of range sites in different parks was significant. For example, ordinary upland (OU) was given top rating at Wind Cave and at Roosevelt Parks but only a "2" and "3" respectively at Badlands Monument and at Fort Robinson (Table 6). Sandy site (Sy) rated a "1" at Fort Robinson but nothing higher than a "4" elsewhere. Clay sites were not important anywhere except Badlands Monument. Other comparisons may be made by referring to Table 6.

These comparisons, though brief, are sufficient, it is hoped, to indicate that variations in parent material, type of soil, topography and even distance apart are great enough to warrant the preservation of all areas reported on in this study.

Table 1. Basal cover, percent species composition of grasses, and carrying capacity on ungrazed ordinary upland (mesa and sheep mountain), and grazed upland sites on Badlands National Monument.

Location	Mesa		Sheep Mt. upland	Grazed Rolling Upland	Grazed gentle slopes	Heavily grazed in past. Now lightly grazed
	Rolling	gentle slopes				
	S12 T38 R16E	S12 T38 R16E	S32 T43N R14W	S2 T28 R15E	S2 T28 R15E	W. of Sage Creek Pass
Basal Cover	39.18	20.70	25.24	46.00	33.25	28.14
Western wheatgrass	2.70	61.50	19.30	3.50	21.95	16.59
Blue grama	31.60	6.00	36.10	32.50	11.63	25.91
Needle-and-thread	28.80	5.80	26.20	—	—	4.55
Threadleaved sedge	8.70	14.50	5.00	0.33	—	14.55
Buffalo grass	20.90	9.10	2.40	62.63	66.30	22.50
Purple threeawn			1.10			
Pennsylvania sedge			5.20	0.63	0.12	
Sand dropseed	0.10		1.50			11.36
Plains muhly			0.60			
Little bluestem			1.80			
Green needlegrass	6.70	1.40	0.50			
Six-weeks fescue				0.13		1.59
False buffalo grass						2.50
Little barley						9.45
Japanese brome	0.50	1.60	1.00			
Carrying capacity AUM per acre	.60	.60	.60	.20	.20	.30

Table 2. Basal cover, percent species composition of grasses, and carrying capacity of sand, sandy, shallow, and very shallow sites on Badlands National Monument.

Location	Sandy		Sand		Shallow	Very Shlw.
	Excellent	Grazed	Hillside and Ridge	Lowland		
	S28 TL3N R11W Sheep Mt. Table	2 mi. W. of Scenic	S28 T38 R11E	S28 T38 R11E	S1 T2S R15E Sage Crk. Trail	S35 T3E R17E S35 T3E R17E
Basal cover	25.60	20.53	10.78	13.96	17.17	19.61 3.91
Blue grass	7.29	51.33	5.00	7.10	15.00	36.12 15.29
Needle-and-thread	51.00	15.83	52.12	35.52	7.50	
Western wheatgrass	1.13	1.67	—	20.83	9.17	20.51
Buffalo grass	0.71	0.67	—	—	16.67	16.91
Prairie sandreed	5.00	1.17	13.00	19.21	2.83	2.15
Threadleaved sedge	21.13	20.51	2.13	—	3.17	0.20
Green needlegrass	—	—	—	—	1.00	—
Side-oute grass	—	—	—	—	11.33	18.57 50.12
Little bluestem	—	—	—	—	1.50	—
June grass	—	—	3.25	1.56	1.67	—
Sand dropseed	2.89	2.50	9.50	6.91	—	1.29 1.29
Sand bluestem	—	—	5.00	10.12	—	—
Pennsylvania sedge	—	—	5.00	6.15	—	—
Plains silky	—	—	—	—	0.67	—
Purple three man	—	—	2.50	—	0.50	0.51
Slender rush	—	—	2.50	—	—	—
Scribner's panicgrass	—	—	—	0.52	—	—
Japanese brome	—	0.33	—	0.52	—	—
Salt grass	—	—	—	—	—	0.11
Carrying capacity AIM per acre	.60	.30	.50	.50	.50	.50 .10

Table 3. Basal Cover, percent species composition of grasses, and carrying capacity of clay, thin clay, and lowland sites on Badlands National Monument.

Location	Clay			Thin Clay			Lowland
	Excellent	Excel.	Grass	Excellent	Excel.	Grass	
	Sage Cr. Basin	S15 T38 R16E	S35 T38 R13E	Sage Cr. Basin	S15 T38 R16E	S15 T38 R13E	
Basal cover	27.36	27.32	27.53	8.03	12.00	11.20	26.45
Blue grass	27.00	30.90	39.50	2.67	16.50	9.20	8.75
Western wheatgrass	16.20	41.60	15.83	93.33	81.40	55.80	14.00
Buffalo grass	21.20	17.50	30.50	2.00	1.00	28.00	3.37
Prairie sandreed	-----	-----	-----	-----	-----	-----	4.13
Threadleaved sedge	1.80	0.50	10.83	-----	-----	-----	0.37
Green needlegrass	3.80	-----	-----	2.00	0.90	2.80	0.88
Side-oats grama	-----	8.10	-----	-----	-----	-----	37.50
Little bluestem	-----	-----	-----	-----	-----	-----	23.30
June grass	-----	-----	-----	-----	-----	-----	1.75
Sand dropseed	-----	0.40	0.33	-----	-----	-----	4.-----
Prairie dropseed	-----	-----	-----	-----	-----	-----	2.25
Switch grass	-----	-----	-----	-----	-----	-----	0.25
Plains milky	-----	-----	-----	-----	-----	3.80	3.37
Purple three awn	-----	0.50	-----	-----	-----	-----	-----
Tumblegrass	-----	0.40	1.67	-----	-----	3.10	-----
Squirrel tail	-----	-----	1.33	-----	-----	-----	-----
Carrying capacity AHE per acre	.60	.60	.25	.50	.50	.25	.80

Table 1. List of forbs found in the various areas. At Badlands Monument forbs found are listed under range sites sand (Sa), sandy (Sy), shallow (Sw), very shallow (Vs), clay (Cl), thin clay (Tc), ordinary upland rolling On/R, and flat On/R, lowland (Lo). Forb counts on other areas were made on upland sites, some fairly heavy soil or sandy. If a species was numerous it was indicated by a figure "1" in the proper column. If very scarce, it was indicated by a figure "5" in the column. Figures "2", "3", and "4" were used to indicate abundance between the two extremes.

Names	Badlands Monument								Wind Cave Upland	Ft. Robinson sandy upland - atypical	Roosevelt South Upland	Roosevelt North Upland
	Sa	Sy	Sw	Vs	Cl	Tc	On R	Lo				
<i>Acerates viridiflora</i>		5										
<i>Achillea</i> , spp.									4			
<i>Allionia linearis</i>	5						5	5	4			
<i>Antrosia elatior</i>					1							
<i>Antrosia psilostachya</i>	2	1				1				4		
<i>Amorpha canescens</i>									1			
<i>Argemone intermedia</i>		1										
<i>Artemisia cana</i>	5						4	1				
<i>Artemisia dracunculoides</i>	4	1							1	5	1	1
<i>Artemisia filifolia</i>	1									1		
<i>Artemisia frigida</i>	4	1	4			4	1		1	5	1	2
<i>Artemisia gnephaedoides</i>	1	2					3		1	5	3	2
<i>Asclepias pusilla</i>		4					2		3	2		
<i>Aster multiflorus</i>	1	2	3		5		3	3	1	1	1	
<i>Aster oblongifolius</i>									2		5	
<i>Astragalus gracilis</i>										4		
<i>Astragalus latiflorus</i>						5						
<i>Astragalus missouriensis</i>		5			5							
<i>Astragalus racemosus</i>			1									
<i>Astragalus triobolus</i>									2			

Names	Badlands Monument										Wind Cave Upland	Ft. Robinson Sandhollow Upland	Roosevelt South Upland	Roosevelt North Upland
	Sa	Sy	Sw	Vs	Cl	Tc	Ou		Lo					
							R	F						
Astragalus spp.							h							
Atriplex canescens				3										
Atriplex hastata			h	h		h								
Baptisia spp.														5
Chamaesyce, spp.		h					h	h						
Cheirinia aspera										3				
Chenopodium album											h	5		
Chenopodium lanceolatum	1	3				h	h	3						
Chrysopsis villosa	1	1								1		h	1	
Cirsium undulatum		1	5				h			5		5		
Cleome serrulata		h												
Comandra pallida			2	3						1	2			
Cryptantha crassiseptala	h	2				h	h							
Delphinium virescens							5							
Echinacea angustifolia										1	3	h	2	
Eriogonum annuum	h	5								5	h			
Eriogonum multiceps			3	1										
Euphorbia marginata					1									
Evax prolifera			h											
Evolvulus pilosus											2			
Gaura coccinea	h	h			5		3	2	5					
Gilia congesta		h	h				5			5				
Glycyrrhiza lepidota			1						1					
Grindelia squarrosa		3			1				5					
Gutierrezia sarothrae			1	1	5					2	5			

Names	Badlands Monument									Wind Cave Upland	Ft. Robinson sandy ordinary upland	Roosevelt South Upland	Roosevelt North Upland
	Sa	Sy	Sw	Vc	Cl	To	On		Lo				
							R	F					
<i>Hedeoma hispida</i>		1							h			3	
<i>Helianthus annuus</i>					1	1	h				h		
<i>Helianthus petiolaris</i>	2	1											
<i>Helianthus rigidus</i>										h		3	3
<i>Ipomoea leptophylla</i>	3	1								h	3		
<i>Rubia glutinosa</i>		5	2				2	5		2			
<i>Lactuca ludoviciana</i>							3	h					
<i>Lactuca pulchella</i>							3						
<i>Lappula</i> spp.							3	3					
<i>Lepidium densiflorum</i>							h					5	
<i>Leptilon canadense</i>		5			h	h	h	3				5	
<i>Lesquerella</i> spp.		h		h									
<i>Liatris punctata</i>		2	2				5			2	3	2	
<i>Linum compactum</i>			3		3	3	3						
<i>Lithospermum linearifolium</i>	5	h								5	5		
<i>Lygodesmia juncea</i>		1								1		h	
<i>Malvastrum coccineum</i>	1	1	1		1	1	1	1		1	1	1	
<i>Mentzelia stricta</i>	h												
<i>Meriollis serrulata</i>										h	5		
<i>Hamillaria vivipara</i>										1			
<i>Oenothera</i> spp.		h											
<i>Opuntia fragilis</i>											1		
<i>Opuntia humifusa</i>	1	1			3					2	5		
<i>Opuntia polyacantha</i>	1			1	5	3	2						
<i>Ostrya lambertii</i>	5									h	3		5

