INVENTORY OF RARE PLANT SPECIES IN THEODORE ROOSEVELT NATIONAL PARK

Billings and McKenzie Counties, North Dakota

October 1990

Natural Heritage Inventory
North Dakota Parks and Recreation Department*
Bismarck, North Dakota

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***In cooperation with The Nature Conservancy**

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Bonnie Heidel
Author and Project Coordinator

EXECUTIVE SUMMARY

State rare plants were inventoried in the North and South Units of Theodore Roosevelt National Park, North Dakota in 1987, 1988 and 1989 by the North Dakota Natural Heritage Inventory. Records of thirteen species were documented as follow: *Chenopodium subglabrum* (S. Wats.) A. Nels. in the South Unit, *Coryphantha missouriensis* (Sweet) Britt. & Rose in the North and South Units, *Dalea enneandra* Nutt. in the South Unit, **Euphorbia robusta* (Engelm.) Small in the South Unit, *Hordeum pusillum* Nutt. in the North and South Units, *Oenothera laciniata* Hill in the South Unit, **Orobanche multiflora* Nutt. in the North Unit, *Physaria brassicoides* Rydb. in the South Unit, *Populus x acuminata* Rydb. in the South Unit, *Sitanion hystrix* (Nutt.) J.G. Sm. in the North and South Units, *Sporobolus airoides* (Torr.) Torr. in the South Unit, *Stephanomeria runcinata* Nutt. in the North and South Units, and **Verbesina encelioides* (Robins. & Greenm.) J.R. Coleman in the South Unit. Three of these species represent new additions to the state flora (asterisked, above).

Five species are assigned new state ranks based on inventory results. The documented species are rare in North Dakota to widely varying degrees (state imperiled to potentially secure or potentially adventive). They are not presently considered by the U.S. Fish and Wildlife Service as federally designated Threatened or Endangered or as candidates for designation. Rangewide status review of *Chenopodium subglabrum*, *Physaria brassicoides*, and *Orobanche multiflora* is needed.

Two species collected in or near the park in previous years were not relocated: *Ambrosia acanthicarpa* (collected near Medora in 1911 and south of Watford City on the Little Missouri River in 1938) and *Oxytropis sericea* (collected in the South Unit in 1958).

Documented rare species are extensively inventoried, and mapped, collected, photographed, their habitats characterized, and management considerations identified for each species. Inventory results are discussed by species and by management practice, and general conclusions offered regarding species rarity, habitat affinity and significance of park biogeography.

Theodore Roosevelt National Park is the only public land of this extent in North Dakota where rare plant species conservation parallels primary management goals. The intrinsic botanical diversity of the park and its complementary management goals underscore its state and regional conservation biology significance.

Doug Eiken

Doug Eiken, Director
North Dakota Parks and Recreation Department

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INTRODUCTION

Theodore Roosevelt National Park (TRNP) in southwestern North Dakota is among the largest expanses of public lands and intact plains habitat in the Northern Great Plains. It is a living monument to the conservation philosophy expounded by Theodore Roosevelt.

TRNP was established by Congress in 1947 in keeping with the National Park Service (NPS) mandate : *"...which purpose is to conserve the scenery and the natural and historical objects therein and to provide for the enjoyment of future generations"* (39 Stat. 535). Its natural resource values have received elevated statewide and NPS system-wide recognition in recent years, and with this has come a shift toward management of the park as a natural area (NPS 1989). Accordingly, a major part of TRNP management is directed toward protecting and preserving the natural plains environment, including both the living and nonliving components and the natural processes belonging to the system, in a total ecosystem concept.

Management of TRNP encompasses hundreds of native plant and animal species and their habitats. Special attention is given to plant and animal species considered endangered or threatened at federal or state levels, by way of surveying rare species resources, and directing appropriate monitoring, research, impact analysis and management (NPS 1984; Project Statements THRO-N-0015, 0008). This contributes to the broader TRNP management objective, to:

"Restore and maintain, to the extent feasible,... plants and animals and ecological processes of the Little Missouri badlands to a condition symbolic of the scene during Theodore Roosevelt's association with the area" (NPS 1985).

This is in keeping with general NPS management policies on the conservation of federally designated threatened and endangered species:

"The Service will identify all threatened and endangered species within park boundaries and their critical habitat requirements... Plant and animal species considered to be rare or unique to a park shall be identified also and their distribution within the park mapped. Management actions for their protection and perpetuation shall be incorporated into the natural resources management plan" (reprinted in Morse and Henifin 1981).

The purpose of this project was to conduct a field inventory of TRNP rare vascular plant resources and compile available information on their protection and preservation needs.

Inventory work spanned the 70,416 acres of Theodore Roosevelt National Park, including the South Unit with 46,346 acres, and the North Unit with 24,070 acres, lying within Billings and McKenzie Counties, respectively (Figure 1).

This report includes information on each rare species documented in the park, including its park

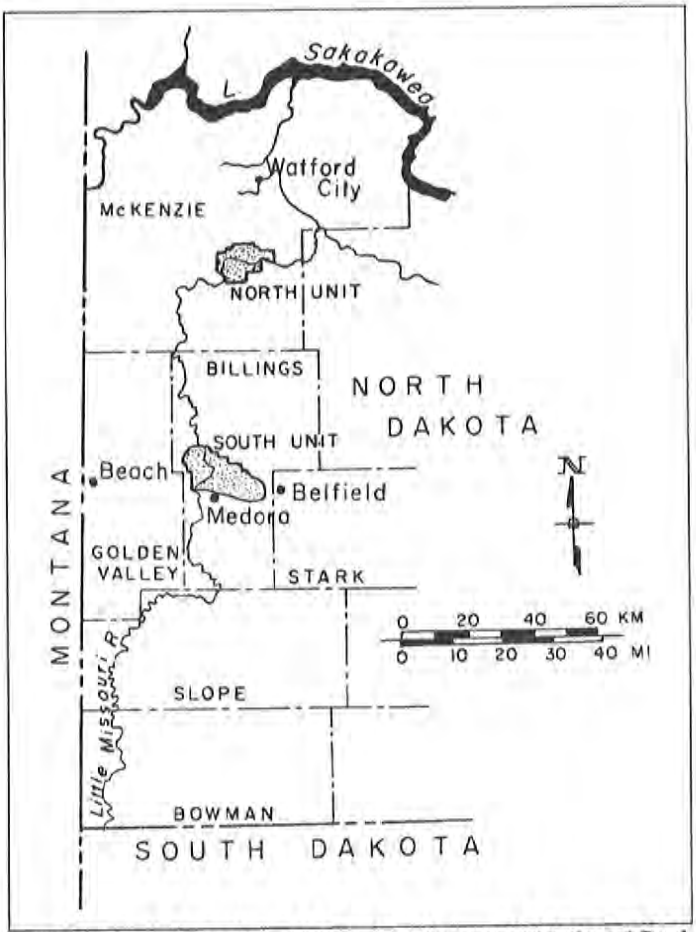


Figure 1. Location of Theodore Roosevelt National Park (From Hansen et al. 1989).

habitat, park distribution, park management concerns, close-up and habitat photographs, as well as state and global rarity status. Following the section on species-specific information is a discussion of management concerns. The appendixes provide detailed background information that supports the results or is included for reference, including a list of all rare plant locations, information on those primary target species which were sought but not found, and an update of the preliminary park flora. A conclusion section delves into significance of park biodiversity and theoretical implications of inventory results.

Information being conveyed separately to the National Park Service includes the following:

- A set of species-specific maps at 1:68,000 showing species distribution within the units of the park. The maps indicate how many plants were found by order of magnitude and how they were distributed.
- Complete mapping of all rare plant species at 1:24,000 on the composite U.S.G.S. 7.5-minute park topographic maps. It represents a compilation of individual species maps above. It also includes rare plant occurrences that are known within one mile of park boundaries.
- Printouts summarizing the biological information and locality information for each rare plant population.
- Rare Plant Forms for each rare plant population, organized by species, the basis for information represented on printouts.
- Site Survey Forms for each field excursion, organized chronologically within the two units of the park, representing the scope and intensity of fieldwork.
- Slides of rare plant species added in the course of the 1989 fieldwork. They include all of the slides from which report prints were made. Slides of plants covered in 1987-88 fieldwork were previously conveyed.
- Rare plant voucher specimens, plus an accession of about 400 specimens which contribute to the floristic inventory of the park.

This written report and accompanying maps, printouts, documentation and field forms are organized for information storage and retrieval needs as cited in Bratton (1981) with intent to keep them accessible and current.

This work was conducted by the North Dakota Parks & Recreation Department through the cooperative efforts of both Theodore Roosevelt National Park and University of Wyoming NPS Research Center. Fieldwork was conducted by Ronald G. Wieland in 1989, W.T. (Duke) Rankin in 1989, and Carolyn Godfread in 1987-88 with the assistance and coordination of Alexis Duxbury and Bonnie Heidel. The preliminary project report on TRNP - South Unit work of 1987 and 1988 was authored by Carolyn Godfread and Alexis Duxbury, and this final report with 1987-1989 data for the South Unit and 1989 data for the North Unit was prepared by Bonnie Heidel. Work was conducted using the herbarium facilities of TRNP and North Dakota State University, and specimens on loan from the University of North Dakota Herbarium, with the logistical support, methodology, and databases of the North Dakota Natural Heritage Inventory under the auspices of the North Dakota Parks and Recreation Department.

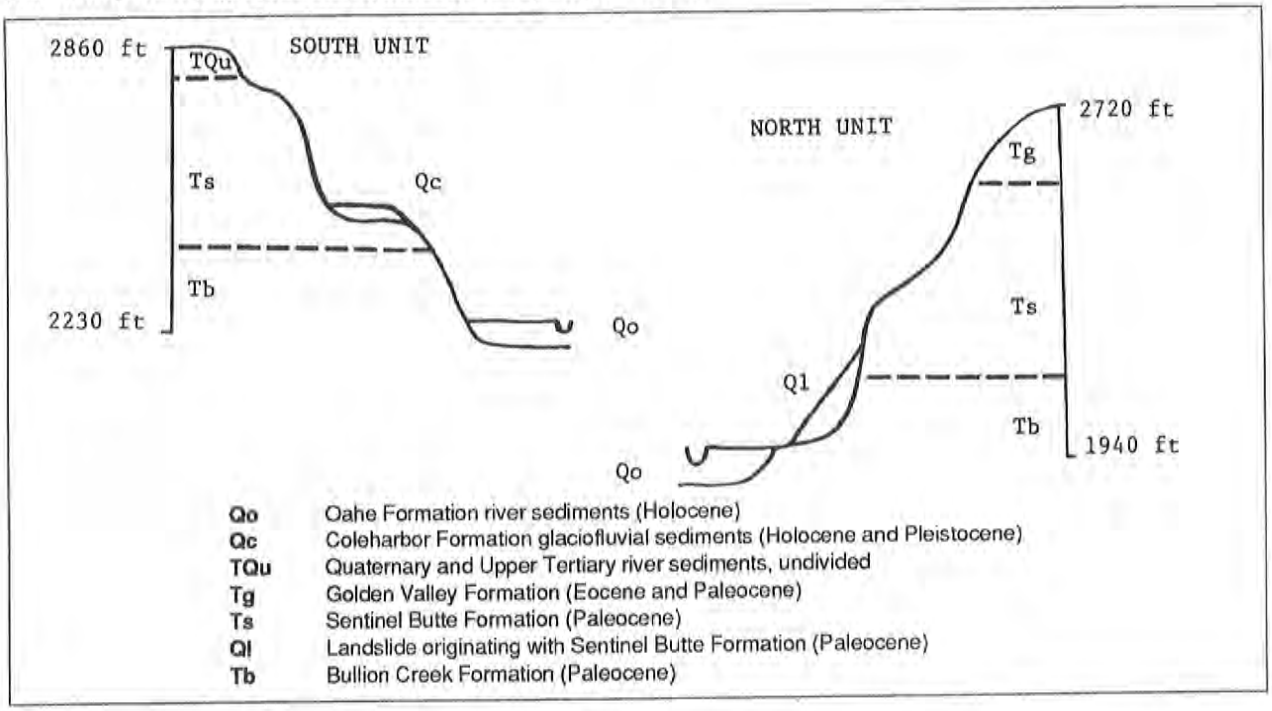
STUDY AREA

Geology

Theodore Roosevelt National Park (TRNP) lies in the Missouri Plateau physiographic region, dominated by badlands topography and limited areas of rolling uplands topography, and straddling the Little Missouri River. The North Unit is approximately 40 miles downstream (north) of the South Unit. The park is unglaciated except for a small portion of the North Unit. The two units of TRNP present complementary and contrasting pictures of outcrop landscape carved by water erosion.

The striking scenic landforms of TRNP are imposed on horizontally bedded Paleocene stratigraphy made up of highly erodible subtropical river, lake and swamp sedimentary formations deposited about 65 million years ago (Bluemle 1981, Clayton 1980). General stratigraphic columns for the two units of the park include the following formations:

Figures 2A, B. General stratigraphic columns of Theodore Roosevelt National Park - North and South Units (based on park topographic maps, Bluemle 1975, Clayton 1980).



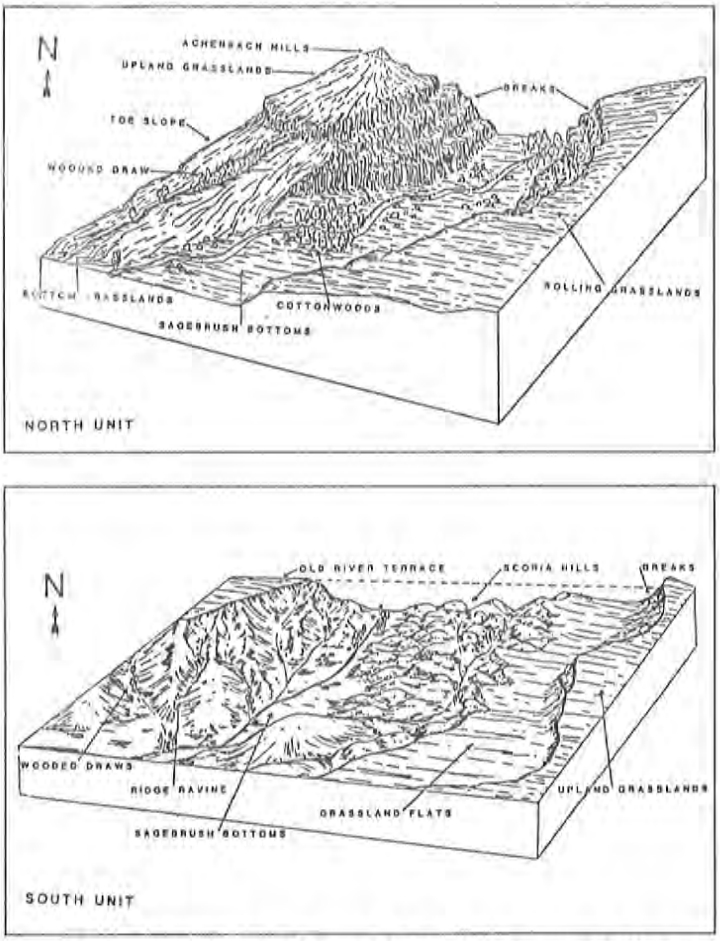
Note that both units of the park contain outcrops of the Sentinel Butte Formation, as well as outcrops of formations unique to the respective units. They have extensive bedrock outcrops and rugged topographic relief. The badlands setting in general has been described in much greater detail by geologists (Bluemle 1972, 1977, 1981, Clayton 1980). The erosional processes of illuviation and colluviation are frequent and extensive in this setting, representing a dynamic landscape (Gonzalez 1987).

The two units have different landform expressions of badlands topography, and the greatest geological difference between the two units is in their landform development. In the Pleistocene Age about 700,000 years ago, the Little Missouri River and the Missouri River were diverted by advancing glaciers from their northeasterly courses toward the Hudson Bay. The course of the Little Missouri River had originally trended northeastward along the present-day courses of Cherry Creek and Tobacco Garden Creek. As a result of diversion by a glacier, the rerouted Little Missouri River turned eastward at about 47 degrees 32 minutes latitude, taking a shorter route and carving a far steeper river gradient

than its original course. This change in the river gradient initiated a major downcutting event that shaped present-day landforms (Schmitz 1955, Bluemle 1972, 1977). It resulted in a highly-dissected erosion topography with tributary streams cutting into the uplands on either side of the original river course, as found in the South Unit, and a deeply entrenched valley that had been prone to landslides along its new downstream course, as found in the North Unit.

Basic landform differences between the two units condition habitat extent and continuity for rare species. The highly-dissected topography of the South Unit as compared to the deeply entrenched valley topography of the North Unit (Figures 3A,B) makes for greater potential substrate surface area but lower habitat continuity in the South Unit as compared to the North Unit.

In addition, the highly dissected nature of the South Unit terrain was more conducive to ignition and combustion of the coal seams common to both units. Coal seams marking the contact between the Bullion Creek Formation and the overlying Sentinel Butte Formation were exposed (Bluemle 1975). Smoldering coal seams baked the overlying shale into bright orange clinker, or "scoria", which is relatively resistant to erosion and caps many South Unit ridges but is uncommon in the North Unit.



Figures 3 A, B. Landforms of Theodore Roosevelt National Park - North and South Units (from: Marlow et al. 1984).

In another example relevant to rare plant habitat, the Bullion Creek Formation of the South Unit contains a major sandstone component that is not found in in other exposed park formations. It also contains a distinct stratum which is almost pure gypsum at about 2400-2440 ft, previously unreported, and which was identified as a preferred substrate for one of the rare species in the project.

Soils

Soils in the park are closely associated with the differences in substrate and landforms. They are predominantly clay and loam textured torriorthents (regosols and lithosols), formed under prairie in a hot, dry climate (Omodt et al. 1968). The predominant soils for both park units belong to the Badlands-Bainville Association (Omodt et al. 1968, Edwards and Ableiter 1944). The Bainville soil series is made up of excessively-drained medium-textured soils developed from calcareous weathered materials, found on prairie ridgetops and steep upper slopes. Surface runoff is rapid on the steep slopes and water infiltration is limited. Erosion removes the organic component almost as rapidly as it forms.

The widespread "Badlands" component is not classified as a soil but represents outcrop slopes without soil development. Despite the lack of organic matter and soil structure, sparse vegetation is found on all but the most unstable slopes and strata. Even on the unstable slopes, a high degree of fluting may provide microtopography in which plants can become established. As with true soils, its vegetation is a product of climate, topography, substrate and presence or absence of other plant life.

At the other extreme, under the conditions of greatest local soil development, soils grade into haploborolls (chernozems) with deep profiles such as the Morton soil series. They are localized and mainly confined to overflow range sites on lower prairie slopes.

The Havre soil series has an alluvial origin and prevails in the valley bottomlands. It is primarily vegetated by the woody sage, *Artemisia cana*. The Patent soil series represents recently-deposited local sediments on the colluvial fans. It is vegetated by woody shrubs including *Artemisia cana* and *Artemisia tridentata* along with other drought-tolerant shrubs and grasses. Both of these soil series are fine-textured and often have a claypan subsoil and build-up of salts (solonetz formation). Much more restricted, the sandy Banks soil series occur on the bottomlands along the present-day Little Missouri River, representing recent alluvial deposits. It supports cottonwood stands (*Populus deltoides*) at different stages of succession. Altogether, relatively large areas of the park are made up of alluvial and colluvial soils in these three series.

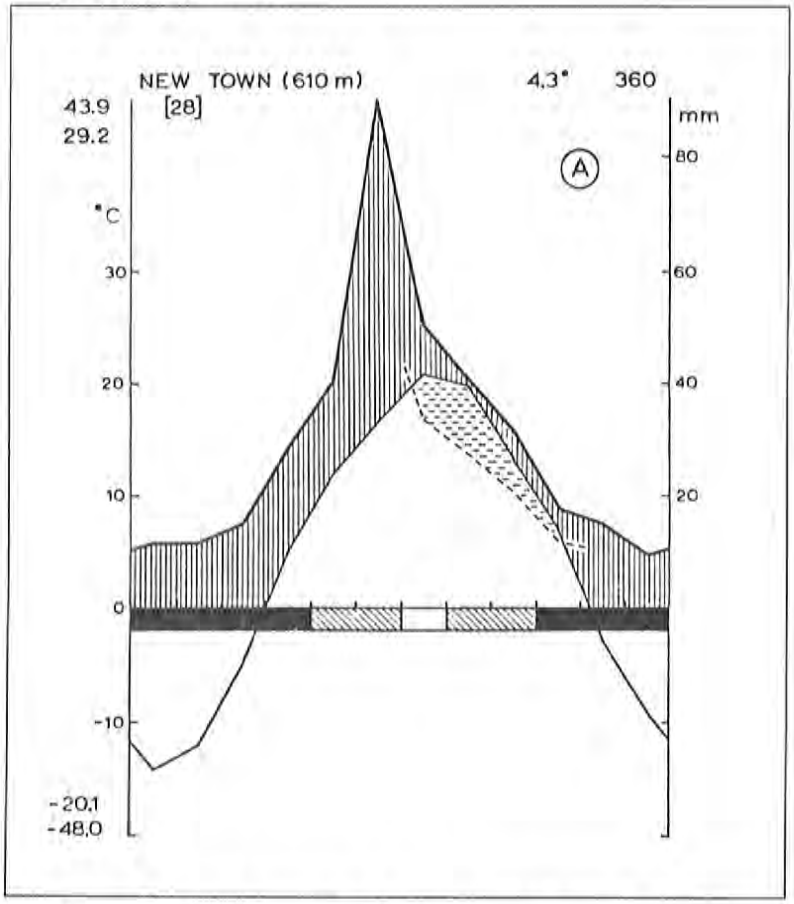
The Flasher soil series is made up of coarse sandy soils on steep side slopes and crests of sandstone-capped ridges. The coarse gravel Parshall (Cheyenne) soil series is found on the high terrace remnants of the ancestral Little Missouri River such as the Petrified Forest Plateau. Both of these support prairie vegetation on flat and low-grade slopes. At the exposed breaks in topography capped by these formations, localized sandstone outcrops and sand prairie are found in the Flasher series, and a very sparsely vegetated gravel prairie is found on the Parshall series.

Climate

The continental climate of the region and of the state is characterized by extremes of temperature, marked season changes, early season rainfall, limited annual precipitation, relatively high winds, and high degrees of climatic variation within and between the span of diurnal, season, and annual periods (Jensen 1971).

In the summer, warm tropical air masses from the Gulf of Mexico raise the temperature and produce heat waves. Subarctic air masses freely move down across the open plains in the winter bringing rapid temperature drops. "Chinooks", which are warm dry air masses descending from the Rocky Mountains, moderate the winter's chill and make that season generally milder than in the eastern part of the state.

Figure 4. Climate diagram for New Town (From Redmann 1975 using 28 years of data).



Climatological data, i.e. macroclimate, is graphically depicted and summarized in climate diagrams (Walter and Leith types) for New Town (Figure 4). It depicts the general climatic features of the western part of the state, based on metereological compilations from New Town as prepared by Redmann (1975). Extreme highs and lows range from 43.9 degrees C (111 degrees F) in the summer, to -48.0 degrees C. (-54 degrees F) in the winter, and annual precipitation is at 360 mm (14.4 inches). Rainfall is heaviest in June, followed by May. Diurnal, seasonal and annual weather patterns maintain exceptionally high levels of variation, signifying high unpredictability levels which range from extreme stress

to ideal growing season conditions. Effective precipitation levels (Figure 4, upper solid line) are recurrently low relative to temperature levels (Figure 4, lower solid line) needed to avert drought.

The 1987-1989 inventory period is a case in point. In comparing 1988 and 1989 growing season conditions with the thirty year averages from Medora, it was found that the summers of 1988 and 1989 were much hotter and drier than average. Year-to-date precipitation through the month of August was only 60% of the average in 1988 and 82% in 1989 (7.25 and 10.0 inches as compared to the normal 12.17 inches). Temperatures during the summers of 1988 and 1989, the average daily maximum temperatures in particular, were higher than the recorded thirty-year averages (Table 1).

Table 1. Average maximum temperatures of Medora, North Dakota.

