REPORT OF STUDY OF GRASSLANDS OF THE GREAT PLAINS

by

Dr. F. W. Albertson

August 1956

IN REPLY REFER TO:

UNITED STATES
DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

L58 Grasslands

Region Two
Omaha 2, Nebraska

Address Reply to:
Regional Director, Region Two
National Park Service

November 26, 1956

Memorandum

To: Regional Director

From: Regional Chief, Recreation Resource Planning

Subject: Grasslands Report of August 1956 by Dr. F. W. Albertson

The following are comments on Dr. Albertson's Grasslands Report of August 1956. The subject is so broad that it is hard to comment without writing a treatise; and a treatise could not be written without a good deal of study of other related material. Hence, these notes are, frankly, incomplete.

When Dr. Albertson was here on his way to India, we received the impression that he was not satisfied with the organization of the report and that he believed he could have improved it had more time been available to him. It is our feeling also that the contents could have been better arranged for smoothness and readability.

Incidentally, it will be noted that Areas 4 and 6 are not included in Tables 1 and 2. The report does not explain the omission, but Dr. Albertson informed us the two areas are so unacceptable that he did not deem it worthwhile to show them in the tables. Also, it will be found that Map No. 1, Key Map, suggests a study area in southwestern South Dakota which is not, however, covered by the report. Dr. Albertson told us that when he was in the vicinity of this area, the roads were in such poor shape due to rains that he did not feel it advisable to attempt them, and also that from having seen something of this territory previously he doubted that it would qualify as an acceptable grasslands.

The report has been reviewed by several interested persons in the Regional Office, and they agree that it contains a great deal of valuable opinion and data. It reminds the reader that much of the best grasslands are under cultivation or are overgrazed, and that the situation in parts of the Great Plains is not less than tragic. However, Dr. Albertson did find that while the effects of overgrazing were apparent in all cases, vegetation on some areas was in such condition that rapid recovery would occur if given protection. From reading the

report, Mr. Dickison received the impression that it makes some assumption of what would be the ideal climax stage of range vegetation where the grasses, forbs, and brush species, all things being equal, would continue to occupy sites for which they are best adapted, the implication seeming to be that there is an ultimate, static stage. Mr. Dickison mentions a different school of thought regarding plant succession where such a stage is never reached but where plants continue to give way successively with variability according to climate to higher forms. From having been in the field with Dr. Albertson on earlier studies, Mr. Ingalls is not certain that he does adhere to any absolute concept of a final climax stage. Mr. Ingalls questions whether the reader should hold Dr. Albertson too literally to the term "climax stage."

Dr. Albertson's recommendations as to a specific area or specific areas of grasslands most suitable for some form of establishment for public enjoyment are concisely given at the beginning of the report. Apparently the most suitable, centrally located grasslands are in southeastern Wyoming, northwestern Nebraska, and southwestern South Dakota. If but one can be selected, he believes it should be centrally located and be one of these, with first choice going to southeastern Wyoming or northwestern Nebraska and next choice to an area in South Dakota; if three areas can be chosen, the two others might be an area in northeastern New Mexico or one in Roberts County, Texas, as a southern area and an area in northwestern South Dakota as a northern area. It seems obvious to us that the Great Plains could be more fully represented by a north, a central, and a south area than by a central area only. However, questions of practicability might easily rule out more than one area.

He has rated or scored the various areas on the basis of point allocations to a number of factors, of which his most important are plant life (abundance of grasses, forbs, and trees) 40 points; condition of vegetation, 15 points; topography and scenic qualities, 15 points; and soils, 15 points. The remaining 15 points were apportioned between such less important factors as climate, location, water supply, possible size, animal life, and historical and archeological features and values. He considers, and we agree, that any grassland area to be established for public enjoyment and education would be most successful if it possesses a considerable variety of interest. The five top areas--southeastern Wyoming, northwestern Nebraska, and three areas in southwestern South Dakota, identified as 11-West, 11-East, and 11-Cahalane--appear to present the four major values and the several lesser ones more significantly than the other areas he examined.

In the final paragraph of his Recommendations, Dr. Albertson points to the need for further studies covering such factors as ecology

and distribution of plant and animal species, geology and soils, water supply, best possible boundary, ownership and acquirability, and historical and archeological qualities, before the final selection of an area or areas could be made. Assuming that there are areas qualified for establishment for some form of public protection, we suggest the need to clarify objectives before much more progress can be made. Has the Service in mind a grand idea of a huge expanse of varied grasslands capable of supporting the original indigenous wildlife including free-ranging bison and other native ungulates, and if so, are we trying to find an area to match? Or are we conducting inventories of material with the idea of making a suit to fit the cloth?

The former is a thought that captures the imagination. Questions of practicability appear, however, to us to mitigate against it; and it seems to us that it would be unfortunate to adhere to it so tenaciously as perhaps to pass up the chance to obtain a lesser but yet adequate thing. The grasslands are rapidly deteriorating through overgrazing and cultivation, and in large sections they have practically disappeared. Time is not on the side of those who would establish a huge grassland area, not to mention a smaller one. Pressure on the land can only be expected to increase with the passage of time.

It can be reasonably assumed that most of the lands desirable for a good grasslands area are now in Indian or non-Federal ownership. We can imagine the anguished protests that would arise from farming and ranching interests, from taxing bodies, and from miscellaneous other sources if a plan were set in motion to remove extensive acreages from agricultural and other private uses and from the tax rolls and to place them in public ownership subject to "no use." It seems as if any proposal to establish a Grasslands National Monument or otherwise designated area would stand the best chance of acceptance if it were spearheaded by a non-Federal organization and if the non-Federal lands involved were donated to the United States. This would require a strong and persuasive group representing a wide membership and possessing ample resources.

Determination of a minimum acceptable acreage needs to be made; this is involved in the determination of objectives. If scientific research only is the objective, a number of areas of limited acreage, each representing different soil, climatic, and related conditions, might suffice. If something to take a place in the National Park System is desired, then the scientific factor becomes joined by what may be called the "wilderness" and esthetic factors. An important essence of the aboriginal grasslands is vastness. To the usual traveler, this is probably the dominant characteristic of the Great Plains. It has

been suggested in this division that, in theory at least, an isodiametric area of "saucer topography," or one carefully tailored topographically to wide apparent horizons, could provide the greatest degree of apparent vastness with minimum acreage. For example, a grasslands about 15 miles square, or about 150,000 acres, with favorable topographic conditions permitting sweeps of view, could provide the full feeling of "wide open spaces." Such an acreage, containing most representative species, might well meet with more favorable response than a figure of around a million acres such as has been mentioned. There is an excellent possibility that this very type of area could be composed within any one of the three favored central areas.

Dr. Albertson's report may give the impression that he is actually recommending up to a million acres. From discussions with him, it is our feeling that he did not intend to be so specific but, rather, that he named acreages in his report as approximate acreages of the study areas. He also had in mind the requirements for restoration of a near-total ecological component.

Closely related to the question of size, of course, is the question of animal life to be represented as a component of the grasslands scene. We are thinking particularly of bison and the management problems they present. Bison are certainly in no danger now of extinction, but on the contrary are increasing through growing numbers of managed herds throughout the country. Consideration might be given to a grasslands without introducing larger wildlife except, for example, as pronghorn would make spontaneous use, and as deer populations would normally develop along wooded stream courses. Elk might also appear, depending on the location of an area selected. Under such management, an area as small as 150,000 acres could, we believe, afford good refuge for a satisfying representation of native Great Plains wildlife.

In lieu of bison and if it is desired to approximate the utilization of rangeland which these animals would make, Mr. Gregg suggests the interesting possibility of an area subject to domestic livestock grazing approximating the aboriginal effect of bison. If a sort of soil bank, parity benefit, or other arrangement for economic disparity of such use as compared with normal livestock range use could be worked out feasibly, the end effect of such use upon the total ecology of the area might be no more adverse than the best we can hope to do on an area without either livestock or freely responsive populations of major ungulates, wolves, grizzlies, and other elements of the very complex thing which was the prehistoric grasslands. To so continue an economic utilization of the range resource, with the experimental and

demonstration values possible, would soften greatly probable opposition and might even produce a plan which could rally wide support of present proponents and those with economic interest in direct use, and actually make possible the designation of a million-acre block as a "national grassland." If such a category were adopted as a parallel with "national seashore," a whole set of standards reconciling departure from those for national parks and monuments could be justified.

Concluding these comments, we think Dr. Albertson has contributed valuably to the survey of potential grassland areas and has made significant suggestions as to what a grassland area should contain.

Chester C. Brown

Chester C. Brown
Regional Chief of
Recreation Resource Planning

In duplicate

Duplicate copy retained in Div of Recreation Resource Planning. JAA

Report of Study of Grasslands of the Great Plains

By

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August 1956

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RECOMMENDATIONS

1. From the studies made during the summer of 1956 and earlier, it is felt that the best possible areas in the Great Plains have been given consideration.

2. It is recommended that at least one grassland area be set aside for use and enjoyment of future generations.

3. If only one area is selected it should be as centrally located as possible in the Great Plains. In this regard, area 2 (north of Cheyenne, Wyoming) and area 1 (north of Scottsbluff, Nebraska) would rank highest. Next most acceptable as to location would be the Cahalane area and areas 11 west and 11 east.

4. It is felt that area 11 east, would be highly satisfactory but unless the eastern boundary could be moved eastward, possible size might be a limiting factor. It has the advantage of being adjacent to the Badlands National Monument where extremes in breaks are plentiful.

5. Area 11 west, is quite small but it has beautiful grasslands and also it lies between the Black Hills on the west and Badlands on the east.

6. Area 2, and the Cahalane area rank near the top when all factors are considered. Both contain beautiful grasslands. They also have the other desired factors as indicated in Table 2.

7. If three areas could be selected, it is recommended that one area from the south and one from the north be added to the one located in central Great Plains. Best location in the north would be area 5 which lies south of Buffalo, South Dakota. Acceptable grasslands from southern Great Plains would be area 7 (northeast New Mexico), and Roberts County (northeast of Amarillo).

8. Even though the Flint Hills of eastern Kansas are not in the Great Plains, these vast areas are so important in many ways, it is recommended that consideration be given to preserving a portion of those extensive grasslands.

9. Before final selection of areas could be made, further consideration should be given to such factors as ecology and distribution of plant and animal species, geology and soils, water supply, best possible boundary, ownership and acquirability, and historical and archeological qualities.

SUMMARY AND OBSERVATIONS

A reconnaissance survey of grassland areas in the Great Plains was made during the summer of 1956. Area 10, south of La Junta, Colorado, and area 7, in northeast New Mexico, were first visited in early June. A grassland in Roberts County Texas was also studied. Later in June and through much of July, the areas northward were given consideration.

In making the study, a car was driven over as much as possible of the area under consideration. It was especially helpful to travel on dirt or gravel roads for along these trails were some of the best grasslands. Stops were made for observations, notes, and photographs.

Ungrazed areas were given special attention, for on these locations was found vegetation of the highest ecological development for that climate. Basal cover and per cent of species composition were given for relict areas found on this survey.

The study was initiated with the thought that several of the obviously unacceptable areas would be eliminated early from further consideration in order to allow more time for important locations. In this manner, areas 4, 8, 9, and 6 were disqualified. This left areas 10, 7, 3, 2, 1, Cahalane, 11 and 5 for further consideration.

It was suggested that selection of areas should be largely on the basis of plant life of the grasslands. Therefore, a record was kept of the different grasses found on each area (Table 1). Abundance of species was also indicated by using number (1) where the grass was very abundant and (5) where it was very scarce. Numbers (2), (3) and (4) indicate a frequency between very abundant and very scarce.

It will be noted that certain plants, blue grama and thread-leaved sedge for example, were very common, while others, such as squirrel tail and green needle grass were always very scarce. Some species were doubtless present but not found on the survey.

It is also evident that certain grasses were never found in the south but were very common farther north. Conversely, a number of species occurred regularly in New Mexico and Texas but were absent farther north.

None of the areas studied contained all of the grass species found in the entire survey. Some, however, contained many of them. On the basis of number of different species of important grasses, areas 3, 2, 11 east, 11 west and Cahalane ranked highest. Areas slightly below those rated first were 7, 1, and 5. It should be recognized that number of species in area 3 was determined through a more extensive survey (Weld County, Colorado study) than what was made for the other areas. Selection of areas could not be made entirely on the basis of number of species found, therefore, it seemed desirable to find other methods of measurement. In an attempt to meet this need, a score card was made which included factors other than number of species (Table 2).

The score card used in this table allows 40 points of the 100 for plant life. Plant life included, in addition to number of grasses, abundance of prairie forbs, shrubs, and trees.

Condition of vegetation was allowed 15 points. Prairies with moderately grazed healthy vegetation were rated higher than those with vegetation weakened by overgrazing.

Topography and scenic qualities were also given 15 points. It was felt that, in order to be most useful and attractive to people, there should be considerable variation in topography from level table-lands to rough breaks.

Fifteen points were allowed for soils of each area. A prairie with soils ranging from clay to sand was rated higher than one with soils of much the same textural and structural qualities.

Other less important factors were climate, location, water supply, possible size, animal life, and historical and archeological qualities.

On the basis of total scores, area 7 rates highest in the south and area 5 is highest in the north. Areas 11 east and west, the Cahalane area, and areas 2 and 1 rate highest in more central Great Plains.

It was evident from this study that much of our best grasslands has been put under cultivation. In fact, many places were found with freshly turned prairie sod. These areas, many of rough topography and shallow soil, will be used to raise more wheat and, thereby, further increase the oversupply of that cereal. Also with a decrease in area of grassland overgrazing is more likely to occur, thus leaving the remaining prairies more susceptible to the ravages of drought.

All of the top ranking areas had a wide range in topography, and also a high rating in scenic value.

It was felt that wild life in all of the top areas was satisfactory. However, one more competent to evaluate should pass judgement on this phase of the problem.

Effects of overgrazing were apparent in all areas, but vegetation on those given high rating was in such condition that rapid recovery would occur if given protection.

Table 1. Species of grass (one sedge) found on various areas during summer of 1956.
Number in table opposite each species indicates abundance. Number 1 indicates species was abundant, number 5 very scarce, and numbers 2, 3 and 4 between abundant and scarce.

SPECIES OF PLANT	AREA NUMBER											
	7	10	3	2	8	1	9	11E	11W	C*	5	R**
Blue grama	1	1	1	1	1	1	1	1	1	1	1	1
Thread-leaved sedge			3	1	2	1	1	2	2	2	1	
Needle-and-thread			2	3	4	2	2	2	2	2	2	
Sand reed			5	5		3		5	5	5	3	
Buffalo grass	3	3	1	3		5	3	3	3	3	4	1
Western wheatgrass	4	4	2	2	1	3	2	1	1	2	4	5
Little bluestem	5		5	5		5		4	5	5	4	4
Big bluestem	5							4	5		5	5
Green needle grass			5	5				4	4	4	4	
Side-oats grama	3	4	5	4				3	4	5	5	4
June grass			5	3		4		4	4	4	3	5
Sand dropseed	5	4	5	5		5				5	5	
Sand bluestem	5					4		5	5			5
Sandberg bluegrass				4	4	4	4	4	4	5	4	
Red three-awn	5	5	5	5				5	5			5
Purple three-awn				5		5				5	5	5
Salt grass			5					4	4	5	5	
Squirreltail	5	5	5	5				5	5	5		
Slender wheatgrass					5			5		5		
Hairy grama			5			5		5				5
Galleta grass	3	4										
Ring muhly	3	3	5									
Hairy dropseed									5			
Switch grass								5				
Indian grass	5											
Tumble grass	5			5				5		5		
Hairy tridens	4	4										
Indian rice grass			5	5		5		5	5	5		
Wooton three-awn			5	5				5		5		
Scribners panic								5				
Plains muhly			5	5							5	
Bluebunch wheatgrass				5								
Beardless wheatgrass				5								
TOTAL SPECIES	15	10	20	20	6	14	6	23	18	19	16	11
Forbs	ok	-	ok	ok	+	ok	+	ok	ok	ok	ok	ok
Shrubs	ok	ok	ok	ok	+	-	+	ok	ok	ok	ok	ok
Coniferous trees	ok	ok	-	ok	ok	ok	ok	ok	ok	ok	ok	ok
Deciduous trees	-	ok	+	ok	ok	+	ok	ok	ok	ok	-	ok

*Cahalane Area
**Roberts County Texas

Table 2. Rating of each area based upon score card in left hand column. Number of points for each item is given in parentheses.

SCORE CARD	POSSIBLE POINTS	AREA NUMBER											
		1	2	3	5	7	8	9	10	11E	11W	Ca*	R**
Plant Life	(40)	30	36	33	30	33	23	23	26	38	35	35	28
Condition of Vegetation	(15)	12	10	5	10	10	3	6	5	14	12	12	12
Topography and Scenic Value	(15)	10	12	10	10	12	10	6	12	12	13	12	11
Soils	(15)	10	11	10	13	12	6	6	10	13	12	11	11
Climate	(3)	2	2	1	2	1	1	2	1	2	2	2	1
Location	(3)	3	2.5	3	1	1	1	1	1	2	2	2	1
Water Supply	(3)	2	2	1	2	2	1	2	2	2	3	2	3
Possible Size	(2)	2	2	2	2	2	2	2	2	2	1	2	2
Animal Life	(2)	2	2	2	2	2	2	2	2	2	2	2	2
Historical and Archeological	(2)	2	2	2	2	2	2	2	2	2	2	2	2
TOTAL SCORE	(100)	75	81.5	69	74	77	51	52	63	89	84	82	73
RATING		6	4	9	7	5	12	11	10	1	2	3	8

*Cahalane Area
**Roberts County Texas

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FORMATION OF GREAT PLAINS

Millions of years ago the area now occupied by the Great Plains was a vast body of water (Harvey, 1908). Evidence of this fact is found in marine fossils embedded in strata of limestone extending over much of the Great Plains area. Beginning at the close of the Carboniferous and extending to lower Cretaceous, the area was mostly land and occupied by certain types of ferns and conifers (Gleason, 1922). During middle and late Cretaceous, the area was again covered with a shallow sea, and following its withdrawal, there occurred the uplift of the Rocky Mountains on the west. These mountains intercepted the moisture laden winds from the Pacific Ocean and largely restricted rainfall in the Great Plains to moisture derived from the Gulf of Mexico.