Names	Badlands Monument										Wind Cave	upland	Ft. Robinson	Sioux	upland	Roosevelt	South upland	Roosevelt	North upland
	Sa	Sy	Sw	Vs	Cl	Tc	Ca	F	Lo										
<i>Paronychia sessiliflora</i>			4	3								4							
<i>Parosela enneandra</i>			1						1										
<i>Pentstemon albidus</i>		1										2	5	5				2	
<i>Petalostemon candidus</i>			1																
<i>Petalostemon purpureus</i>				1					5		1	5	4						
<i>Physalis lanceolata</i>	1																		
<i>Plantago purshii</i>					3	3			5		4	5							
<i>Polygala verticillata</i>			3																
<i>Potentilla</i> spp.											5					5			
<i>Psoralea argophylla</i>	2	3					4		1		5	5	4					2	
<i>Psoralea cuspidata</i>			3				5		1										
<i>Psoralea esculenta</i>							4											4	
<i>Psoralea lanceolata</i>	2	1																	
<i>Psoralea tenuiflora</i>	5	1	1			5					1	1							
<i>Ratibida columnaris</i>		3	3		5				4		5	5							
<i>Ratibida tagetes</i>							3									4			
<i>Salsola pestifer</i>		5																	
<i>Sideranthus spinulosus</i>	2	4				2	1				4	1	3						
<i>Solidago glaberrima</i>											5	5							
<i>Solidago mollis</i>	3		4						3							3		3	

*It is obvious that for various reasons many species of forbs were missed. Those listed are the ones most conspicuous when the survey was made.

Table 5. List of important grasses found on various areas. If a species was very abundant it was indicated by a figure "1" in the proper column. If very scarce, it was indicated by a figure "5" in the column. Figures "2", "3", and "4" were used to indicate abundance between the two extremes.

Location	Asm*	Bgr	Sco	Cfi	Bda	Clo	Bcu	Svi	Asc	Age	Aha	Alo & Apu	Scr	Hcu	Kcr
Badlands	1	1	1	1	1	2	3	2	4	4	4	2	3	5	5
FT. Robinson	1	1	1	1	2	3	3	4	3	4	4	2	3	5	5
South Roosevelt	1	1	1	1	4	3	3	2	3	4	5	4	3	5	3
North Roosevelt	1	1	1	1	5	2	4	4	3	4	5	5	3	1	2
Wind Cave	1	1	1	1	2	4	3	4	1	2	5	3	2	2	5

*Western wheat (Asm), Blue grama (Bgr), Needle-and-thread (Sco), Threadleaved sedge (Cfi), Buffalo grama (Bda), Prairie sandreed (Clo), Side oats grama (Bcu), Green needlegrass (Svi), Little bluestem (Asc), Big bluestem (Age), Sand bluestem (Aha), Red and purple threeseed (Alo & Apu), Sand dropseed (Scr), Plains waily (Hcu), Juno grass (Kcr).

Table 6. List of range sites found on various areas. If the site was important it was given a rating of "1". If unimportant it was rated "5". Figures "2", "3", and "4" were assigned to sites with importance between "1" and "5". The figure "0" indicates the site was not found.

Location	OU*	Sy	Sa	Cl	TC	SW	VS	SS	Lo
Badlands Natl. Mon.	2	4	3	1	2	2	3	5	4
Ft. Robinson	3	1	5	5	0	4	4	1	4
South Roosevelt	1	4	0	4	5	4	4	3	4
North Roosevelt	1	4	0	4	0	4	4	2	2
Wind Cave	1	0	0	3	5	2	3	2	3

* Ordinary upland (OU), Sandy (Sy), Sands (Sa), Clay (Cl), Thin Clay (TC), Shallow (SW), Very Shallow (VS), Savannah site (SS), Lowland (Lo).

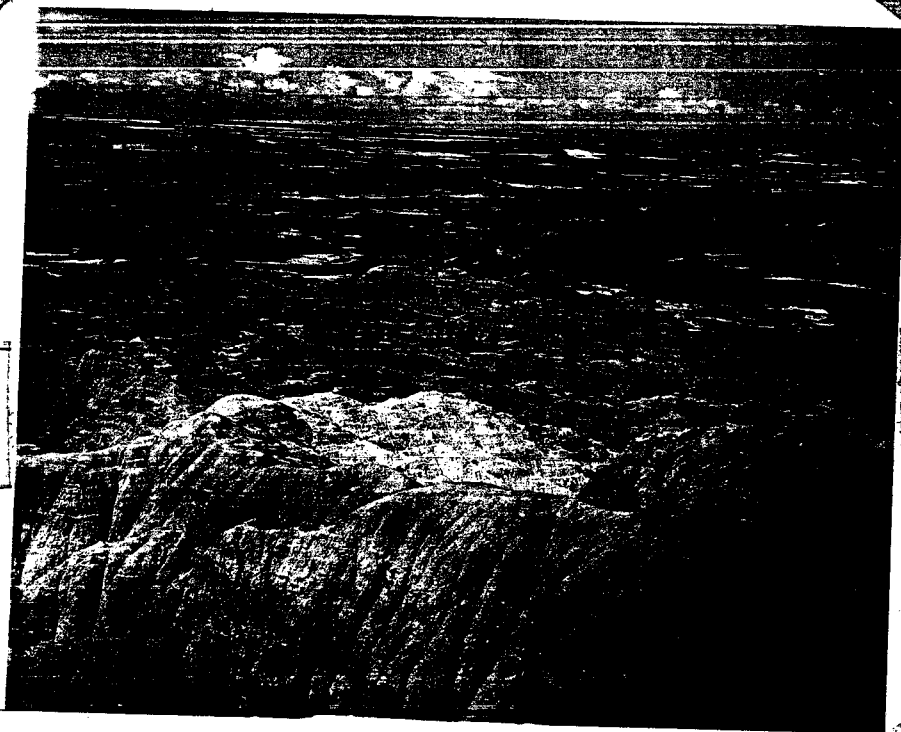


Fig. 1 The barren wall in foreground and the level clay flats (dark areas) several hundred feet below. West of Pinnacles on Sage Creek. Badlands Monument, Aug. 21, 1953

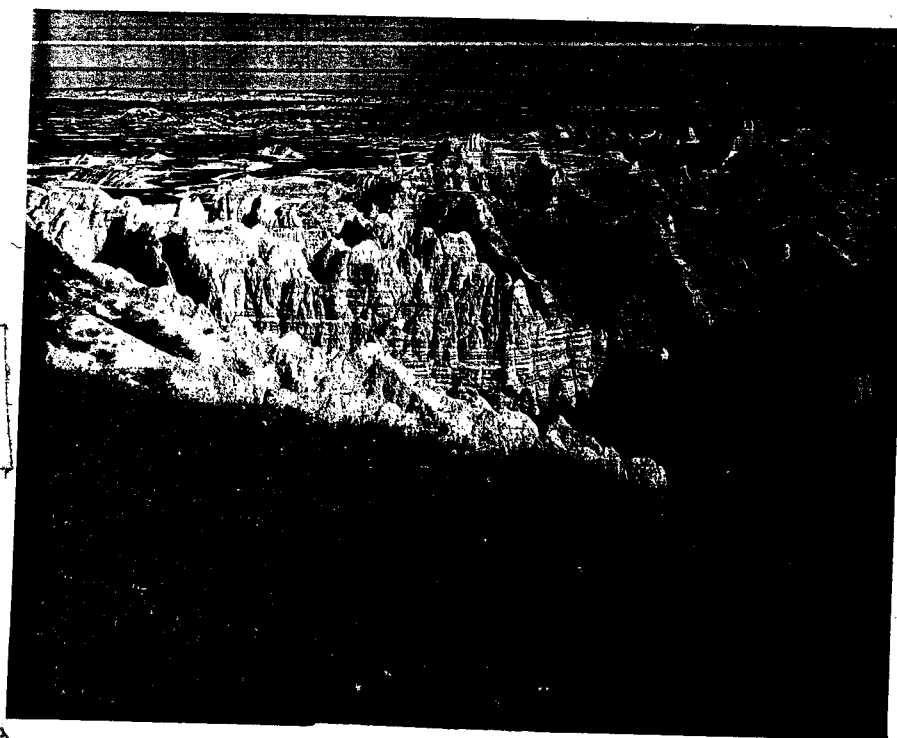


Fig. 2 Upland vegetation in front, sharp Pinnacles in center with clay flats in the distance. Badlands Monument, Aug. 7, 1953

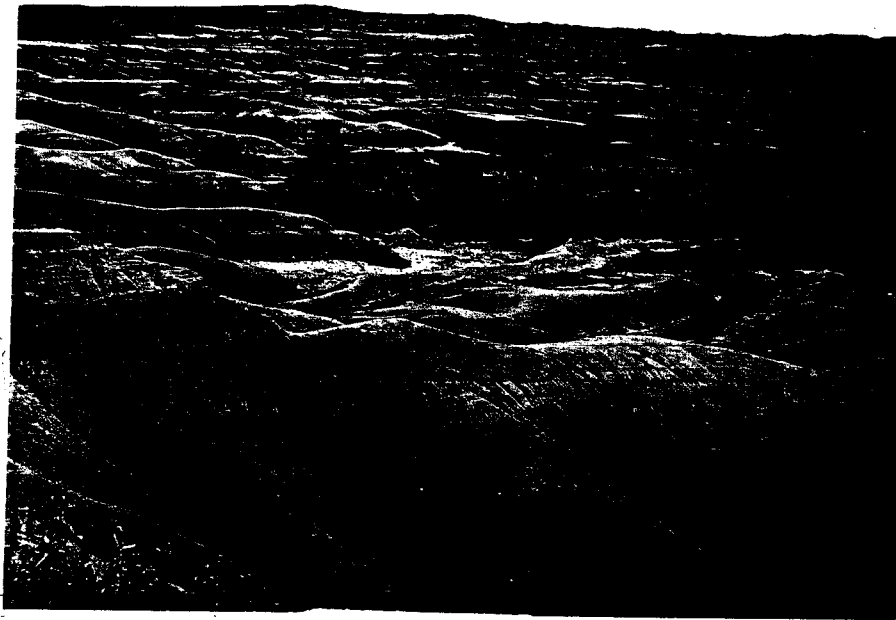


Fig. 3 Dome like hillocks in front and on left, shallow pits (center, right) and clay flats (far right). From rim road several miles west of Pinnacles.