Month	1988 Av. Max. (°F)	1989 Av. Max. (°F)	30-Year Av. Max.
April	66.1	59.3	57.4
May	79.3	72.9	70.2
June	94.0	79.9	79.0
July	93.0	92.8	87.1
August	88.5	87.0	86.7

With the climatic factors varying so widely and unpredictably across the range of stressful to idealized growing conditions, differences in setting amplify major differences in macroclimate. The setting differences signify important microclimate differences. Growing season microclimate of well-vegetated mixed grass prairie was described in the region by Wolters (1968). Slope, aspect, topographic position and substrate all interact with climate and plants to modify plant radiant energy budgets, evapotranspiration and water availability, as demonstrated in the badlands of North Dakota by Dix (1958) and Lee (1983).

Microclimate parameters are also important in the development of badlands topography (Gonzalez 1983) as well as in the patterns of ongoing secondary succession that take place in the badlands. Schmitz (1955) noted that exposed badlands outcrops are maintained in part by evaporation, imperviousness of clay, the angle of slump, exposure to wind and sun, paucity of stabilizing vegetation and susceptibility to water erosion by torrential rains.

Microclimate is an important facet of species habitat specifity in the badlands by virtue of influencing both the effective plant environment and secondary succession. Interpreting species distribution patterns becomes a challenge in separating cause from effect.

Vegetation and Flora

The complexity in landforms, soils, and microclimate of TRNP is matched by its vegetation complexity. All of these factors interact in a highly dynamic system. The physical dynamics and harshness of the system both fosters and constrains the floristic diversity which makes up the vegetation.

A literature review of floristic and vegetation research for the park and the southwestern region of the state reveals a limited number of publications and a wealth of unpublished research. The prevailing vegetation of this region was first analyzed and described by Hanson and Whitman (1939). Major works on general grassland ecology emerged from the region in the works of Hanson (1938, 1950), Dix (1964) and Redmann (1975). Vegetation research was pursued and expanded at the instigation of the Regional Environmental Assessment Project (REAP) for prairie, woodland and wetland vegetation (Whitman 1979, Wali et al. 1980 and Barker and Fulton 1979, respectively). It was subsequently studied within the framework of the habitat typing approach (Daubenmire and Daubenmire 1968, Daubenmire 1970) for the park (Hansen 1980, Hansen et al. 1984) and for the Little Missouri National Grassland area surrounding the park (Girard 1985, Girard et al.1989, Hirsch 1985, Hirsch and Barker 1984).

Over this time span, many other studies have been conducted focusing on select vegetation types: the Rocky Mountain juniper woods (Ralston 1960), the most common badlands woodland types (Nelson 1960), woody draws (Boldt et al. 1979), salt-desert shrub type (Flesland 1964), ponderosa pine woodland (Potter and Green 1964a), and woody sagebrush communities (Hazlett 1972, Hazlett and Hoffman 1975).

Research was also conducted on more localized vegetation of the region: the limber pine woodland (Potter and Green 1964b), the bluebunch wheatgrass association (Dodd 1970) and vegetation on "scoria" (Judd 1939, Hanson and Whitman 1939). Only the latter vegetation occurs in the park.

While all of these studies were aimed at describing natural vegetation in one form or another, few have been directly aimed at describing natural flux, gradient conditions, or the dynamics towards climax conditions (Hanson and Whitman 1937, Quinnild and Cosby 1958, Dix 1960, Everitt 1965, Brand 1980), including species responses and succession following drought (Whitman et al. 1943).

The original park habitat type classification (Hansen 1980) has undergone slight modification (Norland 1984, Marlow et al. 1984) and has been grouped into a system of mapping units that have their component vegetation parts. This has served as the basis for defining and mapping detailed management units of the park at the scale of 8 in = 1 mi, as prepared by Norland (1986).

Floristic research in the park and in the southwestern region of the state was conducted in conjunction with many of the aforementioned studies, but the greatest share of information is from separate collecting work represented in herbarium records. Collections made by C.B. Waldron, H.F. Bergman, W.B. Bell and O.A. Stevens provide the earliest documentation of ommon and rare species making up the flora. Flora of the region was first treated within floristic and taxonomic works of Bolley and Waldron (1900), Bergmann (1917), and Stevens (1963). Systematic floristic inventories were first conducted for the area on a county basis: in Billings, Bowman, Golden Valley and Slope counties by Zaczkowski (1972), and in Dunn, McKenzie and Stark Counties by Rohde-Fulton (1985). Initial work on a park flora was conducted by park personnel (Snow et al. 1985), and four rare species were added to the five that had been collected in the park. Many other people have contributed to the regional and park floras by way of specimen collecting, including V. Facey, G. Larson, M. Meissner, G. Seiler, J. Staudinger, S. Stephens and others. More complete descriptions of earlier floristic work conducted in this region are presented in Zaczkowski (1972) and Rohde-Fulton (1985).

The flora and the vegetation of southwestern North Dakota has a Great Plains character, with smaller components of eastern deciduous forest, boreal forest, Rocky Mountains forest, Great Basin desert, as well as circumboreal species and exotic species. Floristic affinities in North Dakota have been described by Rudd (1951), and the biogeographic affinities characterized for the four southwestern counties by Zaczkowski (1972).

The prevailing Great Plains flora itself is considered to be recent in origin (Kaul, in Great Plains Flora Association 1986), with many of its original components recently migrating from the southeast and southwest. It follows that many of these species have distributions extending beyond the Great Plains. The only two rare species found in the park that are endemic to the Great Plains are *Physaria brassicoides* (based on Hitchcock and Cronquist 1971, Scoggan 1978) and *Stephanomeria runcinata*. It is possible the *Chenopodium subglabrum* may also be a Great Plains endemic, but taxonomic work is needed outside the region.

The flora of southwestern North Dakota is comparatively rich for the state in terms of species numbers. It is premature

Table 2. Vascular plant species of southwestern North Dakota.

	Zaczkowski[1]	Rohde-Fulton[2]	TRNP[3]
Major Plant Groups (# of Species)			
Dicot	441	525	387
Monocot	152	179	122
Pteridophyte	7	8	5
Conifer	5	3	4
Largest Families (% of Total Flora)			
Asteraceae	15.4	15.7	16.8
Poaceae	14.2	13.8	14.5
Fabaceae	6.7	6.1	7.0
Brassicaceae	5.6	5.1	4.6
Cyperaceae	4.6	5.6	5.0
Rosaceae	4.1	4.8	4.3
Total Number of Taxa			
Species	605	701	518
Families	81	90	75

Note: Some of the species additions to the state flora collected in the park represent additions to the county floristic inventory results above, but have not been added into county floristic statistics.

1. Based on Zaczkowski (1972) flora of Billings, Bowman, Golden Valley and Slope Counties.
2. Based on Rohde-Fulton (1985) flora of Dunn, McKenzie and Stark Counties.
3. Based on preliminary park flora (Appendix 7).

to make statements of the proportion of the region's flora found in the park because the flora of the park is incompletely documented to date. But the preliminary figures (Table 2) show that the park, representing less than 1% (0.66%) of the seven-county area contains over 70% of the flora. The park flora also represents almost 40% of the state flora.

Beyond sheer numbers, the habitat heterogeneity accounts for high diversity. Also significant is the comparative intactness of the system as a whole with vegetation structure and process integrity. All of these concepts and the interpretation of the following vegetation characterization are discussed in the final chapter on park biodiversity.

Another way to look at the diversity picture is by examining the landscape as landform units made up of plant associations. This has been the basis for studying ungulate carrying capacity in TRNP and for mapping functional management units (See Table 3, page 9). This system in use is based on the habitat type (h.t.) approach referenced earlier.

From these characterizations, it can be concluded that large areas of the North Unit are made up of *Agropyron smithii - Stipa viridula* h.t. on both Toe Slope and Rolling Grassland physiographic settings. Large areas of the South Unit are made up of *Agropyron smithii - Stipa viridula* h.t. on the Grassland Flat physiographic setting, *Andropogon scoparius* h.t. on the Ridge and Ravine physiographic setting, and the sparingly-vegetated Steep and Rolling Scoria Complex of the Scoria Hills Setting. Both units have in common large areas made up of *Artemisia cana* h.t. of the Sagebrush Bottoms physiographic setting, and Unvegetated Terrain of the Breaks physiographic setting. In both units, large areas are classified as not having potential to become well-vegetated communities (Breaks, Scoria Complexes). These characterizations will be used for point of reference in discussion of rare plant habitats.

Table 3. Physiographic classes and the component habitat types and mapping units of Theodore Roosevelt National Park - North and South Units.

Habitat Types & Mapping Units	Physiographic Classes (in acres)																		TOTAL
	Achenbach Hills	Bottom Grassland	Breaks		Cottonwood Forest		Grassland Flats	Old River Terrace	Prairie Dog Town		Ridge & Ravine	Rolling Grasslands	Sagebrush Bottoms		Scoria Hills	Toe Slopes	Upland Grassland		
	North	North	North	South	North	South	South	South	North	South	South	North	North	South	South	North	North	South	
Achenbach Hills Complex m.u.	191.7																		191.7
Agropyron smithii-Stipi comata h.t.				20.7			5.7	1503.8			256.0	56.1				303.2	425.2	190.8	2761.5
Agropyron smithii-Stipa viridula h.t.		526.3		75.1			3329.2	454.7			919.9	1823.3		115.8	201.9	1506.3	284.4	1268.8	10,505.7
Andropogon scoparius h.t.			20.5	331.6			117.1	19.0			4084.0	120.1		3.9	26.2	657.5	38.8	63.5	5482.2
Andropogon scoparius-Juniperus horizontalis h.t.			18.8	179.9			17.5				1457.4	65.7			11.4	333.6	19.3		2103.6
Artemisia cana h.t.							33.6				51.9		1850.0	2418.9	20.7	15.6			4390.7
Artemisia tridentata-Atriplex confertifolia h.t.			305.4	748.0			22.7				233.0	13.1			88.2	770.9	4.7	1.7	2187.7
Artemisia tridentata-Bouteloua gracilis h.t.				156.9			80.8								35.1				272.8
Brush m.u.		3.7		4.7			7.2				10.9	22.2	3.2			9.1	0.5	6.4	67.9
Grassed sand floodplains m.u.		150.0											179.9						329.9
Hardwood draws m.u.		0.2	8.6	230.8			34.1	7.2			682.0	128.2	15.6	35.8	57.1	769.0	1.5	0.7	1970.8
Introduced grasses m.u.							7.2	64.0				34.8						384.7	490.7
Juniperus scopulorum-Oryzopsis micrantha h.t.		0.5	599.2	579.6			13.3				191.5				155.7	286.6			1826.4
Man-managed m.u.				16.8			6.4	12.8			3.2		17.3	46.0					102.5
Marsh m.u.													46.4						46.4
Petrified forest m.u.								54.4											54.4
Populus deltoides-Juniperus scopulorum h.t.					219.0	219.0													438.0
Populus tremuloides-Betula occidentalis h.t.	3.4		24.9	3.9							5.9	2.0							40.1
Prairie dog town m.u.									119.0	416.0						33.8			535.0
Riverbottom m.u.													41.7	230.3					272.0
Rolling scoria complex m.u.				8.6			31.6				45.0				3474.2				3587.4
Steep scoria complex m.u.				75.1							30.6				5833.8				5939.5
Stipa comata-Bouteloua gracilis h.t.			5.9	30.4				393.9			35.8	18.5				33.8	241.1	475.2	1234.6
Unvegetated m.u.		12.5	6226.2	6674.6			1143.2				3679.8	189.9	37.4	88.1	1295.8	939.9	22.5	105.2	20,415.1
Willows m.u.													76.1						76.1
TOTAL-NORTH	195.1	693.2	7209.5		219.0				119.0			2473.9	2267.6			5659.3	1038.0		
TOTAL-SOUTH				9136.7		219.0	4849.6	2509.8		416.0	11,686.9			2938.8	11,200.1			2497.0	
TOTAL-BOTH UNITS	195.1	693.2		16,346.2		438.0	4849.6	2509.8		535.0	11,686.9	2473.9		5206.4	11,200.1	5659.3		3539.0	

From Marlow et al. 1984.

METHODS

The first step in this inventory project was setting inventory targets. Five plant species considered rare in the state have been recognized as occurring in the park (*Ambrosia acanthicarpa, Stephanomeria runcinata, Physaria brassicoides, Sitanion hystrix* and *Sporobolus airoides*). One of these species, *Ambrosia acanthicarpa*, had vague collection data which predated park establishment, making it unclear whether it had actually been taken from an area which is now part of the park. Additions were made to the target list with four state rare plant species that had recently been documented in the park by park personnel (*Coryphantha missouriensis, Dalea enneandra, Stephanomeria runcinata* and *Verbesina encelioides*), and with two more rare plant species represented in the TRNP herbarium (*Oxytropis sericea* and *Populus x acuminata*). All of these rare plant species records were from the South Unit. Only two of the eleven species were represented by more than one collection location.

Next, all rare plant species documented from southwestern counties of North Dakota were compiled, along with information on species habitat and phenology (Appendix 1). The 65 species of this list were taken from the master state list maintained by the North Dakota Natural Heritage Inventory of the North Dakota Parks and Recreation Department.

Finally, this list was pared back to focus on the state rare plants within 25 miles of the park boundaries which potentially occurred on habitat as found in the park (Table 4).

Alternative approaches of setting the targets list by county, regional and federal standards were made secondary for project effectiveness. Note: The state of North Dakota does not maintain officially designated endangered and threatened species lists. For the purpose of this report, we will simply refer to these species as "rare" from a state perspective. The list of North Dakota rare plants was intitiated by Barker (1978), adopted by the North Dakota Chapter of the Wildlife Society (1982, 1986), and the documenting information has been compiled, integrated and continually updated by the North Dakota Natural Heritage Inventory. Species on the Natural Heritage Inventory list used in this project have been assigned state and global rarity ranks applying a standardized method described by Chipley (1988), to differentiate degrees of rarity and threat and to elaborate on the threatened and endangered adjectives.

Three species were added to the target list during the project with discovery of state rare plants that were previously undocumented from the region *(Eriogonum visheri, Euphorbia robusta, Orobanche multiflora).*

Table 4. Rare plant species targeted in Theodore Roosevelt National Park Inventory.

Scientific Name	Common Name	Unit
Ambrosia acanthicarpa	Bursage	N, S
Astragalus aboriginum	Indian milkvetch	S
Berberis repens	Creeping barberry	S
Boisduvalia glabella	Smooth-spike primrose	S
Chaenactis douglasii	Douglas' dusty maiden	S
Chenopodium subglabrum	Smooth goosefoot	S
Coryphantha missouriensis	Missouri ballcactus	S*
Dalea enneandra	Nine-anthered dalea	S*
Fritillaria pudica	Yellow fritillary	S
Hordeum pusillum	Little barley	S
Oenothera laciniata	Cut-leaved evening primrose	S
Oxytropsis sericea	White locoweed	S*
Physaria brassicoides	Mustard twinpod	S*
Populus x acuminata	Smoothbark cottonwood	S*
Potamogeton amplifolius	Large-leaved pondweed	S
Potentilla tridentata	Three-toothed cinquefoil	S
Rorippa calycina	Hayden's rockcress	N
Sitanion hystrix	Bottlebrush squirreltail	N, S*
Sporobolus airoides	Alkali sacaton	S*
Stephanomeria runcinata	Desert wirelettuce	S*
Stephanomeria tenuiflora	Narrow-leaved wirelettuce	S
Verbesina encelioides	Golden crownbeard	S*

*Previously documented from park.

The targeted species are recognized as rare from strictly a state perspective, with two exceptions. The Visher's buckwheat *(Eriogonum visheri)* is a federal Category 2 species which was found at a 12 mile distance from the South Unit park boundary. The Hayden's rockcress *(Rorippa calycina)* is also a federal Catergory 2 species which was collected in 1858 at the mouth of the Yellowstone River 25 miles from the present North Unit park boundary. "Category 2" means that the species is among the taxa: ***"...for which information now in possession of the U.S. Fish & Wildlife Service indicates that proposing to list them as endangered or threatened is possibly appropriate, but for which***

substantial data on biological vulnerability and threat(s) are not currently known or on file to support the immediate preparation of rules (FR Vol 50, NO. 188 CFR Part 17)."

Fieldwork agendas were developed around phenology and habitat of these species, running from mid-May through August. Species-specific fieldwork was initiated at a time when the species was becoming most conspicuous, usually at the onset of flowering. Fieldwork was also habitat-driven in that working hypotheses were developed for rare species habitat affinity, fidelity, and potential habitat extent. New species were documented in the park by targeting habitat and traversing the full range of park habitats in the course of species-specific pursuits.

Potential habitats were located for fieldwork using color aerial photographs of TRNP, park personnel expertise, and field reconnaissance. Deliberate efforts were made to traverse all areas of the park, crossing most of the approximately 100 sections of land making up the park.

For each field excursion, a Site Survey Form was completed listing the date, location and what was sought (Appendix 2). The general route was mapped onto U.S.G.S. 7.5-minute topographic maps. For each new rare plant population found, a Rare Plant Form was completed, detailing the population size and extent, habitat, and associated species (Appendix 3). All occurrences of rare plants were also mapped.

Rare plants were tabulated as discrete rare plant locations called occurrences. The occurrences are loosely referred to in this report as populations, though it is not possible to delimit populations without studies into reproductive biology. Habitat continuity and distances were taken into account, but genetics information was unavailable. Some of the occurrence boundaries drawn may be artificial, e.g. use of the Little Missouri River to demarcate upland species populations. Some occurrence boundaries were redefined after fieldwork was completed. Some of the elongate valley population occurrences in the North Unit may actually represent many populations.

Rare species documentation included photographs (35 mm slides) showing both close-up morphological features and habitat. Voucher specimens were collected for each species found in North and South Units, following the Plant Conservation Roundtable collecting guidelines (1986) and NPS collecting policy. Specimens were deposited in the TRNP Herbarium in Medora. Duplicate specimens were deposited in the University of North Dakota Herbarium and the North Dakota State Univeristy Herbarium. Specimens were identified using the ***Flora of the Great Plains*** (Great Plains Flora Association 1986) and other technical references. Verification was solicited from taxonomic authorities when the collections represented new additions to the state flora.

RARE PLANT STATUS AND INVENTORY RESULTS

All of the rare target species documented in the park are rare from a state perspective. Some are potentially rare throughout their range. Species inventory results in TRNP are to be measured against state status and rangewide status to come up with a biodiversity focus and management directive.

To develop this focus and direction, species-by-species summaries have been prepared. They incorporate results of the 1987-1989 inventory, state and global status and distribution information, observations made in the field, prior herbarium records, published and unpublished literature and personal communications. Taxonomic descriptions are from the ***Flora of the Great Plains*** (Great Plains Flora Association 1986) unless otherwise stated.

Each of the thirteen species is named by full taxonomic nomenclature, family, and common name, with detailed information provided under the following headings:

Description and identification. Includes diagnostic characteristics and distinctions from other members of the genus, distinctions from superficially similar plants of the park, and the most conspicuous features as used in locating the plant. Note that all accompanying photographs were taken in the park.

State distribution and rank. Includes statewide distribution, depicted on map by county. Note that the state distribution maps shown for each species distinguish beteen historic and recent collection records where a solid circle represents one or more collection records between 1960-1990, and an open circle represents one or more collection records prior to 1960.

Statewide rarity rank is assigned in keeping with a standardized methodology (Chipley 1988) and indicated by the following codes:

S1 Critically imperiled in state
S2 Imperiled in state
S3 Vulnerable in state
S4 Apparently secure
SA? Possibly adventive

Global distribution and rank. Includes rangewide distribution information and any associated taxonomic questions tied to portions of the species range. Other states recognizing the species as potentially rare and collecting information on it are listed.

Global rarity rank is assigned in keeping with a standardized methodology (Chipley 1988) and indicated by the following codes:

G1 Critically imperiled globally
G2 Imperiled globally
G3 Vulnerable globally
G4 Apparently secure
G5 Demonstrably secure
HYB Hybrid; not assigned global rank

Significance of TRNP population(s). The park inventory results are discussed for each species as to prospective or documented county, state, regional, and national significance. Individual rare plant records are referenced by a unique three digit number following the species name, and the master list of all TRNP rare plant records is detailed in Appendix 4. Collection numbers are also included for reference.

TRNP distribution. The total number of populations, habitat preferences, and habitat fidelity are described for the park, characterizing habitat by landforms, topography, slope, aspect, soils, plant associations, and habitat types.

TRNP management. Management concerns are discussed for the species as a whole or for individual populations as occurring in the park.

Chenopodium subglabrum (S. Wats.) A. Nels. *(Chenopodiaceae)*
Smooth goosefoot

Description and identification: Smooth goosefoot is an annual linear-leaved chenopod which can be recognized most readily when mature, starting at the end of June until the time it turns brown in late August or September. Individuals found in the 1989 inventory were less than 30 cm tall, and grew even shorter in the open.

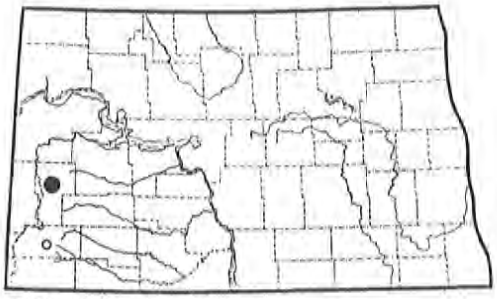
It often occurs with other species of *Chenopodium*, including the closely-related *C. leptophyllum*. It is technically distinguished by the readily detachable seed pericarp, which exposes a jet-black seed, versus an attached pericarp that falls with the seed. Both of these species have linear single-veined leaves, but the leaves of smooth goosefoot are glabrous green rather than farinous white. Some taxonomic references still treat it a a variety of *C. leptophyllum*, but the ***Flora of the Great Plains*** (1986) recognizes it at the species level.

It is readily distinguishable at a glance by the full growth form of well-developed branches and remote glomerules which do not tightly cluster along the branches.

It is perhaps the least showy of the rare plants in the park and belongs to a genus containing the exotic species *C. album* that invades gardens. However, smooth goosefoot represents a native species adapted to western riparian primary succession, a narrow range in a natural disturbance regime. Its rarity in comparison with other native widespread species of *Chenopodium* sharing the same habitat poses interesting questions.

Figure 5. Chenopodium subglabrum close-up (#003), showing robust plants in partial shade.

State distribution and rank: Smooth goosefoot is ranked as critically imperiled in the state (S1), based on six records representing small, susceptible population numbers in Billings County and a 1946 chenopod collection in Slope County that was later annotated to *C. subglabrum* (Stevens #887 NDA). It was rediscovered in the course of the inventory by Ronald Wieland and verified by Ralph Brooks of the University of Kansas. The Billings County records are widely-scattered and almost entirely inside park boundaries. They may represent a single population rather than five populations. As a riparian species, it may occur upstream and downstream along the Little Missouri River. Repeated searches in the North Unit, including promising habitat, turned up no populations.



CHENOPODIUM SUBGLABRUM

Global distribution and rank: The global rank of smooth goosefoot is undetermined (G?) and is a high priority for consultation with botanists from other states. It is known sporadically from Montana to Utah and North Dakota to Nebraska according to the ***Flora of the Great Plains*** (1986), which also notes that "it is quite rare and has been collected very infrequently during the past several decades." Other states currently assigning it a rarity rank include Nebraska and Wyoming. It is on record as being reported from Montana, and as a variety of *C. leptophyllum* in Colorado, Utah and the Pacific Northwest. It has not been considered to date by the U.S. Fish & Wildlife Service for listing as Threatened or Endangered, and cannot be considered until distribution and taxonomy are settled in western parts of species distribution. Taxonomic study may be needed for putative specimens of the Pacific Northwest (Crawford 1975, Reynolds and Crawford 1974), before distribution data can be assembled.

Significance of TRNP population(s): The population(s) located in the course of the 1989 South Unit inventory work are among the few recent collections of this species anywhere. They represent a new Billings County record for North Dakota and the only state occurrences on public land. As a result of the TRNP inventory, the state status of this species changed from known only by historic records (SH) to critically imperiled (S1). Any other state rank changes would come from information outside of TRNP if suitable riparian habitat is found to remain. If smooth goosefoot is a Great Plains endemic, then the TRNP population(s) may be nationally significant (see global distribution discussion). Project specimen collections include Wieland #5121 TRNP, #5135 NDA, #5162 KU, TRNP, UND.

TRNP distribution: Smooth goosefoot is found intermittently along a narrow, discontinuous band of early successional habitat on the Little Missouri River in the South Unit, the most sandy of settings along the river. It lies entirely within the Riverbottom management unit (interpreted from Norland 1986). It grows near the edge of sandy riverbank terraces that are ephemerally flooded and where bare sand is exposed. It is found in open to partially shaded settings. Though it occurs most often in the open, its largest population is in partial shade (Figure 5).