Gradual decreases in rainfall resulted ultimately in a grassy type of vegetation in this extensive area. Probably this grassy type of vegetation has occupied parts of the Great Plains area for millions of years and vast arm-like projections of grassland have pushed out may times in several directions and withdrawn again when changes in climate occurred.

During the period of glaciers there was a migration southward of most living forms. Belts of vegetative types such as tundra, bog scrub, coniferous forest and deciduous forest were usually maintained through the east and middle west as they moved southward. Farther west, however, the treeless plains region was covered by prairie vegetation.

With retreat of ice, the new bare glacial soil was first invaded by mosses and lichens of the tundra. With further retreat of ice, the climate became more suitable for plant growth and prairie grasses from the plains area not only invaded the adjoining tundra to the north but they also succeeded in penetrating the glaciated regions of the middle west. There is evidence that invasion by grasses extended as far east as Ohio (Woodard, 1924).

One explanation of this unusual phenomenon of prairie succeeding forest is that a xerothermic period began during Wisconsin glaciation and persisted during the post-Wisconsin glacial retreat. Because of the dry period, the advance of deciduous forest from the south was delayed but the more humid grasses and their associates moved northward and came in contact with prairie vegetation that moved in from the west. Thus the bluestems, Indian grass, and the panic grasses came to be associated with buffalo grass, the grama grasses, and other xeric forms from the west.

At a later period than the one mentioned above, amelioration of climate occurred which gradually ended the xerothermic period. As a consequence, the oaks, hickories, elms, ashes, and cottonwoods of the deciduous forest followed the retreating grasses in a westward direction. Upon their return to the high plains the more xeric grasses of western origin came to occupy the drier positions, whereas, grasses from the more humid south became established on the eastern border of the grassland formation and along streams and other more favored positions westward. This mixing of short and mid grasses has resulted, in general, in the formation of the Mixed Prairie of central United States.

Areas best suited to preservation for use and enjoyment of future generations would seem to be those composed of a large percentage of grasses that once inhabited this vast grassland.

There are also great variations in topography and soil texture in the Great Plains area. For example, "Some of the features of the Great Plains are sand hills, loess plains, hilly lands, buttes and isolated mountains, mesas and canyons, badlands, stream terraces, wind-blown depressions, buffalo wallows and sink holes, scoria resulting from burning beds of lignite, and glacial features in Northern Montana and North Dakota" (Weaver and Albertson, 1956). Soil texture varies from coarse sand to fine clay. Therefore, an area of grassland to be preserved should also possess a fairly wide variety in topography and in soil texture.

RELATED STUDIES

Much research work has been done on grasslands of the Great Plains during past years. In order to clearly set forth in this report what vegetative composition might be expected in various sections it seems desirable to review briefly results of studies of various research workers.

Vegetation in New Mexico has been discussed rather thoroughly by Arnold Heerwagen, Range Ecologist (Weaver and Albertson, 1956). On the loamy textured upland soils with lime accumulation in the subsoil, blue grama (Bouteloua gracilis) is by far the most important grass species. Other important grasses are buffalo grass (Buchloe dactyloides), western wheatgrass (Agropynon smithii) and galleta (Hilaria jamesii).

Grasses of still less importance are hairy grama (Bouteloua hirsuta), ring grass (Muhlenbergia torreyi), sand dropseed (Sporobolus cryptandrus), three-awn (Aristida spp.), and squirreltail (Sitanion hystrix). In certain post climax locations are found side-oats grama (Bouteloua curtipendula), little bluestem (Andropogon scoparius) and New Mexico feathergrass (Stipa neomexicana).

Most important forbs are scarlet globemallow (Sphaeralcea coccinea), scurfpea (Psoralea tenuiflora), scarlet gaura (Gaura coccinea), cut-leaved goldenweed (Haplopappus spinulosus), plains zinnia (Zinnia grandiflora), gumweed (Grindelia squarrosa), and prairie coneflower (Ratibida columnifera).

Shrubby species are broom snakeweed (Gutierrezia sarothrae), fringed sage (Artemisia frigida), winterfat (Eurotia lanata), and rabbitbrush (chrysothamnus spp.).

Two species of junipers (Juniperus monosperma and J. scopulorum) are common especially on the breaks.

Allred, in his description of the Mixed Prairie in Texas, lists the important grasses and forbs that occupy the Mixed Prairie Climax and several post climax communities (Weaver and Albertson, 1956). In general the important grasses on the mixed Prairie climax are the same as those listed by Heerwagen for New Mexico. Among the grasses added to Heerwagen's list are silver beardgrass (Andropogon saccharoides) and plains bristle grass (Setaria macrostachya). Added forbs are purple prairie clover (Petalostemum purpureum), Dakota verbena (Verbena bipinnatifida), and blazing star (Liatris punctata).

The post climax High Plains Bluestem Community is occupied primarily by Indian grass (Sorghastrum nutans), little bluestem (Andropogon scoparius), switch grass (Panicum virgatum), sand bluestem (Andropogon hallii), sand lovegrass (Eragrostis trichodes), big sandreed (Calamovilfa gigantea), side-oats grama (Bouteloua curtipendula) and Canada wild rye (Elymus canadensis). There are many other species of less importance than those listed above.

Most important highland grasses in eastern Arizona, as given by Nichol (1937), are blue grama and galleta. Less important ones are needle grass, muhlys, bluestems, and three-awns.

Near Alpine, Texas, on a high flat area, Cottle (1931) found the important grasses to be blue grama, hairy grama, and black grama (Bouteloua eriopoda).

Bruner (1931) has described the vegetation of Oklahoma. In the western portion of the state he found blue grama, hairy grama, and buffalo grass as short grasses, and little bluestem, silver beardgrass, side-oats grama and wheatgrass as mid grasses.

In Central Great Plains, Albertson, (1937) found in west-central Kansas a lower story of short grasses beneath or associated with several mid grasses. The hilltops were dominated by blue grama and buffalo grass. Mixed with these two short grasses were sun sedge (Carex heliophila), and scattered bunches of three-awns, (Aristida longiseta and A purpurea), little bluestem, western wheatgrass, squirreltail, sand dropseed, June grass (Koeleria cristata) and side-oats grama. Slopes and lowlands were occupied mainly by little bluestem, side-oats grama, big bluestem, and switch grass. Rocky outcrops were dominated by little bluestem, hairy grama, and hairy dropseed

(Sporobolus pilosus).

Important forbs were scarlet globemallow, scurfpea, blazing star, velvety goldenrod, cut-leaved goldenweed, broom snakeweed, wavy-leaved thistle, scarlet gaura and prairie coneflower.

Shantz (1911 and 1923) has reported on the vegetation of eastern Colorado. He found blue grama as the primary dominant. Associated with this short grass were buffalo grass, needle-and-thread, western wheatgrass, three-awn grasses and thread-leaved sedge (Carex filifolia). Other still less important grasses were June grass, sand dropseed and tumble grass (Schedonnardus paniculatus).

Costello (1944) has added ring grass and galleta to the list of grasses in Colorado.

In central Nebraska, several studies have been made. Weaver and Bruner (1948), and Hopkins (1951), did extensive work on the Loess Hills in that section of the state. Blue grama and buffalo grass comprised over 95 per cent of the grasses. Other species of minor importance were western wheatgrass, big bluestem, side-oats grama, sand dropseed, June grass, plains muhly, and purple three-awn. Forbs were essentially the same as those listed for areas farther south.

There is a vast grassland along the Pine Ridge Escarpment in northwestern Nebraska and northeastward in South Dakota (Weaver and Albertson, 1956). Here mostly on fine sandy loam are blue grama, needle-and-thread, thread-leaved sedge, western wheatgrass, June grass, buffalo grass, three-awns, little bluestem and hairy grama. Tolstead (1939) studied relic areas in northwestern Nebraska. He found the same species as reported above but percentage composition

was significantly different. Forbs were largely those found southward.

Larson and Whitman (1942) studied an ungrazed mesa on Medicine Butte, South Dakota. Most important grasses and sedges found on this ungrazed area were blue grama, thread-leaved sedge, Penn sedge, needle-leaf sedge, (Carex eleocharis), western wheatgrass and needle-and-thread. Less important species were side-oats grama, green needle grass (Stipa viridula), red three-awn, little bluestem and big bluestem.

On the western grasslands of North Dakota (Whitman et al., 1941) found blue grama, needle-and-thread, western wheatgrass and thread-leaved sedge to be most important. Other grasses were June grass, little bluestem and Sandberg bluegrass (Poa secunda). Farther east in North Dakota (Sarvis, 1929, 1923, 1941) made extensive studies near Mandan and found nearly the same species as those listed by Whitman.

Costello (1944) recorded important grasses in the big sagebrush type in east-central Wyoming. Most common species were blue grama, western wheatgrass, needle-and-thread, and plains bluegrass (Poa arida).

Beetle (1952) studied a relic area on the Wyoming shortgrass plains and found, in general, the same species as given by Costello.

Wright and Wright (1948) worked on a small butte (Pompey's Pillar) located about 35 miles east of Billings, Montana. Here the chief grass was blue grama. Thread-leaved sedge, needle-and-thread and blue bunch wheatgrass were present also. Of least abundance were Indian rice grass (Oryzopsis hymenoides), sand reed grass and red three-awn.

Clark et al. (1942) conducted an ecological and grazing capacity study on the native pastures of south-central Canada. Much of the area studied was a climax grassland. Two of the types considered were the Short-Grass Prairie (Bouteloua-Stipa Association), and the Mixed Prairie (Stipa-Agropyron-Bouteloua Association).

On the Short-Grass Prairie, blue grama comprised from one-quarter to two-thirds of the grass cover. Less important grasses were needle-and-thread, western wheat grass, June grass, and Sandberg blue grass. Three sedges were also present. They were involute-leaved sedge, thread-leaved sedge, and spike rush.

Most important forbs found in this type were moss phlox (Phlox hoodii), prickly pear cactus, fringed sage, broom weed, and golden aster. Other forbs were silver sage, prairie sage, winter fat, and Nuttall's atriplex.

Coupland (1950) also made extensive studies of grasslands in southern Saskatchewan and Alberta. Dominant grasses and sedges found by him were needle-and-thread, blue grama, wheatgrasses, June grass and thread-leaved sedge. Some of the less important grasses were plains muhly, Sandberg bluegrass, and Canby bluegrass (Poa canbyi).

Principal forbs were fringed sage, phlox, scarlet globemallow, smooth goldenrod, broom snakeweed, and cut-leaved goldenweed. Some other forbs were hairy golden aster (Chrysopsis villosa), silver sourfpea (Psoralea argophylla), prairie sage (Artemisia gnaphalodes), skeleton weed (Lygodesmia juncea) and blazing star (Liatris puntata).

Only the most important species of grasses and forbs have been given for the various locations in the Great Plains. It is hoped that this brief review of plant species listed by various botanists will be of some assistance in determining what plants should be present in an area best suited for preservation.

STUDY OF 1956

While it is not the purpose of this report to give a complete history of past interest and activity in respect to preserving one or more grassland areas for study and recreation, it does seem proper to refer briefly to a portion of what has been done so that it might serve as a background to the problem at hand.

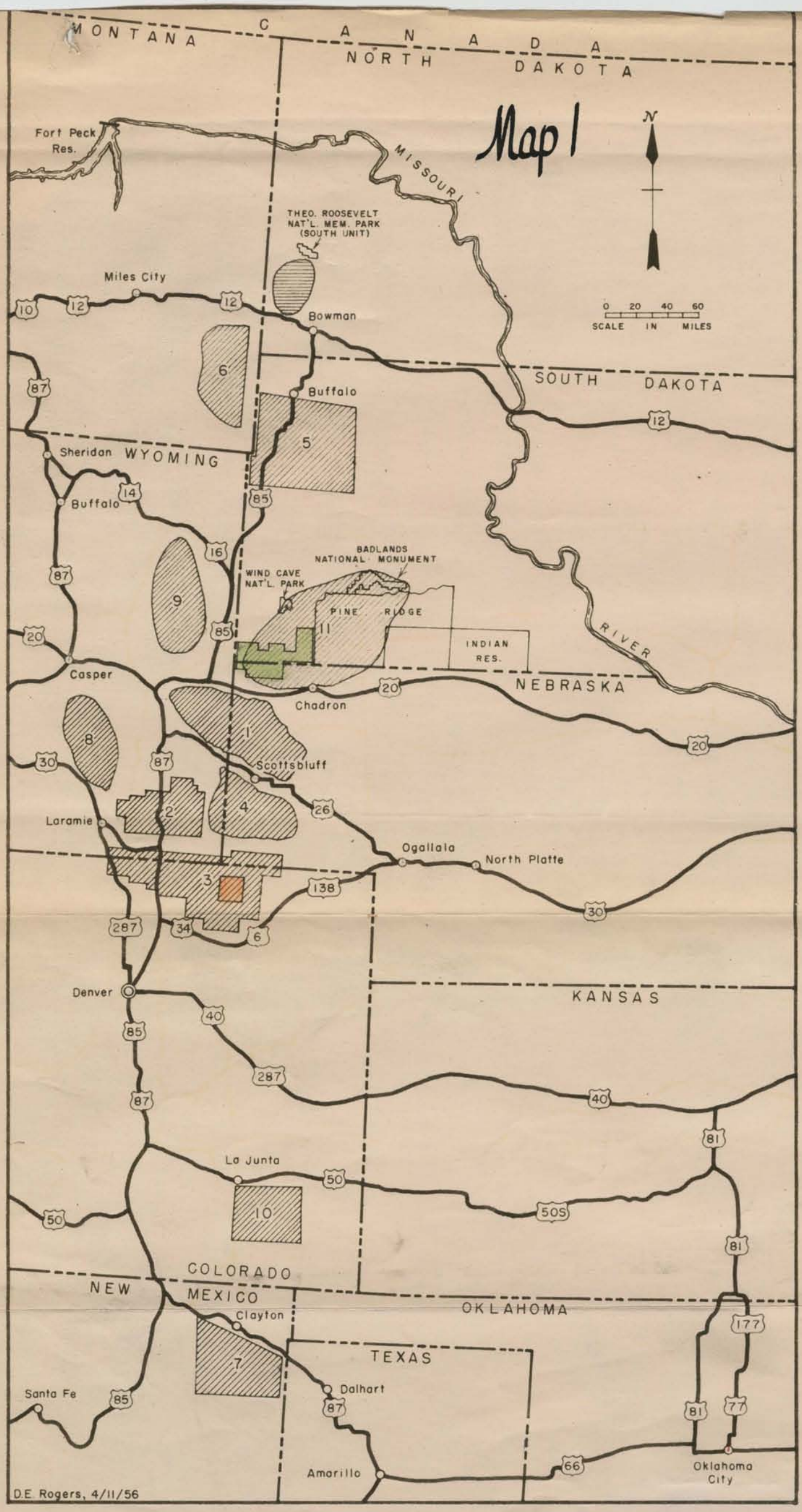
Destruction of natural vegetation in the United States has been closely associated with settlement by the human race. Years ago areas of forests were included in Parks and protected against destruction. Natural grassland areas, however, have not been saved from the terrible destruction that comes from over grazing the range, or from cultivation.

Interest in protecting grasslands has existed for many years but, to date, nothing significant has been accomplished. In 1917, the Ecological Society of America set up the Committee on the Preservation of Natural Conditions. In 1931, the Committee for the Study of Plant and Animal Communities was created.

In 1933, the National Research Council created the Committee on the Ecology of Grasslands of North America. Other organizations of similar interest are Nature Conservancy and Grassland Research Foundation.

The Grassland Committee of the National Research Council and the National Park Service conducted surveys of grasslands during the 1930's and suggested areas for preservation. These tracts of grassland have largely formed the basis for the present study (See map 1).

A Proposal for a Great Plains National Monument was submitted by Victor H. Cahalane in 1938. The area Mr. Cahalane suggested was also considered during the recent study.



Attachment to Contract No. 14-10-232-140

See Article I-(a)

Areas suggested for study by 1937 report of National Research Council

Area reported on by Cahalane, 1938

Additional area suggested for study by Region Two, National Park Service

Area reported on by Albertson, 1954

NOTE: Studies are not necessarily to be limited to the above.

MAP 1
KEY MAP

Areas outside those suggested by the Park Service were found in Roberts County, Texas, in the Flint Hills of Southeast Kansas, in east-central Colorado, and in north-central Montana on the Blackfeet Indian Reservation. The grasslands in Roberts County, Texas, and, in southeast Kansas, have proved to be most acceptable of the outside areas but all were less satisfactory than some of those suggested for study by the Park Service.

Brief descriptions of areas given by members of the Committee on Ecology of Grasslands in 1937 will be included in this report in order to gain some knowledge of the respective grasslands as they existed nearly 20 years ago. In addition to the most considerate assistance from personnel of Region Two, National Park Service, the following individuals were written to or interviewed, and furnished suggestions concerning some phase of the survey:

1. E. Raymond Hall, Museum of Natural History, University of Kansas, Lawrence, Kansas.
2. William M. Bowen, Region Three, National Park Service, Santa Fe, New Mexico.
3. John E. Kelly, Region Three, National Park Service, Santa Fe, New Mexico.
4. ~~Walt~~ Natt Dodge, Region Three, National Park Service, Santa Fe, New Mexico.
5. Arnold Heerwagen, Range Conservationist, soil Conservation Service, Denver, Colorado.
6. C.E. Van Doren, Supt., Amarillo Experiment Station, Amarillo, Texas.
7. Hershel Bell, Soil Conservation Service, Amarillo, Texas.
8. George B. Fell, Nature Conservancy, Washington, D. C.
9. E. J. Kyksterhuis, Range Conservationist, Soil Conservation Service, Lincoln, Nebraska.
10. Warren Whitman, Dept. of Botany, North Dakota Agricultural College, Fargo, North Dakota.