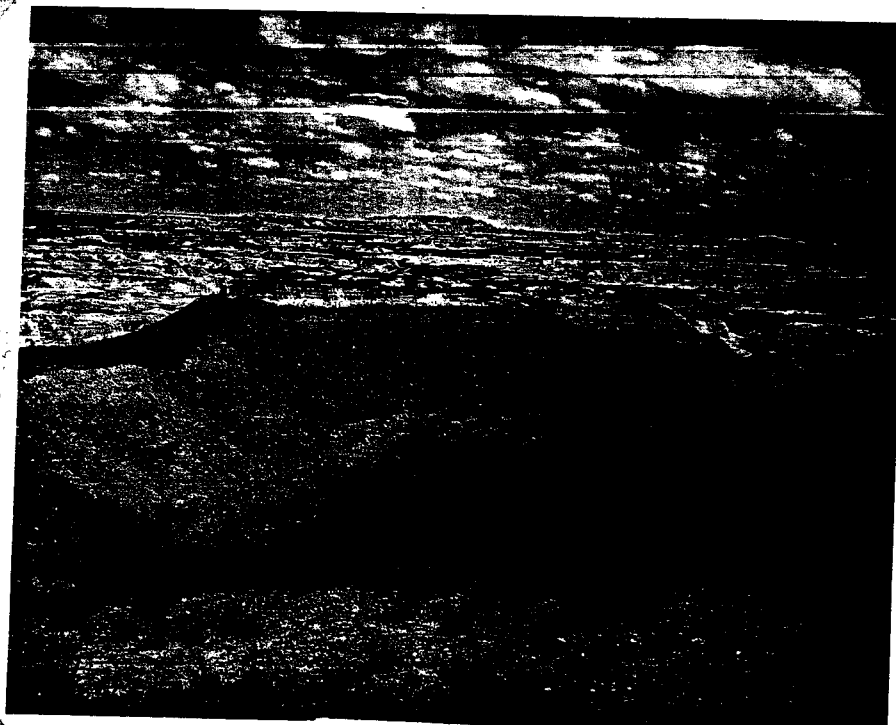


Fig. 4 Small areas of vegetation in foot hills of wall. Badlands Monument, Aug. 4, 1953



Fig. 5 In areas where there are Tertiary deposits the soil is very shallow (front), but on level areas the soil is clay, with mostly, a cover of western wheat grass. Badlands Monument, Aug. 11, 1953



Fig. 6 South of Hwy 16A on Corral Road looking at Pinnacles in distance with cactus and short grasses in front and upland vegetation on low buttes. Badlands Monument, Aug. 11, 1953

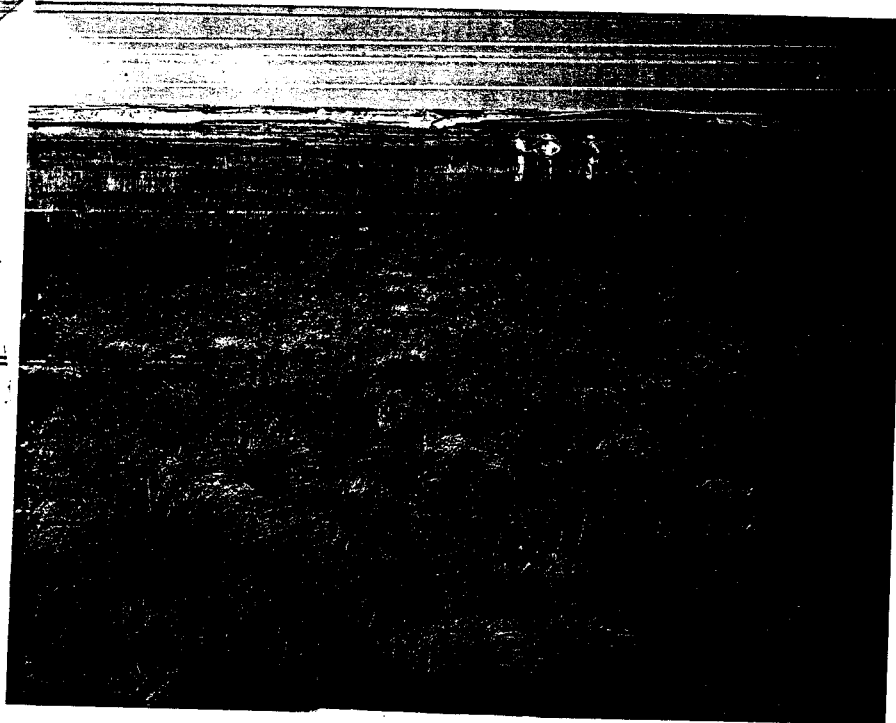


Fig. 7 Ordinary upland site on long buttes extending out from wall. This area is inaccessible to livestock. Badlands Monument, Aug. 11, 1953

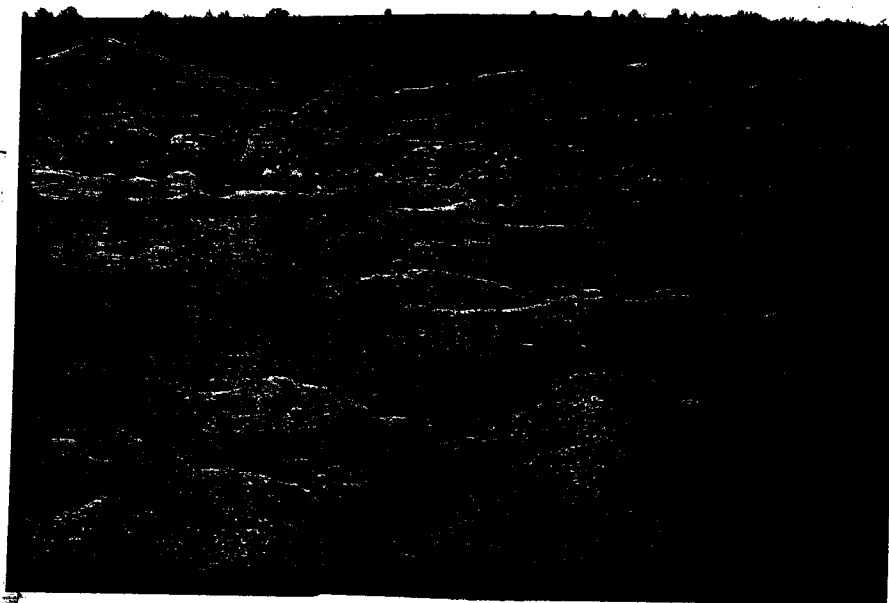


Fig. 8 West across badlands from sheep mountain Table at ungrazed upland vegetation on sheep mountain. Badlands Monument, Aug. 16, 1953

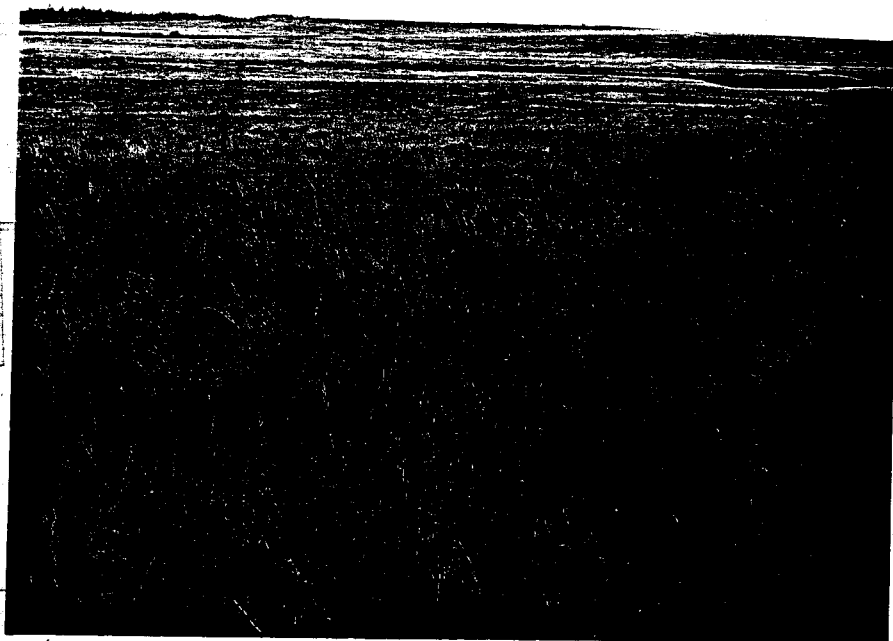


Fig. 9 West from road at upland vegetation on Sheep Mountain Table, Badlands Monument, Aug. 7, 1953