The small population outside the park was partially associated with an abandoned hiking trail to the river, but it was not found associated in the park with the many paths eroding into the riverbank developed by campers, horses and wildlife. Some of the places where it is found might represent old bison trails paralleling the terrace edge that are no longer used.

It is found mainly on level ground at the edge of the sandy terraces (Figure 6), which are flooded for a short period in normal years. A few of these terraces that still get flooded are set back from the river shore. Two isolated plants were found growing on sandy river shore, but these are not taken to represent viable populations in themselves (part of #007). Part of two small populations were also found on the loose, steep sand cutbank slope below the terrace along the river. Known populations occur over an elevation range of 2230-2260 ft following the river gradient on both sides of the river.

This species usually occurs in low numbers and low density. The Billings County records reflect total numbers of individuals ranging from 1-160.

This species is uncommon in what appears to be suitable habitat. Much of what is otherwise suitable habitat is overgrown. As a rule, it is not found in the prevailing perennial native species associations, which include communities dominated by *Calamovilfa longifolia, Artemisia cana, Salix exigua* and *Populus deltoides*. It does occur on occasion with the native bunchgrass *Oryzopsis hymenoides*. It characteristically grows near habitat in which the native species *Psoralea lanceolata* is common. Its species association is typically made up of adventive and non-native short-lived species such as *Ambrosia psilostachya, Chenopodium leptophyllum, Bromus japonicus, Bromus tectorum, Descurainia* spp., *Conyza canadensis, Helianthus petiolaris, Lepidium densiflorum* and *Melilotus* spp.

Figure 6. Chenopodium subglabrum habitat (#003) at a distance, showing the segment of occupied South Unit river terrace habitat.

TRNP management: Management questions associated with smooth goosefoot are the most pressing and complex of any of the rare species in the study. Baseline monitoring of the large population in the South Unit will be needed to distinguish population trends and fluctuations from the threat of leafy spurge encroachment and its treatment.

This annual species may depend on dispersal of its seeds by water. Increased levels of downcutting along the Little Missouri River, as cited by Duerre (1986), may reduce dispersal of the species to suitable habitat and diminish the amount of suitable habitat over time. River hydrology is conditioned by external upstream land use practices.

Successional processes also affect habitat needs of smooth goosefoot. Primary riparian succession diminishes its habitat. Secondary succession induced by beaver activity has unknown influence. It is not found under the continuous cover of rhizomatous grasses, nor under high densities of the nitrogen-fixing scurf pea and sweetclover. Most of its populations were found on bare sand out in the open, but the largest and most vigorous population grew on bare sand under a partial cover of cottonwood saplings. Note: The North Unit contains even greater development of sandy riparian communities, with a few river bends entirely dominated by scurf pea and indian ricegrass. This apparently suitable habitat does not harbor smooth goosefoot.

The greatest immediate threat to the species is invasion of its habitat by leafy spurge and, more recently, Russian knapweed. Not only do the noxious weeds outcompete this species, but the herbicide treatments pose a severe threat to it as well. All of the 1989 park populations were in close proximity to leafy spurge. Russian knapweed is beginning to spread in similar habitat and poses a second major, if less imminent threat. Herbicide treatments for leafy spurge invasion of smooth goosefoot sites is the top priority management need.

It is recommended that the largest 1989 population site (#002) be evaluated and marked on the ground as to leafy spurge extent and proximity to population boundaries. Mechanical treatment or contact herbicide is recommended for treatment of the spurge at this single site. It would also be valuable to monitor population size in order to sort out year-to-year variability in population numbers, population trends, and management responses.

Coryphantha missouriensis (Sweet) Britt. & Rose *(Cactaceae)*

Missouri ballcactus

Description and identification: Missouri ballcactus is a small low-growing cactus with one to several subglobose stems (aereoles). Its pale yellow flowers (Figure 7) readily distinguish it from the similar common species, pincushion cactus *(Coryphantha vivipara)*, which has bright pink to reddish-purple flowers. It flowers earlier than pincushion cactus, i.e. late May to early June. The flowering period seems to last from 2 - 3 weeks, with individual flowers blooming a week to ten days. Only the end of its flowering period overlaps with pincushion cactus flowering.

It is also clearly distinct in fruit, and the fruit matures the following year in spring. The globose 1-cm fruits of Missouri ballcactus are bright red in maturity (Figure 8), while those of pincushion cactus remain green, grow to 2.5 cm, and are oblong in shape.

A third characteristic difference between the two species is associated with their spines, and this difference can be discerned year-round. This is not an unfailing diagnostic character and distinctions were not made on this basis. Missouri ballcactus has radial spines, but almost never any central spines projecting outward from the plant; on rare occasions it has 3-4 central spines. Pincushion cactus always has 3-4 central spines, and these are distinctly longer than the radial spines; on occasion it may have up to 12 central spines. In other words, Missouri ballcactus can almost always be touched without pain, whereas pincushion cactus can never be touched without contacting a spine tip.

These two species were occasionally found growing together or in immediately adjoining habitats and were carefully discerned in making population counts. Within the park, neither of the two is common and pincushion cactus was never seen in large numbers. Pollination vectors are unknown.

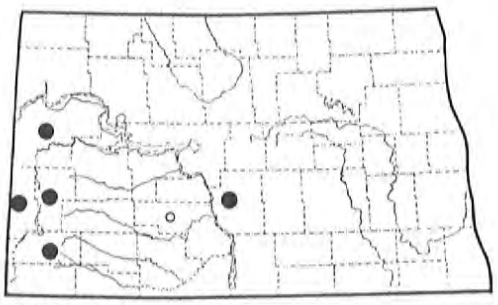
Figure 7. Coryphantha missouriensis in flower (#008).

Figure 8. Coryphantha missouriensis in fruit (#008).

The bright red fruits are highly conspicuous and the red coloration may make it all the more attractive for dispersal by rodents or by birds as suggested by Barr (1983). Tiny seedlings were noted in close proximity to mature plants in only one population (#016), believed to represent germination of seeds that had ripened the same year.

Missouri ballcactus, like all other cacti, is highly drought-tolerant, with morphological and physiological adaptations to endure the extremes of its environment. It is also said to have the capacity to reduce its volume by half and withdraw to ground level with the onset of cold temperatures (Barr 1983).

State distribution and rank: Missouri ballcactus is presently ranked as either vulnerable or possibly secure in the state (S3S4), based on 29 records from five counties. This rank could only be lowered by discovery of vigorous populations outside of the park or more new county records. A small number of plants were found in Slope County incidental to the inventory project, and recent reports of the species in Morton County near the Missouri River and in Grant County near Lake Tschida are pending verification. The great majority of park populations are made up of fewer than ten individuals. Clusters originating from vegetative reproduction are tallied as a single individual. A few major populations at preferred habitat have numbers over 100.



CORYPHANTHA MISSOURIENSIS

Global distribution and rank: Missouri ballcactus is ranked as demonstrably secure globally (G5), ranging from Idaho to North Dakota, south to Kansas and Arizona. No other states assign it a rarity rank at this time.

Significance of TRNP populations: The populations in TRNP represent among the few precisely located populations in North Dakota and by far the highest concentrations and largest numbers. Largest populations are found in the North Unit. Prior to the TRNP inventory, this species was assigned the state rank of "unknown" (SU), revised

to state vulnerable (S3) based on this inventory. Its only Billings County collections are from the park, and it had not been collected in McKenzie County since 1938 (Stevens sn. NDA). Project specimen collections include Rankin sn. TRNP and Wieland #5026 NDA, TRNP, UND.

TRNP distribution: Missouri ballcactus is widely scattered over large areas of both North and South Units. It grows in a variety of open prairie settings, and is the least restricted in habitat of the TRNP rare species. Its largest population numbers, however, are found in a single particular substrate and type of setting, reflecting a distinct habitat preference.

The largest population in the park is in the North Unit (#008), found at the base of the Little Missouri valley walls on gently-sloping south-facing loamy substrate. These slopes are the lower slopes of an ancient landslide originating from the Sentinel Butte Formation above. The two largest South Unit populations (#016,#019) occur in a badlands setting on colluvial deposits also originating from the Sentinel Butte Formation. They seem to endure a certain amount of burial by sediments carried in through erosion, but they were not found on steep slopes or other sites being eroded away immediately around the plant.

Individual plants in the large populations tend to be clustered in a patchy distribution. Highest population numbers are found within sparsely vegetated areas representing a break in otherwise continuous *Agropyron smithii - Stipa viridula* habitat type cover (Figure 9). Litter and groundcover are particularly low. All North Unit populations lie within the *Agropyron smithii - Stipa viridula* habitat type, the secondmost extensive habitat type in the North Unit (Marlow et al. 1984). Many South Unit populations lie in or adjoining areas mapped as this same habitat type, which is the most extensive habitat type in the South Unit. Going by the Norland maps, Missouri ballcactus also occupies the following South Unit associations: *Agropyron smithii - Stipa comata* h.t., *Stipa comata - Bouteloua gracilis* h.t., *Andropogon scoparius* h.t., *Agropyron smithii - Bouteloua gracilis - Distichilis spicata* h.t., rolling scoria complex and steep scoria complex.

It is possible that the suitable habitat patches in the North Unit are early succession conditions associated with intense bison trampling (Rankin pers. obs.). This hypothesis is partially supported by the fact that one of the two largest South Unit populations (#019) corresponds with an area of observed bison aggregation (from Marlow et al. 1984). The other South Unit population which is not part of a documented bison aggregation area (#016) does have a distinct wildlife trail running through it and intermittent bison signs.

Considering the common Sentinel Butte substrate of all the major populations and their landform histories, it is also possible that upward salt migrations as in solonization may foster suitable habitat development. Perhaps formation of suitable microhabitat hinges on soil chemistry differences that also happen to attract bison.

Some South Unit populations occur in excessively-drained, dissected topography near the edge of abrupt cutbank drop-offs. One of these sites is the population (#016) on dissected mid-elevation terrace tops skirting a badlands knoll where "edge habitat" is abundant. Missouri ballcactus grows in soils with little organic horizon development, and in a variety of substrates from clay loams to sandy loams. It favors the finer-textured substrate. These topographically broken areas are mapped in or adjoining the *Agropyron smithii - Bouteloua gracilis - Distichilis spicata* h.t. or steep scoria complex.

Well-vegetated settings, including the prevailing prairie vegetation types, infrequently harbor scattered individuals. The low numbers in prairie sod are believed to represent relatively unstable populations which may have originated with very small-scale disturbance or represent once-larger populations on the decline. These well-vegetated areas include the extensive *Agropyron smithii - Stipa viridula* h.t., as well as areas mapped as *Stipa comata - Bouteloua gracilis* h.t. and *Andropogon scoparius* h.t.

The range of habitats in which this species occurs has not been neatly bracketed, so it is not possible to consider the frequency with which it is found in suitable habitat. It is absent from eroding slopes and nearly absent from the Little Missouri floodplain.

Successional status of Missouri ballcactus is open to question. Its preponderance in barren microhabitats may reflect habitat specificity, reduced competition or enhanced conditions for establishment. If the bareness of its habitat is the result of secondary succession, then Missouri ballcactus is a successional species. The natural soil succession process of soil solonization has not been recently studied in relation to plant succession (Hanson and Whitman 1937). It is interesting to note that there were three unequivocal secondary succession sites in the South Unit at which one or two individuals of Missouri ballcactus were found. One was in a small sand blowout at the far western boundary of the park (#027) another was on an actual homestead building site at the VA Well (#025), and a third was in an old wagon road track within a large population (#016).

Figure 9. Coryphantha missouriensis habitat (#008), in the midst of Agrophyron smithii - Stipa virdula h.t. in a Toe Slope setting of the North Unit.

TRNP management: Missouri ballcactus is a species which may be suppressed by litter buildup, as indicated by low densities of individuals and low levels of vegetative reproduction when litter is present. It is possible that vegetation management reducing litter buildup such as grazing and prescribed burning could benefit the species, or that the heat generated by fire on the ground surface could be detrimental. Assumptions are not to be made about the impact of these practices on Missouri ballcactus without testing them by small scale trials and monitoring. It is to be noted that large areas of the park are free of litter buildup, producing limited forage for grazing ungulates and limited fuels for fire.

Specific sites with management concerns include the following. One of the largest populations in the South Unit (#016) extends next to or onto an area of the park in the private development subzone.

Part of the single largest population, found in the North Unit, lies near the road to the bison holding corral and its intersection with the park scenic road. Any projects involving road upgrading, widening, or roadbed changes should be considered in light of Missouri ballcactus impact.

A single plant was found growing within easy walking distance of the most heavily-visited spot on the park, the Painted Canyon Overlook. However, the fruits and flowers of this species are only conspicuous early in the growing season before heavy tourist traffic. Special preventative measures discouraging cactus-collecting are not warranted at this time above and beyond the existing practice of stating to the general public that park policy does not permit the collection of plant materials.

Dalea enneandra Nutt. (*Fabaceae*)

Nine-anthered dalea

Description and identification: Nine-anthered dalea is a leguminous species that looks dissimilar from all other members of the family in the state, including the prairie clovers (previously *Petalostemum* spp.). Its numerous tiny, delicate, white flowers, less than 8 mm., are on loose racemes, flowering in late July through mid-August (Figure 10). It has nine stamens as the name implies, and the bract subtending the calyx is broad and conspicuous. Its mature pods are less than 4 mm, surrounded by a silky calyx less than 5 mm long that becomes divergent and appears like four plumes forming a fringed cross. It has a knobby or shortly branched caudex, and 7-13 delicate pinnate leaves which are subsessile and glandular. It is glabrous throughout.

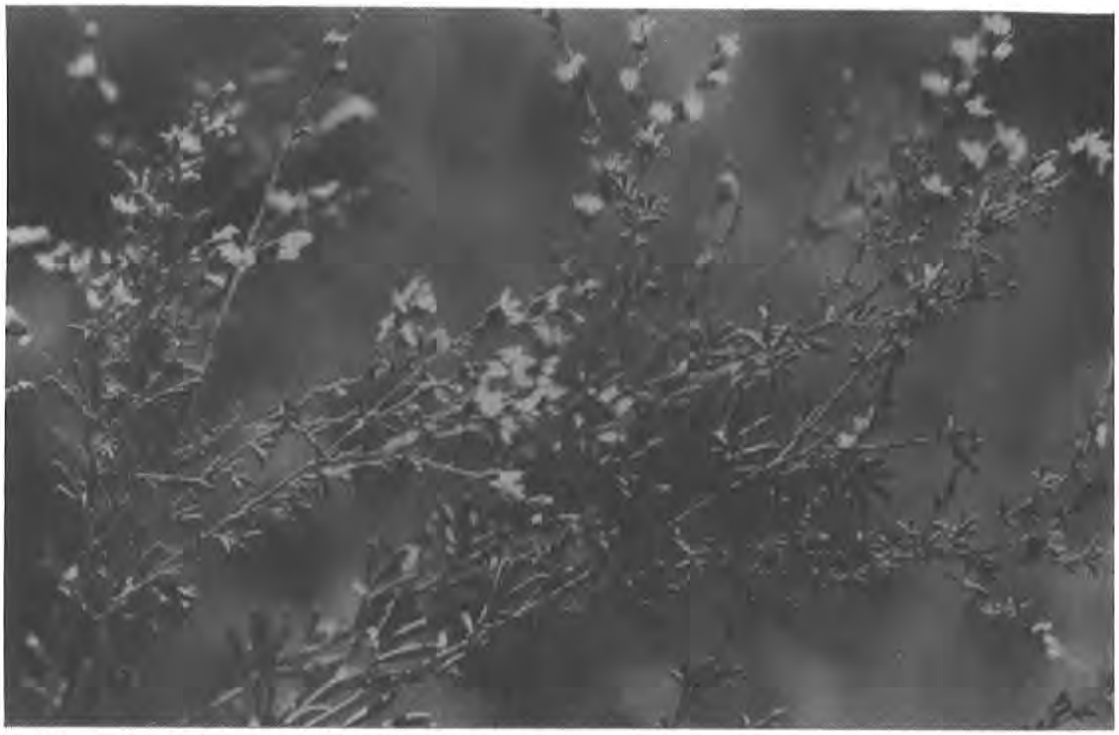
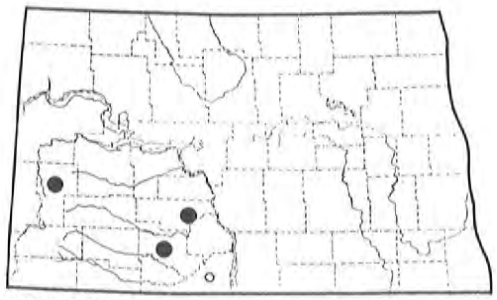


Figure 10. Dalea enneandra in flower (#011).

It stands out from surrounding sparse vegetation in height and stature. It is 3-10 dm tall and grew 7 dm in 1989 and less than 3 dm in 1988. It has a multiple-branched full growth form, sometimes with multiple stems, that also makes it prominent. It has been inferred that its slender, widely-branched stems with white flowers and silvery calyxes produce a "bursting rocket" appearance having horticultural value (Barr 1983).



DALEA ENNEANDRA

State distribution and rank: Nine-anthered dalea is ranked as imperiled or vulnerable in North Dakota (S2S3) based on eleven records from four counties, including four historic records. Its occurrence in TRNP reflects a new county record and state range extension. Its state center of distribution appears to be along the Missouri River and the Heart River, which have not been well-inventoried. Two new population records were collected in 1990 in these areas (Morton County, Mercer County).

Global distribution and rank: Nine-anthered dalea is demonstrably secure globally (G5), ranging across the Great Plains from North Dakota to Missouri, Texas and New Mexico. Other states assigning it a rarity rank include Missouri, Montana and Wyoming.

Significance of TRNP populations: The two known populations in TRNP represent a new county record for Billings County, a major westward range extension in North Dakota, and almost the only records from public land. They do not change the state status of this species. Project specimen collections include Godfread #6586 NDA, TRNP and Wieland #5157 NDA, TRNP, UND.

TRNP distribution: Nine-anthered dalea grows in the South Unit of TRNP below the south-facing rims of plateau tops capped by unconsolidated alluvial gravel deposits (Figure 11). These coarse alluvial deposits were laid by the Little Missouri River before the Pleistocene down-cutting and are found at some of the highest elevations of the park. The steep exposed setting of this species is sparsely vegetated. They are mapped as part of the *Agropyron smithii - Stipa comata* h. t. as found on ancient River Terrace landforms, though the particular settings do not represent climax community. This is consistent with the species reported preference for calcareous soils (Great Plains Flora Association 1986).

The largest population of over 200 plants is located along a segment of Radio Tower Plateau (#011). A small population of fewer than 20 plants is found on the Big Plateau (#010). Both populations occur over the plateau crest extending downslope 10-15 m. These loose gravel slopes are highly-restricted habitat, and nine-anthered dalea was found only on rare occasion in apparently suitable habitat.

Some midwestern states recognize gravel prairie as a discrete vegetation type, but this habitat has not been split from the general mixed grass prairie community or the habitat types of western North Dakota. Dominant grasses include *Andropogon scoparius, Bouteloua curtipendula,* and *Muhlenbergia cuspidata.* Common or dominant shrubs include *Rhus trilobata, Artemisia cana* and *Artemisia tridentata.* Also common is *Yucca glauca.* Groundcover and litter was very low throughout most of the population, but the population did extend into vegetation with nearly continuous cover of *Andropogon scoparius - Bouteloua curtipendula.*

TRNP management: The largest population, at the far northern end of Radio Tower Plateau (#011), is found on a series of three sidearms off a ridge. The largest number are at the far sidearms. The middle sidearm has very low numbers and appears to be a small old borrow pit cut into the hillside. The gravel from the site may have been tried for concrete or road surfacing before park establishment in 1947.

Both populations are now in the designated wilderness part of the park. Most of its habitat is so sparsely vegetated that it would not ordinarily burn. The two sites are free of leafy spurge and there are no known impacts under present park management practices. However, the second population is located along or near the Big Plateau trail; it is not known if being located near a trail has any detrimental influence.

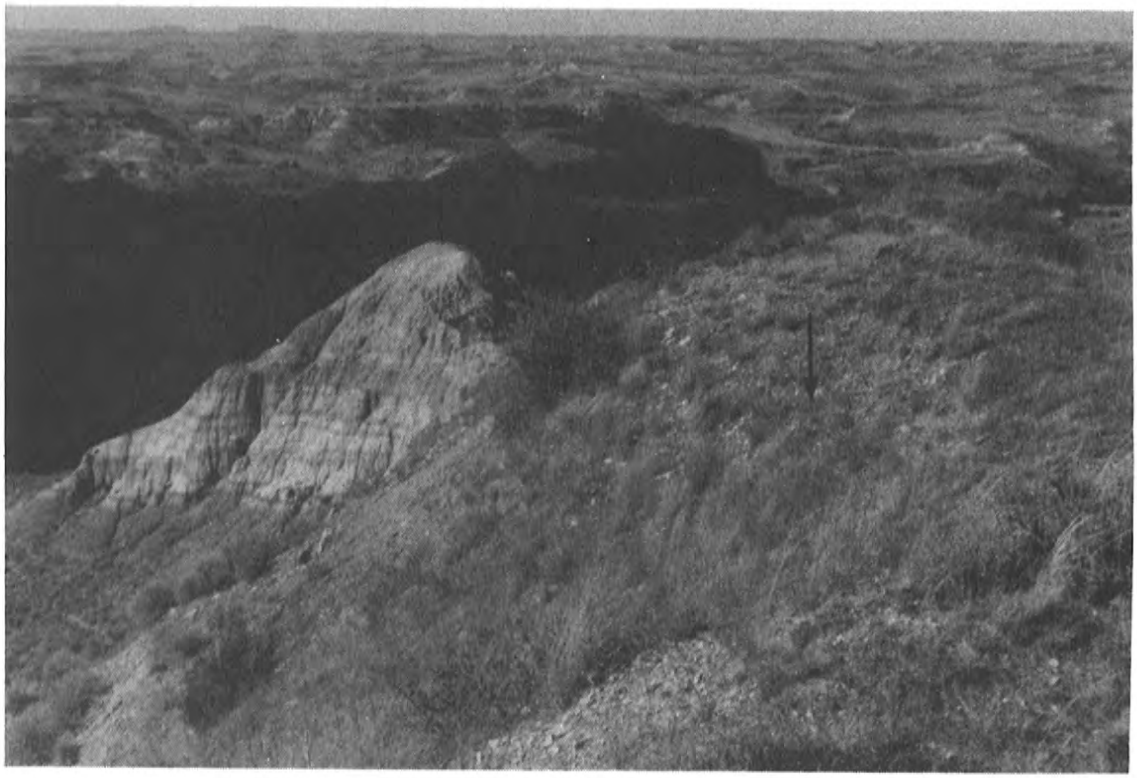


Figure 11. Dalea enneandra habitat (#011) in the South Unit.

Euphorbia robusta (Engelm.) Small (*Euphorbiaceae*)

Shrubby spurge

Description and identification: Shrubby spurge is a small shrub-like perennial which has a distinctive woody branched caudex, mound-like growth form and leaves which are about as wide as long (Figure 12). The leaves are thick, somewhat fleshy and obscurely veined. The lower ones are alternate, with an entire margin, nearly sessile, 1-2 cm long, and acute or abruptly pointed. Its involucre (cyathia) does not have petaloid appendages but it does have 4 or 5 glands. The infloresence is umbelliform. Shrubby spurge has a deep taproot. Plant height of the TRNP population ranged from 1-2 dm in 1989.

Figure 12. Euphorbia robusta close up

State distribution and rank: Shrubby spurge was discovered in North Dakota during the course of the 1989 park inventory work. Based on the single documented occurrence for this species in the state, it has a state rank of critically imperiled (S1). It was first found and collected in North Dakota by Ronald Wieland, working in the South Unit, and verification was provided by Ronald McGregor of the Univeristy of Kansas. There is a stigma attached to the spurge genus because leafy spurge (*Euphorbia esula)* is the most widespread invading noxious weed in the state. This fact does not preclude recognizing the native species of spurge as potentially important in state biodiversity conservation.

EUPHORBIA ROBUSTA

Global distribution and rank: Global rank for shrubby spurge is presently undetermined (G?). ***The Flora of the Great Plains*** (1986) describes its range as extending from Montana to New Mexico and Arizona. No other states assign it a rarity rank at present.

Significance of the TRNP population: The South Unit population in TRNP represents the only documented record in North Dakota and the easternmost occurrence of the species at the northern end of its range. It is one of the two new additions to the state flora documented in the course of this TRNP inventory, and remains among the rarest of the TRNP state rare species. Project specimen collections include Wieland #5047 NDA, UND, #5782 KU, TRNP.