11. Frank H. Anderson, Supt., Scottsbluff National Monument, Gering, Nebraska.

12. Earl M. Semingsen, Supt., Wind Cave National Park, Hot Springs, South Dakota.

13. John A. Rutter, Supt., Badlands National Monument, Interior, South Dakota.

14. Alan A. Beetle, Department of Agronomy, University of Wyoming, Laramie, Wyoming.

15. Farrel A. Branson, Dept. of Range Management, Montana State College, Bozeman, Montana.

The agreement between the National Park Service and Fort Hays Kansas State College provided that the college should:

(a) Supply the necessary personnel and facilities and conduct field reconnaissances of portions of the Great Plains in southeastern Montana, western North Dakota, western South Dakota, eastern Wyoming, western Nebraska, northern and southeastern Colorado, and northeastern New Mexico as approximately outlined on the map attached to this contract, as well as any appropriate areas of the Great Plains in western Kansas, northern Oklahoma, and the Texas Panhandle that the College may have good reason to believe merit examination, with the objectives of:

(1) Ascertaining the extent to which there are relict areas of prairie undisturbed by the works of man, as well as areas modified to some extent by man's activities yet substantially representative of undisturbed prairie, and also other areas more considerably modified yet capable of restoration to an approximation of original prairie; and

(2) Appraising the significance of the areas as to whether they should be conserved as a sample or samples of undisturbed or relatively undisturbed prairie or as areas to be restored to an approximation of original prairie for scientific study and for the general education and enjoyment of the public.

(b) Initiate the necessary field studies on or about June 1, 1956.

(c) Supply the Service in advance of the field studies with a tenative itinerary, this to be supplemented from time to time with revisions as necessary; submit upon conclusion of the field studies a concise progress report listing the areas investigated; and submit not later than September 15, 1956, a comprehensive report in five copies, such findings to include:

(1) Findings and conclusions reached in the study.

(2) Supplemental observations and conclusions regarding related scenic and biotic values of the areas studied.

(3) Findings and conclusions as to the susceptibility for preservation or restoration of any area or areas which the College considers worthy of public conservation.

(4) A map or maps on which will be outlines, in a manner so that they can be easily identified, the areas examined with special designation of any such area or areas as are believed to be worthy of preservation or restoration.

(5) Photographs as may be desired to indicate the general characteristics of the area and to support conclusions.

In carrying out the survey an attempt was made to eliminate rather quickly those areas where cursory examination indicated they were unacceptable for one reason or another.

The survey was made with the very able assistance of Mrs. Albertson who helped at times in reading road maps, so necessary in a study of this kind. Also in cooking meals, and in preparing lunches for days when we were in the prairies some distance from towns.

Willard Phillips, a graduate student at Fort Hays Kansas State College, was also of great assistance in reading maps, in keeping a log of speedometer readings with comments on kinds and conditions of vegetation as far as we could see on each side of the road, and in taking photographs and notes where stops for study were made.

PROGRESS REPORT ON STUDY OF GRASSLANDS IN THE GREAT PLAINS

We left Hays, Kansas, on the morning of June 5, 1956, and drove through western Kansas, then to Kit Carson, Colorado and then southwest to La Junta.

We used approximately two days in a survey of area 10 which lies south of La Junta. From La Junta, we drove southeastward to Springfield, Colorado, then south from Springfield to Boise City, Oklahoma, and then west to Clayton, New Mexico.

After two days of study on area 7, we went to Amarillo, Texas, and then northeast to a large grassland area north of Miami, Texas, in Roberts County. We returned to Hays late on June 11 and had our photos and notes processed.

We left Hays again on the morning of June 16 and drove through a large area in western Kansas, south of Hiway 40, then back to Hiway 40 and on into Colorado. We examined the grasslands in Colorado along Hiway 40 from Cheyenne Wells to Denver.

On Monday morning, June 18, we drove north to Fort Collins and then east and north through area 3 and on to Kimball, Nebraska and then north through area 4 to Scottsbluff, Nebraska. We stayed at Scottsbluff for several days during which time we studied parts of area 1, area 2, area 8 and area 9.

We left Scottsbluff, June 23 and drove through area 1 and the west part of the Sand Hills on our way to Chadron, Nebraska. From Chadron we studied the Cahalane area and eastward in area 11, and also south of Rushville, Nebraska, in the Sand Hills.

Next we drove through area 11 on our way to Rapid City, South Dakota. While at Rapid City, we studied various parts of area 11, particularly south and west of Interior and east of Hermosa and Fairburn.

On July 1, we drove through area 5 to Buffalo, South Dakota.

After arranging for a motel room, we visited the northeast part of area 5; then on July 2, we continued our survey through the southeast section of this area and then westward through the northwest portion of the area and on into area 6. In driving through all areas careful attention was given to the distance on each side of the road that certain conditions prevailed. In most cases, we could see for miles on each side of the road. This policy, of making notes on conditions for long distances, was especially valuable during the afternoon of July 2 when a fairly steady rain made travel on dirt roads most difficult. We drove through area 6 and stopped in Baker, Montana for the night.

We drove eastward from Baker to Bowman, North Dakota and then north on Hiway 85 through some beautiful grasslands. However, much of the ground was under cultivation. Clouds and rain continued throughout the afternoon.

While at Watford City, North Dakota, we called Mr. Brown and Mr. Ingalls and then drove west and north to Plentywood, Montana, where we spent the night of July 3. Next day we drove to the Canadian border but found the gate closed at 6:30 a.m. Because of rain we turned back and drove westward to Great Falls, Montana.

On July 5, we drove northward through the Blackfeet Indian Reservation north of Great Falls but found these extensive grasslands to be badly depleted by overgrazing.

During the next three days we prepared maps, photos, and data for use in our meeting with Mr. Ingalls, and Mr. Childs in Scottsbluff on July 12.

We left Great Falls on Monday morning, July 9, and drove through some splendid grasslands on our way to Billings. Too much cultivation was found, however, for any consideration.

We stopped at Custer Battlefield National Monument but it was too late to find the superintendent in his office. After a short stop we drove to Sheridan, Wyoming, where we remained for the night.

On July 10, we drove to Newcastle, Wyoming, from where we studied the north end of area 9 and then on to the west portion of the Cahalane area. That evening we drove to Chadron, Nebraska for the night.

Next day, July 11, we revisited area 11, South of Interior, South Dakota, and later in the afternnon we revisited area 1 on our way to Scottsbluff.

During July 12 we had our conferences in Scottsbluff and then on July 13 (Friday) we revisited area 4 and area 2 on our way to Fort Collins, Colorado.

On Monday, July 16, we revisited the grasslands in east-central Colorado and stayed all night in Limon, Colorado. On July 17 we revisited more grasslands in eastern Colorado, and western Kansas on our return to Hays.

We kept speedometer readings and a "running" account of conditions, close and far, from the roads through all the 9,482 miles traveled.

Often the roads were extremely rough but, along these roads, were found our best grasslands. It was not uncommon to be temporarily lost due to the fact that roads as indicated on the road maps did not exist.

In making observations and in taking notes, consideration was given to the following factors:

I. Plant life
   (a) Abundance and distribution, importance of grasses and forbs.
   (b) Presence of shrubs and trees.

II. Condition of vegetation - state of health, were grasslands badly deteriorated?

III. Topography and scenic quality - was there a variety in topography - level land, gently rolling to rolling, breaks, cliffs, mesas?

IV. Soils - was there a variety of soils from sands to clays?

V. Water supply - were there running streams, springs and ponds?

VI. Animal life - what mammals and birds were found?

VII. Possible size.

Descriptions of areas as found in this study will be arranged in approximately the order in which the survey was conducted.

AREA 10

Area number 10 as suggested by the National Park Service is rectangular in shape and approximately 48 miles from east to west and 36 miles north and south. This area of slightly more than a million acres lies south and east of La Junta, Colorado and covers parts of Otero, Las Animas, Baca and Bent Counties. Perhaps 20 per cent of the total land area is under cultivation or has been cultivated and is now go-back.(See map 2).

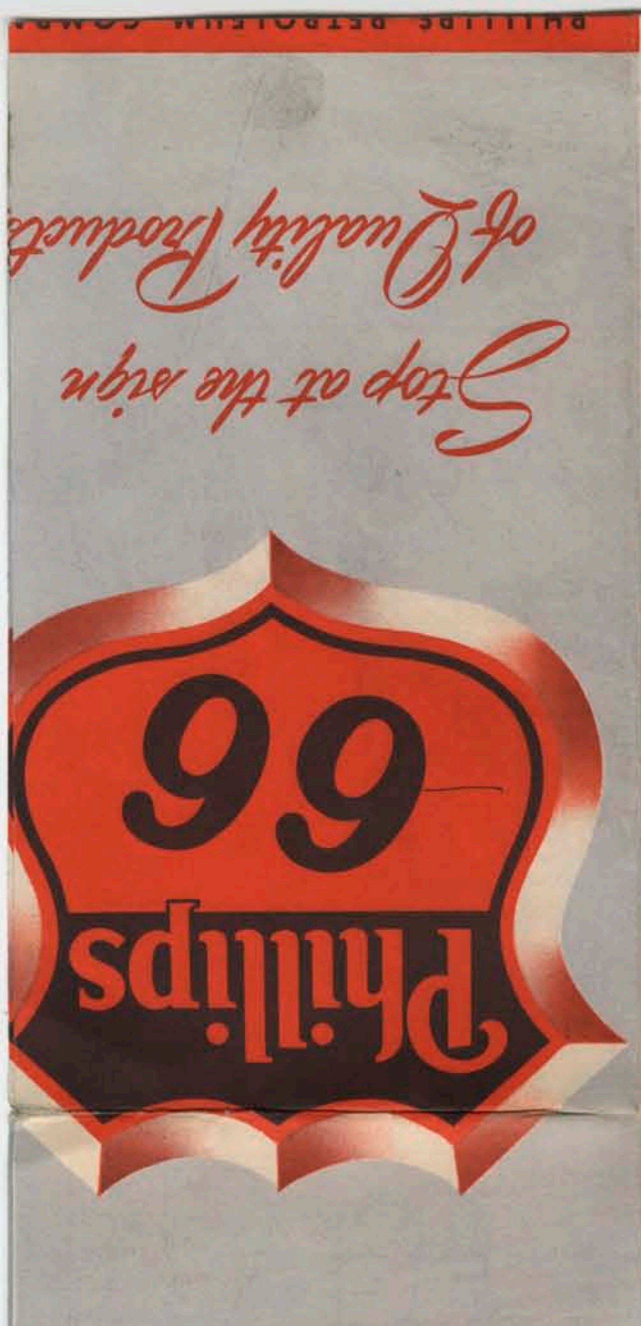
The villages of Higbee, Minaview, Toonerville and Deora are included in this area. All are extremely small. A lack of prosperity

Area 3
Green line - Area Boundry
Blue line - Route of Travel in 1954
Red line - Route of Travel in 1956

Map 2

Area 10
Green line - Area Boundry
Red line - Route of Travel

MAP 2
AREAS 3 & 10


PHILLIPS PETROLEUM COMPANY
Stop at the sign
of Quality Products
Phillips
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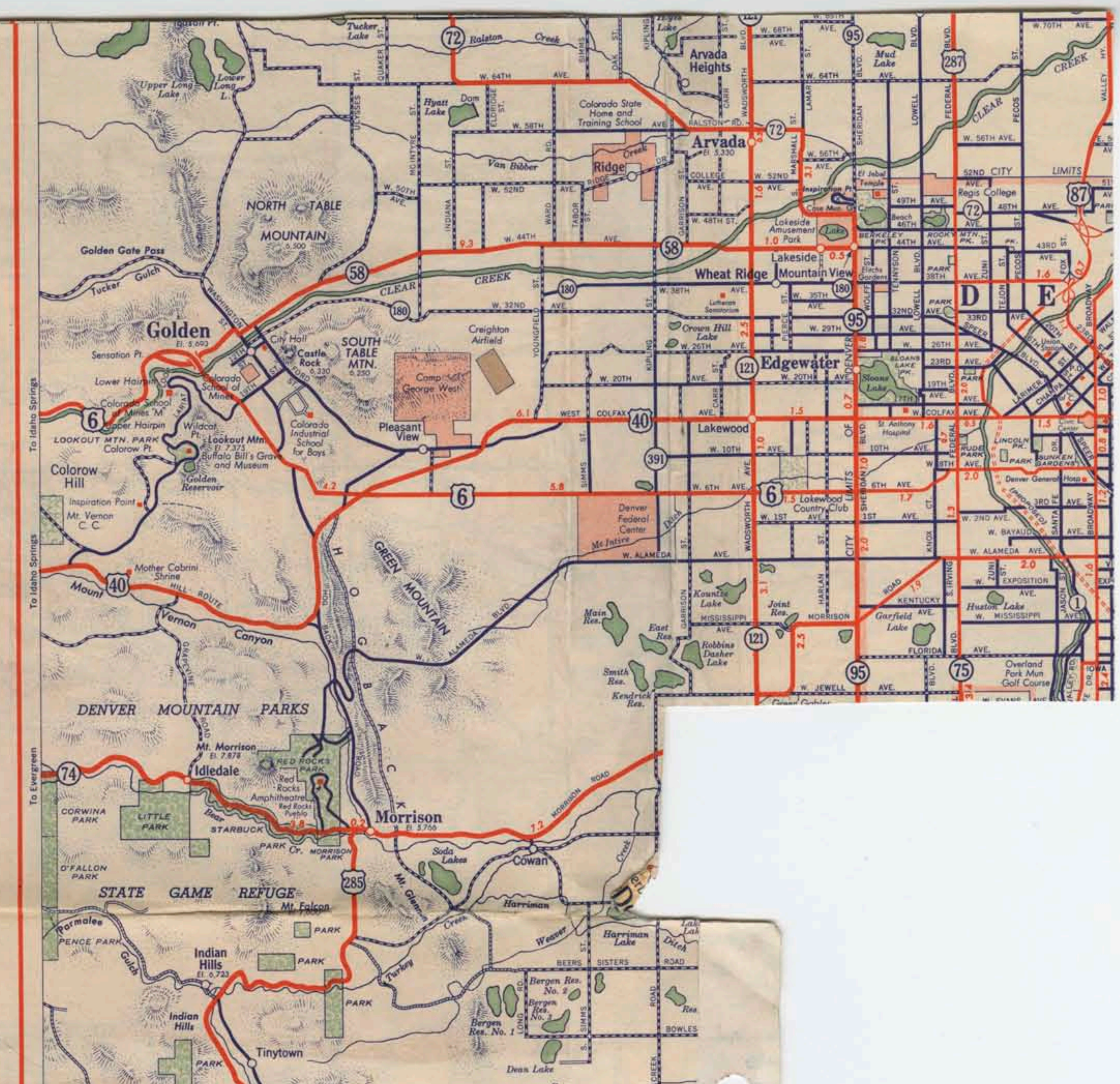
Golden
North Table Mountain
South Table Mtn.
Golden Gate Pass
Tucker Gulch
Clear Creek
Lookout Mtn.
Lookout Mtn. Park
Colorow Hill
Buffalo Bill's Grave and Museum
Golden Reservoir
Colorado School of Mines
Colorado Industrial School for Boys
Camp George West
Creighton Airfield
Pleasant View
Arvada
Arvada Heights
Ridge
Wheat Ridge
Lakeside
Mountain View
Edgewater
Lakewood
Denver Federal Center
Lakeside Amusement Park
Regis College
Sloans Lake
Green Mountain
Hogback
Mother Cabrini Shrine
Mount Vernon Canyon
Denver Mountain Parks
Mt. Morrison
Idledale
Red Rocks Park
Red Rocks Amphitheatre
Morrison
Cowan
Soda Lakes
State Game Refuge
Mt. Falcon
Indian Hills
Tinytown
Corwina Park
Little Park
O'Fallon Park
Pence Park
Bergen Res. No. 1
Bergen Res. No. 2
Harriman Lake
Dean Lake
Kendrick Res.
Smith Res.
Main Res.
East Res.
Robbins Dasher Lake
Kountze Lake
Garfield Lake
Huston Lake
Overland Park Mun Golf Course
To Idaho Springs
To Evergreen

is in evidence throughout the area. Population is relatively light.

The area has three topographic or land types. These are the level or slightly rolling upland, the breaks, and broad slightly rolling valleys.

The upland is located on the north side of the area and projects in necks southward above the break area. These level uplands have the greatest percentage of cultivation. In some places the land is nearly all broken for several miles. Drifting of soil is common (Figure 1). Frequently the grasslands lying adjacent to cultivated fields were badly damaged by dusting.

Surface soil on the level uplands was ashy and light in color with relatively little organic matter and structure. Natural revegetation was common.

Grasses on the upland soils were mostly blue grama (Bouteloua gracilis), with smaller amounts of buffalo grass (Buchloe dactyloides), ring muhly (Muhlenbergia torreyi), side-oats grama (Bouteloua curtipendula), squirreltail (Sitanion hystrix), red three-awn (Aristida longiseta), and galleta (Hilaria jamesii) (Figure 2). Often the level uplands had been contoured to reduce surface run off and furnish additional moisture to the vegetation in the furrows (Figure 3).

Usually the blue grama plants were small with considerable space between bunches. In some cases, however, the nearly dead crowns were 8-24 inches across. Ring muhly occurred in islands several feet across and occasionally was mixed with blue grama and buffalo grass. Galleta was most abundant in favored places such as buffalo wallows or road

ditches where soil moisture was somewhat higher than in surrounding areas.