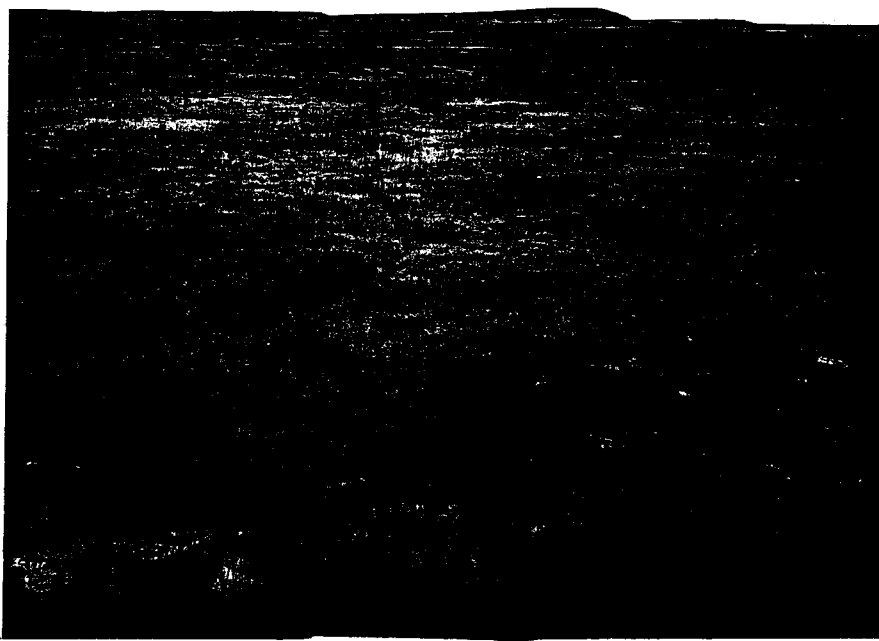


Fig. 10 Heavily grazed ordinary upland area north of rim wall. Nearly all western wheatgrass is gone and blue grass, and buffalo grass have come in. Badlands Monument, Aug. 8, 1953



Fig. 11 On upland clay flats grazing greatly reduces western wheat grass (dark) and buffalo grass (light) increases. Badlands Monument, Aug. 8, 1953

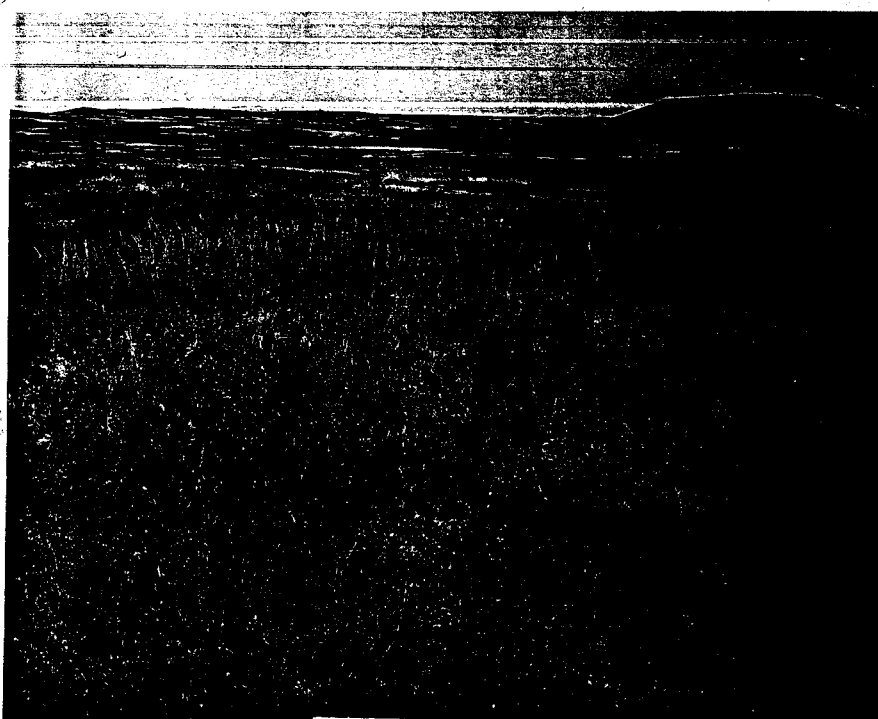


Fig. 12 On an upland site northeast of Dillon, Mont., the grasses and needle-and-thread occupy the higher locations but on the lower level areas western wheat grass is dominant. Badlands Monument, Aug. 11, 1953



Fig. 13 East at ordinary upland in Sage Creek Basin. Has been heavily used in past years but now it is lightly grazed. Badlands Monument, Aug. 5, 1953



Fig. 14 Sandy site on Sheep Mountain Table. Not shown in photo is a lower story of threadleaved sedge, and blue grama grass. Much of the cover is needle-and-thread, (shiny stem), and (prairie sandreed (communities of taller grasses) and bush morning glory (dark bunches). Badlands Monument, Aug. 7, 1953



Fig. 15 West from sandy site on Sheep Mountain Table, at ungrazed upland on Sheep Mountain (along skyline). Badlands Monument, Aug. 7, 1953



Fig. 16 Along ridgeline on sand site. The open cover is composed mostly of needle-and-thread, blue grama, prairie sandreed, and others. The large bushy plants are sand sage. Badlands Monument, Aug. 7, 1953



Fig. 17 Along hillside and across lowland in Sand site.
Badlands Monument, Aug. 7, 1953



Fig. 18 North up Sage Creek Basin at Clay Flats from west of
Sage Creek Pass. Badlands Monument, Aug. 5, 1953

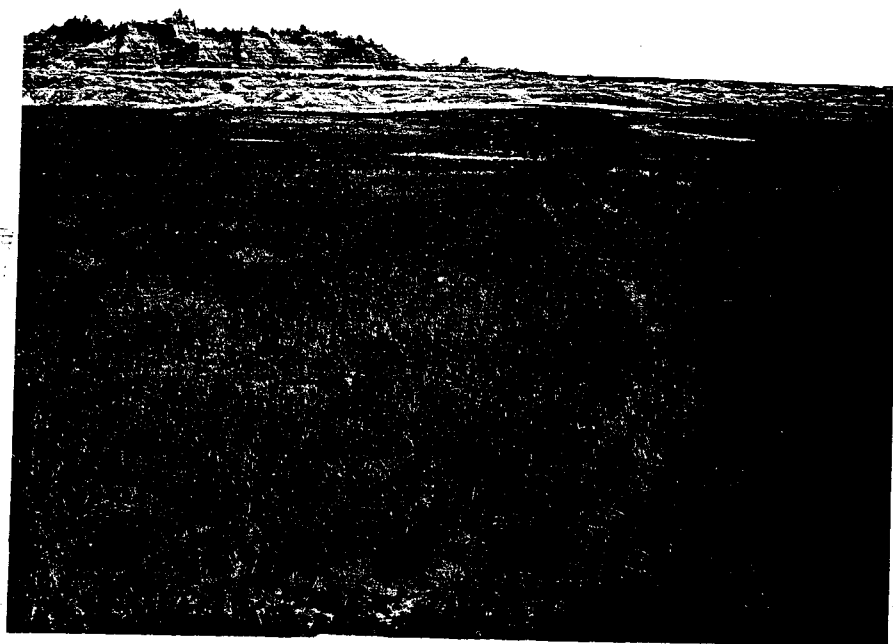


Fig. 19 Across Clay Flats at upland vegetation on gentle slopes at foot of Norbeck Peak. Clay Flats are mostly western wheatgrass. Badlands Monuments, Aug. 4, 1953

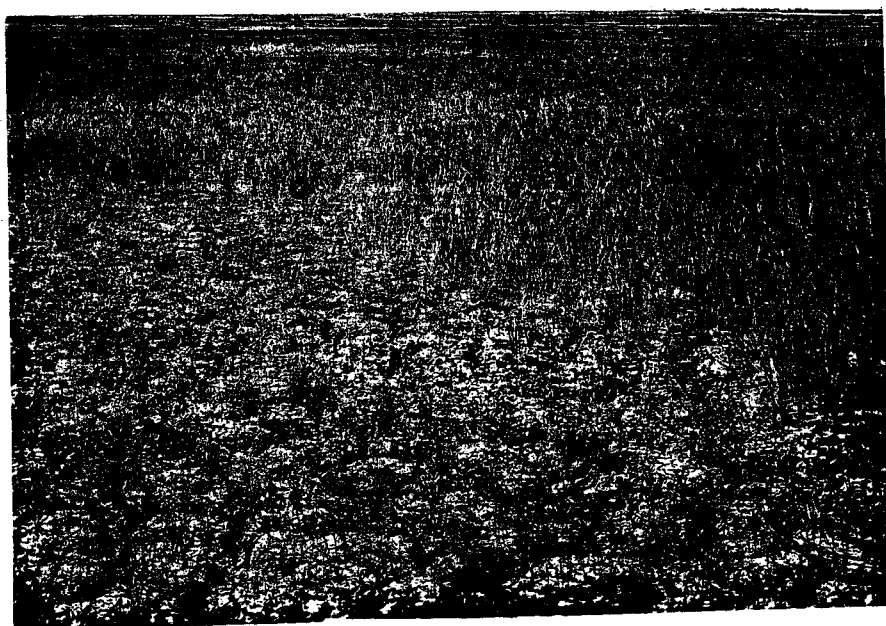


Fig. 20 Across thin clay site on Clay Flats below the wall. Drought cracks in clay (front) with thin stand of western wheatgrass. Badlands Monument, Aug. 5, 1953



Fig. 21 Thin clay site heavily grazed. Here the wheatgrass (dark areas) suffered from grazing and buffalo grass (light areas) made enormous gains. Badlands Monument, Aug. 7, 1953