TRNP distribution: Shrubby spurge occupies sandstone outcrop of the Bullion Creek Formation at about 2560 ft, mainly on extensive, interrupted jutting sandstone ledges within a 1/4 mile area and to a lesser extent on the loose sand and silt or gravel slopes immediately adjoining (Figure 13). This habitat is similar to that occupied by mustard twinpod elsewhere in the park, but at about 60 feet higher elevation, and on coarser sandstone without silt and clay. Shrubby spurge was found in conjunction with searches for mustard twinpod and nearby desert wirelettuce. There is only one population site documented for it from the park and the state. The outcrop extensiveness, grain coarseness and elevation differ somewhat from other sandstone outcrops of the park. The 40-50 plants of shrubby spurge occupy only a fraction of apparently suitable habitat at the site.

These areas are mapped as *Agropyron smithii - Stipa comata* h.t., but the species does not occupy climax community settings. Species associates at the site include: *Andropogon scoparius, Lesquerella alpina, Solidago missouriensis, Cryptantha celesoides, Rhus aromatica, Hymenopappus filifolius*, and *Calamovilfa longifolia.*

Figure 13. Euphorbia robusta habitat, showing sandstone ledge habitat at extreme western end of South Unit.

TRNP management: Leafy spurge is invading small areas of the shrubby spurge population. This site is in the designated wilderness area of the South Unit. Localized herbicide treatment to keep the leafy spurge invasion under check is needed before the entire population is threatened.

Hordeum pusillum Nutt. (*Poaceae*)

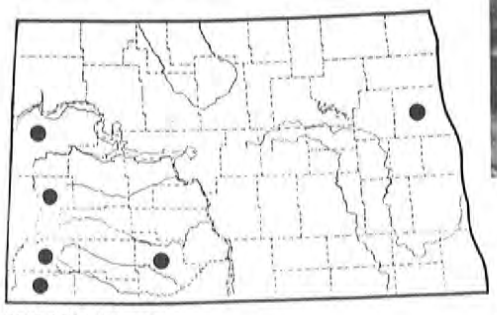
Little barley

Description and identification: Little barley is an annual grass that germinates and matures quickly early in the growing season, much like sixweek fescue. It heads out in early or mid-June and most of its mature spike has completely fallen off by late July.

Its high-density populations are a distinctive feature, located in otherwise sparsely-vegetated flats and terraces. It resembles a barley plant, with the typical three one-flowered spikelets at each node and the disarticulating rachilla (Figure 14). Its glumes are noticeably inflated. Compared to the much more common foxtail barley (*Hordeum jubatum*), little barley has awns which are stiff and short (8-15 mm long). The plant itself is also relatively short, averaging around 2 dm in TRNP, and it has small leaves which never give the impression of a lush meadow grass like foxtail barley.

The short life cycle of little barley synchronized to peak water availability adapts it to the rigors of the badlands environment, just as its short forage value synchronized with seed maturity may give the high density populations a special value in dispersal.

State distribution and rank: Little barley is categorized as having unknown rank in the state (SU), based on 16 records from six counties. Its positive response to disturbance has been recognized elsewhere in its range (see following section) but not documented in North Dakota. Zaczkowski (1972) had listed only two collections for the species in Billings and Slope Counties but it is expected that the species has been overlooked. It will be dropped to the demonstrably secure rank in the state if it is found to occur as an invader species under livestock grazing or if large new populations are documented.



HORDEUM PUSILLUM

Figure 16. Hordeum pusillum close up.

Global distribution and rank: Little barley is ranked as demonstrably secure globally (G5), ranging throughout the Great Plains states and much of the country except parts of New England and the Great Lakes. It has the widest distribution of any species in this inventory and is considered an increaser and invader with heavy livestock grazing in more southern and western states (e.g. Weaver 1954, Smith 1976). Other states assigning it a rarity rank include Illinois, Minnesota and Pennsylvania.

Significance of TRNP populations: Results of the TRNP inventory confirm this species from the park for the first time, and confirm that the species has been overlooked in the region. Collection of little barley in the North Unit signifies a new county record for McKenzie County. South Unit populations represent the only known concentration of populations in the state. In TRNP it is not consistently associated with overgrazed conditions but with alkaline sparsely vegetated settings. The North Unit population occurs near an intensively grazed well site. The TRNP inventory results do not change the state rank of this species. Project specimen collections include Rankin sn. NDA and Wieland #5075 NDA, #5097 TRNP, UND.

TRNP distribution: Little barley is widely scattered across claypan and outwash flats and open valleys between 2520-2600 ft. on Sentinel Butte Formation. There are large areas of apparently suitable potential habitat for this species in the park. A single population was found in the North Unit, and eight populations were found in the South Unit. It prefers fine-textured substrate, often clay loams. Some sites have claypans and others have surface clay washes but all have limited water availability and high alkalinity.

It occurs in areas variably mapped as steep scoria complex, *Stipa comata - Bouteloua gracilis* h.t. and *Artemisia tridentata - Atriplex confertifolia* h.t. It does not occur in areas of climax community but in barren pockets of impeded moisture infiltration and/or solonization (Figure 15).

This species of annual grass has the highest population densities of any TRNP rare plant species, occurring in local abundance over a restricted area. The largest population (#013) has population numbers in at least the 10,000 order of magnitude, concentrated in an area not much more than 1000 square meters. This raises questions of its dispersal mechanism(s), lack of intraspecific competition and ecological niche.

Many of the species associated with little barley are short-lived increaser species, including *Selaginella densa, Plantago elongata, P. patagonica, Opuntia polyacantha, Bromus japonicus, Festuca octoflora,* and *Kochia scoparia.* Much of the largest population was closely associated with a decreaser species, *Ceratoides lanata,* a favored big game browse. It also occurs intermixed among but negatively associated with areas dominated by *Bouteloua gracilis, Agropyron smithii* and *Artemisia cana.* Its community is possibly either a grazing-induced seral community or a solonization-induced seral community. In either case little barley is a secondary succession species. This is consistent with its preference for open sparsely-vegetated habitat.

Its characterization as an increaser species may also be consistent with its dispersal and establishment patterns. One small population (#015) had clearly gotten its start on recent horse droppings. At many of the population sites, wildlife trails, pack trails, and bison sign were noted (Figure 16). Like other species of barley, little barley has sharp-pointed joints in its mature spikes that disarticulate and can penetrate nose and mouth tissue of grazers or get caught on fur and hide.

Its TRNP distribution may be linked closely to presettlement migrations and grazing regimes of bison and elk, the post-settlement migrations and grazing regimes of cattle drives and early ranching enterprises, and/or the ongoing mosaic of grazing that takes place in the park involving bison, elk, wild horses, pack horses, and longhorn steers.

TRNP management: Little barley is not under any apparent threat in the park. It might serve as an indicator species on a very local scale, but more information is needed on its species biology and year-to-year variations in order to use it for this purpose.

Figure 15. Hordeum pusillum habitat (#008) in the North Unit.

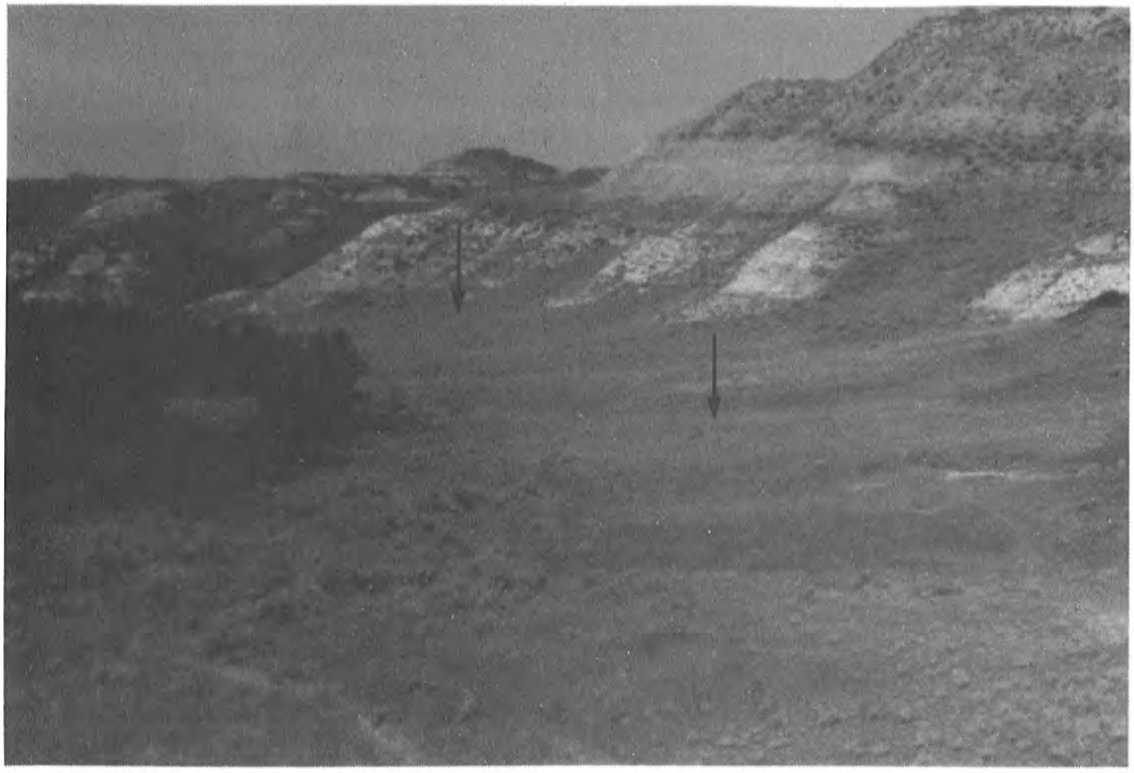


Figure 16. Hordeum pusillum habitat along the Lone Tree Loop in the South Unit (#013).

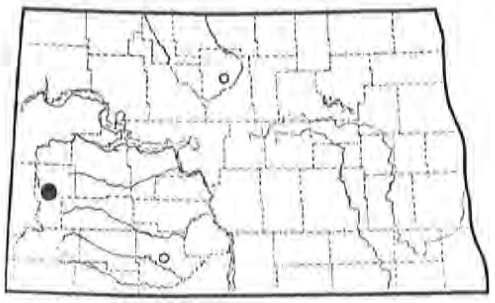
Oenothera laciniata Hill (*Onogracaceae*)
Cut-leaved evening primrose

Description and identification: Cut-leaved evening primrose is an annual plant that varies in stature, ranging from stems simple to much-branched, stems glabrous to densely strigulose or sometimes villous, and 1-3 dm in height. Basal leaves appear to be in rosettes, the leaf blades are oblanceolate, entire to usually sinuate and dentate or pinnatifid, and the stem leaves are alternate and highly variable in outline. Flowers are yellow, fading to pinkish, solitary in axils, opening near sunset, usually nodding, and were found blooming in the park in early to mid July. Petals are obovate, 5-18 mm long, and the floral tube is 1.5-2.5 cm.

It is distinguished from *O. nuttallii* Sweet, which it was originally identified as in the field, in being an annual versus a perennial with caudex, in its presence of basal rosulate leaves, in its yellow versus white flowers (both species fading pinkish), in stamen length 2-4 mm and anther length 5-7 mm versus stamen length 5-6 mm and anther length 8-10 mm.

Photographs are not available of this species.

State distribution and rank: Cut-leaved evening primrose is ranked as possibly adventive in North Dakota (SA?), based on six records in three counties. All records except for two in Billings County are historic. The site of the previous Billings County collection was in an abandoned sandy field (Godfread #5626 NDA). The other county collections do not provide indication that it occurred as an adventive species. In the South Unit of the park, a single individual was found within an old homestead site. If it is primarily adventive, then it will be deleted from further consideration. Part of it was collected by Ronald Wieland (##5164 KU), and the specimen was verified by Ralph Brooks of the Univeristy of Kansas. This tends to support its designation as adventive, which would drop it from consideration as rare in the state, unless it was an isolated instance. Annotation of park specimens identified as *O. nuttalli*, and revisiting of sites where *O. nuttallii* was noted in the park, is necessary to help settle state rank.



OENOTHERA LACINIATA

Global distribution and rank: Cut-leaved evening primrose is demonstrably secure globally (G5), and is found at a range of latitudes across the Great Plains and eastern United States. Other states assigning it a rarity rank include Iowa, Illinois, Minnesota, New York and Wyoming.

Significance of TRNP population(s): The single TRNP collection was not annotated to *O. laciniata* until after the field season, and it was not found in the course of short duration but extensive searches for *Chenopodium subglabrum* in the North and South Units in 1990. It is a species needing more inventory work in the park (see following section). The results of that inventory may determine its state rank.

TRNP distribution: A single plant of cut-leaved evening primrose was found on an old homestead site at the VA Well in the South Unit, located in the Little Missouri River floodplain on the west side of the river. It was originally identified as *O. nuttallii*. Field observations were also made of plants that could be *O. laciniata* or *O. nuttallii* in North Unit prairie habitat, and in the South Unit at two sites where it was not collected: the cottonwood stand on the east side of the river immediately north of Interstate 94, and on the river cutbank immediately northwest of the Cottonwood Campground near *Chenopodium subglabrum*.

TRNP management: No management conclusions can be drawn pending inventory and review of the species status.

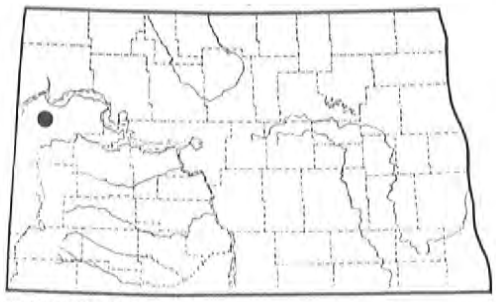
Orobanche multiflora L. (*Orobanchaceae*)

Yellow broomrape

Description and identification: Yellow broomrape is a whitish saprophytic plant lacking chlorophyll. It is distinguishable at a glance because of its stout fleshy stem and numerous sessile yellow flowers that are in very dense spikes (Figure 17), unlike the other two species in the park. The more common *Orobanche fasciculata* has pale purplish or yellowish flowers in loose, pediceled inflorescences. The *Orobanche ludoviciana* has purple flowers with comparatively short calyx lobes in dense sessile inflorescences. Yellow broomrape emerges by mid July and withers by mid August.

Technically, yellow broomrape is distinguished by its nearly sessile flowers (the lower flowers have very short pedicels), rounded corolla lobes, style persisting in fruit, and long calyx (10-19 mm) exceeding the fruit. The calyx lobes are glandular or viscid-pubescent on the outside and tinged violet on the inside, attenuate, erect, and nearly equal. The corolla lobe are obtusely rounded to slightly mucronate and are yellow or faintly purple. Seeds of yellow broomrape, like other members of the genus, are minute and proliferant. Establishment hinges on contact with a suitable host plant.

State distribution and rank: Yellow broomrape was first discovered in North Dakota during the course of the 1989 inventory work. It is assigned a rank of critically imperiled in the state (S1) based on this single known population. It was first collected in North Dakota by W.T. Rankin, working in the North Unit, and verification was provided by Theodore Van Bruggen and Frederick Peabody of the University of South Dakota.



OROBANCHE MULTIFLORA

Global distribution and rank: The global rank of yellow broomrape is presently undetermined (G?). ***The Flora of the Great Plains*** (1986) describes it as a species of the southern Great Plains extending from Kansas to Texas and Washington to California. However, the records from California and Utah are now being treated as a variety of *O.*

Figure 17. Orobanche multiflora in flower.

ludoviciana. With its nearest neighboring population over 600 miles away in Nebraska, this is one of the most highly disjunct species in the state. The only other state assigning it a rarity rank is Kansas. Information on its global status will be sought from other states by way of this report.

Significance of TRNP population: The yellow broomrape population in TRNP represents the only documented record in North Dakota. It is one of the two new additions to the state flora discovered in the course of the TRNP study, and the rarest of all TRNP state rare plants. This is also the only rare plant species documented from the North Unit which does not also grow in the South Unit.

TRNP distribution: Yellow broomrape occurs in the silty creekbed flats covered above Squaw Creek, close to the border between this habitat and eroding sand outwash at the base of badlands slopes. Its habitat is dominated by short-stature *Artemisia cana*, and it is saprophytic on such species of composites. Another common composite present is *Chrysothamnus nauseosus*, dominant in the adjoining sand outwash. Two individual clumps of plants grew in 1989 under a shrub of *Artemisia cana* (Figure 18). In 1990, one individual plant was found growing under *Chrysothamnus nauseosus* less than 2 m distant from the 1989 location and a second plant was found growing in a clump on open barren habitat near the base of the butte over 8 m distant. The particular rabbitbrush bush associated with the 1990 yellow broomrape plant showed marked decline in vigor over the season (Semerau pers. comm.). The shrub cover is about 3 dm tall and widely-spaced. Grass cover is sparse, with such species as *Agropyron smithii* and *Calamovilfa longifolia* present, and with much bare ground between. The site is nearly level and dry, but subject to flash flooding. The site is not a well-vegetated example of the *Artemisia cana* h.t. and is in fact mapped under the *Agropyron smithii - Stipa viridula* h.t. (Figure 19).

Figure 18. Orobanche multiflora growing in close association with woody shrub cover.

Based on its small population, it is difficult to project potential habitat. It is possible that yellow broomrape is restricted to a well-aerated/xeric zone at the margins of the *Artemisia cana - Agropyron smithii* habitat type, representing a limited ecotone.

Its occurrence over 600 miles from the nearest known populations is highly unusual and subject for conjecture.

Figure 19. Orobanche multiflora habitat of sparse Artemisia cana cover, between badlands outcrop (background right) and dense grass and buckbrush cover intermingled with sage (background left)

TRNP management: The yellow broomrape site is close to a high visitation area along the park scenic drive, near the trailhead at the Cannonball Concretion pullout. The plants occur at roughly a 40 m distance from the pullout, in the vicinity of the Buckhorn Trail where the trail is diffuse. Three of the four plants observed to date grew directly under shrub cover, where trail trampling or pack animal grazing impact is low or unlikely. The fourth plant growing out in the open was the most distant from the trail, occuring near badlands slopes in a locale that does not get traffic. Trail use is not a direct impact but a consideration in setting up any monitoring or other management.

Members of the broomrape genus are notoriously inconsistent in emerging each year, and often low in numbers. A permanent mapping system and monitoring program was initiated in 1990, noting population size and location for consecutive years.

Further inquiry into species biology may help narrow the search across potential habitat. Its habitat has been extensively searched, but search is to be continued during peak flowering in mid-July.

Physaria brassicoides Rydb. (*Brassicaceae*)

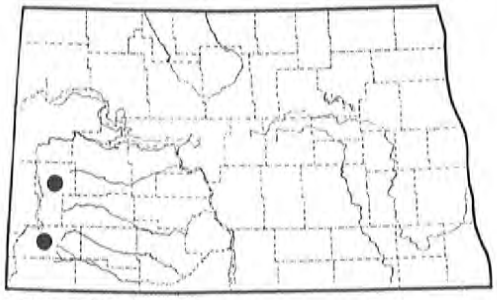
Mustard twinpod

Description and identification: Mustard twinpod is most readily located in flower from mid-May to very early June, when the deep yellow clusters of flower stalks show in bright contrast to the bare slope setting (Figure 20). In fruit it forms a distinctive pair of inflated spherical pods (1-2 cm long, and wider than long) which give it its name. It can also be identified with ease throughout the growing season based on its basal rosette of whitish grey leaves with their unmistakeable dense stellate hairs and broad spatulate shape (Figure 21). It is distinguished from the closely related *Physaria didymocarpa* in having four-locule fruits rather than two-locule fruits, which was the identification originally given to North Dakota specimens. It most closely resembles *Lesquerella ludoviciana*, another small yellow-flowered mustard with whitish leaves, from which it differs in having numerous comparatively large basal leaves (2-8 cm) with spatulate shape, comparatively large petals (9-12 mm) also with spatulate shape, double-pod silicles, and short dense racemes (5-10 cm).

It is a small caespitose plant that is adapted to its harsh unstable environment, at least in part, by an early-flowering phenology, deep branched caudex that anchors the plant and reaches deeply for subterranean moisture, and the heat-reflecting properties of its whitish leaf hairs.

Figure 20. Physaria brassicoides closeup in flower and in fruit, showing bright flower clusters and pairs of inflated pods.

Figure 21. Physaria brassicoides close up in vegetative condition, showing basal leaf shape and plants believed to be of different age classes.



State distribution and rank: Mustard twinpod is ranked as vulnerable in the state (S3) based on twenty-five records in two counties. Known occurrences are centered around TRNP - South Unit in Billings County, and the Ranger Grove in Slope County. The herbarium label for an historic record from Gorham (Moran #400 NDA) is believed to have erroneously listed the county as McKenzie County rather than Billings County.

Global distribution and rank: Mustard twinpod is presently ranked as demonstrably secure globally (G5). No other states assign it a rarity rank at present. North Dakota specimens were recently annotated from *Physaria didymocarpa,* a closely related species. It is possible that the ***Flora of the Great Plains*** (1986) mistakenly merges distribution information of both species in describing the range of Mustard twinpod. According to Rollins (1939), Mustard twinpod ranges only from North Dakota and Wyoming to Nebraska. If this is the case, and global rank was assigned based on mistaken distribution information, then a reconsideration of global rank might be warranted.

Significance of TRNP populations: The South Unit of TRNP contains the highest population numbers and concentrations known from North Dakota, and is the area best-suited to protecting this species in the state. As a result of the TRNP inventory, the state rank was shifted from possibly imperiled or vulnerable in the state (S2S3) to vulnerable (S3). Any other changes in state rank would come from information outside the park if the species habitat and distribution patterns prove as extensive and recurrent as within the park. Its high concentration in the park is reflected in it having been collected by at least six different botanists prior to this inventory work. Project specimens collected include Godfread #6449 TRNP, #6573 TRNP and Wieland #5003 UND.

TRNP distribution: Mustard twinpod is a plant of exposed badlands outcrops and poorly consolidated early successional ridgetops and slopes. It is found scattered across large areas of the South Unit. It is restricted to specific substrates which lack almost all soil development.

Most park populations lie within the Bullion Creek Formation, occurring most often on sandstone or loose sand slopes around 2500 feet (Figure 22). Sandstone in the park is more resistant to erosion than the soft shales which prevail. In some sites, the sand is overlain or intermixed with scoria. Larger size populations are generally found on a particular silty Bullion Creek outcrop which appears to be less extensive than sandstone outcrop, occurring at around 2400-2440 feet. This latter substrate has high sulfate and calcium ion concentrations (1724 mg/L and 649 mg/L, respectively of TDS= 2586 mg/L) signifying a low grade of gypsum (Arndt pers. comm.). Both of these Bullion Creek outcrops are located mostly within two miles of the Little Missouri River valley on scoria hills and ridge-ravine systems.

Sandstone outcrops also occur between 2700-2800 on a few of the higher park promontories and ridges in what is believed to represent the Sentinel Butte Formation. The extreme eastern populations near Peck Hill and the western boundary population are associated with Sentinel Butte Formation outcrops. Suitable slopes have not been found at similar breaklands elevations elsewhere.

In the highly dissected topography of the South Unit, suitable habitat is exposed most consistently on steep south-facing slopes. Mustard twinpod can be found at many other combinations of aspect and gradient. It tolerates very strong spring winds which tend to sandblast the slopes, keeping them mostly unvegetated.

Populations tend to extend along suitable substrate for any given population site. Population sites are found less than a third of the time at apparently suitable habitat. The largest populations numbered several hundred. Few seedlings were noted in the particularly harsh seasons of the past two years, but small plants believed to represent a relatively young age class from around 1987 were common.

In the sparsely vegetated setting occupied by mustard twinpod, there are not distinct community dominants. In the case of the Bullion Creek sandstone and gypsum outcrops, the mustard twinpod is sometimes the most frequent species across the exposed outcrop. Typical species associates include *Chrysopsis villosa, Andropogon scoparius, Eriogonum flavum, Lesquerella alpina, Muhlenbergia cuspidata, Oryzopsis hymenoides, Rhus trilobata* and *Melilotus officinalis.* All populations fall in or adjoining two habitat types: the *Agropyrom smithii - Stipa viridula* h.t. or *Andropogon scoparius* h.t. As noted above, it does not occupy climax community but seral outcrops.