Most important forbs were scarlet globemallow (Sphaeralcea coccinea), silky sophora (Sophora sericea), skeleton weed (Lygodesmia juncea), and scurfpea (Psoralea tenuiflora). There were numerous seedlings of Russian thistle and annual sunflower.

Southward from the north edge of the area the topography became more rolling and in the lower places were found small stands of squirreltail (Sitanion hystrix), side-oats grama (Bouteloua curtipendula), and red-three awn (Aristida longiseta).

Vegetation, except in low places, was fully dormant and often 80 per cent was dead due to overgrazing and drought.

The breaks occupied areas along the Purgatoire River and Muddy Creek, and were most in evidence in the southwest corner of the area. These breaks had a cap rock of iron bearing sandstone typical of lower Cretaceous below which there was a steep slope into broad valleys below. Above the breaks and extending for some distance into the grassland were numerous junipers (Juniperus monosperma and J. scopulorum) (Figures 4 and 5).

Between and below the breaks were the broad lowlands. Vegetation in these valleys consisted of blue grama as the major dominant. Less important grasses were galleta, ring muhly, buffalo grass and red three-awn. Yucca (Yucca glauca) and cholla (Opuntia spp.) were conspicuous (Figure 6).

Flowing water was found in Purgatoire River but Muddy Creek was quite dry except were a dam was constructed to furnish water storage (Figure 7).

In general, vegetation on this area was dormant and badly damaged from drought and overuse. Numerous half-dead seedlings of annual weeds were found in open spaces especially near cultivated fields where dusting was severe. Grasshoppers were abundant everywhere.

Wildlife found on the area were jackrabbits, eagles and numerous song birds, especially the horned lark.

Between Springfield and Campo, Colorado, was an area of grass some of which was cultivated. Much of the soil was sandy. An area extending 22 miles south of Campo and crossing the Cimarron River was mostly all rough grassland with a small amount of cultivation and natural revegetation.

AREA 7

This area is located in northeastern New Mexico, mostly in Union County with a small portion extending into Harding County on the south. Roughly 10 per cent of the land is under cultivation or has been cultivated (See map 3).

The town of Capulin is at the northwest corner of the area. Clayton is at the northeast corner at the intersection of New Mexico Hiways 18 and 58, and Federal Hiways 87 and 64. The south line runs approximately along New Mexico Hiway 65. The area occupies over 1.5 million acres. Much of the fairly fine soil is formed from white cherty limestone that is conspicuous on the breaks.

In the 1937 survey, Dr. A. O. Weese of the University of Oklahoma studied this grassland and reported in part as follows: "The New Mexico area proved somewhat more interesting than I expected. The western part is in pretty good shape, with perhaps ten percent of

cultivation. A great deal of the area is under fence but seems not to be badly overgrazed. There is a good seed crop of Grama grass this year and this grass seems to be coming on in good shape, even in abandoned cultivated areas. Of course, the vegetation is not as luxuriant as in the northern tract which we inspected, and could not support as many animals per square mile. The eastern part has been very abused. I believe there is a sufficient area in such condition that it might be worthy of consideration if, for any reason, the northern areas are not available. I would place it far ahead of the northeastern Colorado tract."

Dr. W. B. McDougall, Wildlife Technician, also made a special report, a portion of which is included here. "The entire area may be described as consisting of three plains at three different levels. Most of it is at the middle level, giving that portion of the area a somewhat hilly appearance, and most of the southeastern portion is at the lower level.

identify McDougall grades

"The area is just at the edge of the great short-grass plains, its western end being less than fifty miles from the Sangre de Cristo Mountains. It is decidedly a blue grama (Bouteloua gracilis) country, this species being dominant practically everywhere the land has never been plowed except in some of the lower places. In some places side-oats grama (Bouteloua curtipendula) is mixed with it but the blue grama is the common grass. This is in sharp contrast to the grassland examined last summer north of Scottsbluff in Nebraska, where the blue grama had suffered so much from drought that it was not conspicuous. About twenty miles northeast of the town of Roy there is a small

valley where alkali sacaton (Sporobolus airoides) is dominant and has been mowed for hay but this is the only place where I saw this species in any abundance. Nearly everywhere where blue grama is dominant there are numerous scattered yuccas and often prickly pears (Opuntia sp.).

"Traveling east, about eleven miles east of Mosquero, on state highway 65, one descends by a long, steep grade into a broad valley, the lower level plain mentioned above. This is characterized in part in shrubs, principally mesquite (Prosopis velutina) and cholla (Opuntia sp.) and in some places dense patches of sagebrush (Artemisia filifolia), while the common grass here is hairy grama (Bouteloua hirsuta). In the hills to the west of this lower plain there is a considerable amount of juniper.

"Throughout the area, but more especially through the central portion, there are natural depressions that have filled with water, thus forming small lakes without inlets or outlets. Water for the animal life is, therefore, not a problem.

"In my opinion this area is too far from the center of the shortgrass plains to be entirely typical, or to completely satisfy the objects of the Committee on Ecology of Grasslands of the National Research Council. This is evidenced by the presence of juniper, mesquite, and cholla on the area. On the other hand, this area would be much better than nothing and has the advantage that it could possibly be acquired at a reasonable price. If a suitable grassland cannot be obtained nearer the center of the typical shortgrass plains, I recommend that the Committee give this area further consideration."

In the study of 1956 it was found that the area slopes from the northwest corner of the area toward the east and south. There are five

topographic types described as follows:

Type 1 includes a high section in the northwest corner which consists of a small mountain (Sierra Grande) with an elevation of 8732 feet, and the surrounding grasslands (Figure 8). Grasses on this type were blue grama, ring muhly, buffalo grass, side-oats grama, red three-awn and western wheatgrass. Indian grass was found in road ditches. Most important forbs found in this location were scarlet globemallow, heath aster (Leucelene ericoides), gum weed (Grindelia squarrosa), fringed sage, western wallflower (Erysissimum asperum), broom snake weed, scarlet gaura, blue flax (Linum lewisi) and Cirsium sp. There is a small amount of farming in this section.

The second type of importance was one of great expanse of rolling plains sometimes surrounded by gently sloped buttes (Figure 9). On the west of Clayton the vegetation was in good condition and growing rapidly (Figures 10 and 11). Here blue grama was very common with less amounts of buffalo grass, galleta, ring muhly and side-oats grama. The main forbs were scurfpea (Psoralea tenuiflora), Cirsium sp, and rayless thelesperma (Thelesperma gracile).

A few miles westward near Mt. Dora several pastures were severely grazed and drought loss ran as high as 80 per cent. South of Cremville were wide uplands occupied mostly by short grasses (Figure 12). Some of the rolling grasslands were covered with dark brown igneous rocks* (Figure 13). In this same locality was a small stream bordered with rocks where big bluestem and silver beard grass were found (Figure 14).

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*Statements concerning geology of various areas were made after consulting with Professor M. V. Walker, Department of Geology, Fort Hays Kansas State College, Hays, Kansas.

About 13 miles southwest of Grenville along New Mexico Hiway 426 was a fairly large tract of ungrazed prairie. Basal cover was 54 per cent, and per cent composition was as follows for various species: blue grama 65, buffalo grass 16.5, galleta 9.2, and ring muhly 6.4 (Figure 15). West of Sofia was a wide range of grasslands on gravelly soils, where deciduous trees, in excellent condition, were scattered along lowlands and streams (Figure 16).

The third type was located to the south of the plains section. Extending mostly across the area on Hiway 58 is grassland on loam, slightly sandy, to sandy soil. Near Clayton the topography is characterized by steep sandy banks with yucca, ill-scented sumac (Rhus trilobata), and sand sage (Artemisia filifolia). Scattered junipers were found on the hills. Grasses along ditches and in natural-low places were big bluestem and sand bluestem. On gravelly knolls were scattered bunches of little bluestem. Blue grama and side-oats grama were common on the flats.

Farther west and at a lower level on Hiway 58 the soil was slightly heavier than eastward and largely occupied by blue grama and its associates. Near the western boundary of the area was more sandy gravelly soil on rolling topography (Figure 17).

In the southeast corner of the area was the fourth type, a level treeless plain with a good stand of blue grama and buffalo grass (Figure 18). There were no buttes but westward were shallow ravines. Along the ravines or near farm homes were scattered stands of deciduous trees (Figure 19).

The fifth type was found mostly in the south-central portion of the area where juniper breaks are extremely conspicuous. Here was an

understory of bluestems, side-oats grama, and other mid grasses (Figure 20).

In general the vegetation in area 7 was in much better condition than in area 10. Plants were growing vigorously from recent rains. Many jack rabbits, several antelopes, and numerous songbirds were seen.

TEXAS GRASSLANDS

In an attempt to find other areas than those proposed for study, inquiry was made of grassland workers at Amarillo, Texas, and elsewhere. It was suggested that a good grassland area could be found in Roberts County, northeast of Amarillo. Roberts County is in the Panhandle of Texas. Miami, the county seat, is a town of 646 population. The county is 30 miles square and has an area of 576,000 acres (See map 4).

Three land types were found in this area the most extensive of which was the rolling upland with deep tight soil that lies on both sides of the Canadian River and Red Deer Creek (Figure 21). On this type of grassland an ungrazed area was studied. Here basal cover was 20.7 per cent. Percent composition was as follows: little bluestem 30, side-oats grama 28, blue grama 24, purple three-awn 7, silver beard grass 6, western wheatgrass 3, and hairy grama 1. Yucca was fairly conspicuous. Near the streams was a broad belt of breaks (Figure 22). Here natural erosion had prevented accumulation of top soil in many places. Grasses were mostly big bluestem, silver beardgrass and side-oats grama. Junipers were scattered over the steepest slopes and yucca lower down the hillsides. Above the steep slopes was an open stand of cats claw (Acacia greggii), mountain mahogany

(Cercocarpus montanus), and ill-scented sumac (Rhus trilobata) (Figure 23). Along the streams were wide valleys with occasional dense stands of elm, hackberry, cottonwood, and salt cedar near the water (see Figure 23). Near the east side of the county the soil was more sandy than westward and here many mid grasses were found. It was estimated that about 10 per cent of Roberts County was in cultivation.

In western Kansas an attempt was made to locate an extensive grassland that might deserve consideration. Those surveyed, however, proved to be badly deteriorated by overgrazing and drought, or, with too large a percentage of cultivation.

In eastern Colorado vast grasslands were found but damage from overuse and drought were often little short of tragic. Areas along Hiways 36, 24, and 40 were given careful consideration and it was evident that it would require many years of protection from grazing to restore these areas to climax conditions (Figures 24 and 25).

AREA 3

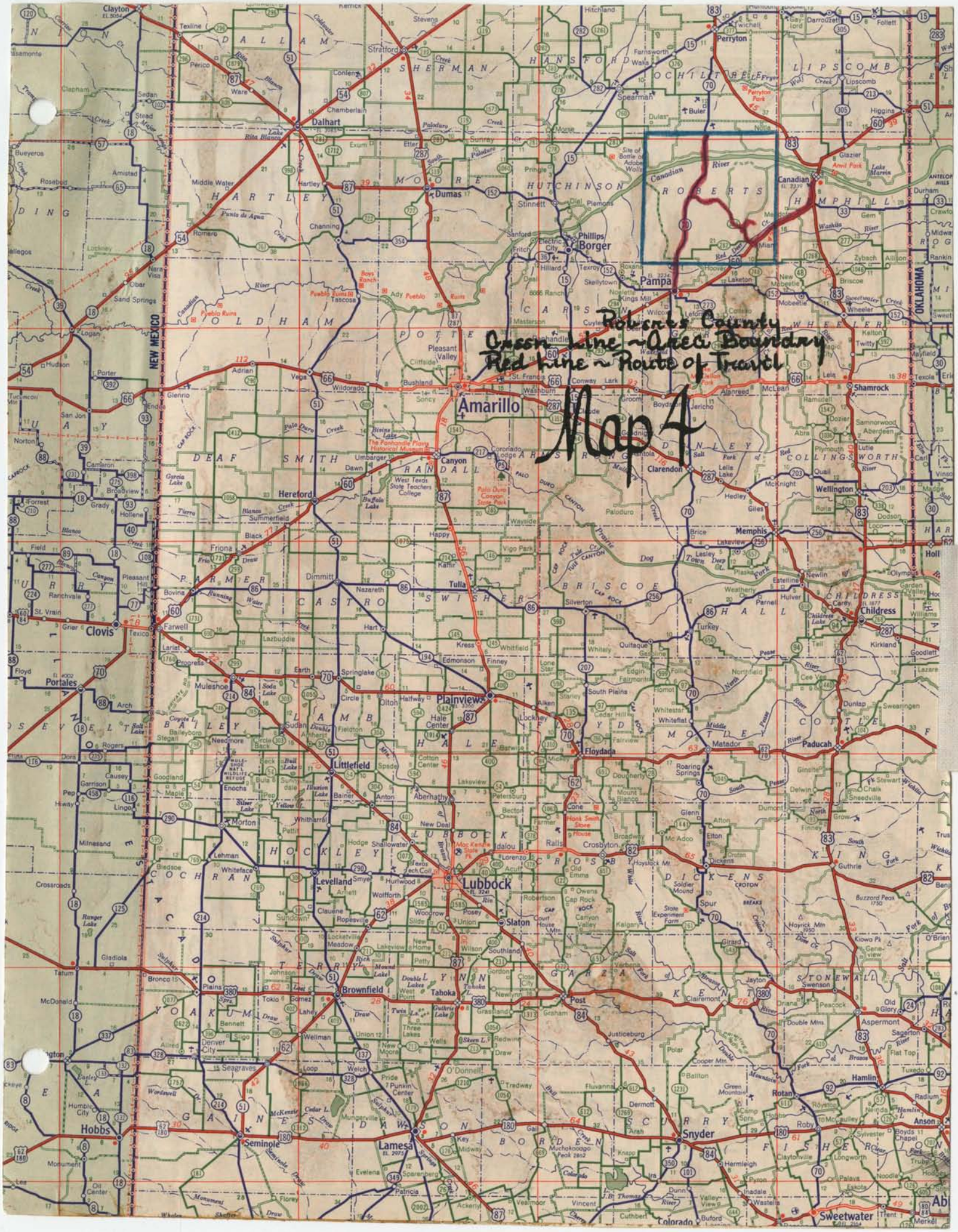
This area was considered by members of the Grassland Committee in 1937. Here is recorded the comments by Dr. B. C. Tharp. "Dr. Weese and I found the area to be badly over-grazed, quite generally populated and cut up both by numerous improved dirt roads and the Burlington Railroad branch. Much of the area is thickly covered with cacti. In short, I would put this area last choice on my list even without having seen Area No. 2. If Area No. 2 is worse than Area No. 3 it is worse than impossible."

Descriptions of portions of Area 3 have been given in a previous survey (see Report of Study of Weld County and surrounding areas by Albertson and Tomanek, 1954). On the recent study the area was crossed along Colorado Hiway 14 from Fort Collins to New Raymer and then north to Bushnell, Nebraska, on a gravel road. At a later date a crossing was also made from Cheyenne, Wyoming to Fort Collins, Colorado on Hiway 87. Description of this grassland may be found in the 1954 report, and its rating in comparison to other grasslands studied may be found in a summary table of the present report (See map 2).

AREA 4

In 1937, Dr. V. E. Shelford wrote briefly as follows concerning Area 4: "This region was inspected at the suggestion of Mr. Green of the Scottsbluff Chamber of Commerce. The central part of the area is mainly composed of the level valley of Pumpkin Creek. In the eastern half of this there is some irrigated land. The western part is rolling. The north edge of the area lies in the Wild Cat Ridge which furnishes protection on the north. The Wild Cat Ridge includes peaks, some of which rise more than a thousand feet above the floor of the North Platte Valley. In this area lie the Scottsbluff National Monument and the Wild Cat Hills Game Preserve.

The grasses showed a better variety of species than other areas inspected. The best grasslands were in the rolling western portion. Antelope, etc., are less abundant than in the area north of Scottsbluff. The area is probably satisfactory but to be large enough would be in the form of a triangle with one apex near Torrington and its base reaching nearly to Kimball."



MAP 4
ROBERTS CTY., TEX.

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Going north from Kimball, Nebraska, on Nebraska Hiway 29, area 4 was crossed near the middle. It was evident from this brief survey that, because of excessive cultivation, this section of land would be unacceptable. At a later date, however, this area was again crossed going west on a gravel road running from Hiway 29 through the northwest section of the area. There were some good grasslands along this road (Figure 26) but much of the land was now being cultivated (See map 5).

Area 8 lies northwest of Laramie, Wyoming and north of Rock River and Medicine Bow, Wyoming. It extends northward toward Medicine Bow National Forest. It is an oval shaped, flat table land roughly 50 miles by 25 with long axis running northwest and southeast (See map 6).

The area was, by far, the driest and most deteriorated grassland that was studied in the summer of 1956. Drought loss would run as high as 90 percent over much of the area. Cover was very open with many dead crowns of plants (Figures 27). Winter fat (Eurotia lanata), and salt bush (Atriplex canescens) were the dominant plants (Figure 28). State of deterioration, alone, would disqualify this area from further consideration. Four pronghorn were seen here.

AREA 9

Area 9 is located southwest of Newcastle, Wyoming and extending toward Lance Creek, a small town northwest of Lusk, Wyoming. The area is oval shaped and extends roughly 48 miles north and south and 24 miles east and west (See map 6).


Area 4
green line - Area boundary
red line - Route of travel
Map 5
SOUTH DAKOTA
WYOMING
COLORADO
INDIAN RESERVATION
Phillips 66
OMAHA 490 Miles CHEYENNE, WYO.
To Casper
To Guernsey
To Cheyenne
Chadron
Crawford
Harrison
Hay Springs
Rushville
Gordon
Merriman
Hemingford
Alliance
Torrington
Mitchell
Scottsbluff
Gering
Minatare
Bayard
Bridgeport
Kimball
Sidney
Chappell
Oshkosh
Lewellen
Ogallala
Hyannis
Arthur
Julesburg
Grant
Holyoke
Haxtun
Sterling
Imperial

MAP 5
AREA 4

The topography of the area is very broken but there are no mountains closeby. The Cheyenne River bisects the area from west to east.