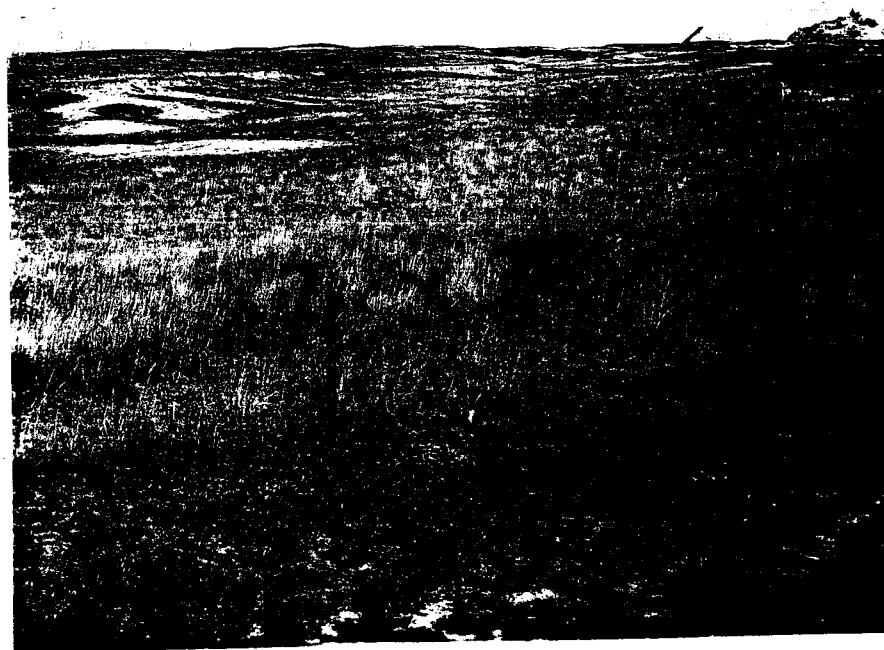


Fig. 22 Up lowland in Sage Creek Basin. Blue grama in front, side oats grama at left, middle (tall) and little bluestem (right) near Rutter and Tomarok. Badlands Monument, Aug. 5, 1953

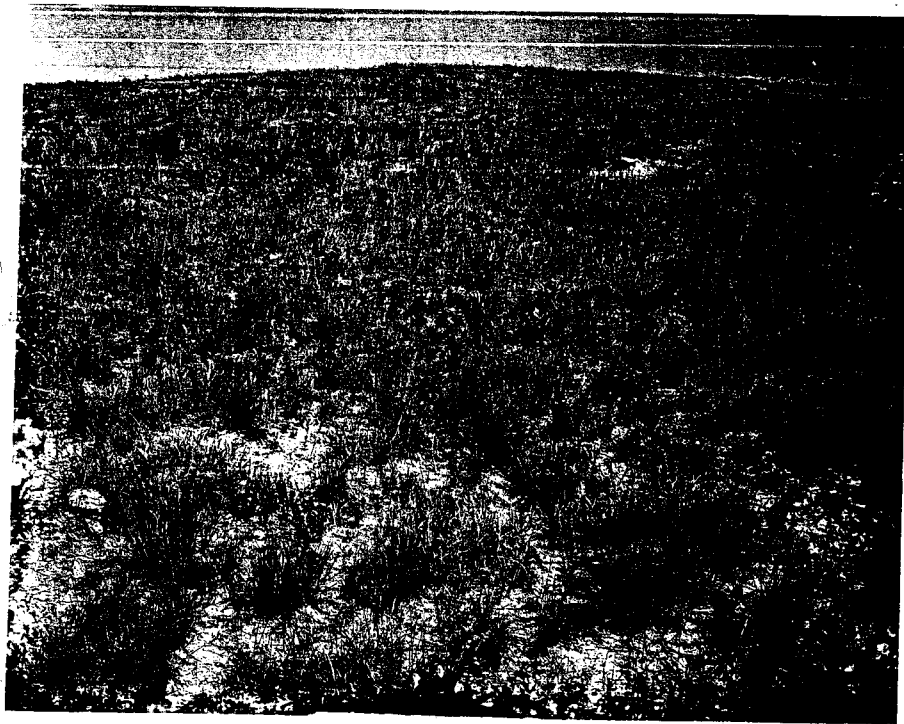


Fig. 23 Shallow site near Sage Creek Trail. Cover of blue grama, buffalo grass, side-oats grama and thread-leaved sedge. Badlands Monument, Aug. 9, 1953



Fig. 24 Shallow site in front and along slopes with trees in ravines and clay flats in distance. Badlands Monument, Aug. 9, 1953



Fig. 25 Lowland with herefords in Sage Creek Basin. Western wheatgrass (dark) and buffalo grass and blue grama (light). Dried sunflowers. Badlands Monument, Aug. 5, 1953

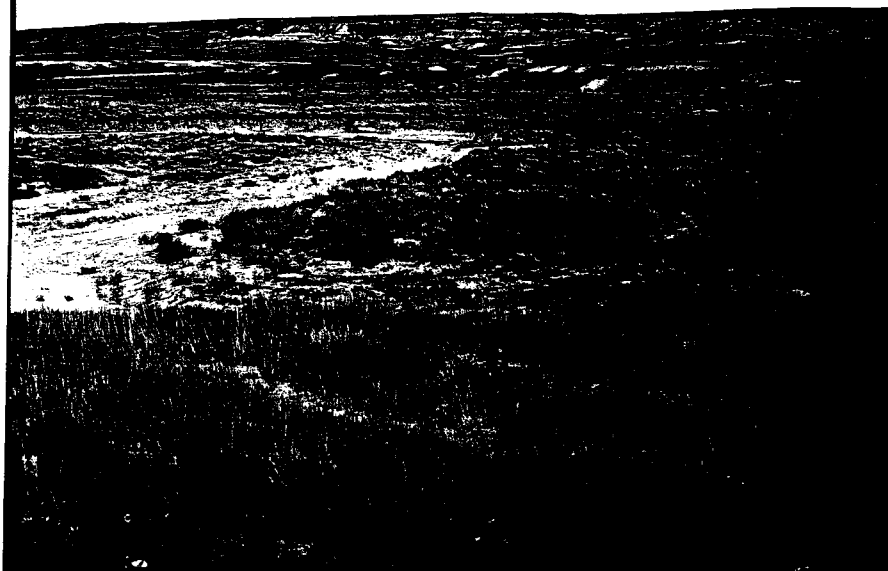


Fig. 26 North at Sage Creek lowland below Sage Creek entrance. Badlands Monument, Aug. 8, 1953

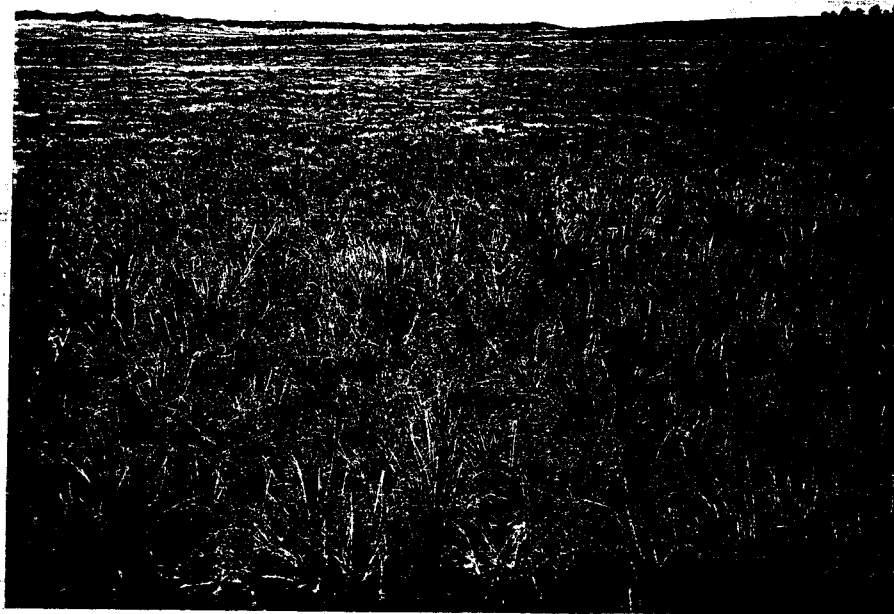


Fig. 27 Southwest across Sandy site west of Crawford, Nebraska. Lower story of blue grama, sand dropseed and thread-leaved sedge. Upper story of needle-and-thread and three awns. Yucca glauca is at right center. Fort Robinson, Aug. 19, 1953



Fig. 28 Same location as Fig. 27, but looking west at steep slope with vegetation, above which is barren butte. Fort Robinson, Aug. 19, 1953

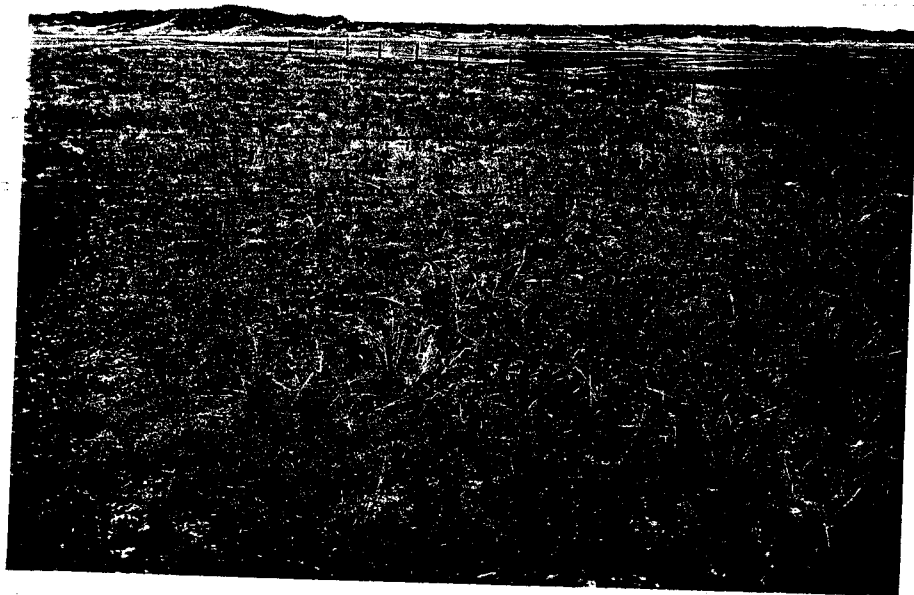


Fig. 29 Across ordinary upland site southeast of headquarters. Blue green and buffalo grass, and threadleaved sedge formed an even understory with scattered tufts of needle-and-thread and purple three awn. Fort Robinson, Aug. 19, 1953