TRNP managment: With few exceptions, this species grows in habitat of limited accessibility which is little-influenced by park management practices. Erosion onto a roadway has taken place in the NE corner of Section 23 in T.140N R.98W, and any recontouring of the slope poses potential impact to part of a major population (#004). Another part of this population extends to the scenic overlook in T. 140N R. 100W Sec. 15 where less than five plants are now being trampled. This area is also slated for development of a widened, paved handicap-accessible path and any such work should include a salvage operation.

In a few limited population sites, it faces competition from invasion by sweetclover and plants benefiting from the increased nitrogen levels resulting from sweetclover nitrogen fixation. It might be interesting to see the population response of mustard twinpod to the fluctuations in population size of this exotic biennial species, but there are no vegetation management needs identified at this time.

Figure 22. Physaria brassicoides on extensive sandstone habitat; both outcrop surfaces and the loose sparingly vegetated sandy slopes below.

Populus x acuminata Rydb. (*Salicaceae*)

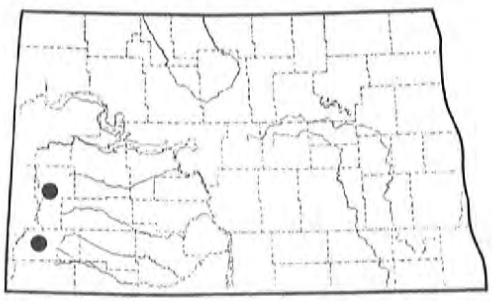
Smoothbark cottonwood

Description and identification: Smoothbark cottonwood is most readily distinguished by its angular lanceolate leaves. The leaf shape is longer than wide, unlike *Populus deltoides*, and the leaf margin is incompletely serrated, unlike *Populus balsamifera.*

It is a single-stemmed tree with branches horizontal to shallowly ascending (Figure 23), a narrowly-spreading flat-topped crown, resinous leaf buds, orange-tan twigs of the first year and furrowed bark.

Figure 23. Populus x acuminata site showing decadent mature tree and downslope suckers or new saplings.

State distribution and rank: Smoothbark cottonwood has a rank of critically imperiled in the state (S1) based on two records in Billings and Slope Counties. Both populations are probably unviable as hybrids and their origin remains a mystery.



POPULUS X ACUMINATA

Global distribution and rank: Smoothbark cottonwood is a hybrid between *Populus deltoides* and *P. angustifolia*, the range of the latter extending no closer than central Montana and northwest Wyoming. As a hybrid, it is not assigned a global rank. It also occurs sporadically in South Dakota and Nebraska and ranges from New Mexico to Alberta. Stephens (1973) notes it as occurring only sporadically where it is found in the north central Great Plains.

Significance of TRNP population: The single TRNP population in the South Unit represents the easternmost extent of the taxon at the northern end of its range. The stand may actually represent a clone rather than a population because it is made up of a single mature tree of 13.6 inches diameter and numerous saplings in close proximity (Figure

23). Collection was made of this hybrid from Dedication Hill (Peck Hill) by Stevens and Weiser (Stevens #1286 NDA) in 1951, taken from "a single tree 2-3 dm in diameter", and by Ralston (Ralston #271 TRNP) in 1957. This is almost certain to be the same slope setting, and may in fact be the same mature tree if the word "diameter" was used incorrectly on the label in place of "circumference". Project specimens collected include Heidel #464 NDA, UND and Wieland #5022 TRNP.

TRNP distribution: Smoothbark cottonwood is found in a single harsh upland setting on Peck Hill, the highest point in the South Unit. It grows below a sandstone outcrop on steep, loose sand slopes exposed just below the top of the plateau and facing southeast (Figure 24). Springs emerge below this strata elsewhere on the slope. There are no similar outcrops at this relatively high elevation elsewhere in the park, though there are certainly many areas of sandstone outcrop at lower elevations.

Several mature cottonwood trees (*Populus deltoides*) also grow in the open elsewhere on the slope. Prairie grasses dominate at the site, including *Andropogon scoparius* and *Calamovilfa longifolia*. Other species present include *Rhus trilobata*, *Yucca glauca* and *Physaria brassicoides*. The plateau top is mapped as the *Stipa comata - Bouteloua gracilis* h.t., but the setting where the tree grows is a seral stage of this community.

This taxon is considered to be a riparian species. The South Unit site is atypical. The other North Dakota site is found at the spring-fed headwaters of a riparian corridor.

As mentioned previously, it is not known whether the TRNP occurrence represents a population or a clone. It is made up of a single decadent mature tree having many dead branches and surrounded downslope by heavily browsed living and dead sapling-size sprouts that may represent suckers from the mature tree.

Figure 24. Populus x acuminata ridge setting, below sandstone outcrop on Peck Hill

TRNP management: Silviculturalists will be consulted on weighing stand viability. If viability is attainable, then the source of the heavy browse is to be investigated and measures considered for reducing browse.

Generally, hybrids are not given as high a biodiversity protection priority as rare species, though they may represent populations of great interest to science.

Sitanion hystrix (Nutt.) J.G. Sm. (*Poaceae*)

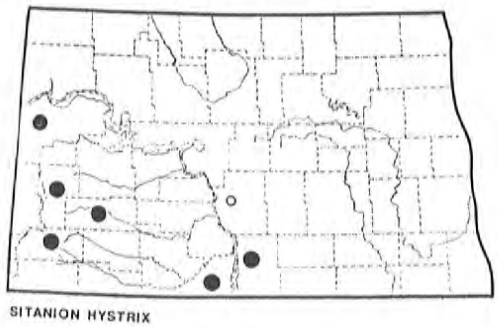
Bottlebrush squirreltail

Description and identification: Bottlebrush squirreltail is a tufted, bristly-headed perennial grass. The long awns of the spike project outward, giving it the appearance of a bottlebrush, as the name implies (Figure 25).

Before the seedheads mature in mid-June, the awns are upright and green-colored, superficially resembling the more common wild barley. It differs from wild barley in that the spike raceme is elongate, and the awns stiffly project outward. Its seedheads disarticulate at maturity, so that the spike is easily knocked apart when mature. It also differs from the barley genus in having only two instead of three spikelets per node and with 2-3 flowered spikelets instead of 1-flowered spikelets.

Figure 25. Sitanion hystrix close up, showing tufted growth form and awns projecting outward at right angles.

State distribution and rank: Bottlebrush squirreltail is ranked as possibly secure in the state (S4) based on 29 records spanning eight counties in North Dakota where shale bedrock outcrops are found. Zaczkowski (1972) had listed only two collections for it in Billings and Slope Counties but it is expected that this species has been overlooked. It remains undetermined whether this species warrants consideration as a state rare species, and it will be dropped to demonstrably secure in the state (S5) if the more remote historic records are found to have persisted, if other areas of recurrent badlands populations are found as in TRNP, or if it is found to occur as an invader species under livestock grazing (see comments below). Where it does occur, populations are very low in number and widely scattered, with the exception of one population in the South Unit where plants were recurrent over a discrete area.



SITANION HYSTRIX

Global distribution and rank: Bottlebrush squirreltail is ranked as demonstrable secure globally (G5), ranging from North Dakota to Texas and west to California and Oregon. It is on the state rare plants list of Illinois, which would seem to be out of its range. It is characterized as an invader species under livestock grazing pressure in at least parts of its range (Smith 1976).

Significance of TRNP populations: Results of the TRNP inventory corroborate the hypothesis that this species has been overlooked. A total of 19 records are now known from Billings Coungy, most of them in TRNP - South Unit. Collection of bottlebrush squirreltail in TRNP - North Unit signifies a new county record for McKenzie County. They represent the highest known numbers and concentrations in the state. Incidental to the TRNP work, it was also relocated in a Natural Areas Registry site in Stark County on an entirely different geological formation. Project specimens collected include Rankin sn. TRNP, Wieland #5077 NDA, TRNP, #5086 UND, #5104 TRNP, #5124 TRNP.

TRNP distribution: Bottlebrush squirreltail is very widely distributed across both the North and South Units of TRNP. It is found on all geological formations and a wide range of elevations between 2000-2100 feet elevation in the North Unit and between 2450-2600 feet elevation in the South Unit. The North Unit occurrences are in valley settings and most of the South Unit occurrences are at the base of bare high clay slopes (Figure 26).

It is always found in sparsely-vegetated settings with a fine-textured substrate component. It is most often found in alluvial clay outwashes but can also occur in small rills and pockets on steep, highly erodible, barren badlands slopes. This means that it occupies habitat where both erosion and deposition are taking place. Both positions are arid microhabitats and competition is absent from these settings. Many of the populations represent a sparsely-vegetated contact between the *Agropyron smithii - Stipa viridula* h.t. and the rolling scoria hills complex.

Populations of bottlebrush squirreltail have the lowest densities of TRNP rare plants. Even though there are many populations, the population numbers are very low and the total number of plants is limited. In TRNP it is associated with secondary succession badlands habitat but not with overgrazed or adventive conditions.

Its habitat is characteristically barren, but ther may be other hardy plants present like *Chrysothamnus nauseosus, Atriplex confertifolia, Puccinellia nuttalliana* and *Grindelia squarrosa.*

TRNP management: Existing park management practices have limited direct affect.

Figure 26. Sitanion hystrix habitat includes both erosion and deposition settings, with the most frequent setting being clay outwash fans (# 012).

Sporobolus airoides (Torr.) Torr. (*Poaceae*)

Alkali sacaton

Description and identification: Alkali sacaton is a perennial bunchgrass. Its culms are 2-10 dm tall with a loose spreading panicle about half the height of the plant and 1-2 times as long as wide.

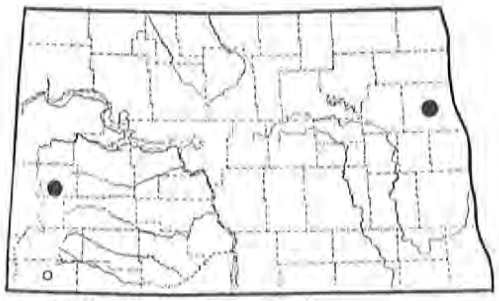
It is most distinctive when its seedheads mature in August, but it can be recognized throughout the year as the only bunchgrass in sparsely-vegetated clay outwashes. The individual bunches may range from 2 to 20 dm in diameter (Figure 27). It has involute leaf blades that are wide at the base and taper to long, slender points. Like other members of the genus, it has a distinctly pilose ligule and leaf sheath.

Its seeds readily fall from the 1-flowered spikelets at maturity and are likely to be scavenged by rodents. It is not known how this would account for its colonization in settings such as the I-94 right-of-way.

Alkali sacaton is the only C4 species among the TRNP rare plants, meaning that it operates in a different photosynthetic pathway which has a higher optimum temperature and has accompanying morphological adaptations which may confer drought tolerance.

Figure 27. Sporoblus airoides showing bunch growth form, large clump size and small stature within the park (#003).

State distribution and rank: Alkali sacaton is presently ranked as imperiled in the state (S2) based on eight records from three counties, including one county record in Grand Forks County believed to represent a transplant from Billings County. It is found in a limited range of substrates in TRNP - South Unit, and its rank may be lowered if it is found to having a broader ecological amplitude within the park if new major populations are found within the park, or if new county records and populations are found outside of the park.



SPOROBOLUS AIROIDES

Global distribution and rank: Alkali sacaton is ranked as demonstrably secure globally (G5), ranging from North Dakota to Washington and south to Missouri, California and Mexico. The only other state assigning it a rarity rank is Missouri.

Significance of TRNP populations: All North Dakota collections of alkali sacaton except the 1958 collection from Bowman County (Quinnild sn. NDA) are believed to have come from TRNP - South Unit. This means that the South Unit is the only place in the state where this species is recurrent and relocatable. The largest park population extends in numbers onto outer backslopes of the I-94 right-of-way, indicating a certain colonizing capacity and possibly colonizer habitat requirements. Project specimens collected include Godfread #6579 TRNP, #6585 NDA, TRNP and Wieland #5102 NDA, TRNP.

TRNP distribution: Alkali sacaton is restricted in the South Unit to around 2500 ft in elevation. This corresponds with the contact between the Golden Valley and Sentinel Creek Formations, which are marked by clay outwashes interrupted by badlands ridges, knobs and gullies.

This species is almost completely restricted to a single area of the park even though apparently suitable habitat is extensive elsewhere in the park. It occupies the common *Agropyron smithii - Stipa viridula* h.t. interfacing with the rolling scoria hills complex most often in clay outwash settings (Figure 28). Either it is more habitat-specific than is currently known, its distribution is limited by dispersal, or there are major gaps remaining in its inventory. It is concentrated in the south-central area of the South Unit along Sheep Creek (#003) and one adjoining area above Paddock Creek (#008). A single outlying occurrence was found near Boicourt Spring in the northeastern corner of the South Unit (#007).

Two previous previous collections sites of alkali sacaton in the park made by Facey (Facey #1023 UND, #1024 UND) and Zaczkowski (#3812 NDA, #4557 NDA) were both relocated and are treated as part of the above-mentioned population records. Facey characterized its habitat as bentonitic shale substrate.

Alkali sacaton occupies secondary succession habitat of clay outwashes similar to bottlebrush squirreltail in outwash settings. It doesn't occupy eroding habitat but does occur in its highest density on road cuts along a segment of I-94 where the outside embankment has been scraped bare. In this setting it is a colonizer.

Species associations in these settings are not consistent but other plants frequently associated with alkali sacaton are halophytic species like *Sarcobatus vermiculatus, Atriplex confertifolia, Chrysothamnus nauseosus, Artemisia cana, Gutierrezia sarothrae,* and *Distichilis stricta.*

Figure 28. Sporobolus airoides habitat above Sheep Creek on heavy clay outwash soils (#003)

TRNP management: Unlike the other two rare TRNP grasses, alkali sacaton is classified as a decreaser in response to livestock grazing in at least parts of its range (Smith 1976). It is considered a good forage grass in alkaline areas (Hitchcock 1971). Response patterns to bison and other grazers in the park were not discerned.

If habitat is limiting for this species in the park, then park management will have little effect. If dispersal is limiting for the species, then wildlife management or pack travel use may have importance. All of the sites where it was observed were so sparely-vegetated that they would not ordinarily burn.

Any consultation on projects with the U.S. Department of Transportation regarding work in the I-94 right-of-way should consider potential population impacts. Part of the Sheep Creek population extends onto areas of the park having private interests in the private development subzone, where any proposed work should also be considered in light of prospective population impacts.

On outwash areas in the park, it looks markedly different than roadside plants. In the park it is short and in large clumps with dead centers and low seed set, compared to the vigorous, tall, new plants established in the right-of-way. The difference in age and habitat may account for the apparent differences in vigor and reproduction. Note: It was not among the grasses planted in the right-of-way when I-94 was constructed in the early 1960s (State Highway Dept. - Dickinson Office pers. comm.) though it is propagated for such purpose at the USDA Kansas Plant Materials Center.

Stephanomeria runcinata Nutt. (*Asteraceae*)

Desert wirelettuce

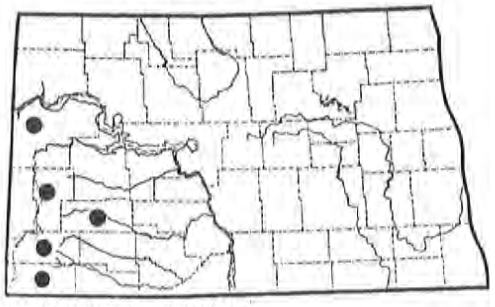
Description and identification: Desert wirelettuce is a wiry-looking perennial with sparse foliage. It is most conspicuous in flower beginning in late June and its flowering extends through at least mid-July depending on rainfall. Its pink flowers are terminal at the ends of wiry stems (Figure 29). The five ligulate flowers have a white, plumose pappus that is conspicuous.

The lowest stem leaves are very narrow and "runcinate" (sharply serrated, with teeth pointing backward), up to 7 cm long. The upper leaves are shorter and without teeth, looking more like bracts. Evidence of vegetative reproduction by rhizhomes was observed in the South Unit (Wieland pers. comm.).

This species superficially resembles skeletonweed, which also has reduced leaves, milky sap and is a member of the *Lactuceae*. The diagnostic characteristic for desert wirelettuce is its plumose pappus, as opposed to a pappus of simple capillary bristles. It is also different in having well-developed stem leaves and an altogether narrower shape with very little branching from the base. Desert wirelettuce does not occur in the same habitats as skeletonweed, its habitat being much more harsh and unstable.

Figure 29. Stephanomeria runcinata close up, showing terminal flower and optimal leaf development on a scoria setting (#019) in the North Unit.

State distribution and rank: Desert wirelettuce is ranked as either vulnerable or possibly secure in North Dakota (S3S4) based on 22 records in five counties. Largest documented population densities and numbers are at Burning Coal Vein on U.S. Forest Service land and at Little Badlands, a privately-owned Natural Areas Registry site. The latter corresponds with the Stark County collections of Facey and Zaczkowski. If additional large populations or high concentrations of populations are found outside of TRNP, its state rank may be lowered further.



STEPHANOMERIA RUNCINATA

Global distribution and rank: Desert wirelettuce is ranked as demonstrably secure (G5). It is a Great Plains species ranging from Montana and Wyoming to North Dakota and Nebraska. The only other state assigning it a rarity rank is Nebraska.

Significance of TRNP populations: The highest documented statewide population concentrations of the species are found in TRNP - South Unit. The numbers collectively add up to a greater total than found on any other public land in North Dakota. The North Unit population represents a new county record for McKenzie County. Two other new county records were found on public land in Bowman and Slope Counties in 1989 using the species search images gained from TRNP inventory. Based on the TRNP inventory work and other new county records, the state rank of desert wirelettuce has been changed from unknown (SU) to vulnerable or possibly secure in the state (S3S4).

There is a taxonomic question tied to desert wirelettuce which TRNP collections may help to resolve. The related species, narrow-leaved wirelettuce (*Stephanomeria tenuifolia*), was collected by Zaczkowski immediately west of the South Unit (Zaczkowski #789 NDA). It is reported from the Great Plains only from Slope, Billings and Stark Counties of North Dakota, otherwise being a Great Basin species extending from British Columbia to New Mexico and east to Texas. The Stark County specimen has been annotated to *S. runcinata* by Rhode-Fulton, but none of the Billings and Slope County specimens have been annotated. In TRNP, individuals of *S. runcinata* appeared to have the gross morphology of *S. tenuifolia* once their basal leaves had shriveled away (Wieland pers. obs.). For specimens lacking seed material, they could have mistakenly been identified as *S. tenuifolia*. It seems that all of the North Dakota specimens of *S. tenuifolia* deserve examination. Many collections of *S. runcinata* were made in the South Unit reflecting its variation in morphology with habitat and phenology, including Godfread #6571 TRNP, Wieland #5104 UND, #5164 TRNP, #5167 TRNP, #5172 UND, #5173 TRNP, #5174 TRNP, #5175 TRNP, #5176 NDA, #5188 TRNP.

TRNP distribution: Desert wirelettuce is a species of broken badlands topography, found over large areas of the South Unit and at one site in the North Unit. It is localized on the slopes where it occurs, but is found on various substrates and elevations across the park. It occurs on nearly every mapped prairie habitat type in the South Unit.

The largest population of 250-500 plants is found on loose scoria and sand (#012). The second largest population of 200-300 plants is found on clay slopes (#009). The third largest population of 100-130 plants is found on silty loams and very fine sands (#010). All these populations are in the South Unit; the North Unit population of about 100 plants occurs on loose scoria slopes (Figure 30). The populations all have in common a well-drained setting on loose, friable substrate ideal for spread of rhizomes and very low competition (Figure 31). Many of the sites were also clearly unstable and early successional. Plants in one population (#011) were prostrated and noticeably injured by sheet and rill erosion following a thunderstorm.

Most population sites were barren and not clearly dominated by a discrete vegetation association. Species frequently occuring with *S. runcinata* include *Muhlenbergia cuspidata, Haplopappus acaulis, Hymenopappus filifolius, Eriogonum pauciflorum, Rosa arkansana, Gutierrezia sarothrae* and *Chrysothamnus nauseosus*.

Park populations of desert wirelettuce characteristically have low densities, with few plants at any given spot. Most park populations are made up of fewer than 20 plants. With such broad substrate specificity and limited numbers of park populations, this species seems to have low frequency in apparently suitable habitat.

Figure 30. Stephanomeria runcinata habitat on open scoria slope in the North Unit (#019)

Figure 31. Stephanomeria runcinata typical habitat (#015) with low population numbers and restrictions in population extent that do not correspond with apparent habitat extent.

TRNP management: Desert wirelettuce grows in habitat of limited accessibility that is little influenced by park management practices.

A few South Unit populations grow above infestations of leafy spurge (#014). While they are not threatened by encroachment, they could be affected by herbicide drift. One population barely extend into a road right-of-way in the South Unit (#011).

Verbesina encelioides (Robins. & Greenm.) J.R. Coleman (*Asteraceae*)
Golden beardtongue

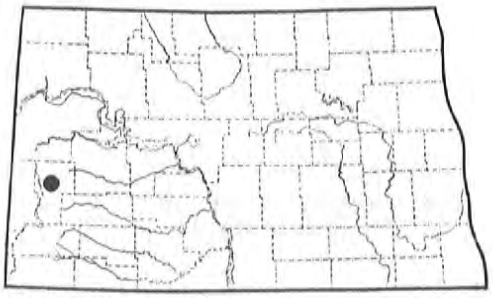
Description and identification: Golden beardtongue has an infloresence like a small sunflower, with a radiate head at the end of a long leafless stalk (Rickett 1970). The receptacle is flat and chaffy, and there are 10-15 yellow ray florets. The disk is mostly less than 2 cm across. Its achenes are unmistakably winged, broad, and flat.

It is a taprooted annual that is customarily single-stemmed. Stem and leaves are strigose-canescent. The leaves are grayish underneath, rough on the upper side, and toothed with large, sharp teeth. At least the lower leaves are opposite along the stem, and they are petioled. Plants in TRNP were 2-5 dm high.

When the plant was found in 1988, it had the shape of a robust mound-like growth form due to early-season browse of the main stem (Figure 32) and development of branches. Each of the branches off the main stem had inflorescences. All plants appeared single-stemmed in 1989. In 1989 it began blooming in late July and in 1988 it was blooming vigorously right before frost in Septemeber. Plants observed in 1989 were of two different size classes and phenological states, raising the possibility that it may germinate in both fall and spring.

This species is clearly drought-tolerant and able to take advantage of summer showers. It was notably robust and profuse in its flowering at the end of the 1988 growing season which had been a severe drought year.

Figure 32. Verbesina encelioides showing radiate infloresence and unusual mound-like growth form and vigor at end of 1988 drought season.



VERBESINA ENCELIOIDES

State distribution and rank: Golden beardtongue is currently ranked as possibly adventive in North Dakota (SA?) based on the single state record as found in TRNP - South Unit and information from other Great Plains states. The proximity of this population to the original park main entrance increases the probability that the species was introduced subsequent to park establishment. The species has been known to disperse in hay mixtures further south in its Great Plains range (Barkley pers. comm.). It is also considered adventive at its nearest known populations in extreme southeastern South Dakota (Van Bruggen 1976) and extreme southwestern Montana (Shelly pers. comm.). If it is adventive, then it will be deleted from further consideration.

It was first found and collected in North Dakota in the park by Karen Mastel (Mastel #293 NDA) in 1986. It was recollected by Bonnie Heidel (Heidel #466 KSU) in 1988 and verified by T. Barkley of Kansas State University.

Global distribution and rank: The global rank for golden beardtongue remains undetermined (G?), ranging from Florida and North Carolina to Kansas and farther west into California and northern Mexico. It also has been recorded northward, possibly as adventive, from New England, Missouri, and Illinois. Its habitat is said to include open, disturbed, often waste places (Great Plains Flora Association 1986) and it is adventive in Central America (Barkely pers. comm.). Other states considering it for possible rarity ranking include Arkansas, Illinois and Wyoming.

Significance of TRNP population: The single population of TRNP - South Unit is a highly disjunct population several hundred miles from the nearest known collection sites that also represent disjunct populations. It is the northernmost collection known for this species throughout its range. Project specimens collected include Heidel #466 KSU, NDA, #471 TRNP, UND.

TRNP distribution: The single South Unit population occurs at the original main park entrance, now part of a prairie dog town. It lies inside the entrance and below the base of badlands

Figure 33. Verbesina encelioides in bison wallow setting above original park entrance gate. Other buffalo wallows were covered by Cirsium arvense in 1989 where Verbesina encelioides had appeared in 1988.