Vegetation in the south part of the area tends to be of woody nature with many shrubs, forbs and deciduous trees (Figure 29 and 30). Eastward the topography is more gentle than mentioned above and grass forms a better cover. Pines are common on the breaks (Figure 31).

The north end of the area is rolling, but more sandy and with a better cover of vegetation than southward (Figure 32).

Near the middle of this grassland, grazing is close and plants were generally in poor condition. Blue grama, needle-and-thread, Sandberg bluegrass and thread-leaved sedge made up most of the vegetation. Big sage and cacti were common.

Several white-tailed jackrabbits, a black-tailed deer, two pronghorn kids and an adult pronghorn were seen in this area. There were numerous oil wells with several small fields located within the area.

AREA 1

This area, located north of Scottsbluff, Nebraska, extends roughly 40 miles north and south and 50 miles east and west. Most of the area is in Nebraska with a small portion in southeast Wyoming (See map 7).

A portion of the report in 1937 follows: "This area, made up for the most part of gently rolling plains, is covered with the finest growth of grasses seen on the survey. For the most part the region is uncultivated, cattle raising being the principal industry. Ranches

are few and far between. Water is found in abundance at Agate and in the nearby region. Important animals are present in encouraging numbers, antelope being found throughout most of the area. Four of these animals were observed one day and three another day (two of these were very young kids). A total of twenty-one species of birds was noted in the area."

In the present survey it was found that much of the east end of the area for consideration suggested by the Park Service was largely cultivated land, therefore, the eastern boundary has been relocated several miles to the west. This leaves the remainder with perhaps five percent cultivation. The south boundary runs near the Interstate Irrigation Canal. The area as given in this report contains slightly in excess of a million acres.

Topography was mostly rolling with some level land and in other places fairly prominent breaks. North of Mitchell is a fine weakly cemented sandstone from which a fine sandy soil is derived. North and east of Scottsbluff is a caprock of mortar bed type that contains fine sand, a "caliche". Much of sandy loam soil is derived from this cap rock.

The White River crosses the northeastern corner and the Niobrara River enters this grassland from the northwest and flows southeastward to Agate where it turns east and leaves the area. Small creeks were fairly common, some with beautiful clear water fed by springs. Wind mills are common. Fossil beds are found near Agate.

Uplands with rolling topography often extend for miles in every direction. As one would drive over the highest point, a broad upland

valley appeared ahead before another high point was reached. Thus this rolling grassland was a succession of broad uplands followed by extensive high valleys for miles and miles (Figures 33 and 34).

Vegetation is composed largely of blue grama, thread-leaved sedge and needle-and-thread. Where the soil is mostly sand, sand reed grass was easily seen in dark colored patches scattered over the hillside (Figure 35).

Little bluestem was found on sand knolls near small blowouts (Figure 36). It looked as if sand bluestem and blowout grass would be found in these blowouts. Sand sage was also common on the more sandy types. Some also on the uplands and in the valleys (Figures 37 and 38.)

Less important grasses were Indian ricegrass found in ditches and disturbed places, also June grass and Sandberg bluegrass were scattered throughout the more important grasses in some locations.

Forbs consisted of scarlet globemallow (Sphaeralcea coccinea), scurfpea (Psoralea tenuiflora), skeleton weed (Lygodesmia juncea), (Pentstemon albidus), downy painted cup (Castilleja sessiliflora), Allium sp., Lambert's loco (Astragalus lambertii), narrow-leaved puccoon (Lithospermum linearifolium), broomweed (Gutierrezia sarothrae), Petalostemon sp., Meriolix sp., Haplopoppus spinulosus, blazing star (Liatris punctata) and Optuntia sp.

An ungrazed area on rolling upland 19 miles northeast of Scottsbluff was studied. Basal cover was 40.6 percent. Percent composition was thread-leaved sedge 48, blue grama 37, needle-and-thread 15. A study was also made on the Scotts Bluff National Monument on a mound near the base of a bluff. Basal cover here was

31.5 percent and percent of composition was little bluestem 33, thread-leaved sedge 31, blue grama 13, needle-and-thread 12, side-oats grama 3, June grass 3, slender wheatgrass 2, sand reed 2, and green needle grass 1.

Level upland was hard to find. Some, however, was studied 18 miles east and 21 miles north of Scottsbluff (Figure 39). Another area was found south and east of Van Tassell, Wyoming (Figure 40).

Breaks were found near the south edge of the area above the Interstate Irrigation Canal, along the Niobrara River, and adjacent to the White River.

About 20 miles east and 5 north of Scottsbluff were fairly steep slopes but exposed rock was not conspicuous. Here were found significant effects of close grazing. Overuse had greatly reduced the amount of needle-and-thread (Figures 41 and 42).

A greater exposure of rock was found 14 miles north of Scottsbluff where steep banks of bare rock were common. "Signal rock" is one such place where the owner of the land said that Indians would hide on top the rock and signal to those below near a spring where wild game were coming in for water (Figure 43). In these lowlands on slightly heavier soils was a good mixture of western wheatgrass and, nearer the water, were certain sedges and rushes.

Breaks were also located 11 miles north of Mitchell on Hiway 29. Here the fine sandstone breaks were less steep than north of Scottsbluff (Figure 44).

North of Henry 51 miles and near Van Tassell, Wyoming, on the Niobrara River was a broad valley with breaks on each side (Figure 45).

On these breaks was an open stand of blue grama, needle-and-thread and thread-leaved sedge on the highland and western wheat grass in the valley.

One of the most interesting sights on the area was the clear stream flowing from springs 21 miles north of Henry. Here were the common plants and animals that usually inhabit locations of this kind (Figure 46).

Deciduous trees and coniferous trees were relatively scarce in this grassland but an attempt was made to include some in the northeast corner near Crawford.

In some ways this area appears a bit monotonous because of the vastness of the rolling grasslands and the limited number of species of grass. However, what it lacks in variety it perhaps makes up in vastness.

Ten pronghorn and numerous white-tailed jackrabbits were seen here. There is also a bird refuge near the southeast corner.

Area 2

This area, located in general north of Cheyenne, Wyoming, is approximately 36 miles north and south and 50 miles east and west. The major grassland areas are more gently rolling than are those of Area 1.

Vorhies gave a rather complete description of this area in 1937. "That portion (southeastern) of Area No. 2 traversed by Highway 85 is potentially beautiful rolling grassland, broken slightly by Horse Creek. Gently rolling would describe this part. There is a medium degree of overgrazing and some disturbance by plowing. Plowing disturbance probably does not amount to more than 10% - 25% for this portion.

"The middle portion--the wedge between Highways 85 and 87, is apparently much the same as the southeastern part, though not much of the top (north) part of the wedge was seen. In the southern point of this wedge is probably the heaviest overgrazing and greatest percentage of plowed land. Perhaps as much as 25% of the land here has been plowed.

"The western portion of the Area, west of Highway 87, rises toward the west, and is more steeply rolling, cut by the deeper valleys of Bear, Little Bear, and Horse Creeks, with high ridges between. While this is somewhat overgrazed, there are some areas of very good grass, and there is much less plowed land. It is estimated that not more than 10% of this is broken up, unless immediately adjacent to Highway 87. I believe not over 10% of this entire section of Area 2 has been plowed.

"Breaks along the valley slopes are pronounced here, giving somewhat greater variety, though it is doubtful if the whole of Area 2 gives any more diversity of grass types than does Area 1--perhaps not so much. There are limestone-topped ridges at the western edge, but no sand-hill country could be seen in the whole of Area 2. Cercocarpus bush(low) occurs along the breaks, especially of this western portion, but there are no pines or other trees in the breaks.

"The high western edge as far as observed drops off abruptly into the valley in which lies the railroad and the western boundary of the area appears to follow approximately the 'rim'.

"The diversity of contour is about the same as that of Area No. 1, less if anything than of No. 1, and nothing like so great as that of the uncharted area visited by the Committee south of Scottsbluff.

"There is no irrigation agriculture, and the whole area could be readily recreated a grassland, givenprotection and time. Some sheep grazing has produced areas of rather heavy overgrazing, but nowhere to the point of serious erosion. The degree of overgrazing averaged for Area No. 2 as a whole is a little greater than in Area No. 1.

"Although this appears to be more of a 'hard land' area than No. 1, this observer did not detect noticeable differences in the grasses (or weeds) present. However, he is not sufficiently familiar with the grasses of the region to pass really expert judgment on this point.

"The bird and mammal life is essentially similar to that of other areas visited. More Richardson ground squirrels were observed and a few more whitetailed jackrabbits, but there is no serious infestation by either. Three antelope, a buck and two does, were seen at rather close range near the western edge.

"the area is quite as well and perhaps even better watered than is Area No. 1."

In 1956 vast grasslands were found on both sides o f Hiway 85 between Meriden and Cheyenne. In some places the broad table lands and valleys were surrounded or bordered on one side by rather steep bluffs (Figure 47). Usually, however, the gently rolling prairies extended for miles in every direction (Figures 48 and 49) (see map 8).

At the northeast corner of the area are Bear Mountains (Figure 50) and Lonetree Canyon (Figure 51). Along these steep ravines and cliffs is a wide variety of deciduous trees and coniferous trees and other woody plants. It would seem logical to find some of the more mesic grasses and forbs growing in these protected places.

West from Hawk Springs toward Chugwater are large areas of nearly level land. Nearest the road was much cultivation (Figure 52) but farther south less cultivation occurred and here beautiful level prairies were found (Figure 53).

South and west from Chugwater are steep rolling grasslands with mountain mahogany (Cercocarpus montanus) dotting the steep slopes. Beneath these woody plants were scattered stands of bluebunch wheatgrass (Agropyron spicatum) and beardless wheatggass (A. inerme) (Figure 54).

In the southwest corner of the area are the Mesa Mountains that extend to nearly 7,000 feet elevation and give great diversity to topography of the area (Figure 55). Between the buttes are high table lands largely occupied by an open cover of grasses (Figure 56).

The area is crossed from west to east by Bear Creek, Little Bear Creek, Horse Creek, and Lodgepole Creek. These streams should furnish a plentiful supply of water except, perhaps, in extreme drought.

Vegetation on this area was largely grassland except where topography and altitude were such that trees and shrubs could be supported in growth. Even these favored locations had a lower story of grasses and forbs.

Blue grama and western wheatgrass were two of the most important species. Buffalo grass, needle-and-thread and thread-leaved sedge were nearly always present but of less abundance than those mentioned above. Prairie June grass and Sandberg blue grass were widely distributed but seldom abundant. Little bluestem and side-oats grama occurred on slopes with open soil. Sand reed was fairly common

on sandy sites. Six-weeks fescue, present almost everywhere, was most abundant where grazing was heaviest.

Principal grassland forbs found on the level to rolling topography were scarlet globemallow, scurfpea, many-flowered aster, beard tongue, blazing star, velvety golden rod, fringed sage and Opuntia fragilis. On the rough sandy to gravelly sites were mountain mahogany, lead plant (Amorpha canescens), ill-scented sumac, sand sage, eriogonum and yucca. Less than 10 percent was under cultivation.

Both black-tailed and white-tailed jackrabbits were found and five pronghorn were seen in this area.

AREA 11

Area 11 as suggested by the Park Service is so extremely large that it was very difficult to describe as one unit. Its description, therefore, will fall under three headings, namely the Cahalane Area, Area 11 west, and Area 11 east (see Map 9).

THE CAHALANE AREA

In 1937 the Cahalane area - part of Area 11 - was briefly described by Dr. King as follows, "Beginning about three miles west of Chadron, Nebraska, there is an excellent piece of range land which we went through on Nebraska Highway No. 19. We were unable to make any side surveys at this point but this land stretched as far as we could see in either direction. At the South Dakota boundary, there was quite a little cultivated land and I understand from the Superintendent of the Wind Cave National Park that there is quite a little cultivation southwest

of Wayside, Nebraska. If so, this area would not be large enough.

"However, it seemed to us that it was worth securing a little further authoritative information about this area as there might be a sufficiently large area of suitable grassland available there and, if so, it would seem a reasonably promising situation. On the northeast, it could extend to the Pine Ridge Indian Reservation which would serve in some measure as a buffer zone on that side."

In November 1938, Victor H. Cahalane submitted to the Director of the National Park Service a comprehensive report on the grassland now designated as the Cahalane area. A very small portion of his excellent report is included here.

"An area is suitable for designation as a Great Plains National Monument must meet a number of important specifications if it is to serve its purpose. It must for several reasons be of large size. From the recreational point of view size is important, for the greatest inspirational value of the plains is to be gained from natural areas for some types of research. The preservation of truly natural conditions of vegetation requires that outside, mancaused factors be excluded. To prevent pollution of even a comparatively small central area by exotic plants that may spread and travel as seeds on the wind, a wide surrounding buffer zone under rigid control is a requirement. Also, if the large members of the fauna of the Great Plains are to be restored under natural conditions a great acreage is necessary. Bison, antelope and elk need large amounts of forage which in the shortgrass type is not truly abundant. If the bison, particularly, is to be preserved as a wild species in the United States it must be granted a large natural range free

from the domesticating confinement of small fenced parks. From a consideration of all these points, it seems that a million acre tract would be needed.

"Size being a necessity, it is also evident that the shape of the area selected would be important. The most ideal one would be essentially isodiametric, for an elongated section of land would be more and more exposed to outside influences with any increase in the ration between length of boundary and acreage.

"The area herewith proposed does not measure up to the ideal area originally sought by the Committee on Ecology of Grasslands of the National Research Council. Perhaps the most important respect in which it falls short of the ideal is its elongated, irregular shape. The area, however, approaches the ideal sufficiently closely in size and in compactness to recommend it for monument purposes, and other considerations of location and land status make it highly desirable."

The Cahalane area considered in the 1956 study lies north of Crawford and Chadron, Nebraska and extends north to a line three miles south of Edgemont, South Dakota (See map 9). It is over 50 miles east and west and about 30 miles north to south, with an area of about 1 million acres. The east end of the south line has been pushed north-ward to exclude an area with much cultivation along the White River.

Northwest of Chadron along Hiway 19 are vast grasslands on rolling topography. These prairies were some of the best found in any of the areas studied. Extending for miles, vegetation and topography appeared much the same (Figure 57). Here the cover of

mostly blue grama, Sandberg bluegrass, needle-and-thread, western wheatgrass, thread-leaved sedge, buffalo grass and green needle grass in favored locations, and many forbs were in good condition (Figure 58). Forbs were Indian breadroot (Psoralea esculenta), wild flax (Linum compactum), scarlet globemallow (Sphaeralcea coccinea), scurfpea (Psoralea tenuiflora), Thelesperma spp., broomweed (Gutierrezia sarothrae), prostrate scurfpea (Psoralea cuspidata), western wallflower (Erysisimum asperum), Opuntia spp., gumweed (Grindelia squarrosa), Plantago purshii, Astragalus spp, Vicia spp, Cogswellia spp., Psoralea argophylla, purple prairie clover (Petalostemon purpureus), Gilia spp. In some of the low places were dams to supply livestock with water (Figure 59).

Going east on Hiway 18 toward Oglala, South Dakota, grasslands extended for great distances on each side of the road (Figure 60). In addition to the plants listed above were little bluestem, sideoats grama and yucca as indicators of a slightly sandier soil. Nearby was a broad rolling lowland with heavier soil where western wheatgrass and green needle grass were common (Figure 61).

Eastward on Hiway 18 near Oglala, topography became much rougher near White River (Figure 62) and beyond Oglala are trees and lakes along the River (Figure 63 and 64) and coniferous trees along Pine Ridge Escarpment (Figure 65). Overgrazing was common in many pastures near Oglala and also in many pastures near the west end of the area.

On an ungrazed site quite similar to many of the hill tops in the east end of the Cahalane area but located 15 miles east of Chadron, Nebraska, basal cover was found to be 31.8 percent. Percent composition was needle-and-thread 71, little bluestem 10, thread-leaved sedge 6,

plains muhly 5, side-oats grama 3, June grass 2, blue grama 2 and western wheatgrass 1.

Twenty miles northwest from Oelrichs on a gravel road, the prairie begins to give way to post climax pines and grasses (Figure 66).

Westward through the pines is another broad rough grassland where side-oats grama, needle-and-thread, little bluestem and blue grama are common (Figure 67). Deciduous trees were growing along Hat Creek. Looking southwest from this position Sandberg bluegrass and big sage were conspicuous (Figure 68).

For several miles south of Edgemont, South Dakota, the topography is broken and much partly disintegrated stone is exposed to weather (Figure 69). Southward, however, prairies extend for miles in every direction (Figure 70).

It is doubtful if more than 10 percent is under cultivation.

AREA 11 West

Because of the extensiveness of area 11 an attempt was made to select small sections that would qualify as a grassland monument. Area 11 west lies east of Hermosa, Fairburn, and Buffalo Gap, South Dakota. It is 33 miles long from north to south and only 15 miles in width. The acreage is about one third million acres (See map 9).

This grassland is largely rolling hills covered with a fairly solid stand of grasses and forbs. The Red Shirt Table appeared to be the most outstanding topographic feature; however, it was not examined in this study. The Cheyenne River cuts through the southern corner and runs in a deep canyon most of the time.

The largest concentration of cultivation is in the southwest corner on an upland west of the Cheyenne River (Figure 71). Some farming was also found on the flat bottom land along the Cheyenne River and along Spring Creek and French Creek.

East of the Cheyenne River on top of the west end of Cuny Table was an ungrazed area found to have a basal cover of 42.8 percent. Composition was 51, 23, 13, 6 4, and 3 percent, respectively, for thread-leaved sedge, blue grama, buffalo grass, Sandberg bluegrass, needle-and-thread and squirreltail.