Fig. 30 Ordinary upland site in front, shallow and very shallow, rocky slope (center), White River Valley and sandy slopes leading up to Western Yellow pine near the barren cliffs. Fort Robinson, Aug. 19, 1953

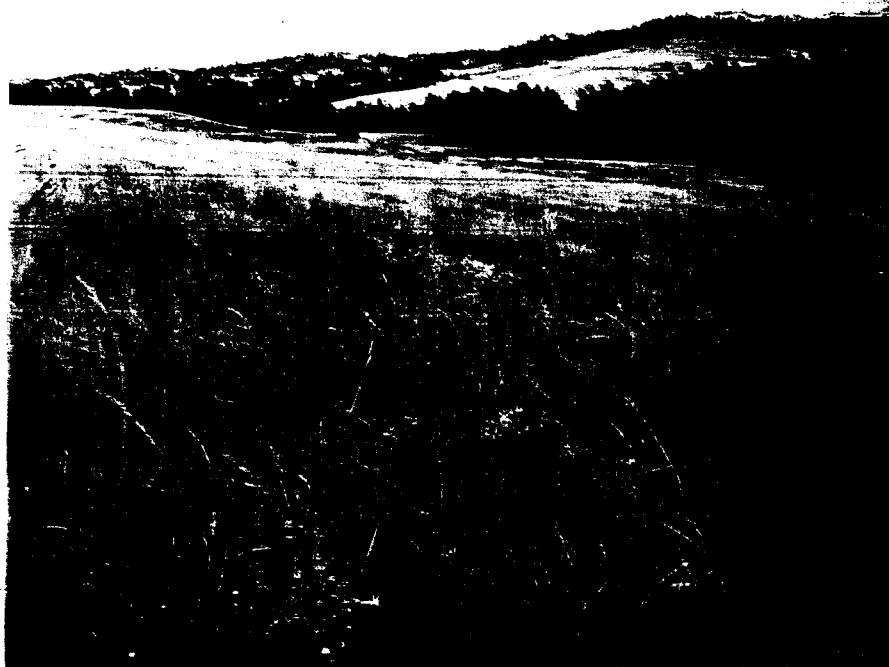


Fig. 31 Western Yellow pine and open grasslands on West Unit. Photo taken in storm with high wind. Fort Robinson, Aug. 19, 1953

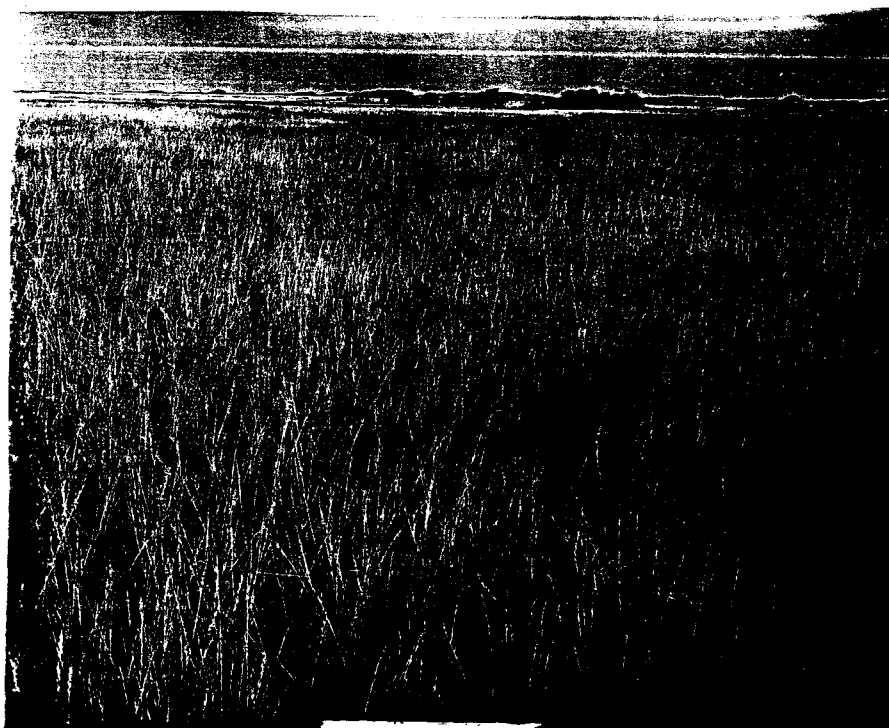


Fig. 32 North across east end of Big Plateau. Good stand of needle-and-thread, green needlegrass, western wheatgrass as an upper story, and blue grama and threadleaved sedge as a lower story. South Roosevelt Park, Aug. 14, 1953



Fig. 33 Looking south on same area as Fig. 32. Heavier grazing has increased blue grama stand and decreased needle-and-thread and western wheatgrass. South Roosevelt Park, Aug. 14, 1953

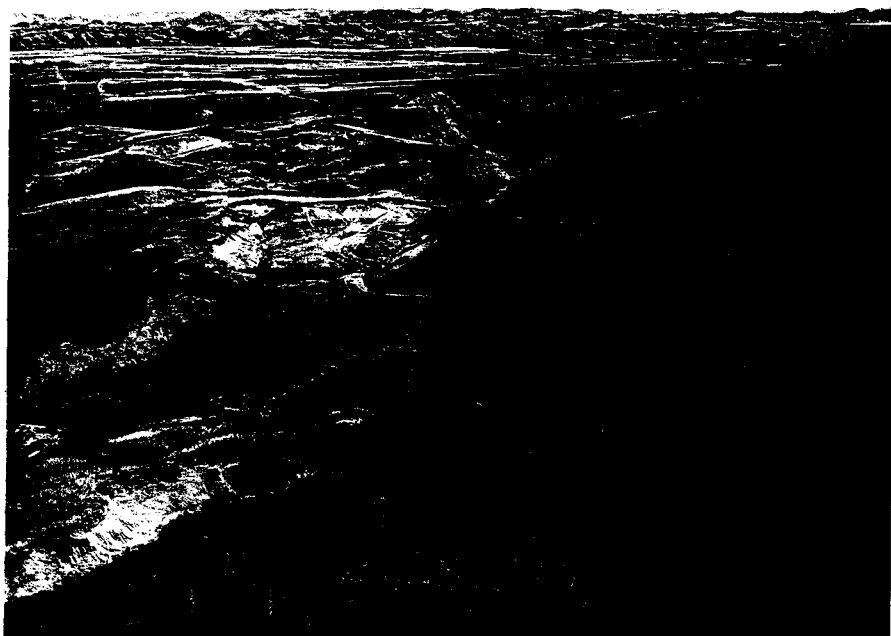


Fig. 34 Looking down from the rim of Petrified Forest Plateau at Big Plateau (across breaks). South Roosevelt Park Aug. 14, 1953

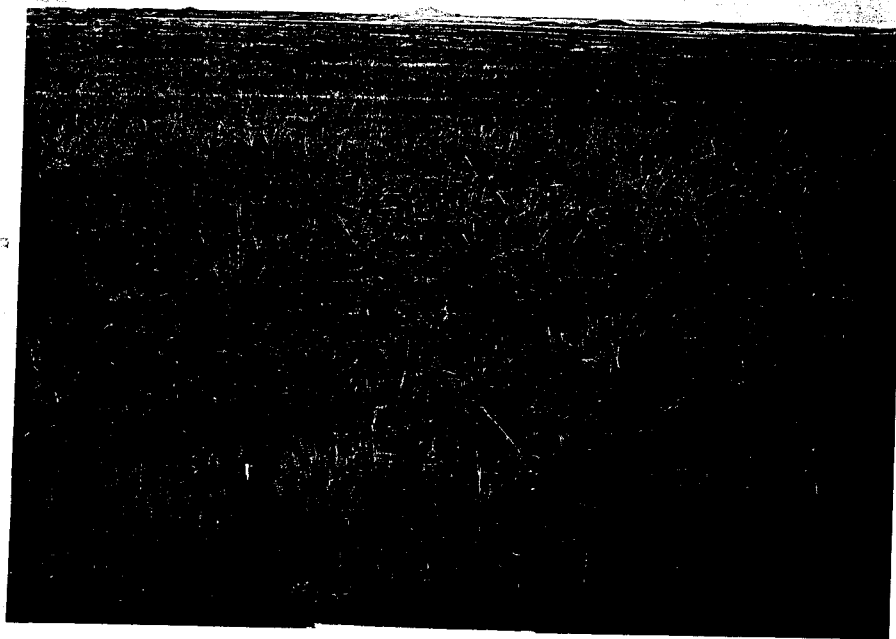


Fig. 35 and 36 West and south respectively from south of spring on Petrified Forest Plateau. Mostly blue grama, and threadleaved sedge as lower story and needle-and-thread, fringed sage, and green sage as upper story. South Roosevelt Park. Aug. 14, 1953