Figure 34. Verbesina encelioides is highly restricted to the fringe of the prairie dog town and shows no signs of expanding. Note historic entrance station wall to right for reference.

slopes near the prairie dog town margin, above headwaters of Sheep Creek. It is a very dry setting marked by shallow depressions believed to be bison dust wallows, and the golden beardtongue distribution appears to correspond to these wallows (Figure 33).

Golden beardtongue occurs in high density clumps, with widely-spaced plants in the immediate vicinity outside of the clumps. Plants did not reappear in the same spot over two consecutive years, as seen over 1988-1989, and occur in only a small area of similar habitat (Figure 34).

Plants inside high-density clumps were distinctly phenologically advanced compared to the widely spaced plants, suggesting that mutualism confers a maturation advantage, that plants can grow as both winter and spring annuals depending on microhabitat or that the mutualism reflected a microhabitat difference in a factor such as nutrients that fostered maturation.

The population site was among declining *Artemisia tridentata* habitat locally associated with many ruderal species like *Dyssodia papposa, Salsola kali, Melilotus officinalis* and *Plantago patagonica*. It did not occur locally with prairie dog burrows but the prevailing vegetation was clearly influenced by the prairie dog town.

TRNP management: Canada thistle invasion and Canada thistle herbicide treatment pose significant threats. Canada thistle and golden beardtongue were never found growing right next to one another, but both occur in clumps near the old entrance and have superficially similar single-stemmed appearance. Clumps of Canada thistle were sprayed with herbicides at this site in 1989 and the clumps of golden beardtongue were mistakenly sprayed as well. One of the major Canada thistle infestations in 1989 (Figure 33) had been a site of robust golden beardtongue individuals in 1988. The latter apparently did not grow at all among Canada thistle the following year.

Herbicide spraying of golden beardtongue in 1989 took place after early flowers had set seed. It did not reach individuals outside the cluster which had yet to flower. It likely did not kill the entire population of this annual species but it did substantially reduce seed production.

The priority of golden beardtongue management depends on its status. If it is adventive, then it does not warrant monitoring. Careful distinction between Canada thistle and golden beardtongue is needed for the present, with aggressive herbicide treatment of the former.

MANAGEMENT

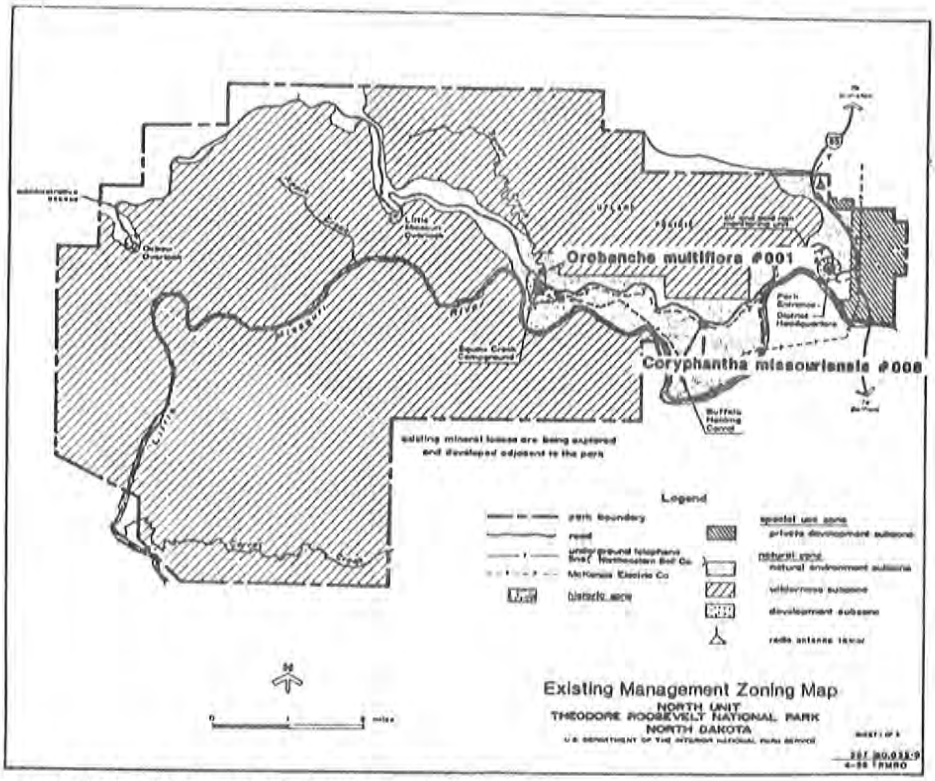
This chapter represents a reorganization and elaboration of the species-by-species management topics discussed in the previous chapter. The management practices are treated separately in the following text and cross-referenced by zone and by species population.

Management of Theodore Roosevelt National Park is treated within a framework of policies, management issues and zoning guidelines (National Park Service 1987, 1989). Threatened and Endangered species policy is addressed in the current park planning documents (National Park Service 1989). The policy calls for coordination with other agencies for surveying, management and monitoring of populations within the park, and evaluation of habitat suitability for supplementing existing populations or starting new ones. To put this general policy into practice, and to identify issues, it is important that existing operating plans and future planning documents incorporate the results of the rare plants inventory, including species-by-species protection goals as appropriate. A rare plant management plan should be developed from the inventory results recognizing which species are in need of management and research, those which can be satisfactorily managed as part of the habitat unit, and those which have no identified needs.

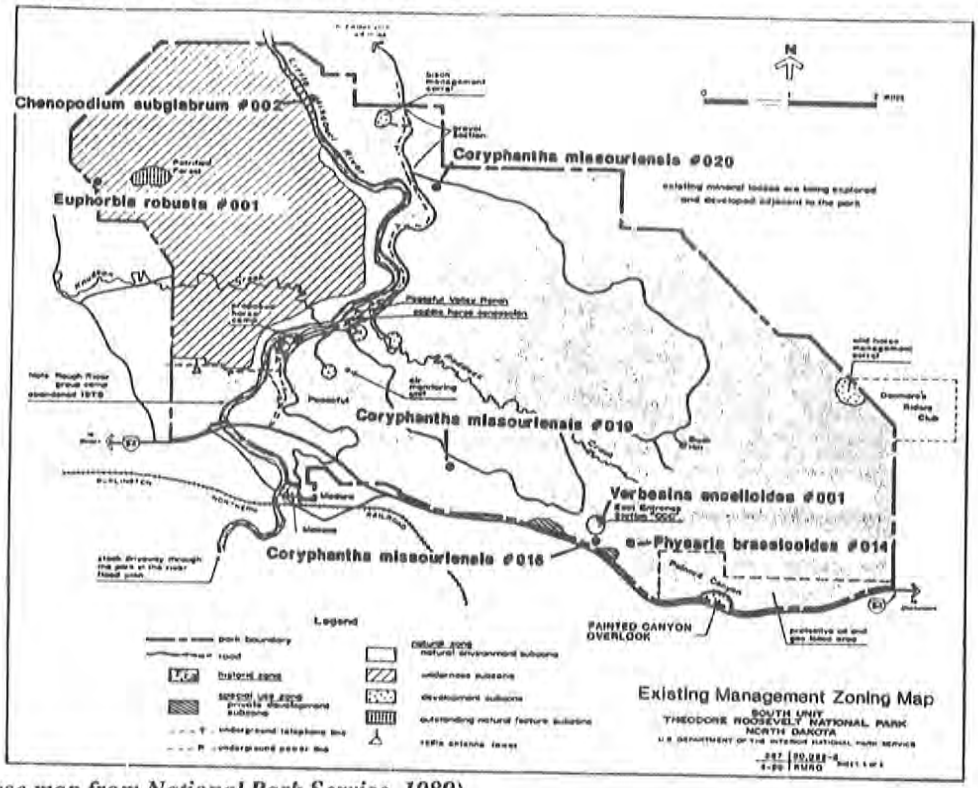
Over 99% of both units are part of the Natural Zone, with the remainder in the Historic Zone and in the Special Use Zone - a designation for private holdings within park boundaries. There are rare plant populations in all the zones, but nearly all those requiring management attention are in the Natural Environment Subzone (see Table 5, below). The Natural Environment Subzone is an intermediate zoning level designed to maintain the landscape integrity while accomodating access and high visitation. The Development Subzone covers high intensity use areas, including campgrounds, shelters and overlooks. The Wilderness Subzone is intended to place retention of natural values foremost, signified by reduced access.

Recommended actions are summarized by species populations on the management maps of the two units (Figures 35A,B) and on a summary table listing management needs (Table 5). Specific actions are detailed later in this chapter.

Figures 35 A, B. Management units and rare plant management needs of Theodore Roosevelt National Park - North and South Units.



(Base map from National Park Service. 1989)



(Base map from National Park Service. 1989)

Table 5. Rare plant populations and their associated management units and management needs in Theodore Roosevelt National Park - North and South Units

Population	Management Unit	Recommended Action
Chenopodium subglabrum		
#002	Nat. Env. Subzone	Leafy spurge management,monitoring,research, special management unit
#003,#007	Nat. Env. Subzone	Leafy spurge management
Coryphantha missouriensis		
#008,#016,#019	Nat. Env. Subzone	Research
#020	Nat. Env. Subzone	Leafy spurge management
Dalea enneandra		Existing habitat management
Euphorbia robusta		
#001	Wilderness Subzone	Leafy spurge management, special management unit
Hordeum pusillum		No management needs
Oenothera laciniata		Inventory
Orobanche multiflora		
#001	Nat. Env. Subzone	Inventory, monitoring, special management unit
Physaria brassicoides		
#014	Nat. Env. Subzone	Leafy spurge management
Populus x acuminata		
#003	Nat. Env. Subzone	Possibly browse restriction
Sitanion hystrix		Existing habitat management
Sporobolus airoides		
#003	Nat. Env. Subzone	Monitoring
Stephanomeria runcinata		Existing habitat management
Verbesina encelioides		
#001	Historic Zone	Canada thistle management, possibly monitoring

To further advance this policy, it is proposed that the National Park Service and the North Dakota Parks and Recreation Department pursue a memorandum of understanding (MOU) to promote exchange of information on all state rare plant data for species inhabiting or potentially inhabiting the park, regardless of location. The MOU might include cooperation in project reviews, environmental assessments and steps for promoting rare plant species conservation as treated by management practices in the following text.

Acquisition and Easement

Two South Unit tracts along I-94 contain part of a major Missouri ballcactus population (#016), part of a major alkali sacaton population (#003), a minor bottlebrush squirreltail population (#029), and possibly a small part of a mustard twinpod population (#014). There are no private developments taking place in these areas at present and they all lie within the park boundary fence.

The rare plant populations are to be considered in the event of proposed development or if additional park acquisitions or easements become feasible.

Fire

Three of the park rare plant species occupy habitat which could carry fire: Missouri ballcactus, yellow broomrape and smooth goosefoot. Of these three, Missouri ballcactus appears to be suppressed by litter accumulation, so that the litter-reducing effects of prescribed burning might be expected to have a net positive influence if fire iteslf is not damaging to the plant. Often it occurs in habitat which is topographically broken by erosion, so that fire would rarely affect entire populations made up of more than a few individuals. The major exception is the largest Missouri ballcactus population (#008) as found in the North Unit across an even, continuous slope. Any prospect of prescribed burning in that area would first require burn trials on a small portion of the population.

Yellow broomrape, by contrast, would probably not be favored by fire because it is a saprophytic species on woody shrubs such as silver sage, which are injured or killed by fire. Yellow broomrape would be favored by fire only if fire injury weakened the host plants to favor the saprophytic association with yellow broomrape. The population as presently known is so small that any prescribed burning is discouraged in the vicinity.

Smooth goosefoot is an annual species requiring open groundcover along the Little Missouri River for establishment, so that fire might have a beneficial influence. However, much of the existing and potential habitat is invaded by leafy spurge. Fire will foster spurge under at least some wildfire and prescribed burn scenarios. For this reason, application of prescribed burning alone as a single management agent is discouraged in areas of smooth goosefoot populations in the South Unit.

Inventory

Both inside the park and on adjoining lands administered by the U.S. Forest Service, it is recommended that resource personnel carry information on four easily recognized priority rare plant species whose badlands distributions are scanty. These include:

Chenopodium subglabrum	Smooth goosefoot
Euphorbia robusta	Shrubby spurge
Eriogonum visheri	Dakota buckwheat
Orobanche multiflora	Yellow broomrape

The Dakota buckwheat was not found in park but was discovered for the first time at a higher elevation site 12 miles away. It is a species of potential federal concern.

In addition, further park inventory work is needed in revisiting the two *Oenothera laciniata* South Unit sites where it is believed to have been mistaken with *O. nuttallii*, as well as general prairie habitat in the North Unit where *O. nuttallii* was noted. In addition, early-season searches for *Oxytropis sericea* and late-season searches for *Ambrosia acanthicarpa* need to be continued.

Agency and nonagency people with interest and expertise are encouraged to carry the complete list of rare plants found in southwestern North Dakota (Appendix 1). Inventory of rare plants is an increasingly high priority on public lands outside of Theodore Roosevelt National Park, and inventory results on lands outside the park might be expected to have bearing on the park.

Monitoring and Research

Major changes in the management practices surrounding the largest populations of three rare plant species will warrant monitoring to gauge trend and effect. The most pressing of these is management accompanied by monitoring at the largest smooth goosefoot population (#002), mentioned earlier, where there is need for leafy spurge control. It might be designed to not only gauge management effect, but to determine trends for this annual species and to sort out habitat preferences. Monitoring will also be needed to gauge management effect when leafy spurge control is put into place at the single population of shrubby spurge (#001) in the South Unit. Monitoring might also be set up at the largest population of Missouri ballcactus (#008) mentioned previously, either as part of a permanent transect system to gauge bison utilization, vegetation trend and vegetation condition, or as a test area for burn trials. This might be designed to investigate the Missouri ballcactus life cycle and habitat preferences as well.

Baseline monitoring or research are recommended for four other rare plant populations independent of management practices. A system to relocate and monitor yellow broomrape (#001) has been set up. The population was relocated in 1990 at approximately a five foot distance from the 1989 plants. Compass bearings and distances from two permanent markers have been recorded. There are no known conflicts with nearby trail use. Smoothbark cottonwood (#003) should be more closely investigated to confirm that the nearby shoots are in fact suckers, and silviculturalists consulted on stand viability. Any vegetation transects in the vicinity of *Sporobolus airoides* should be set up to also record establishment of new clumps, clump dimensions, and plant vigor. The golden crownbeard population (#001) is also a target for monitoring if it is considered nonadventive in origin. If so, it would be valuable to track location and numbers to determine trend and whether or not the population moves around.

Noxious Plant Control

Noxious plant control is the most pressing management need associated with rare plant conservation in the park. The rare species most sensitive to noxious weed invasion and measures of noxious plant control in the park is smooth goosefoot. Severe leafy spurge invasions are found throughout existing and potential riparian habitat areas. The Cottonwood Campground area encompasses part of a smooth goosefoot population (#003), in the Development Subzone. The largest smooth goosefoot population (#002) lies within the Natural Environment Subzone. Both have severe leafy spurge infestations. At the latter, the leafy spurge invasion needs to be evaluated and plans made for mechanical treatment or application of a contact herbicide treatment spray such as Roundup. Spurge extent and rare plant population boundaries are to be held in regard during all treatment, perhaps calling for a marking system on the ground. Elsewhere, the most effective herbicides are to be applied by hand spraying, focusing on late season application after the smooth goosefoot has set seed, and limiting or excluding early season application when the plant cannot be identified and is vulnerable to application.

Part of the only population of shrubby spurge (#001) is also threatened by leafy spurge encroachment. There are very few individuals of the rare spurge growing side-by-side with leafy spurge, at the westernmost extent of the population. This circumstance calls for contact herbicide treatment spray such as Roundup or else Tordon pellets, and the remainder of the area is to be carefully hand-sprayed. This population lies within the Wilderness Subzone, but is readily accessible from roads outside the park. It is also to be noted that the boundary fence in at least one spot adjoining the shrubby spurge population is inadequate for keeping out the Angora goats proposed for spurge control on the adjoining Little Missouri National Grassland.

Leafy spurge has also been identified as immediately adjoining or encroaching upon a Missouri ballcactus population on the terrace along Jules Creek (#020) and part of the mustard twinpod population on Peck Hill (#014). Hand spraying in these areas is to be carefully administered.

Canada thistle invasion and management is a concern in one unusual circumstance associated with golden crownbeard, which is known in the park from only one location (#001). It lies in a Historic Zone of the South Unit, immediately north of and inside the original East Entrance Station constructed by the CCC. The whole area is encompassed by a prairie dog town, and the thistle is found in swards, possibly old buffalo wallow sites, very close to the golden crownbeard. The thistle invaded at least one area of habitat occupied by the golden crownbeard in 1988, dominating and excluding it in 1989. Herbicides were applied to the Canada thistle in 1989, but were also inadvertently applied to a high density area of golden crownbeard lying close to thistles. Golden crownbeard normally has a relatively

tall unbranched stature, and aggregate distribution at this site like Canada thistle, but it is not otherwise mistakable for the thistle. Seeds had set among some of the golden crownbeard individuals and the more scattered individuals escaped spraying altogether, so that this annual species population was not extirpated by the 1989 spraying practice. Careful avoidance of golden crownbeard is needed along with continued herbicide spot treatment spraying for Canada thistle in the future. Golden crownbeard may have accidentally been introduced into the park with feed for horses or on vehicles, as mentioned in the species text. In any case, it is not aggressive. If it is not adventive, then baseline monitoring is also being proposed for the species population site, as mentioned previously.

Plant Collection

Existing park practices restricting collection of wild plants suffice in limiting public collection pressures on the park rare plants. As a family, cacti are viewed as having horticultural interest, but public collection pressure is not being directed to any extent on park cacti in general or the Missouri ballcactus in particular. An individual Missouri ballcactus does grow near the Painted Canyon Overlook west of the parking lot, but is most conspicuous outside of the tourist season and does not warrant special consideration.

Extended collection among the rare plant species of the park is not warranted apart from the initial voucher specimen, documentation of major range extensions, or documentation of morphological and phenological differences.

In general, the plant collection guidelines developed by the Plant Conservation Roundtable (1986) provide a sound framework for applying collection policy.

Road Development and Trails

At least five rare plant populations occur within road right-of-ways or in close proximity to roadbeds and trailways. An extensive mustard twinpod population (#004) enters the park road right-of-way on Johnson Plateau of the South Unit, and borders a foot trail at the I-94 overlook nearby. Development of handicap access has been proposed at the latter area, and it is recommended that if the paved trail course would impact any mustard twinpod, that the individual plants in jeopardy be transplanted nearby. The same recommendation would hold for any regrading along the road right-of-way slope.

Desert wirelettuce (#011) also extends onto the road right-of-way in this same section just north of the Boundary fence.

Alkali sacaton actually seems favored in the road right-of-way setting along I-94 and the park road crossing over I-94. This propensity to colonize is significant because plants growing within the park generally show considerably less vigor and have died out at the center of the bunches. Impact to alkali sacaton is to be considered with any proposed grading in the vicinity of populations, and monitoring considered accordingly.

In the North Unit, the single population of desert wirelettuce (#019) is located near the Little Missouri Overlook on steep slopes below the road right-of-way. It is important that any roadwork in this area maintain stable slopes in the vicinity. Also in the North Unit, the large aforementioned populaton of Missouri ballcactus (#008) extends within the park road right-of-way and the Buffalo Corral Service Road right-of-way.

Special Rare Plant Manangement Unit

Designation of a special rare plant management unit might be considered for the single populations of yellow broomrape and shrubby spurge, as well as for the largest population of smooth goosefoot. It may help flag any activities in their vicinity, since these populations are highly significant and particularly sensitive.

Structural Developments

Relocation of the historic East Entrance Station in the South Unit has been proposed in the TRNP General Management Plan (1987) and the potential impact on golden crownbeard immediately north of the site should be taken into account. Travel of heavy machinery along the existing abandoned road route will not affect the population if heavy machinery is kept off of the north side of the entry gate.

Relocation of the Bison Corral in the North Unit has been proposed and should take into account potential impact on Missouri ballcactus. The service road to the corral lies adjacent to the park's largest population (#008).

Water Rights

Upstream management practices and flows affect riparian habitat quality and condition for rare plants such as smooth goosefoot. The water quality may not be so important as the hydrology that conditions processes of flooding, deposition and erosion. Park water rights have not been established, nor basin plans developed with regard to surface and subsurface water quality. Nonconsumptive water rights will come into play at some time in the future and rare plants concerns should be incorporated in the planning process.

Wild and Domestic Ungulate Management

It is interesting that several of the rare plants may be positively associated with bison. Golden crownbeard appears to be concentrated in old bison wallows. Two of the three areas where Missouri ballcactus reaches its highest numbers are documented areas of high intensity use by bison. It has been suggested that old bison trails along the river afford suitable habitat for smooth goosefoot (Wieland pers. comm.).

The only rare plant directly impacted by ungulates is the smoothbark cottonwood, browsed perhaps by wild horses, elk or deer. This action effectively prevents maturation of any of the young shoots. If the stand is indeed viable, then it is recommended that means of deterring this action be considered.

CONCLUSIONS

What conclusions can be derived from a rare plant inventory? Three forms of interpretation are pursued in the following text. First, inventory results are considered by habitat in qualitative terms of rare plant habitat commonalities and differences, rare plant frequency, and rare plant management implications. Second, the individual species themselves are considered in terms of which ones are the most rare and most threatened at the geographic scale of park, state, Northern Great Plains, and rangewide distributions. Finally, a contribution is made toward a framework for weighing Theodore Roosevelt National Park biodiversity significance from a state, regional, and global perspective.

Habitats of Rare Species

All of the thirteen rare plant species under study occupy plant associations and landform settings that are common in the park as defined and mapped by Norland (1986; see Table 4). Many of the rare plants occupy the most pervasive combination of plant associations and landforms, i.e., the common prairie associations of breaks, scoria hills, ridge and ravine, and sage flats settings.

Four plant species are restricted to discrete classification units. Smooth goosefoot and possibly cut-leaved evening primrose are best adapted to the early successional young cottonwood phase of the sandy Riverbottom management unit, representing a narrow, discontinuous zone along the Little Missouri River. Nine-anthered dalea is adapted to the coarse, sparsely-vegetated open gravel phase of River Terrace, which might be considered an early successional stage at droughty crests of buttes and ridgetops. Alkali sacaton occupies *Agropyron smithii - Stipa viridula* habitat in settings abutting rough topography where there is solonization and limited vegetation development.

Species that are known from only one TRNP location are by definition restricted within the park. These include shrubby spurge, yellow broomrape, golden crownbeard and smoothbark cottonwood. The remainder are not consistently limited to any plant association or landform setting.

All of the documented rare species occupy upland xeric habitat except for the two riparian species whose habitat is intermittently flooded in spring. There are rare aquatic plants known from the southwestern area of the state and aquatic habitats were searched in the course of this inventory project. The ommission of rare aquatic plants from the park flora is unexplained.

Despite the extensiveness of the habitats occupied by the plants, and the recurrence of apparently suitable habitat, none of the plants is in any sense of the word "common" in the park. This is because they do not occur with high frequency in apparently suitable habitat. Mustard twinpod is among the plants with the highest habitat frequency, though distinctly less that half of what appears to be suitable sandstone or gypsum outcrop actually supports this species. Some plants were more predictable in their distribution in the North Unit as compared to the South Unit, e.g., bottlebrush squirreltail. Nine-anthered dalea is an example of a species with very low habitat frequency, for which apparently suitable coarse open gravel has slim chances of harboring a population. For some of the species, e.g. alkali sacaton, we may not have refined its definition of necessary habitat to the point of being able to predict frequency. Relatively low habitat specificity and frequency are shared in common among other rare plants of southwestern North Dakota. We offer as possible hypotheses that microhabitat dictates over habitat in some of the cases, and that dispersion in habitat mosaics of highly variable climates and the accompanying natural disturbance regimes involves extremely high degrees of chance.

This is consistent with the pattern that virtually none of the populations of the rare species occupies settings in climax condition as defined by the current park vegetation classification (Marlow et al. 1984). All thirteen species show positive correlation with successional habitat, and for this reason are likely to be poor competitors. Twelve of the thirteen seem to be most closely associated with primary succession. Even the little barley, appearing to be dispersed by ungulates, is less frequently found on secondary succession sites attributed to overgrazing (e.g., the North Unit well site) than on other sparsely-vegetated sites. Both little barley and bottlebrush squirreltail are characterized as grazing increasers farther west in their range (Smith 1976). This raises the questions of whether these species are preadapted for secondary succesion by virtue of adaptation for primary succession or vice versa. If they are shown to behave as

major increasers in surrounding North Dakota rangeland, then they will be removed from the working state list of rare plants. Only the golden crownbeard is clearly a secondary succession species, found in buffalo wallow settings superimposed on prairie dog towns.