South of Rapid City were fairly good grasslands some of which were broad, flat lowlands on silty soils dominated by western wheatgrass (Figure 72). Deciduous trees usually were scattered along the stream banks.

On an ungrazed lowland with tight soil 6 miles east of Fairburn basal cover was found to be 8.3 percent. Percent composition for western wheatgrass was 77. Blue grama was 18, thread-leaved sedge 3, and buffalo grass 2.

East of Hermosa were extensive grasslands that stretched for miles across the rolling plains (Figure 73). Often broad valleys occurred between higher hills. These lowlands were usually disected by small creeks with deciduous trees bordering the streams (Figure 74).

Grasses on these lightly grazed areas were blue grama, buffalo grass, needle-and-thread, and thread-leaved sedge. Most important forbs are scurfpea, fringed sage, scarlet globemallow, snakeroot (Echinacea angustifolia), western wallflower (Erysissimum asperum), and Opuntia spp.

Southeast of Fairburn, though vast, the grasslands were generally heavily grazed (Figure 75). In this section the soil was clay-like and occupied mainly by western wheatgrass and green needle grass (Figure 76). Some small depressions showing alkali were occupied by saltgrass, western wheatgrass, and alkali sacaton (Sporobolus airoides).

Farther east in the area the topography becomes steep and grades into badlands. Here for many miles is a magnificent example of what erosion can do (Figure 77 and 78).

No pronghorn were located in area 11 but white-tailed jackrabbits were common.

AREA 11 East

Area 11 East is located south of the Badlands National Monument in South Dakota. It is roughly 40 miles from east to west and 30 miles from north to south. The area is approximately 750 thousand acres (See map 9).

These grasslands were much the same as those in Area 11 west except that, in area 11 east, the vegetation is in much better condition due to lighter grazing during past years.

South of Interior was considerable cultivation but the grasslands that remained were mostly clay flats similar to that shown in Figure 79. Southward were vast rolling prairies with deciduous trees in the ravines (Figure 80). Excellent condition was indicated by the fact that big bluestem, little bluestem, switch grass and other mesic plants were abundant. Even lead plant, whose absence is an indicator of heavy grazing, was abundant (Figure 81). This condition of extensive

rolling prairies continued for miles to beyond Kyle (Figure 82). In all of these areas blue grama, needle-and-thread, buffalo grass and thread-leaved sedge on the uplands, and side-oats grama, little bluestem, big bluestem, switch grass, Scribner panic grass, and Indian grass on the slopes and lowlands.

Forbs found here in addition to those mentioned in Area 11 West were green sage (Artemisia dracunculoides), daisy fleabane (Erigeron ramosus), plains goldenrod (Salidago mollis), Aster oblongifolius, Aster multiflorus, and prairie cone flower (Ratibida columnifera).

Southwestward, western yellow pine made its appearance, and there, was scattered over the grassland slopes (Figure 83). As the breaks became more prominent and steep cliffs occurred, the pines became more abundant and often were found in large groves (Figure 84).

AREA 5

Area 5 lies south of Buffalo, South Dakota. It covers an area of over 500,000 acres that lies mostly between two units of Custer National Forest. Some of the west unit, however, is included in the west end of the area (See Map 10).

In 1937, Dr. King wrote the following concerning the area: "We spent nearly a full day surveying the area northeast of Newell, South Dakota. From Newell we followed U.S. Highway 212 to Mud Butte and thence north to Zeona to State Highway 8 north to Strool thence west to Buffalo, South Dakota.

"There is a very large area here of range land with very little cultivated land and, in our opinion, this is sufficiently promising to justify looking into with some care. From its present condition, it

would seem to have a high degree of acquirability. Some of it, especially on very heavy gumbo, has been so badly overgrazed as to have deteriorated to an extreme but very little of it has ever been plowed. There is quite a variety of soils represented and some fairly broken country, but not a great deal of winter protection such as found in Area No. 4.

"While there are disadvantages as well as advantages about this area it does seem as though it might hold the greatest probability of being able to secure the very large area which the Committee considers desirable for the purpose in view."

Topography varies from level to rolling with some of the Custer National Forest on small table lands at higher elevations. The flat portion is broken by small domes which break sharply with the plain. An area east of Buffalo has several sand dunes with small blowouts.

Near the south edge of the area, grazing is quite heavy and on heavy clay soil the cover is very open and composed mostly of green needle grass and western wheatgrass (Figure 85). Farther into the area and at a slightly higher altitude, the soil is more open and grazing is less intense. Here the grasses were blue grama, needle-and-thread, western wheatgrass, and thread-leaved sedge (Figure 86). Saltgrass was present in several small depressions showing concentrations of alkali.

Moderately grazed, broad rolling uplands were found 8 miles southeast of Buffalo. Here the cover was mostly thread-leaved sedge (Figure 87). Near the upland shown in Figure 87 was a wide lowland covered mostly with thread-leaved sedge, blue grama, and

needle-and-thread (Figure 88). Other grasses were June grass and Sandberg bluegrass.

Some fairly heavy grazing was found 11 miles south and two miles east of Buffalo (Figure 89). Farther east, however, grazing was moderate and the grass cover was much improved (Figure 90). In the southeast corner little bluestem was quite abundant on slopes along draws.

An ungrazed area 3 miles east of Redig was studied. Here basal cover was 24.4 percent and percent composition for blue grama 53, western wheatgrass 13, needle-and-thread 11, June grass 9, thread-leaved sedge 9, Sandberg bluegrass 4, and sand dropseed 1.

In all of these locations were good stands of such forbs as fringed sage, sand sage, green sage, lead plant, scarlet globemallow, blazing star, scurfpea and hairy goldenaster. Deciduous trees were found along draws and small streams in the Custer National Forest. Coniferous trees were abundant along rock outcrops. We found practically no land under cultivation.

elsewhere dense shelas indicator of no overgrazing, yet the area is reported overgrazed

Twenty-four pronghorn and numerous white-tailed jackrabbits were seen in this area.

AREA 6

Dr. King reported also on area 6: "We went through on U.S. Highway 12 but did not give much attention to the details, even of the portion we passed through. From what I remember of it, I do not think that it would be any more advantageous than Area No. 5 and probably less so."

This area is long and narrow and lies southward from Baker, Montana. Topography is generally quite rough with broad valleys between buttes. These valleys are level but a very high percentage of the flat land was

under cultivation. Cursory examination revealed that this area was far less acceptable than Area 5 (see map 11).

OTHER AREAS

The Sand Hills South of Rushville, Nebraska, were surveyed with the thought of including a portion of these grasslands with the Cahalane area or perhaps east of this area in area 11. The Sand Hills were beautiful and most deserving of being preserved but no way was found to connect them with another area without including a large amount of cultivated land.

Another area lies north of Great Falls, Montana, mostly in the Blackfeet Indian Reservation (see map 11). These grasslands extended as far as one could see in every direction. However, in contrast to the excellent condition of vegetation on the Pine Ridge Indian Reservation, these grasslands were heavily grazed and, consequently, the species composition was greatly different from what was found on ungrazed areas.

Grasslands of the Flint Hills of eastern Kansas and northeastern Oklahoma for many years have been of great interest to people in various professions. For a number of years, there has been much effort given in support of a program of setting aside some of this grassland in order that it might be preserved for use and enjoyment of future generations.

These grasslands are characterized by the presence of a stand of mid and tall grasses on the hilltops. Among these grasses are big and little bluestem, switch grass, tall dropseed, Indian grass and side-oats grama. On ungrazed areas are many forbs. One of the most important is lead plant (Amorpha canescens) (Figures 91 and 92).

In the spring of 1956, a cursory survey was made of a portion of this vast grassland by members of the Kansas Academy of Science. Dr.

MAP 11
AREA 6

Map 11

Area 6
Green Line - Area Boundary
Red Line - Route of Travel

E. Raymond Hall was in the group (the author of this report also) and following is a description of one area visited which Dr. Hall included in a letter to Mr. Ben Thompson of the National Park Service: "A couple of hours ago my wife and I returned from an excursion into the tall-grass prairie of eastern Chase County, Kansas. Unbroken by road for 23 miles from north to south and 14 miles from east to west, this prairie sod on the Flint Hills and in the valleys of the headwaters of the Verdigris River supports, for six months of each year, Texas cattle, which take the place of bison and prong-horned antelope. At one pool below a rock outcrop we watched upland plover, solitary sandpiper, horned lark, lark sparrow, western kingbird, and a greater prairie chicken. The inflated pods on the wild indigo plants are almost fully formed. Jerseytea ceanothus, poppymallow, pentstemon, Missouri evening primrose, and blue-eyed-grass are in bloom. Big bluestem, side-oats grama, switch grass and other components of the true tall-grass prairie flora are in full growth. It was a pleasant day, indeed.

"I said that no roads penetrated this sizeable area. Actually, the new turnpike (a toll road from Kansas City to the Oklahoma border <u>via</u> Wichita, Kansas) cuts through the center of the area from northeast to southwest (it makes me sad) and we talked our way onto this, as yet only partly constructed trafficway, and spun along for 33 miles. Then we found an opening, soon to be closed, in the formidable fence that flanks the turnpike on each side. Once through this we drove overland across the prairie south of the turnpike, in the same manner as, on the previous Sunday, we had explored the prairie north of the turnpike.

Bozaar 144

AXZ 2R-145

146

147

148

149

150

105

AXZ 2R-104

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102

101

100

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98

97

74

AXZ 27-75

76

77

78

79

80

81

AXZ2R-33

32

31

30

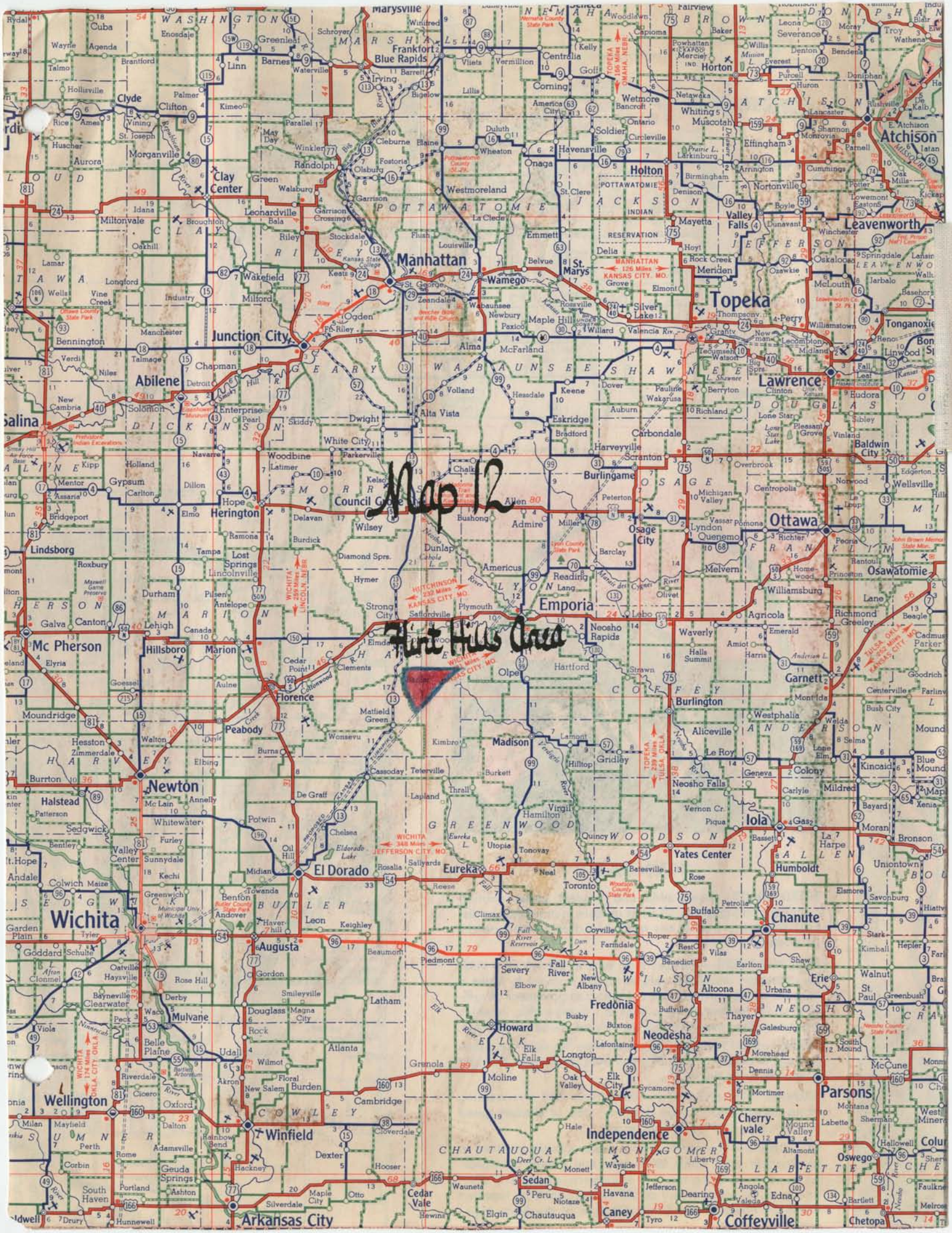
flown 6-23-56

Available in Salt Lake City

SCS aerial photos, from 1 mi + no. of Bozaar, in columns going South, & consecutive columns eastward. The last group (33-30) farthest northeast.

Flint Hills area seen by Dr ERH Chet Brown & me 8-13-57

(Scale approx 1660' per mi about right size)


Map 12
Flint Hills Area
Manhattan
Junction City
Abilene
Salina
Council Grove
Herington
Lindsborg
Mc Pherson
Hillsboro
Marion
Florence
Peabody
Newton
Halstead
Wichita
Augusta
El Dorado
Eureka
Mulvane
Wellington
Winfield
Arkansas City
Clay Center
Clyde
Clifton
Morganville
Randolph
Leonardville
Riley
Wakefield
Milford
Ogden
Bennington
Chapman
Solomon
Enterprise
Abilene
Wamego
St. Marys
Alma
McFarland
Maple Hill
Willard
Topeka
Silver Lake
Rossville
Wabaunsee
Newbury
Paxico
Alta Vista
Volland
Dwight
White City
Woodbine
Parkerville
Navarre
Chalk
Burlingame
Admire
Allen
Osage City
Lyndon
Quenemo
Ottawa
Melvern
Osawatomie
Williamsburg
Lane
Richmond
Greeley
Garnett
Centerville
Burlington
Westphalia
Aliceville
Le Roy
Colony
Kincaid
Blue Mound
Mildred
Iola
Gas
Moran
Bronson
Humboldt
Uniontown
Yates Center
Neosho Falls
Neosho Rapids
Emporia
Americus
Reading
Olpe
Hartford
Strong City
Plymouth
Sallyards
Madison
Virgil
Hamilton
Quincy
Toronto
Eureka
Rosalia
Reese
Climax
Buffalo
Chanute
Coyville
Roper
Farmdale
Rest
Benedict
Vilas
Earlton
Shaw
Erie
Walnut
St. Paul
Greenbush
Altoona
Urbana
Thayer
Galesburg
Neodesha
Fredonia
Howard
Elk Falls
Longton
Moline
Grenola
Latham
Atlanta
Douglass
Rock
Udall
Wilmot
Floral
New Salem
Burden
Cambridge
Oxford
Dalton
Cloverdale
Dexter
Hooser
Geuda Springs
Rainbow Bend
Adamsville
Rome
Corbin
Hackney
Sedan
Cedar Vale
Wauneta
Peru
Niotaze
Chautauqua
Elgin
Hewins
Caney
Havana
Tyro
Independence
Cherryvale
Mound Valley
Parsons
McCune
Dennis
Mortimer
Sycamore
Oak Valley
Elk City
Coffeyville
Dearing
Jefferson
Wayside
Liberty
Altamont
Labette
Oswego
Chetopa
Edna
Angola
Valeda
Bartlett
Tonganoxie
Linwood
Lawrence
Eudora
Baldwin City
Ottawa
Osawatomie
Atchison
Leavenworth
Holton
Horton
Hiawatha
Troy
Wathena
Doniphan
Severance
Powhattan
Kickapoo
Mercier
Whiting
Muscotah
Netawaka
Wetmore
Bancroft
Ontario
Soldier
Circleville
Havensville
Onaga
Wheaton
Duluth
Cleburne
Blaine
Olsburg
Fostoria
Westmoreland
Garrison
Louisville
Emmett
Belvue
Delia
Meriden
Rock Creek
Hoyt
Mayetta
Valley Falls
Winchester
Oskaloosa
Ozawkie
Perry
Williamstown
Lecompton
Midland
Tecumseh
Watson
Berryton
Pauline
Wakarusa
Clinton
Dover
Keene
Eskridge
Bradford
Carbondale
Auburn
Richland
Lone Star
Pleasant Grove
Sibley
Vinland
Harveyville
Scranton
Overbrook
Peterton
Michigan Valley
Centropolis
Norwood
Wellsville
Edgerton
Olathe
Gardner
Spring Hill
Paola
Osawatomie
Lane
Greeley
Garnett
Iola
Yates Center
Humboldt
Chanute
Parsons
Independence
Coffeyville
Arkansas City
Winfield
Wellington
Mulvane
Wichita
Augusta
El Dorado
Eureka
Newton
Halstead
Mc Pherson
Hillsboro
Marion
Florence
Peabody
Lindsborg
Salina
Abilene
Junction City
Manhattan
Clay Center
Clyde
Clifton
Morganville
Randolph
Leonardville
Riley
Wakefield
Milford
Ogden
Bennington
Chapman
Solomon
Enterprise
Herington
Council Grove
Lindsborg
Mc Pherson
Hillsboro
Marion
Florence
Peabody
Newton
Halstead
Wichita
Augusta
El Dorado
Eureka
Mulvane
Wellington
Winfield
Arkansas City
MAP 12
FLINT HILLS, KAN.