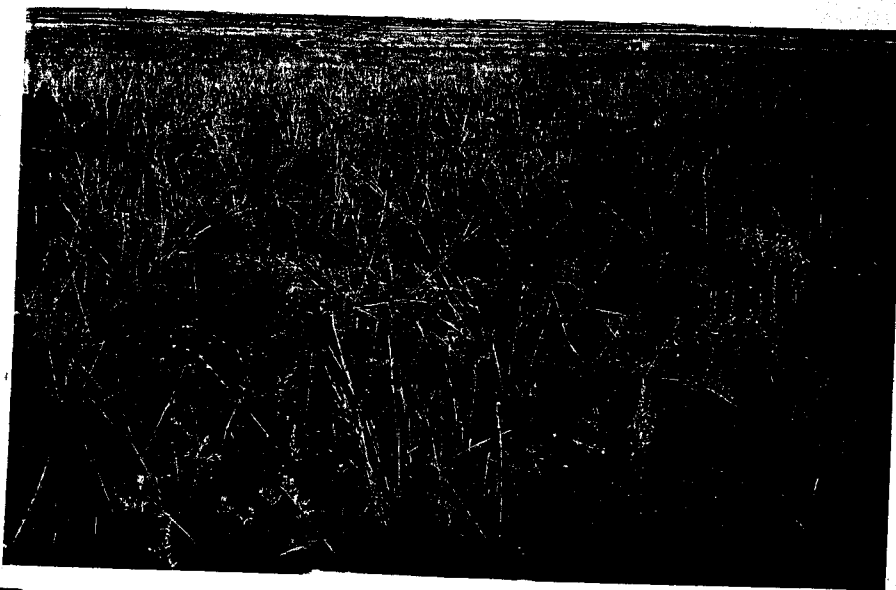


Fig. 36



Fig. 37 East on Dedication Hill at Ordinary Upland Site and Geok
Ingalls. Lower story of blue grama and threadleaved sedge.
Upper story of needle-and-thread and Mr. Ingalls. South
Roosevelt Park, Aug. 14, 1953

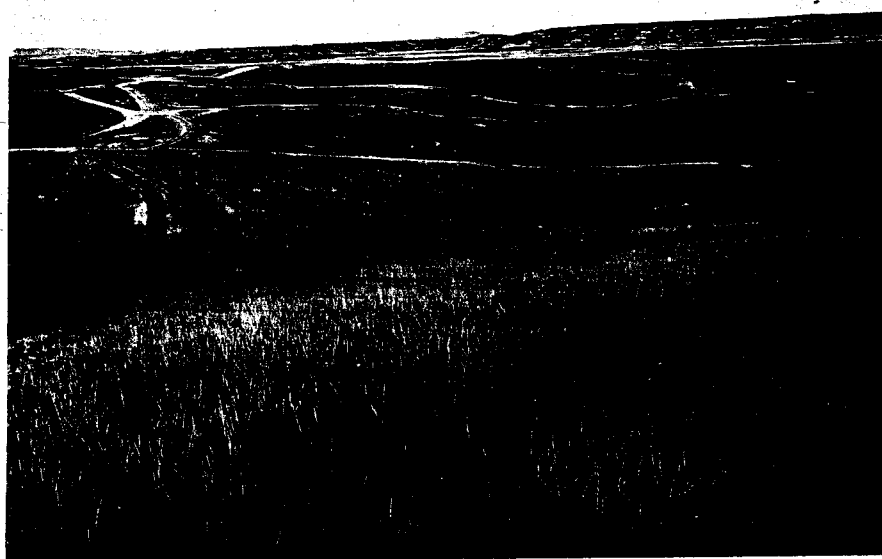


Fig. 38 West at Johnson Plateau (in distance) across rolling
grassland of blue grama, needle-and-thread, and western
wheatgrass. South Roosevelt Park, Aug. 14, 1953



Fig. 39 North west at Big Plateau (in distance) down ravine slopes covered with little bluestem, needle-and-thread and western wheatgrass. Trees in ravine. South Roosevelt Park. Aug. 14, 1953



Fig. 40 West at buttes from Dedication Hill. Cedars on north facing slopes (right) and bare hills facing south. South Roosevelt Park, Aug. 16, 1953

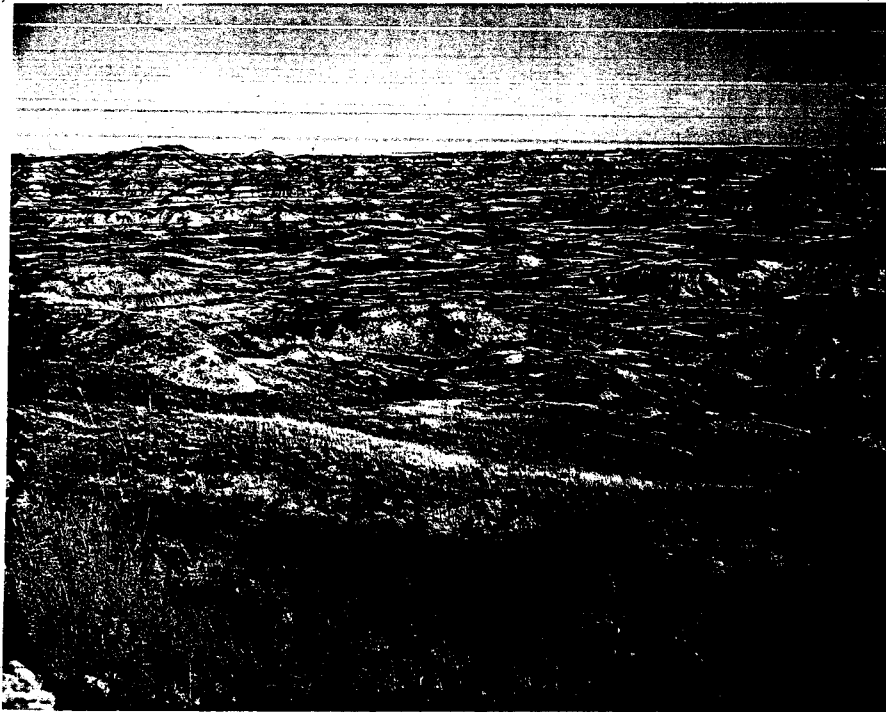


Fig. 41 Northeast from observation point at entrance of Park. Steep Breaks merge into foot hills with broad grassed valleys between. South Roosevelt Park, Aug. 16, 1953

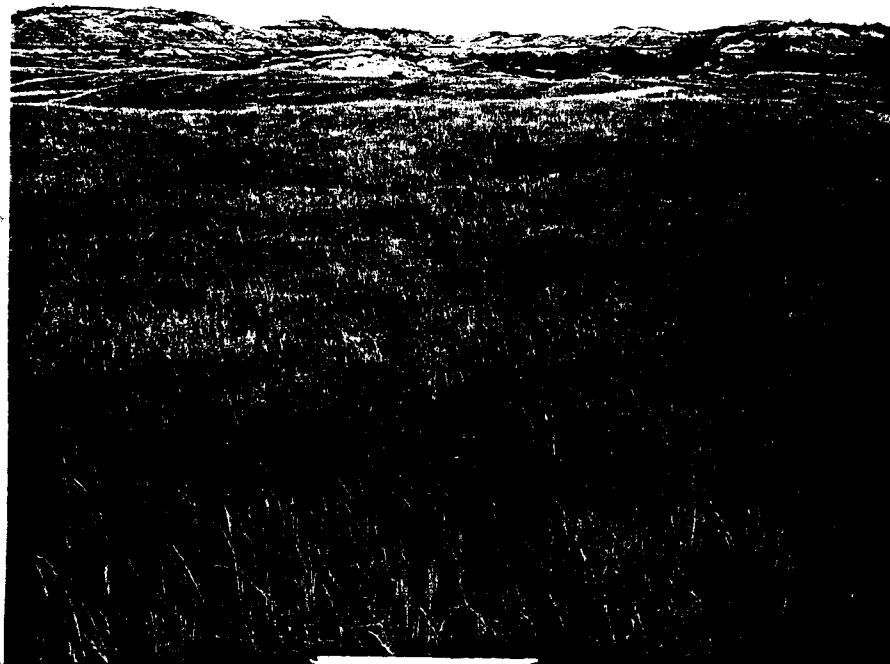


Fig. 42 Across one of the many broad valleys occupied by western wheatgrass and needle-and-thread grass. Also prairie sand-
reed grass. South Roosevelt Park, Aug. 14, 1953

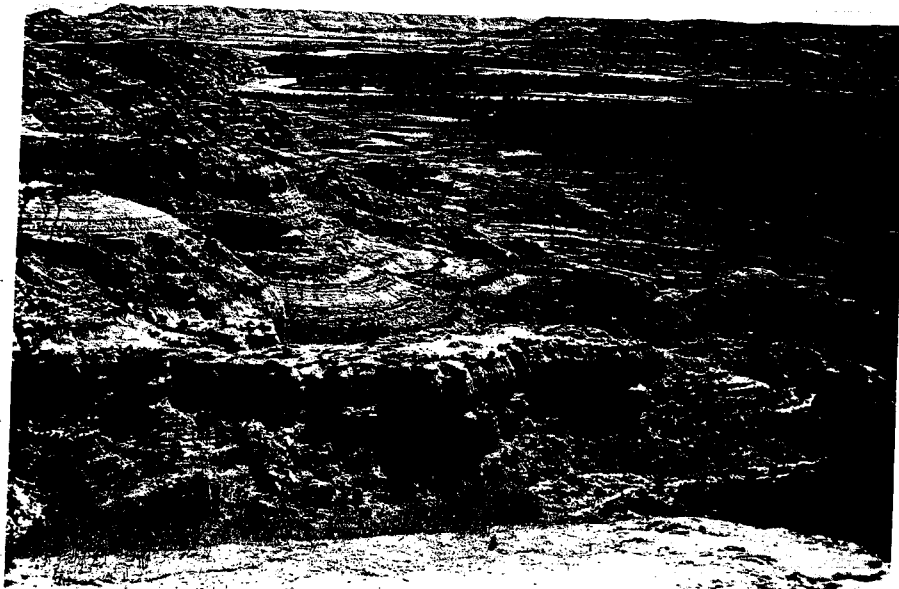


Fig. 43 Down Little Missouri River from Lookout Point at
Steep breaks and trees in valley. North Roosevelt
Park, Aug. 14, 1953



Fig. 44 and 45 Upland vegetation on nearly level topography
(figure 44), and on rolling topography (figure 45).
blue grama grass, and needle-and-thread. Little
stem on steep slope of knoll in Fig. 45. North Roosevelt
Park, Aug. 14, 1953



Fig. 45



Fig. 46 Along rocky steep slope clothed with blue grama, June grass, little bluestem, western wheatgrass, etc. North Roosevelt Park, Aug. 14, 1953