There are two major groups of primary succession plants among the rare species: those that occupy slopes and those that occupy flats. The one species that falls outside of these two primary succession categories is smooth goosefoot, a riparian succession species. Cut-leaved evening primrose may possibly belong to the same riparian succession association. The plants of slope settings include nine-anthered dalea, shrubby spurge, mustard twinpod, smoothbark cottonwood, bottlebrush squirreltail and desert wirelettuce. The plants of more level habitat include little barley, yellow broomrape, bottlebrush squirreltail (South Unit plants only), and alkali sacaton. Note that bottlebrush squirreltail occupies both barren slope and barren outwash flats settings. The steep slope group withstands illuviation and environmental stress compounded by sun and wind. The latter group withstands colluviation and environmental stress compounded by sun and solonization. Five of these thirteen rare plants are annuals, in a flora dominated by perennials. In a sense, they epitomize the badlands flora as adapted to dynamic conditions.

While some of the rare plant species can be managed by trying to maintain the landscape processes, others call for deliberate management action. The most pressing is represented in pervasive leafy spurge invasion of smooth goosefoot habitat.

Biogeography of Rare Species

The rarest plants in the park are those known from only single occurrences, i.e. shrubby spurge, yellow broomrape, golden crownbeard and smoothbark cottonwood. They are also the most rare plants in the state, except that smoothbark cottonwood is known from a second site in North Dakota. Smooth goosefoot joins them as extremely rare in the state, known only from the park area among recent state herbarium collection records.

In the Northern Great Plains, the smooth goosefoot, golden crownbeard and yellow broomrape are very rare; in fact, the North Unit population of yellow broomrape represents the only documented Northern Great Plains population. Mustard twinpod may not be extremely rare in the Northern Great Plains, but it is possible that its distribution is entirely restricted to this area, so attempts are underway to evaluate its rangewide status. The other targeted rare plants are at the eastern extent of their range in North Dakota, and tend to be more common to the west.

On a global scale, the smooth goosefoot, yellow broomrape and mustard twinpod may, in fact, be rare throughout their range. Information is being collected from other states which will be used to make recommendations to the U.S. Fish & Wildlife Service regarding Endangered Species Act listing candidates.

Among the thirteen species, the most threatened in the park and perhaps throughout its range is the smooth goosefoot. Leafy spurge invasion in the park calls for both aggressive and careful herbicide application at present. Outside the park it occupies riparian vegetation habitat which is impacted by rangeland management practices throughout the species' distribution.

A second approach to analyzing park species biogeography is suggested in works of Rudd (1951) and Zaczkowski (1972), using the preliminary park flora (Appendix 7) plus the ***Atlas of the Flora of the Great Plains*** (1977). In a cursory manner, it is noted that the least common floristic components of the southwestern counties, the eastern deciduous and boreal components, are almost fully represented in the park. Eleven of the twelve eastern deciduous species and eight of the nine boreal species singled out by Zaczkowski (1972) as constituting these uncommon floristic components are present in the park. It is also estimated that over 10% of the park flora documented by collections in the course of recent inventory work represents new county records (over 50 species).

Several taxa require more fieldwork or rangewide information before biogeographic perspective can be considered: cut-leaved evening primrose, smoothbark cottonwood and golden crownbeard . Suspected but unconfirmed park occurrences of *Ambrosia acanthicarpa* and *Oxytropis sericea* also warrant further study.

Park Biodiversity

What does this mean for Theodore Roosevelt National Park biodiversity status as a whole? Part of the question will remain unanswered until rare plant inventories are conducted in surrounding public land under different management. To date, the park is recognized as supporting the highest concentration of rare plant populations in southwestern North Dakota. The Killdeer Mountains has been documented as having almost as many state rare plant species (11 species). The Killdeer Mountains species are much more restricted in numbers of populations and their local extent, and are not the same species as found in the park. Higher numbers of state rare plant species and total numbers of rare plant populations have been found elsewhere in the state in the Sheyenne Sandhills and in the Pembina Gorge.

Of the thirteen rare plant species that are in the park, only five are found elsewhere in the state on public land (little barley, nine-anthered dalea, mustard twinpod, smoothbark cottonwood and desert wirelettuce). Two of these have larger populations outside the park (desert wirelettuce and smoothbark cottonwood).

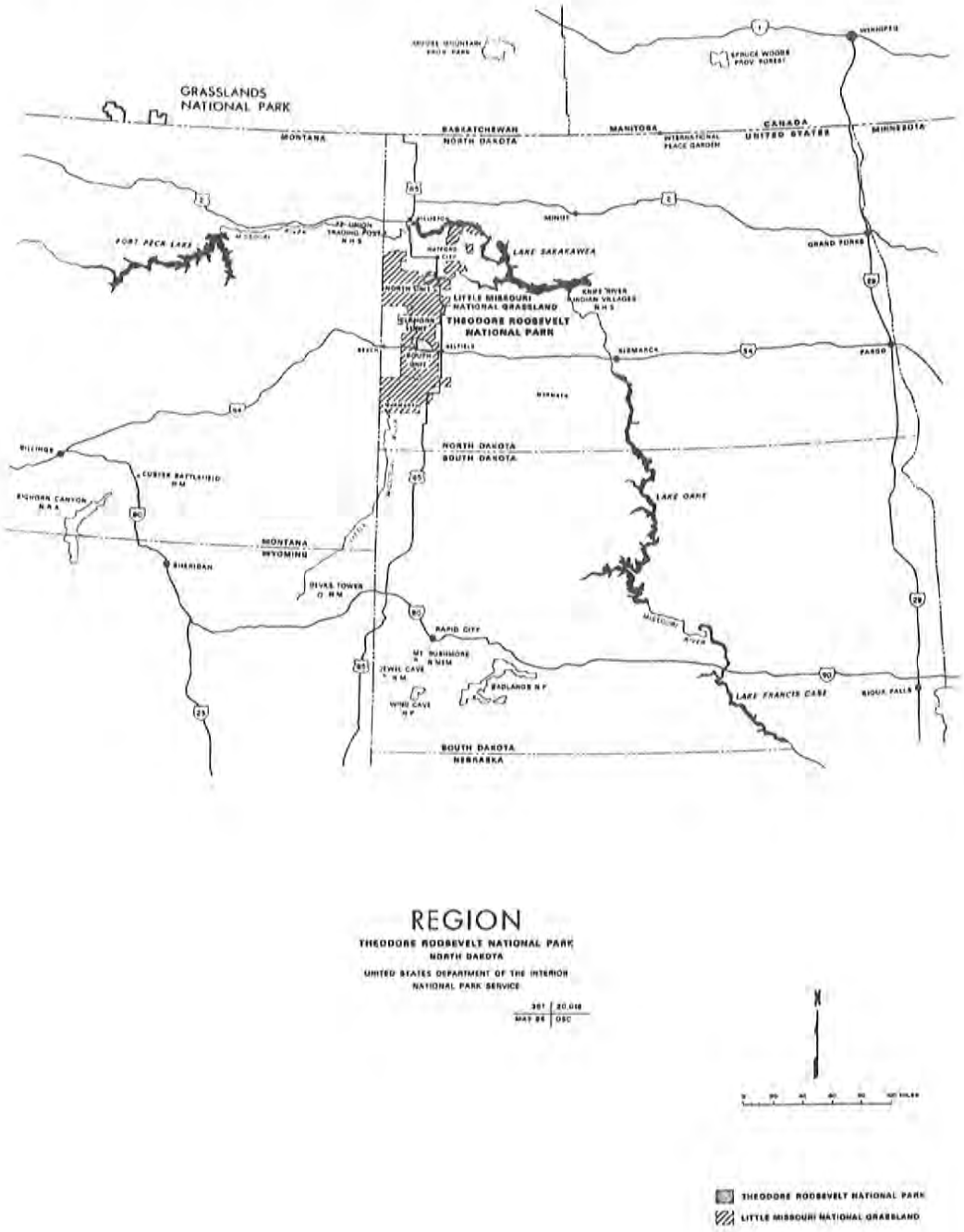
However, Theodore Roosevelt National Park is the only place of this size in the state where rare species protection and management has a high status. Other rare species sites designated as nature preserves in the state include Cross Ranch Nature Preserve (The Nature Conservancy), Gunlogson Nature Preserve (North Dakota Parks & Recreation Department), John E. Williams Nature Preserve (The Nature Conservancy) and Mirror Pool Nature Preserve (North Dakota Game & Fish Department), with similar rare species protection and management objectives but none of the same rare species.

In the region, Theodore Roosevelt National Park is among four extensive Northern Great Plains national parks of prairie habitat in which landscape integrity and natural landscape processes are emphasized. It has the most extensive public lands bordering it among the four parks, as represented in the Little Missouri National Grassland (Figure 36). The three other parks are: Badlands National Park (SD), Wind Cave National Park (SD) and Grasslands National Park (Saskatchewan). At some point it would be valuable to exchange not only rare plant species lists, but complete information on park floras, faunas, baseline monitorings, and management framework. As inferred by Zaczkowski (1972) and Rohde-Fulton (1985), Theodore Roosevelt National Park can also serve as a baseline for reading the health of the regional landscape. To use it as a baseline, we need to know its rare and sensitive components.

In the country, Theodore Roosevelt National Park fills a gap in representing part of the largest vegetation unit in North America, the midcontinental prairie (Stubbendieck 1987). It was suggested by Stubbendieck (1987) that this vegetation unit may not have been considered in previous conservation biology works expousing bioreserve concepts and prospective sites (e.g., Franklin 1977). It has been inferred in an earlier National Park Service publication that the Great Plains parks are wanting in the forb and native ungulate component of the prairie ecosystem (Allen 1979), but for Theodore Roosevelt National Park, the latter are being reintroduced and the former are becoming better documented. Though Northern Great Plains national parks do not have endemic vascular plant species and nationally significant levels of vascular plant species diversity, they might be considered to exemplify stability in the wake of frequent natural disturbances and genetic diversity at the ecotype level.

The rare plants of Theodore Roosevelt National Park encapsulate the resiliency of the Northern Great Plains system. In this context, the rare plants under study reflect intact landscape processes as well as unanswered questions at the species and systems level. They are among the newest clues in a biogeography riddle out of which will emerge an elevated national conservation stature for Theodore Roosevelt National Park.

Figure 36. National Parks of the Northern Great Plains.



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Appendix 1. Original Theodore Roosevelt National Park Service target list for rare plants inventory, representing state rare plants of southwestern North Dakota

Scientific Name	Common Name	TRNP Unit Target	G Rank	S Rank	Phenology	Habitat
Agrimonia gryposepala	Tall hairy grovebur	N	G5	S3	Late July-Aug; in flower + fruit	Thickets, woodland edges, partial shade
Agrostis exarata	Spikebent	N	G5	S1	July-Aug	Streambed in aspen
Ambrosia acanthicarpa	Bursage	N,S	G5	SHSA?	August-October	Open sandy sites on sandbars, riverbanks, disturbed settings
Astragalus aboriginum	Indian milkvetch	N,S	G5	S2S3	Mid-May - possible early July	Open prairie, wooded hills; possibly with creeping juniper
Astragalus gracilis	Slender milkvetch	S	G5	S3	At least mid-June-July	Variable well-drained slopes, incl. scoria and sand substrate
Astragalus vexilliflexus	Bent-flowered milkvetch	N,S	G4	S3	June-August	Calcareous substrate of youngest rock formations in ND
Boisduvalia glabella	Smooth-spike primrose	S	G5	S1S2	June-early July	Creek banks and dry streambeds
Bromus carinatus	Keeled brome	S	G5	S1	May-July	Woody draws on butte and in badlands
Carex foena	Dry-spiked sedge	N	G5	S1S2	June	Open aspen woods
Carex haydenii	Hayden's sedge	N	G5	S1	Early July	Marsh wetland margin
Carex nebraskensis	Nebraska sedge	S	G5	SU	Mid June - mid-July	Emergent around pool in creek, possibly also in spring areas
Carex scirpiformis	Spikerush sedge	N	G5	S1S2	Mid-June - Aug	Calcareous bare ridgetops, sandplain swales
Chaenactis douglasii	Douglas' dusty-maiden	S	G5	SU	Mid-June - mid-July; id all season	Scoria buttes
Cheilanthes feei	Slender lip fern	N	G5	S1	Identifiable all season	Dry rocky slopes of Killdeer Mts.
Chenopodium subglabrum	Smooth goosefoot	S	G?	S1	Late June - August	Sandy riverbanks on Little Missouri River
Clematis columbiana tenuiloba	Slender-lobed clematis	N	G?	S1	Late May-June; id all season	Aspen and paper birch woodlands of Killdeer Mts.
Collinsia parviflora	Blue lips	N,S	G5	S1S2	Early May-June	Sparsely wooded hillsides
Corallorhiza trifida	Early coralroot	N	G5	S3S4	Late May-early July	Aspen woods
Coryphantha missouriensis	Missouri ballcactus	S*	G5	S3	Early June-July	Sparsely-vegetated near-level prairie on clay loam or loam
Cryptanthera torreyana	Torrey's cryptantha	S	G?	SH	Late June-July	Scoria hillside, outcrop setting
Cypripedium calceolus	Yellow lady's-slipper	N	G5	SU	Early May-June	Aspen forest and wetland thicket edges, brooksides, wet prairie
Dalea enneandra	Nine-anthered dalea	S*	G5	S2S3	Late June-July; id all season	Gravel prairie slopes

Scientific Name	Common Name	TRNP Unit Target	G Rank	S Rank	Phenology	Habitat
Elatine triandra	Waterwort	N	G5	SH	Late June-Aug	Ephemerally inundated low areas in prairie
Erigeron divergens	Spreading fleabane	S	G5	S1	Late June-late July	Dry gravel hillsides, possibly exposed sandy sites
Erigeron radicatus	Cushion fleabane	N	G3	S1	Late May-June	Bare calcareous ridgetop of Killdeer Mts.
Eriogonum visheri	Visher's buckwheat	-	G3	S2S3	Early July-Aug	Badlands slopes and outwash fans
Fritillaria pudica	Yellow fritillary	S	G5	SH	May-June	Base of bluffs, possibly among sagebursh
Hordeum pusillum	Little barley	S	G5	S3S4	Late May-June; id in fruit July	Sparsely-vegetated pockets and outwash fans among sage, prairie
Lechea stricta	Upright pinweed	S	G?	S1	Early June-late July	Sandy areas
Leucocrinum montanum	Sand lily	S	G5	S2	Late May-early June	Dry prairie upland, possibly with major sedge component
Linnaea borealis	Twinflower	N	G5	S4	June-July; id all season	Aspen and paper birch woodlands
Mahonia repens	Creeping barberry	S	G5	S2	Late May-June	Green ash woody draw and juniper woodland edge on Pierre Shale
Mentzelia pumila	Dwarf mentzelia	S	G?	S1	Mid-June-July	Scoria outcrop
Monotropa uniflora	Indianpipe	N	G5	S3	Mid-June-Aug	Paper birch and aspen woodland
Myosurus aristatus	Sedge mousetail	S	G?	S1	April-May	Drainageways and moisture-collecting sites
Najas flexilis	Slender naiad	S	G5	SU	Late July-early Aug	Impoundment, slough, lake
Oenothera laciniata	Cut-leaved evening primrose	S	G5	SA?	June; possibly all season	Sandy areas: Little Missouri riverbank, possibly disturbed sites
Oxytropis sericea	White locoweed	S	G?	S1	Late May-early June	Dry prairie hillsides
Pellaea glabella	Smooth cliffbrake	N,S	G5	S4	Identifiable all season	Rock outcrops, calcareous and sandstone
Phlox alyssifolia	Alyssum-leaved phlox	N,S	G5	S1S2	Early May-mid-June	Edge of prairie habitat at rocky slope crest
Physaria brassicoides	Mustard twinpod	N,S*	G5	S3	Early May-early June; id all yr	Sandstone and gypsum outcrops, loose sand and scoria slopes
Pinus flexilis	Limber pine	S	G5	S1	May-June; identifiable all year	Scoria ridge outcrops
Polygonum douglasii	Douglas' knotweed	N,S	G5	S3	Mid-July-Aug	Open settings on buttes, shale outcrops
Polygonum leptocarpum	Thin-fruited knotweed	S	G?	S1	August	Damp or dry often brackish soils and shores
Populus balsamifera trichocarpa	Black cottonwood	S	G5	S1	Fruit May-June	Sheltered N-facing spring-fed bench
Populus x acuminata	Smoothbark cottonwood	S	Hybrid	S1	Fruit May-June	Springs, shallow water tables

Scientific Name	Common Name	TRNP Unit Target	G Rank	S Rank	Phenology	Habitat
Potamogeton ampilifolius	Large-leaved pondweed	S	G5	S2S3	Mid-July-Aug	Creek, creek pools and impoundments
Potamogeton diversifolius	Water-thread pondweed	S	G5	S2S3	Mid-July-Aug	Shallow water of ponds and marshes
Potamogeton vaginatus	Sheathed pondweed	N	G5	S3	Mid-July-Aug	Submergent in lake, reservior?; maybe restricted to sandy sites
Potentilla diversifolia	Mountain meadow cinquefoil	S	G?	S1	Late May-mid-June	Meadow, along watercourse
Potentilla tridentata	Three-toothed cinquefoil	S	G5	S1	Late May-June	Dry scoria hilltop, dry shale outcrop
Psoralea tenuiflora	Slim-flowered scurfpea	S	G5	SHSA?	June-early July	Badlands site, disturbed site
Ranunculus cardiophyllus	Heart-leaved buttercup	N	G?	S1	Late June	Meadow and moist ravine along Missouri River
Ribes inebrians	Squaw currant	S	G5	S3	Early May-June; id all season	Scoria and other outcrops, pine and juniper woodlands
Rorippa calycina	Hayden's yellowcress	N	G3	SH	May-June	Moist sandy soil of riverbank
Sitanion hystrix	Bottlebrush squirreltail	S*	G5	S4	Late May-June; id through July	Clay badlands slopes and outwash fans
Smilax eccirhata	Upright greenbrier	S	G?	S1S2	June	Base of large boulders on butte slope
Sporobolus airoides	Alkali sacaton	S*	G5	S2	Mid-July-Aug	Sandy to clayey outwash
Stephanomeria runcinata	Desert wirelettuce	S*	G5	S3S4	Late June-July	Scoria ridges, clayey and rocky hillsides
Stephanomeria tenuifolia	Narrow-leaved wirelettuce	S	G5	SU	July	Scoria ridges, hillsides
Suckleya suckleyana	Poison suckleya	S	G5	SA?	Aug-Sept	Moist alkaline soil; all records in road right-of-ways to date
Talinum parviflorum	Prairie fameflower	S	G5	SU	Early July-Aug	Sandy outwash
Townsendia hookeri	Hooker's townsendia	S	G5	S1	Early May	Dry butte top setting
Viola conspersa	Bog violet	N,S	G5	SU	May	Wooded ravine

Appendix 2. Site Survey Summary

SITE SURVEY SUMMARY

Site Name: _____

Quad Name: _____

Quad Code: _____ 10/10 locator: _____

State: _____ County: _____

Town: _____
or
Township/Range/Section: _____

Field Quad Margin #: _____

Source of lead:

_____

_____

_____

Site Visit Chronology

Date: _____ Time: _____ to _____ Source Code: _____
Surveyor(s): _____

Date: _____ Time: _____ to _____ Source Code: _____
Surveyor(s): _____

Date: _____ Time: _____ to _____ Source Code: _____
Surveyor(s): _____

Date: _____ Time: _____ to _____ Source Code: _____
Surveyor(s): _____

Date: _____ Time: _____ to _____ Source Code: _____
Surveyor(s): _____

Other individuals knowledgeable about site and/or EO's: _____

Current use of site: _____

Tract ownership or managed area name (names, addresses, phone #). Continue on last page for others.

_____ _____ _____

_____ _____ _____

_____ _____ _____

_____ _____ _____

INDEX

List all listed species/communities sought, found, or reported from site.

Element Name	Code on Base Map	Occ.#	Date: Found?	Transcr/ Updt?	Found?	Transcr/ Updt?	Found?	Transcr/ Updt?	Found?	Transcr/ Updt?	Found?	Transcr/ Updt?	Revisit needed? When?

SITE DESCRIPTION

Written description - Describe the site in the space below. Try to convey a mental image of the site's features (including vegetation, significant species, aquatic features, notable landforms, natural disturbances, scenic qualities, natural hazards, etc.):

Evidence of disturbance - Describe any unnatural disturbance(e.g. livestock grazing, structures,past logging, mining, plantations/orchards, etc.) and discuss management implications, threat to site, AND/OR why sought species/communities may no longer exist here:

Surrounding land use - Describe structures and land use practices in the surrounding area (e.g. abandoned chicken coop, tree house, forestry, agriculture, recreation, residential, etc.):

Appendix 3. Rare Plant Survey Form

NORTH DAKOTA RARE PLANT SURVEY FORM

EO# _____

SPECIES: _____ Quad Code _____

Site Name: _____ Collection #, Repository _____

County: _____ Slide _____ Plant List _____

T-R-S: _____

Ownership _____

Location (directions, access, UTM): _____

_____

_____

Surveyor _____ Date _____ Source Code _____

Date and Source Code of repeat visits _____

Full extent of occurrence known and mapped? (Y/N) _____ Precise location of individual mapped on base map? (Y/N) _____

HABITAT AND BIOLOGY

Habitat description (Natural Community, topographic position, aspect, relief, exposure, moisture, substrate, others): _____

_____

_____

_____

_____

_____

_____

Habitat Demarcation : _____

_____

_____

Evidence of Disturbance to Habitat: _____

_____

_____

_____

Approximate Area Covered by Population: _____

APPROPRIATE SKETCH (location, habitat, habitat demarcation, disturbance):

Associates (indicate relative abundance - dominant, common, occasional, uncommon, rare; and fidelity of association. For extensive list use Plant List.): _____

Approximate Number and Distribution of Individuals: _____

Reproductive Success and Population Structure (flower and seed production, vegetative reproduction, seedling establishment, phenology): _____

Vigor (feeble, normal, vigorous, unknown): _____

Threats to population or Habitat (human activities, successional changes, exotics, grazing, browsing, parasitism, disease, others): _____

SUMMARY (A=Excellent, B=Good, C=Marginal, D=Poor)

Quality (population and individual vitality and vigor): _____

Condition (habitat condition and recoverability): _____

Viability (long-term prospects of survival at existing quality): _____

Defensability (ability to protect from extrinsic human factors): _____

Total Rank (Summary of above): _____

Additional Comments (Highlight distinguishing features of this site or population, contributions to existing information, continuation of notes from previous sections of form): _____

Appendix 4. Location of rare plant occurances documented from Theodore Roosevelt National Park