"On April 28, the day after the Annual Meeting of the Kansas Academy of Science at Winfield, Kansas, Professor F. W. Albertson and colleagues and myself drove northward as far as Matfield Green, exploring some of the prairie that lies east of Cassoday and Matfield Green in southern Chase County and adjoining parts of Butler and Greenwood counties.

"Of course several of the biologists on our Museum staff were acquainted with this area previously.

"The three recent excursions alluded to were made with an eye to appraising which part of this unspoiled area seemed most worthy of preservation as a sample of the tall-grass prairie. My feeling is that the most worthy area is the 36 square miles or so in eastern Chase County, bounded on the southeast by the new toll turnpike, on the southwest by the county road that extends northwest from the turnpike to a point approximately one mile north of Bazaar, and on the north by a section line extending from that point eastward to the toll turnpike. Described in another way, the mentioned area is in townships 20S and 21S and Ranges 8E and 9E. The area is shaded red on the inclosed Phillips 66 road map of Kansas---highway maps that I have seen of other oil companies as yet do not show the toll highway that is concerned.

I would add that there is one (and only one) exit and entrance to the toll turnpike in the area described in Chase County. This access road is for cattle loading: It is in the w 1/2 of Sec. 16, T12S, R 9E. If there has to be a turnpike through this area, the one access road could be a valuable point. The land is all owned privately. It sells for approximately $50 per acre. This tract is nearer populous areas than are the other prairie tracts that I think of as feasible for preservation. If the tract were set aside, I feel that it should be

for the purpose of preserving natural conditions and natural changes, that visitor-use should be principally from autos on roads that would have to be laid out, that overnight accommodations not be provided (they are available a few minutes away on the turnpike in Emporia, El Dorado and in other cities).

"To the best of my knowledge there is no area of tall-grass prairie preserved for the purpose that we have in mind and the areas available are decreasing instead of increasing; also, most of the areas are being measurably altered by overgrazing by cattle. Consequently, now is the time to set aside prairie areas.

"My own feeling is that no fewer than two prairie areas should be considered for preservation--a tall-grass area toward the east, and a short-grass area toward the west.

"As indicative of widespread interest in prairie lands, I am sending separately a booklet recently issued by Mr. Boots Adams, an alumnus of this University. Aren't the illustrations marvelous?

"In the course of our visit to Matfield Green and vicinity on April 28, I told Professor Albertson that I would visit adjoining tracts in order to firm up my own opinion as to the part of this prairie area that seemed most worthy of detailed examination.

"Whether he could examine this area in the course of his work this summer would depend, I suppose, or plans that he, you, and others concerned, have already made."

It was planned to revisit the Flint Hill prairies in late summer 1956, but time would not permit.

Flint Hill grasslands are not typical of those of the Great Plains. It would seem unfortunate, however, if man should fail to set aside for posterity an area of this grassland.

Area 10

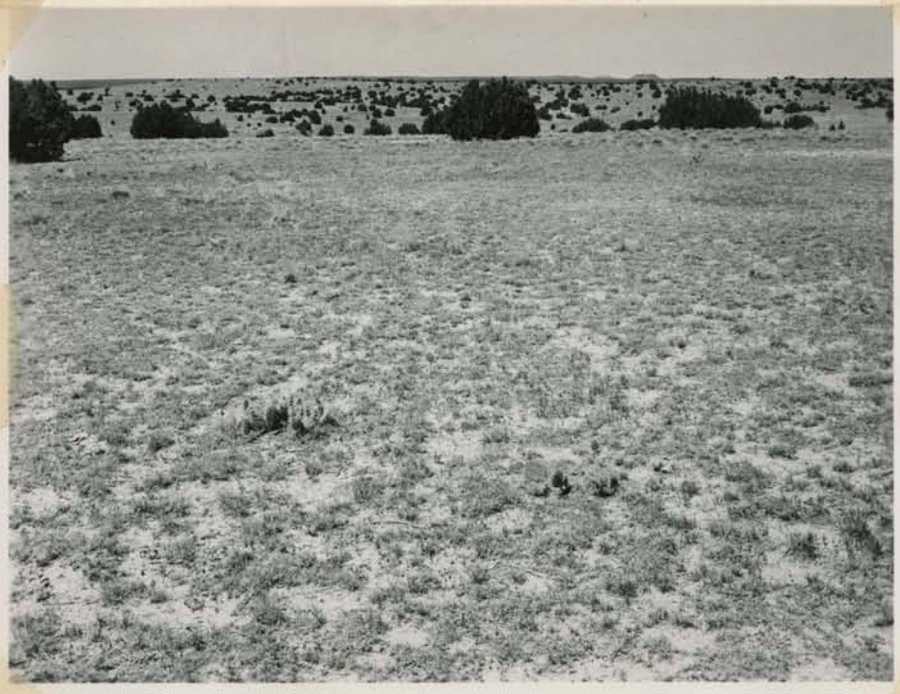
Fig. 1. Drifts of top soil blown from cultivated field (right) and deposited along fence near road 4 miles south and 11 miles east of Las Animas, Colorado. June 6, 1956.

Area 10

Fig. 2. Broad level upland 8 miles southeast of La Junta, Colorado. Open cover of nearly dead blue grama with Opuntia spp in front. Red three-awn and side-oats grama in low places. June 6, 1956.

Area 10

Fig. 3. Large level prairie 7 miles southeast of La Junta, Colorado, with contour furrows 30-40 feet apart. Very open cover between contour furrows but good growth of grass in the furrows. June 6, 1956.



Area 10

Fig. 4. Junipers on rolling topography typical of area near south edge of level grassland several miles south of La Junta, Colorado. June 7, 1956.

Area 10

Fig. 5. Farther away from the level grassland, the slopes were steep and rock strata were exposed. Junipers thrive in these rocky locations. Ten miles south of La Junta, Colorado. June 6, 1956.

Area 10

Fig. 6. Wide lowland five miles west of Ninaview, Colorado. Blue grama, yucca, and cholla in front. Buttes in distance. June 6, 1956.

Area 10

Fig. 7. Large lake on Muddy Creek 6 miles north of Minaview, Colorado. June 7, 1956.

Area 7

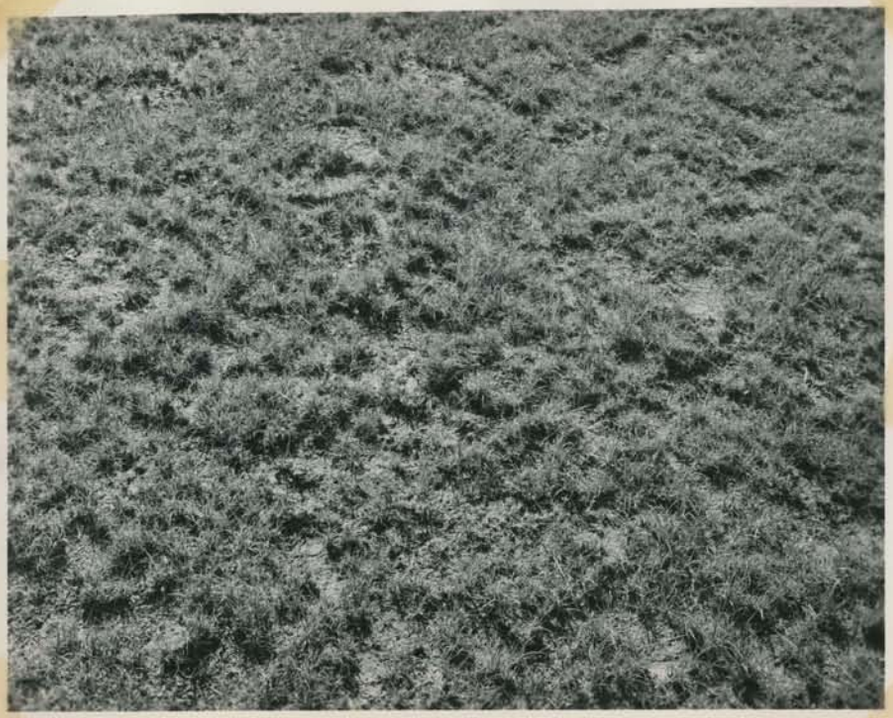
Fig. 8. Broad level land in front of Sierra Grande Mountain 12 miles southwest of Des Moines, New Mexico. Grasses were mostly blue grama, western wheat grass, ring muhly, buffalo grass, red three-awn and side-oats grama. June 9, 1956.

Area 7

Fig. 9. Range with open cover 12 miles southwest of Mt. Dora, New Mexico. Buttes with gentle slopes in distance. June 8, 1956.

Area 7

Fig. 10. Moderately grazed pasture 5 miles west of Clayton, New Mexico on Highway 64. Grasses are blue grama and buffalo grass. Ranch home in distance. June 8, 1956.



Area 7

Fig. 11. Closeup to show condition of grass in pasture shown in figure 10. June 8, 1956.

Area 7

Fig. 12. Broad level grassland with buttes in distance. Mostly blue grama with old flower stalks from last year. Five miles west of Sofia, New Mexico. June 8, 1956.

Area 7

Fig. 13. Rolling prairie with volcanic rocks scattered over the surface of the soil. Grasses are blue grama, buffalo grass, and side-oats grama. Ten miles south of Grenville, New Mexico. June 9, 1956.

Area 7

Fig. 14. Small stream bordered with rocks. Grasses are mostly big bluestem and silver beard grass. Eleven miles south of Grenville, New Mexico. June 9, 1956.

Area 7

Fig. 15. Ungrazed grassland near road 16 miles west of Mt. Dora, New Mexico. Grasses are blue grama, buffalo grass, and galleta (tallest grass). June 8, 1956.

Area 7

Fig. 16. Broad grassland on gravelly soil 16 miles southwest of Sofia, New Mexico. Grasses were blue grama, buffalo grass, ring muhly, and galleta. Trees along stream. June 6, 1956.

Area 7

Fig. 17. Near the western boundary was much sandy to gravelly soil with rolling topography. Blue grama, Yucca, and Artemisia were common. Fifteen miles southeast of Gladstone, New Mexico. June 6, 1956.

Area 7

Fig. 18. Broad level grassland typical of southeastern corner of area 7. Blue grama, buffalo grass, and western wheatgrass. June 9, 1956.

Area 7

Fig. 19. Deciduous trees found occasionally near farm homes or along streams. Thirty-two miles south and 11 miles west of Clayton, New Mexico. June 9, 1956.

Area 7

Fig. 20. Juniper breaks in southcentral part of area 7. Blue grama, broom snakeweed and junipers were common. June 8, 1956.

Roberts County, Texas

Fig. 21. Ungrazed area 7 miles northeast of Miami, Texas. Blue grama, buffalo grass, side-oats grama, red three-awn and little bluestem were present. June 11, 1956.

Roberts County, Texas

Fig. 22. Breaks along Canadian River near Highway 70 north of Pampa, Texas. June 11, 1956.

Roberts County, Texas

Fig. 23. Breaks of mortar bed type of rock along Canadian River 7 miles northwest of Miami, Texas. Catclaw (Acacia greggii) in front. Grasses were mostly side-oats grama and blue grama. Deciduous trees along river. June 11, 1956.

Eastern Colorado

Fig. 24. Dead crowns of blue grama and winter fat. Two miles east of Limon, Colorado. July 16, 1956.

Eastern Colorado

Fig. 25. Live tufts of blue grama and buffalo grass coming from mostly dead crowns. Buick, Colorado. July 17, 1956.

Area 4

Fig. 26. Prairie 15 miles south and 21 miles west of Cering, Nebraska in area 4. Sand reed (dark spots) are on level and slopes. Other grasses are western wheatgrass, needle-and-thread, blue grama, and thread-leaved sedge. July 13, 1956.

Area 8

Fig. 27. Upland in area 8, 26 miles north of Rock River, Wyoming. Dead crowns of blue grama, and thread-leaved sedge. Small tufts of western wheatgrass and needle-and-thread. Badly depleted by drought and heavy grazing. June 21, 1956.

Area 8

Fig. 28. South along road across wide semi-desert grassland. Small tufts of blue grama, western wheatgrass and Sandberg bluegrass. Large plants are winter fat and Atriplex. Thirty-six miles north of Rock River, Wyoming. June 21, 1956.

Area 9

Fig. 29. Rough grassland, trees, and bluffs. Much silver sage, and big sage. Four miles east and 15 north of Lance Creek, Wyoming, in area 9. June 20, 1956.

Area 9

Fig. 30. Broken topography with trees along stream in distance. Much like this grassland in area 9. Four miles east and 15 miles north of Lance Creek, Wyoming. June 20, 1956.

Area 9

Fig. 31. Pines were common on some of the breaks. Grasses were blue grama, needle-and-thread, and some buffalo grass. Sixteen miles north and 13 east of Lance Creek, Wyoming. June 20, 1956.

Area 9

Fig. 32. Sandy rolling range 21 miles southwest of Newcastle, Wyoming. Open cover with 60 percent drought loss. July 10, 1956.

Area 1

Fig. 33. Vast rolling prairie of alternating highlands and valleys. Mostly blue grama, needle-and-thread (shiny stems), and thread-leaved sedge. Thirty miles north of Scottsbluff, Nebraska. June 19, 1956.

Area 1

Fig. 34. Broad valley 17 miles north of Henry, Nebraska. Blue grama, needle-and-thread, sand reed and trees are present. June 20, 1956.

Area 1

Fig. 35. Rolling prairie with sand reed (dark spots) scattered about in nearly pure stands. Other plants were needle-and-thread, thread leaved sedge, and scurfpea. Twenty-nine miles north of Scottsbluff, Nebraska. June 23, 1956.

Area 1

Fig. 36. Little bluestem (right front) was found on sandy knolls. Blowout in far left. Thirty-one miles north of Henry, Nebraska. June 20, 1956.

Area 1

Fig. 37. Sand sage on sandy uplands 30 miles northeast of Scottsbluff, Nebraska. Grasses were blue grama, needle-and-thread, and thread leaved sedge. June 19, 1956.

Area 1

Fig. 38. Wet sandy lowland and hay meadow 10 miles east and 21 north of Scottsbluff, Nebraska. June 19, 1956.

Area 1

Fig. 39. Level upland 40 miles northeast of Scottsbluff, Nebraska. June 19, 1956.

Area 1

Fig. 40. Nearly level upland southeast of Van Tassell, Wyoming. June 20, 1956.

Area 1

Fig. 41. Closely grazed rolling range 19 miles east and 4 north of Scottsbluff, Nebraska. Blue grama, thread-leaved sedge, and Opuntia. June 19, 1956.

Area 1

Fig. 42. Across the road from area shown in figure 41 was a moderately grazed range with good stand of needle-and-thread, blue grama and thread-leaved sedge. June 19, 1956.

Area 1

Fig. 13. Signal rock (left center) on Highway 87, 14 miles north of Scottsbluff, Nebraska. June 19, 1956.

Area 1

Fig. 14. Rolling sandy soil 11 miles north of Mitchell, Nebraska. More sandy than eastward. June 18, 1956.

Area 1

Fig. 15. Broad valley and breaks beyond the Niobrara River 51 miles north of Henry, Nebraska. Silver sage (right front) was common. June 20, 1956.

Area 1

Fig. 16. Clear stream of water 20 miles north of Henry, Nebraska. June 20, 1956.

Area 2

Fig. 47. Broad rolling grassland with bluffs in distance. Grasses here were blue grama, needle-and-thread, western wheatgrass, buffalo grass, and thread-leaved sedge. Sixteen miles south of Hawk Springs, Wyoming. June 21, 1956.

Area 2

Fig. 48. Gently rolling prairie north of Cheyenne, Wyoming and 4 miles east of junction of Highways 85 and 87. Mostly western wheatgrass and blue grama. June 21, 1956.

Area 2

Fig. 49. Gently rolling upland 17 miles southeast of Horse Creek, Wyoming. Grasses were needle-and-thread, western wheatgrass, June grass, and blue grama. Fringed sage was also common. June 21, 1956.

Area 2

Fig. 50. Bluffs on Bear Mountains at northeast corner of area 3. Blue grama, needle-and-thread, Yucca and sand sage in front. Evergreens on steep slopes. About 8 miles south of Hawk Springs, Wyoming. June 21, 1956.

Area 2

Fig. 51. Lonetree Canyon, 3 miles south and 12 miles west of Hawk Springs, Wyoming. Yucca, pine and green sage are common. July 13, 1956.

Area 2

Fig. 52. Strip-cropping 3 miles south and 1 mile west of Hawk Springs, Wyoming. Rotation of wheat, oats, and fallow. July 13, 1956.

Area 2

Fig. 53. Excellent range on nearly level land 3 miles south and 9 miles east of Chugwater, Wyoming. Good stand of needle-and-thread, blue grama, and thread-leaved sedge. Green sage was also common. July 13, 1956.

Area 2

Fig. 54. Rolling prairies 9 miles north and 6 miles west of Cheyenne, Wyoming. Mountain mahogany forms an upper shrubby story with bluebunch wheatgrass and other plants below. July 13, 1956.

Area 2

Fig. 55. Steep bluffs with coniferous and deciduous trees. Silver sage, and Opuntia in front. Two miles west of Horse Creek, Wyoming. June 21, 1956.

Area 2

Fig. 56. Upland range 9 miles west of Horse Creek, Wyoming. June 21, 1956.

Area II
Cahalane

Fig. 57. Extensive grasslands on rolling topography 13 miles north and 2 miles west of Chadron, Nebraska. Most important grass was blue grama. Ripe heads (shiny) of Sandberg bluegrass were common. June 23, 1956.

Area II
Cahalane

Fig. 58. Closeup of prairie shown in figure 57. Grasses were growing vigorously. June 25, 1956.

Area II
Cahalane

Fig. 59. Broad grassland with farm pond for livestock. Fourteen miles north and 2 miles west of Chadron, Nebraska. June 25, 1956.