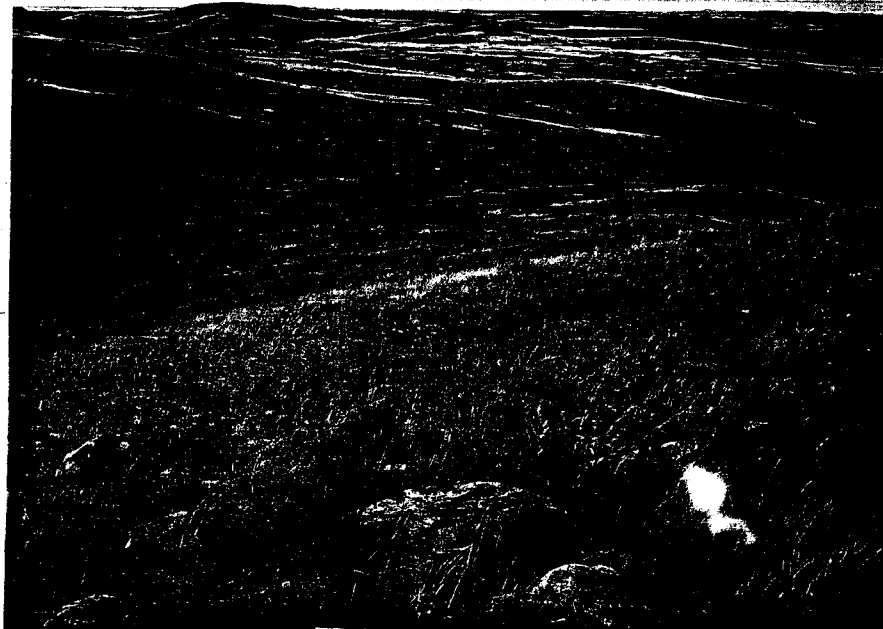


Fig. 47 West Across low, broad, rolling upland with glacial rocks in front. North Roosevelt Park, Aug. 14, 1953



Fig. 48 Steep wall (coal vein across front) with little vegetation and broad valley with numerous trees. North Roosevelt Park, Aug. 14, 1953



Fig. 49 Across Little Missouri River at low buttes (an exception), sand flats, and trees. Steep slope beyond River. North Roosevelt Park, Aug. 11, 1953

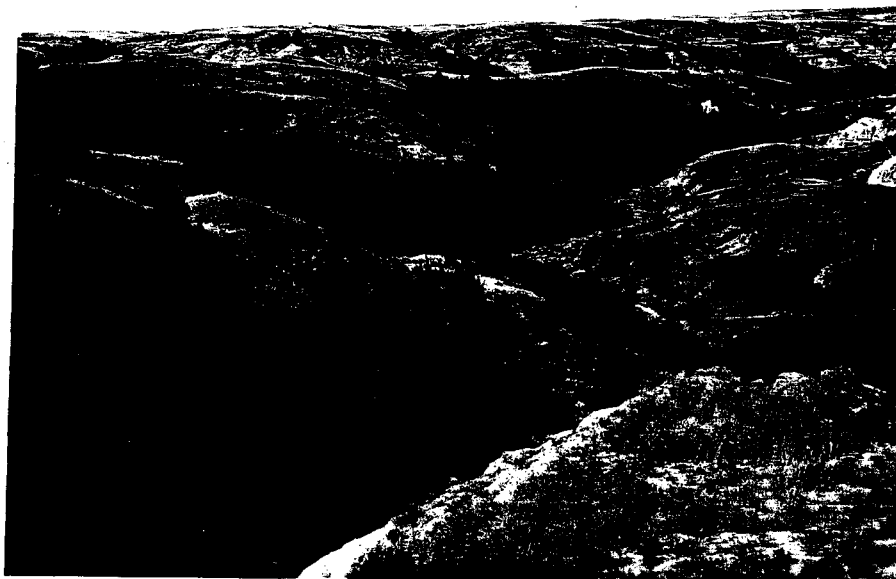


Fig. 50 In ravine with trees and grass on north-facing slopes, and nearly bare cliffs on south facing slopes. North Roosevelt Park, Aug. 11, 1953



Fig. 51 East across ravine in east end of Park at steep slope clothed with grass and a few evergreens. Wind Cave Park, Aug. 17, 1953

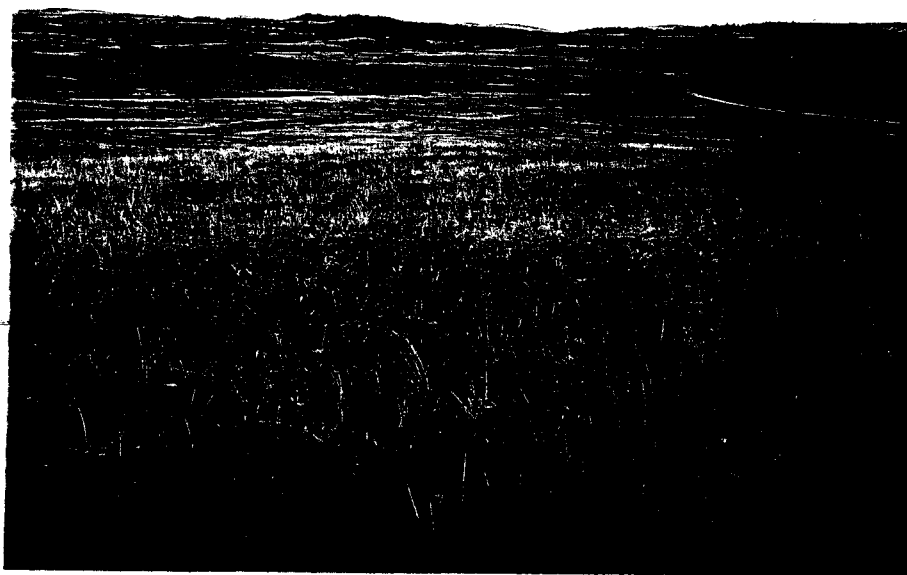


Fig. 52 Northwest from near Highway 85A at rolling overgrazed upland covered with little bluestem, blue grama, and needle-and-thread grass. Wind Cave Park, Aug. 12, 1953



Fig. 53 and 54 Across shallow site on steep slope with little bluestem, and across lowland with western wheatgrass. Western yellow pine in distance. Wind Cave Park. Aug. 17, 1953



Fig. 54



Fig. 55 Across heavily grazed lowland south of Headquarters with western wheatgrass, needle-and-thread, blue grama, and buffalo grass. Fence on hill enclosed an ungrazed area. Wind Cave Park, Aug. 17, 1953



Fig. 56 South from upland down broad valley near east end of Park. Red soils in valley covered with western wheatgrass and green needle grass. Wind Cave Park, Aug. 17, 1953



Fig. 57 Across valley of red soil with western wheat and green
needle at dome-like knolls of Tertiary with nearly pure
little bluestem. Wind Cave, Aug. 17, 1953

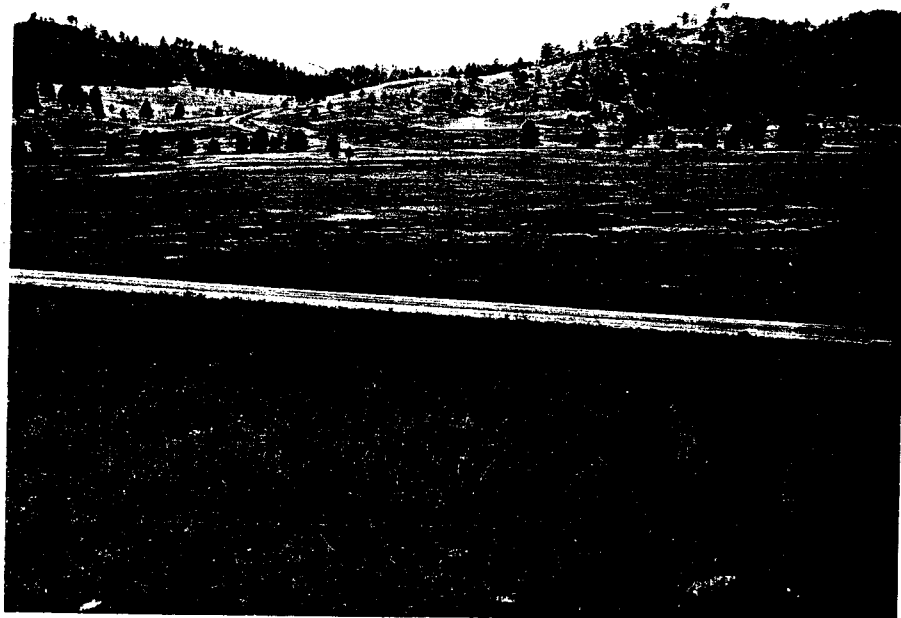


Fig. 58 West across Hwy 87 and closely grazed valley to
Pringle Road (in distance). Wind Cave, Aug. 17, 1953

APPENDIX D

SCIENTIFIC AND COMMON NAMES OF PLANT SPECIES MENTIONED IN TEXT

Ash, green	<i>Fraxinus pennsylvanica</i>
Bluestem, little	<i>Andropogon scoparius</i>
Brome, Japanese	<i>Bromus japonicus</i>
Buffaloberry, silver	<i>Shepherdia argentea</i>
Buffalograss	<i>Buchloe dactyloides</i>
Chokecherry	<i>Prunus virginiana</i>
Grama, blue	<i>Bouteloua gracilis</i>
Gumweed, curlycup	<i>Grindelia squarrosa</i>
Hawthorne	<i>Crataegus</i> spp.
Needleandthread	<i>Stipa comata</i>
Needlegrass, green	<i>Stipa viridula</i>
Sagewort, fringed	<i>Artemisia frigida</i>
Snowberry, western	<i>Symphoricarpos occidentalis</i>
Wheatgrass, western	<i>Agropyron smithii</i>