Area II
Cahalane

Fig. 60. Rolling prairie that extended for miles, 19 miles west of Oglala, South Dakota. Grasses were blue grama, side-oats grama, little bluestem and western wheatgrass. June 25, 1956.

Area II
Cahalane

Fig. 61. Rolling lowland 15 miles west of Oglala, South Dakota. Most important grasses were western wheatgrass and green needle grass. June 25, 1956.

Area II
Cahalane

Fig. 62. Clay breaks near White River and White Clay Creek with many deciduous trees. Pine Ridge in distance, ant hill, needle-and-thread, and blue grama in front. Six miles west of Oglala, South Dakota. June 25, 1956.

Area II
Cahalane

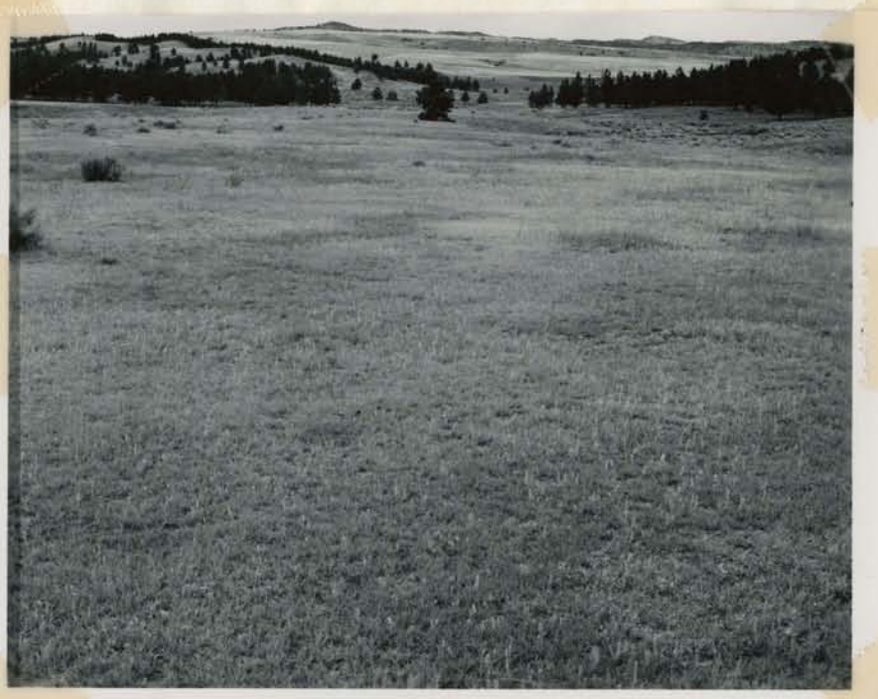
Fig. 63. Pine Ridge in distance. Deciduous trees along White Clay Creek 3 miles southeast of Oglala, South Dakota. Common plants in front were needle-and-thread, blue grama, green sage, and loco. June 25, 1956.

Area II
Cahalane

Fig. 64. Lake on White Clay Creek 3 miles southeast of Oglala, South Dakota. June 25, 1956.

Area II
Cahalane

Fig. 65. Pine Ridge 3 miles east of Oglala, South Dakota. Needle-and-thread, blue grama and green sage in front. June 25, 1956



Area II
Cahalane

Fig. 66. Rolling topography with pines, sagebrush, blue grama, and western wheatgrass 20 miles northwest of Oelrichs, South Dakota on gravel road. June 25, 1956.

Area II
Cahalane

Fig. 67. Side-oats grama, needle-and-thread, little bluestem, and blue grama on rough grassland 28 miles southwest of Hot Springs, South Dakota. Deciduous trees along Hat Creek. June 25, 1956.

Area II
Cahalane

Fig. 68. High tableland 28 miles southwest of Hot Springs, South Dakota. Cacti, blue grama, buffalo grass, thread-leaved sedge, and big sage, and Sandberg bluegrass (tall grass) make up most of the cover. June 25, 1956.

Area II
Cahalane

Fig. 69. Thin stand of grasses on broken topography 9 miles south of Edgemont, South Dakota. Blue grama, buffalo grass, and western wheatgrass are in front. June 25, 1956.

Area II
Cahalane

Fig. 70. Rolling prairie 7 miles south and 3 miles east of Provo, South Dakota. Important grasses were buffalo grass, blue grama, Sandberg bluegrass, and western wheatgrass. July 10, 1956.

Area 11
West

Fig. 71. Looking west across Cheyenne River, 13 miles east of Buffalo Gap, South Dakota. West of the river was much farming. Yucca, needle-and-thread, and blue grama in front. June 28, 1956.

Area 11
West

Fig. 72. Broad lowland 8 miles south and 7 miles east of Rapid City, South Dakota. Western wheatgrass was abundant. Deciduous trees were along stream with grass covered hills beyond. June 27, 1956.

Area II
West

Fig. 7a. Vast grassland 9 miles east of Hermosa, South Dakota. Common plants were blue grama, buffalo grass, needle-and-thread, thread-leaved sedge, scurfpea, and fringed sage. Excellent grassland. June 27, 1956.

Area II
West

Fig. 7b. Grasslands like this often had streams crossing them with deciduous trees close to the water. June 27, 1956.

Area II
West

Fig. 75. Closely grazed pasture 4 miles south of Fairburn, South Dakota. Fairly heavy soil with much western wheatgrass (dark) and little barley (light). Other grasses were blue grama, buffalo grass, thread-leaved sedge and green needle grass. June 27, 1956.

Area II
West

Fig. 76. Broad lowland of tight soil with western wheatgrass, green needle grass, blue grama, buffalo grass, and thread-leaved sedge. Ten miles northeast of Buffalo Gap, South Dakota. June 27, 1956.

Area II
West

Fig. 77. Badlands 5 miles west of Rocky Ford, South Dakota. June 29, 1956.

Area II
West

Fig. 78. Badlands several miles south of Scenic, South Dakota. June 29, 1956.

Area II
East

Fig. 79. Extensive clay flat, typical of those found south of Interior, South Dakota. Grasses were mostly blue grama, buffalo grass, and western wheatgrass. August 8, 1953.

Area II
East

Fig. 80. Lightly grazed rolling prairie 11 miles south of Interior, South Dakota. Grasses were blue grama, needle-and-thread, buffalo grass, and thread-leaved sedge on the upland. Big bluestem, little bluestem, switch grass and side-oats grama were in the ravine. June 28, 1956.

Area II
East

Fig. 81. Abundance of lead plant indicated light grazing. Fifteen miles south of Interior, South Dakota. June 28, 1956.

Area II
East

Fig. 82. Rolling pasture 4 miles southwest of Potato Creek, South Dakota. Beautiful prairie. June 29, 1956.

Area II
East

Fig. 83. Scattered stand of pine 12 miles south of Kyle, South Dakota. Both big and little bluestems were found here. July 11, 1956.

Area II
East

Fig. 84. Grasslands with pine-covered cliffs were common northeast of Potato Creek, South Dakota. July 11, 1956.

Area 5

Fig. 85. Heavily grazed range near south edge of area 5. Clay soil with western wheatgrass, green needle grass and blue grama were common. July 1, 1956.

Area 5

Fig. 86. Moderately grazed grassland 21 miles south of Buffalo, South Dakota. Grasses here were blue grama, needle-and-thread, western wheatgrass, June grass, Sandberg bluegrass, and thread-leaved sedge. July 1, 1956.

Area 5

Fig. 87. Beautiful rolling prairie 8 miles southeast of Buffalo, South Dakota. July 1, 1956.

Area 5

Fig. 88. Broad lowland 8 miles southeast of Buffalo, South Dakota. Most important grasses were blue grama, needle-and-thread, and thread-leaved sedge. Custer National Forest in distance. July 1, 1956.

Area 5

Fig. 89. Fairly heavily grazed pasture 11 miles south and 2 miles east of Buffalo, South Dakota. Drought loss of 50 percent. Grasses were blue grama, needle-and-thread, and thread-leaved sedge. July 2, 1956.

Area 5

Fig. 90. Lightly grazed pasture 11 miles south and 11 miles east of Buffalo, South Dakota. Grasses were needle-and-thread, thread-leaved sedge, blue grama, western wheatgrass, purple three-awn, and sand-reed grass (dark areas). July 2, 1956.

Flint Hills

Figure 91. Lightly grazed prairie near Emporia, Kansas. Good stand of tall grasses and lead plant (Amorpha canescens). June 10, 1955

Flint Hills

Figure 92. Heavily grazed pasture near the one shown in Figure 91. Tall grasses and lead plant are nearly all gone and in their places are shortgrasses, little barley and increaser forbs such as cactus and iron weed (Vernonia baldwini). June 10, 1955

AREA 7

Boundary of Area

Route of Travel

Vegetation

Symbol	Common Name
Afi	Sand sage
Afr	Fringed sage
Age	Big bluestem
Aha	Sand bluestem
Alo	Red three-awn
Aristida	Three-awn
Asc	Little bluestem
Asm	Western wheatgrass
Bcu	Side-oats grama
Bda	Buffalo grass
Bgr	Blue grama
Gsa	Broomweed
Hja	Galleta
Ile	Bush morning glory
Juniper	Juniper
Mto	Ring muhly
Scr	Sand dropseed
Snu	Indian grass
Spa	Tumblegrass
Yucca	Yucca

Map 3

Old Goodnight Trail

Snu

Coniferous Trees

some cultivation

Asm

Fig. 8

Bgr Bda Asm Mto Bcu Gsa Aristida Afr

Gravely soil well developed deep and black

Heavy stand Gsa

A small amount cultivation

scattered rock on surface

some go back

Very wide upland with scattered Bgr Buttes

Clear Water in Creek

Age

Bcu Bgr Bda Mto Gsa

Fig. 13

Fig. 14

poor condition

a number of pasture overgrazed

80% loss in some cases

Gsa thick

Bgr Bda Mto Hja

Fig. 11

Fig. 10

Bgr Bda Mto

Gently rolling in good condition Bgr

Fig. 12

Cultivation and olive drifted

Fig. 9

Fig. 15

Bgr Bda Mto

in good condition Bgr

Flowing Stream

Bgr Bda Mto Hja

Fig. 16

Rolling

Afi Rtn Yucca

Age Asc Aha Snu

Nearly level

scattered junipers

in good condition

in good condition

Rolling

some cultivation

some cultivation

Some cultivation

Rolling

some sandy bottom land cultivated

Good grassland

Some go-back and abandoned homes

Fig. 20

Fig. 17

Rough

Yucca Ile

good grassland

Afi

sand on both sides of creek

Juniper breaks

Several fields of go-back

Yucca

Heavy sand

AREA-7

Rough range with Asc Bcu

Juniper breaks

Juniper

Bgr Bda Mto Bcu Scr Gsa

Fig. 19

Level upland Bgr Bda Mto

Fig. 18

Rough

Spa Scr

Nearly level upland with deep soil

Level

some cultivation

Rough Yucca Afi

AREA 1

Boundary of Area

Route of Travel

Vegetation

Symbol	Common Name
Aca	Silver sage
Afi	Sand sage
Asc	Little bluestem
Asm	Western wheatgrass
Bgr	Blue grama
Bhi	Hairy grama
Cfi	Thread-leaved sedge
Clo	Sand reed grass
Foc	Six-weeks fescue
Kcr	June grass
Opuntia	Cactus
Ohy	Indian ricegrass
Psc	Sandberg bluegrass
Sco	Needle-and-thread
Scr	Sand dropseed
Yucca	Yucca

Map 7

AREA-1

Gently rolling

Bgr Cfi Asa

Fig. 45

a valley with bluff sides

Aca

Nearly level upland

Pine on hills

Rough breaks pine covered

Pines on hilltops

Bgr Cfi Sco Foc

Fig. 40

Rolling

Trees and cultivation along creek next to road

Cfi Bgr Clo Kcr Scr Bhi

several small blowouts

Fig. 36

Asm small amounts

a lot of hay meadows along river

Clear and flowing

Cfi abundant

Nearly level grassland

Fairly level soil

Bgr Cfi Sco

Asm in lowland

Yucca Bgr Cfi Sco Sandy soil

Fig. 33

Cfi Sco Bgr

Rolling Rough

More Sco and Clo less Bgr than further South

Fig. 46

Wide grassland valley

Fig. 35

Very fine sandstone buttes

Clear running stream

Bluffs

Cfi Bgr Sco

Fig. 34

Bgr Sco Clo

Cfi absent here

Rolling grassland with wide valleys

Rolling grassland with wide valleys

Wide valley

Grassland

Fairly tight soil

Ohy Clo

Rolling grassland with wide valleys

Asm in lowland Bgr Cfi Sco

Fig. 38

Afi Sco

Bgr Cfi

Fig. 44

Rolling in good condition

Ohy in Ditch

Valley with hay meadows

Fig. 37

Fig. 39

Afi Cfi Bgr

Afi Cfi Bgr

Bgr Cfi Level upland

Sandy loam

Breaks of very fine sandstone

Fig. 43

Breaks

Signal Rock

High % cultivation

irrigation

irrigation

irrigation

High % cultivation

Opuntia Rolling grassland Bgr Cfi

Fig. 42

Fig. 41

irrigation

MAP 7 AREA 1

AREA-2

Nearly all cultivated

Fig. 51

Bgr Cfi Sco Psi
Yucca Rtr Afr
Sandy loam upland

Fig. 52

nearly all cultivated

90% Bgr Sco Che
Asc Yucca
Afr Ara

Several cultivated fields

Coniferous trees and a few deciduous trees

Fig. 50

Irrigation

Fig. 53

more Cfi than last miles East
Sandy loam

Rolling

Nearly level

mostly Bgr
Cfi Asm Sco
Adr Psc Ker Clo
Ohy Anistida

Level to gently rolling sandy loam

Nearly level

Gently rolling grassland

wide grassland valley

Rolling grassland

Fig. 47

Rolling

Rolling

Small amount Asc

Sandy Loam
Cfi Sco Ker
Psc Soms Bgr

Rolling

Pine on hills Area

Cmo on breaks
wide valley
Cmo on breaks

Fig. 54

Asp Beu
Ain Ker
Bgr Clo
Asc Asm

all grassland

Meu

Bgr Cfi Ker Sco Bda Psc

Nearly level

Some cultivation

more cultivation than north of 85

a lot of cultivation as far as one can see

Rough with breaks and buttes

Deciduous trees in lowland

Fig. 55

Heavy grazing Opuntia thick

Fig. 56

Rolling high

Ker
Foc
Asm

very open cover

Nearly level

Bda Asm
heavily grazed

Fig. 48

Asm
Bgr

Level to gently rolling

Asm
Bgr
Che

Fig. 49

Asm
Ker Bgr

CHEYENNE

Rolling

Map 8

AREA 2

Boundary of Area

Route of Travel

Vegetation

Symbol	Common Name
Aca	Silver sage
Adr	Green sage
Afr	Fringed sage
Ain	Beardless wheatgrass
Asc	Little bluestem
Asm	Western wheatgrass
Asp	Bluebunch wheatgrass
Beu	Side-oats grama
Bda	Buffalo grass
Bgr	Blue grama
Cfi	Thread-leaved sedge
Che	Sun sedge
Clo	Sand reed grass
Cmo	Mountain mahogany
Foo	Six-weeks fescue
Ker	June grass
Ohy	Indian ricegrass
Opuntia	Cactus
Psc	Sandberg bluegrass
Rtr	Ill-scented sumac
Sco	Needle-and-thread
Yucca	Yucca

AREA-5

Nearly Level

Rolling

Rolling

Rolling

Some cultivation along river

Gently rolling range broken by small mounds as far west as one can see

Coniferous Trees

Level land with scattered small mounds
Sco
Cfi
Bgr
Fig. 86

Badly depleated range

Fig. 85 ↑

Sheet erosion and some gully erosion

Asm Sir Clo in low places

Cfi thick on top of dunes

Cfi Bgr Sco
Fig. 87
Fig. 88

Sandy soil

Several small blowouts

Bgr Cfi Sco
Running Stream

Range in good condition

Alkali in small depressions
Dst

Clo on hillsides
Light grazing
Apu
Clo in clumps

Asm thick in depressions

Mcu Small amount Bgr Asm
Ker Asm in depressions

Fig. 89
Sandy loam
Clo
Islands of Bda in depressions

Fig. 90
Atr Afr Ker
Opuntia Pse
Fairly tight soil

Bda Cfi Sco
Scr Clo

Deciduous trees along streams
Coniferous trees in hills

Foc
Sandy loam
Aca

Cfi Bgr Sco
Rolling

Moderate grazing
Rolling
Bgr Cfi Sco Asm

Asc in breaks near lowland

Gently Rolling

Bda

Sandy loam
Asm Pse in depressions

Rolling Range in good Condition

Ker
Afr

CUSTER NATIONAL FOREST

ANTELOPE PRESERVE

THE CASTLES

CUSTER NATION

BUFFALO

CAMP CROOK

HARDING

MOREAU PEAK

IRON BUTTES

HAYSTACK BUTTE

CASTLE ROCK BUTTE

ANTELOPE BUTTE

TWO TOP BUTTE

CASTLE ROCK

T16N T17N

CARTER COUNTY

MONTANA

Map 10

AREA 5

Boundary of Area

Route of Travel

Vegetation

Symbol	Common Name
Aca	Silver sage
Afr	Fringed sage
Apu	Purple three-awn
Asm	Western wheatgrass
Atr	Big sage
Bda	Buffalo grass
Bgr	Blue grama
Cfi	Thread-leaved sedge
Clo	Sand reed grass
Dst	Saltgrass
Foc	Six-weeks fescue
Ker	June grass
Mcu	Plains muhly
Pse	Sandberg bluegrass
Opuntia	Cactus
Scr	Sand dropseed
Sco	Needle-and-thread
Svi	Green needle grass

MAP 10
AREA 5