Scientific/Common Name	Unit	Record Number	UTM	Township, Range & Section
Chenopodium subglabrum Smooth goosefoot	South	002	612.41 E, 5206.92 N	T.141N R.101W SEC 30 NE/NE
		003	610.66 E, 5199.11 N; 611.17 E, 5199.35 N; 612.14 E, 5200.95 N	T.141N R.102W SEC 10 SE/SE/NE
		005	614.23 E, 5203.21 N	T.140N R.102W SEC 1 NW
		006	613.00 E, 5205.75 N	T.141N R.101W SEC 29 NE/SE
		007	614.75 E, 5204.93 N; 614.91 E, 5204.76 N; 615.00 E, 5204.46 N; 614.95 E, 5204.40 N; 614.90 E, 5204.37 N; 614.85 E, 5204.33 N	T.141N R.101W SEC 33 NE/SW, SE/NW
Coryphantha missouriensis Missouri ballcactus	North	008	625.75 E, 5272.49 N; 626.05 E, 5272.77 N; 626.76 E, 5272.61 N; 628.08 E, 5272.04 N; 627.67 E, 5272.67 N	T.148N R.99W SEC 31 NE, 32 SE/NW, 33 SW/SE
		013	624.05 E, 5274.15 N; 625.17 E, 5273.00 N	T.148N R.99W SEC 30 NW/SW, 31 NE/NE
		014	616.87 E, 5270.81 N; 616.93 E, 5270.56 N	T.147N R.100W SEC 5 SE/NW, NE/SW
		015	618.16 E, 5267.66 N; 618.74 E, 5267.58 N; 619.53 E, 5267.56 N	T.147N R.100W SEC 15, 16 NE
		030	623.41 E, 5273.25 N	T.148N R.100W SEC 25 SE/SE
		031	617.58 E, 5269.20 N; 617.94 E, 5269.42 N; 617.96 E, 5268.84 N	T.147N R.100W SEC 9 W
		032	619.03 E, 5269.67 N; 619.56 E, 5270.09 N; 621.38 E, 5268.17 N	T.147N R.100W SEC 3 SE/SW, 10 NW/NW, 14 NW/NE
	South	006	625.87 E, 5199.63 N	T.140N R.100W SEC 18 NW/SE
		009	615.53 E, 5199.06 N	T.140N R.101W SEC 35 SE/SW, SW/SE
		010	614.51 E, 5199.31 N	T.140N R.102W SEC 13 NE/SW
		011	612.28 E, 5198.47 N	T.140N R.102W SEC 22 NE/NE
		012	615.44 E, 5203.08 N	T.140N R.101W SEC 6 SW/NW
		016	619.92 E, 5195.83 N; 619.87 E, 5195.59 N; 619.55 E, 5195.35 N	T.140N R.101W SEC 28 S/SE, 33 NW/NE
		017	627.01 E, 5198.13 N	T.140N R.100W SEC 20 NE/SW
		018	622.06 E, 5194.66 N	T.140N R.101W SEC 35 NW/SW
		019	615.66 E, 5197.24 N; 616.00 E, 5197.58 N; 615.79 E, 5197.84 N; 616.65 E, 5197.55 N; 616.06 E, 5198.00 N; 616.07 E, 5198.28 N	T.140N R.101W SEC 18 SW/SW, 19 NE/NW
		020	615.30 E, 5205.24 N	T.141N R.101W SEC 33 NW/NE
		021	622.19 E, 5202.00 N	T.140N R.101W SEC 11 NW/NW
		022	613.04 E, 5204.50 N	T.141N R.101W SEC 32 NW/SW
		023	620.69 E, 5202.78 N	T.140N R.101W SEC 3 SE/NW
		025	612.12 E, 5207.00 N	T.141N R.101W SEC 19 SW/SE
		027	606.91 E, 5204.59 N	T.141N R.102W SEC 34 NW/NW, SW/NW
		028	612.02 E, 5199.53 N	T.140N R.102W SEC 15 SE/NE
		029	610.78 E, 5207.77 N	T.141N R.102W SEC 24 SE/NE
Dalea enneandra Nine-anthered dalea	South	010	609.29 E, 5204.37 N	T.141N R.102W SEC 35 NE/SE
		011	610.11 E, 5200.51 N; 610.19 E, 5200.42 N; 610.26 E, 5200.36 N	T.140N R.102W SEC 9 SW/SE
Euphorbia robusta Shrubby spurge	South	001	606.85 E, 5205.11 N; 606.78 E, 5204.76 N	T.141N R.102W SEC 34 NE/NW

Scientific/Common Name	Unit	Record Number	UTM	Township, Range & Section
Hordeum pusillum Little barley	North	007	617.12 E, 5270.66 N	T.147N R.100W SEC 5 NE/NE
	South	008	615.98 E, 5197.95N	T.140N R.101W SEC 19 SE/NW
		009	621.22 E, 5198.42 N; 621.74 E, 5197.82 N	T.140N R.101W SEC 22 NW/NE,NE/SE
		010	622.24 E, 5202.20 N	T.140N R.101W SEC 2 SE/SW
		011	620.06 E, 5202.65; 620.76, 5202.68	T.140N R.101W SEC 3 NE/SW, 4 NE/SE, 10 NE/SE
		012	616.84 E, 5198.74 N	T.140 N R.101W SEC 18 SE/SE
		013	608.73 E, 5204.26 N; 608.89 E, 5204.27 N; 609.04 E, 5204.29 N	T.141N R.102W SEC 35 NW/SE
		014	624.00 E, 5201.61 N	T.140N R.101W SEC 12 SE/NW
		015	619.72 E, 5196.00 N	T.140N R.101W SEC 28 NW/SE
		016	616.67 E, 5203.72 N	T.140N R.101W SEC 6 NE/NE
Oenothera laciniata Cut-leaved evening primrose	South	006	612.12E, 5207.00N	T.141N R.101W SEC 19 SW/SE
Orobanche multiflora Yellow broomrape	North	001	625.30 E, 5272.67 N	T.148N R.99W SEC 32 SW/NW
Physaria brassicoides Mustard twinpod	South	004	611.77 E, 5198.68 N; 612.29 E, 5198.55 N; 612.57 E, 5198.31 N; 612.58 E, 5198.55 N; 612.67 E, 5198.45 N; 613.72 E, 5198.29 N; 614.00 E, 5197.31 N; 614.37 E, 5197.49 N	T.140N R.102W SEC 23, 24, 14 SW, 15 SE
		006	614.59 E, 5199.56 N; 614.69 E, 5199.01 N; 615.24 E, 5199.08 N; 615.32 E, 5199.61 N	T.140N R.102W SEC 13 NE,NW/SE, 18 NE/SE
		014	620.81 E, 5195.35 N; 621.11 E, 5195.69 N; 621.18 E, 5195.79 N; 621.27 E, 5195.89 N	T.140N R.101W SEC 27 SW/SE
		015	616.04 E, 5204.17 N	T.141N R.101W SEC 31 NE/SW
		016	611.70 E, 5198.00 N	T.140N R.102W SEC 22 SW/NE
		017	611.92 E, 5199.64 N	T.140N R.102W SEC 15 NE
		018	615.41 E, 5202.80 N; 615.58 E, 5202.28 N; 615.83 E, 5202.37 N; 616.41 E, 5203.07 N	T.140N R.101W SEC 6 SW
		019	610.45 E, 5199.47 N	T.140N R.102W SEC 16 SE/NE
		020	606.87 E, 5206.26 N; 606.93 E, 5206.33 N; 607.02 E, 5206.45 N	T.141N R.102W SEC 27 SE/NW, SE/SW, 34 E/NW
		021	610.40 E, 5201.38 N; 611.02 E, 5201.15 N	T.140N R.102W SEC 9 NE/NE, 10 SW/NW
		022	613.00 E, 5204.55 N; 613.14 E, 5205.00 N	T.141N R.101W SEC 32 NW/SW, NE/SW, NE/NW
		023	609.63 E, 5198.84 N; 609.88 E, 5198.79 N	T.140N R.102W SEC 16 SE/SW
		024	611.78 E, 5204.24 N	T.141N R.101W SEC 31 NW/SE
		025	615.13 E, 5200.95 N	T.140N R.101W SEC 12 NE/SE
		026	619.75 E, 5196.46 N	T.140N R.101W SEC 28 SW/NE
Populus x acuminata Smoothbark cottonwood	South	003	621.27 E, 5195.89 N	T.140N R.101W SEC 27 SW/SE
Sitanion hystrix Bottlebrush squirreltail	North	015	619.11 E, 5267.63 N; 619.55 E, 5267.71 N; 620.16 E, 5267.40 N; 620.53 E, 5267.62 N; 621.23 E, 5267.80 N; 621.35 E, 5268.14 N; 621.74 E, 5268.41 N	T.147N R.100W SEC 14,15,16
		016	624.98 E, 5275.50 N; 624.40 E, 5274.81 N; 624.43 E, 5274.30 N	T.148N R.99W SEC 19 S, 30 NE
		O17	626.98 E, 5272.99 N; 628.35 E, 5272.16 N	T.148N R.99W SEC 33 NE/SE, SW/NW
		032	622.64 E, 5273.59 N; 623.58 E, 5273.33 N	T.148N R.100W SEC 25 SW, SE/SE
		033	617.10 E, 5273.66 N; 617.03 E, 5272.49 N; 617.22 E, 5272.14 N; 616.94 E, 5271.78 N; 616.62 E, 5271.22 N; 616.88 E, 5270.76 N; 616.84 E, 5270.51 N	T.148N R.100W SEC 29 NE/SE, 28 NW/SW, 32-33; T.147N R.100W SEC 5 NE, SE, 8 SE/NW

Scientific/Common Name	Unit	Record Number	UTM	Township, Range & Section
Sitanion hystrix Bottlebrush squirreltail	South	012	627.45 E, 5195.20 N	T.140N R.100W SEC 32 NW
		018	612.13 E, 5199.48 N	T.140N R.102W SEC 15 SE/NE
		019	618.01 E, 5204.03 N	T.141N R.101W SEC 35 SE/SW
		020	606.75 E, 5205.85 N; 606.78 E, 5205.32 N; 607.76 E, 5205.25 N	T.141N R.102W SEC 27 NE/SW, SE/SE, 34 NE/NE, 35 NW
		021	616.74 E, 5201.10 N	T.140 N R.101W SEC 7 NE/SE, 17 SW/SW, 19 NE,SE/NW
		022	610.70 E, 5200.88 N	T.140N R.102W SEC 10 NW/SW
		023	611.53 E, 5206.42 N; 611.52 E, 5206.06 N; 611.13 E, 5205.69 N	T.141N R.101W SEC 30 SE/NW, N/SW
		024	622.85 E, 5200.81 N; 624.15 E, 5199.84 N; 624.11 E, 5199.03 N	T.140N R.101W SEC 3,4,10,11,12,13,14
		025	614.87 E, 5197.34 N	T.140N R.102W SEC 24 SW/SE
		026	609.00 E, 5204.36 N	T.141N R.102W SEC 35 NW/SE
		027	626.41 E, 5200.60 N	T.140N R.100W SEC 7 SE/SE
		028	609.58 E, 5200.66 N	T.140N R.102W SEC 9 NE/SW
		029	618.47 E, 5196.09 N	T.140N R.101W SEC 29 NE/SE
		030	619.81 E, 5197.32 N	T.140N R.101W SEC 35 NE/SW
		031	622.62 E, 5194.58 N	T.140N R.101W SEC 21 SE/SE
Sporobolus airoides Alkali sacaton	South	003	613.21 E, 5197.45 N; 615.14 E, 5196.73 N; 619.51 E, 5195.31 N	T.140N R.101W SEC 27,28,29,30,33
		007	622.66 E, 5202.36 N	T.140N R.101W SEC 2 SW/SE
		008	616.17 E, 5198.70 N; 615.80 E, 5198.45 N; 615.91 E, 5198.00 N	T.140N R.101W SEC 19, N/SW,N 18 SE
Stephanomeria runcinata Desert wirelettuce	North	019	621.41 E, 5274.04 N; 621.75 E, 5274.17 N; 622.03 E, 5274.10 N	T.148N R.100W SEC 26 NE
	South	002	614.53 E, 5199.40 N; 615.03 E, 5198.72 N	T.140N R.102W SEC 13 NW/SE, SW/SE
		004	615.99 E, 5202.82 N	T.140N R.101W SEC 6 NE/SW
		007	617.77 E, 5204.12 N; 618.31 E, 5204.42 N	T.141N R.101W SEC 35 NW/SE, SW/SW
		008	611.08 E, 5200.73 N; 611.36 E, 5200.64 N	T.140N R.102W SEC 10 SE/SW, NW/SW
		009	614.29 E, 5204.54 N; 614.19 E, 5204.05 N	T.141N R.101W SEC 32 SE/SE
		010	613.42 E, 5197.53 N; 614.25 E, 5197.49 N; 614.95 E, 5197.07 N; 615.37 E, 5197.18 N	T.140N R.102 W SEC 23 NW/SE, 24 S/SE, NW/SW
		011	621.61 E, 5201.50 N	T.140N R.101W SEC 10 SE/NE
		013	616.84 E, 5201.04 N; 616.43 E, 5200.87 N; 616.93 E, 5200.48 N	T.140N R.101W SEC 7 NW/SE, 19 NW/SE, 20 NW/NW
		014	606.75 E, 5204.77 N	T.141N R.102W SEC 34 SE/NW
		015	611.87 E, 5204.27 N	T.141N R.101W SEC 31 NE/SW
		016	610.42 E, 5199.50 N	T.140N R.102W SEC 16 SE/NE
		021	614.72 E, 5201.77 N; 615.12 E, 5201.36 N; 615.16 E, 5200.93 N	T.140N R.102W SEC 12 NE
		022	615.77E, 5204.77N	T.141N R.101W SEC 33 SE/NE
Verbesina encelioides Golden crownbeard	South	001	620.23 E, 5196.10 N	T.140N R.101W SEC 28 NE/SE

Appendix 5. Summary of Theodore Roosevelt National Park Rare Plant Occurences

Scientific Name	Global Rank	Original State Rank	Current State Rank	Total No. of Pops.
Chenopodium subglabrum	G?	SH	S1	5
Coryphantha missouriensis	G5	SU	S3	25
Dalea enneandra	G5	S2S3	S2S3	2
Euphorbia robusta	G?	-	S1	1
Hordeum pusillum	G5	SU	SU	10
Oenothera laciniata	G5	SA?	SA?	1
Orobanche multiflora	G?	-	S1	1
Oxytropis sericea	G5	S1	S1	1
Physaria brassicoides	G5	S2S3	S3	19
Populus x acuminata	Hybrid	S1	S3	1
Sitanion hystrix	G5	S4	S4	20
Sporobolus airoides	G5	S2	S2	3
Stephanomeria runcinata	G5	SU	S3S4	14
Verbesina encelioides	G5	-	SA?	1

Appendix 6. Background Information On Select Target Species

The following information is provided for reference on the twelve high-likelihood target species that were not found in the course of project work.

All of these species occur within a twenty-five mile radius of TRNP boundaries, and occupy habitat that may be represented in the Park. The two species of federal concern, *Eriogonum visheri* and *Rorippa calycina*, are included for reference, though their habitat specificity in the state has not been delimited. Two other species are considered to have a high probability of occurring in the Park but were not found despite repeated efforts. These two include:

- *Ambrosia acanthicarpa* - collected on the Little Missouri River near Medora in 1911 (Bergman sn. NDA) and south of Watford City on the Little Missouri River in 1938 (Stevens sn. NDA), both before Park establishment.
- *Oxytropis sericea* - collected on prairie east of Wind Canyon in the South Unit in 1958 (Dix #12958 TRNP); the specimen is insuffcient for verification with complete certainty.

Information included for each species includes taxonomic nomenclature, current state and global rank, description (taken from the ***Flora of the Great Plains*** unless otherwise stated), phenology, habitat and distribution.

Ambrosia acanthicarpa Hook.

Common Name: Bursage
Family: Asteraceae
Status: G5 SHSA?
Description: Branching annual, 2-10 dm tall, long pubescent to hispid. Leaves opposite below to alternate above; blade variable, broadly ovate to lanceolate,2-8 cm long, lobed to pinnatifid, upper surface sometimes white-pubescent. Staminate inflorescence racemiform; pistillate heads in clusters below the staminate inflorescence, involucre 5-10 mm long and up to 14 mm across, 1-flowered, with several series of flattened or pointed spines.
Flowering Time: July-September
Habitat Description: Open, sandy sites, river sandbars. Its collection near a Fargo railroad switchyard in 1935 indicates that it can act as an adventive species in at least the eastern part of the state, but this does not match its habitat patterns in western North Dakota.
Distribution: Western portion of the Great Plains, occasionally adventive eastward. Collected from sandbar near Medora in 1911, from McKenzie County in 1938, from Benson County in 1911 and from Cass County in 1935.

Astragalus aboriginum Richards.

Common Name: Indian milkvetch
Family: Fabaceae
Status: G5 S2S3
Description: Perennial with a woody taproot and branching caudex, stems 0.5-3 dm tall, erect or decumbent, sparsely to densely strigose or villous, all hairs basifixed. Leaves alternate, odd-pinnate. Flowers whitish with a purple keel, calyx 4-8 mm long, black-hairy, banner 8-12 mm long, wings 7-12 mm long bidentate at apex. Fruit 3-8 mm long, pendulous, stipitate, laterally compressed.
Flowering Time: May-July
Habitat Description: Steep rocky hillsides, river bluffs.
Distribution: Western parts of the Great Plains. Collected from Billings, Grant and Morton Counties in North Dakota.

Berberis repens Lindl.

Common Name: Creeping barberry
Family: Berberidaceae
Status: G5 S2
Description: Low or prostrate shrub. Leaves odd-pinate, borne mostly near the branch tips. Leaflets 3-7, 6-30 cm long, ovate to orbicular, green or glaucous, serrate, serrations spinulose-tipped. Racemes axillary among the upper leaves, 3-6 cm long, bracts ovate, 2-4 mm long. Sepals and petals 6 each, yellow, petals about 6 mm long. Berries blue-black, borne in grapelike clusters.
Flowering Time: May-June
Habitat Description: North Dakota habitat does not resemble the habitat characterization by the Great Plains Flora Association (1986) of sandy, chalky or granitic soil in conifer forest. In North Dakota it was found to grow in Pierre shale at the edge of Rocky Mountain juniper woodland, and below green ash in a woody draw.
Distribution: Rocky Mountain distribution, from British Columbia to California and west Texas. Recently collected in Billings and Bowman Counties in North Dakota.

Boisduvalia glabella (Nutt.) Walp.

Common Name: Smooth-spike primrose
Family: Onagraceae
Status: G5 S1S2
Description: Annual herbs; stems decumbent, rooting at the nodes, usually branched from the base, 1-3 dm tall, glabrous below, fine white hairs above. Lowest leaves opposite, the rest alternate, subsessile, somewhat crowded, lanceolate, 8-20 mm long, 3-6 mm wide, sparsely denticulate. Inflorescence erect, each flower borne in axil of a bract which appears as reduced upper foliage leaves. Floral tube 0.3-1 mm long, bilobed about 1/3 length. Capsule about 7 mm long, usually hidden by subtending bract, 8-14 brownish seed per locule.
Flowering Time: June-July
Habitat Description: Creek sides, dry stream bed and small ponds that dry by flowering time.
Distribution: Throughout the Great Plains. Collected from Billings and Hettinger counties in North Dakota.

Chaenactis douglasii (Hook.) H. & A.

Common Name: Douglas' dusty maiden
Status: G5 SU
Description: Low, slender taprooted annual, 5-15 cm tall. Stems freely branching upward, strigose to hispid-pubescent. Leaves alternate, linear, mostly 5-10 mm long, lower ones sometimes longer. Heads solitary at ends of upper branches; involucre 3.5-4.5 mm tall, 2-3 mm wide; involucral bracts inbricate; receptacle flat, naked; ray florets 5-13, pistillate and fertile, ligule white or pinkish, 2-4 mm long; disk florets few, corolla yellow. Achenes prismatic, 5-nerved, 1.6-2 mm long, pubescent; pappus of 5 short hyaline scales alternating with 5 long slender awns, 1-3 mm long.
Flowering Time: June
Habitat Description: Rocky butte crests
Distribution: Northwestern Great Plains. Collected in Billings and Golden Valley counties in North Dakota. The source of the Billings County collection is unknown.

Eriogonum visheri A. Nels.

Common Name: Visher's buckwheat
Family: Polygonaceae
Status: G3 S2S3 This species is a Federal Category 2 species
Description: Annual, much-branched herb, from a slender taproot. Single stem 15-25 cm tall. Leaves in a basal rosette, the blades ovate to reniform, 15-20 mm long, the petioles sometimes longer than the blades. Bracts of the inflorescence elliptic; involucres turbinate, sessile and slender'pedunculate, erect. Flowers 1-few / involucre, yellow; perianth members narrowly oblong, 1-1.5 mm long. Achene ovoid-acuminate.
Flowering Time: June-July
Habitat Description: Dry, sparsely-vegetated Badlands slopes.
Distribution: Restricted to western South Dakota and southwestern North Dakota. Collected in North Dakota from Golden Valley, Grant and Sioux Counties; possibly also in Mountrail County.

Fritillaria pudica (Pursh) Spreng.

Common Name: Yellow fritillary
Family: Liliaceae
Status: G5 SH
Description: Plants 7-16 cm tall, from a thick scaly bulb. Leaves 2-4, linear to lanceolate, alternate or appearing whorled, 4-10 cm long, 3-7 mm wide. Flowers solitary, pendent, narrowly campanulate, yellow to orange, turning red with age, perianth segments oblong, 10-18 mm long; style single.
Flowering Time: May-June
Habitat Description: Prairie slopes.
Distribution: Northwestern Great Plains. Collected in North Dakota in the 1930's from Billings and Morton Counties.

Oxytropis sericea Nutt.

Common Name: White Locoweed
Family: Fabaceae
Status: G5 S1
Description: Cespitose perennial herbs with stout taproot and branched caudex, silky-pilose throughout with basifixed hairs. (White flowered forms of *O. lambertii* possess dolabriform hairs.) Leaves 4-30 cm long, leaflets 11-19, opposite or scattered, 1-3 cm long; racemes with 10-30 flowers. Calyx tube tubular 8-12 mm long, with white and black hairs; petals white, ochroleucous, fading yellowish, keel often with purple tip; banner and wings both 15-20 mm long, keel 12-17 mm long. Pods erect, sessile, 1-2.5 cm long.
Flowering Time: May-June
Habitat Description: Prairie
Distribution: Western Great Plains. Collected in Benson, Billings and Slope Counties in North Dakota.

Potamogeton amplifolius Tuckerm.

Common Name: Large-leaved pondweed
Family: Potamogetonaceae
Status: G5 S2S3
Description: Perennial rhizomatous aquatic. Stems terete, 2-4 mm thick, to 1 m long. Upper submersed leaves broadly lanceolate to avate, falcately folded, 8-20 cm. long, 2-7 cm wide, 25-50 nerved. Floating leaves usually present at flowering time, ovate to elliptic, 5-10 cm long, 3-7 cm wide; petioles 5-15 cm long. Stipules open and free of the petiole, persistent. Spikes cylindrical, dense, 4-8 cm long in fruit. Fruits greenish-brown, 4-5 mm long, dorsal keel prominent, beak to 1 mm long.
Flowering Time: June-August
Habitat Description: Quiet water of stream and lakes.
Distribution: Northern United States and southern Canada. Collected in Barnes, Billings, Grand Forks, McHenry and Oliver Counties in North Dakota.

Potentilla tridentata Ait.

Common Name: Three-toothed cinquefoil
Family: Rosaceae
Status: G5 S1
Description: Perennial with spreading subterranean stems to 10 cm long and erect branches 0.5-3 dm tall which are woody at base and herbaceous above, terminating in an inflorescence; flowering stem strigose. Leaves palmate, with 3 firm, oblong-oblanceolate leaflets, 1-2.5 cm long, 3-toothed at apex, bright green on both surfaces. Inflorescence an open, flattened, rather stiff cyme. Petals white, 6.5-7.5 mm long; carpels numerous, ovary villous, style subbasal. Achenes 0.9-1.2 mm long, surface with white hairs at least at the base.
Flowering Time: June-August
Habitat Description: Scoria hilltop, mixed grass prairie.
Distribution: Northeastern United States. Collected recently in Billings and Cavalier Counties in North Dakota.

Rorripa calycina (Engelm.) Rydb.

Common Name: Hayden's rockcress
Family: Brassicaceae
Status: G3 SH
Description: Perennial from slender rhizomes, forming large clones. Stems few to numerous, decumbent to prostrate, 1-4 dm long, moderately to densely hirsute with slender trichomes expanded at the base and pointed at the apex. Middle cauline leaves sessile, auriculate and clasping, oblong to oblanceolate, 2.5-5 cm long, 0.5-1 cm wide. Shallow to strongly sinuate, hirsute above and below, especially on midrib, the apex acute to obtuse. Racemes terminal and axillary, 0.5-1.5 cm long, or lateral. Siliques globose to subglobose, 2.3-3.4 mm long, 1.1-2.3 m wide, 1.3-2 times longer than wide. Fruiting pedicels 3.5-6.5 mm long, glabrous to sparingly hirsute, 1.5-2 x longer than the siliques, strongly recurved, often in the same direction and giving the siliques the appearance of being borne unilaterally.
Flowering Time: May - July
Habitat Description: Moist sandy soil along riverbanks
Distribution: Restricted to Wyoming, Montana and North Dakota. The only record in North Dakota is an 1858 collection from the mouth of the Yellowstone River in what is now McKenzie County.

Stephanomeria tenuifolia (Torr.) Hall.

Common Name: Narrow-leaved wirelettuce
Family: Asteraceae
Status: G5 SU
Description: Perennial 2-5 dm tall, arising from an apparently deep, creeping root system, herbage glabrous to puberulent. Leaves linear to filiform, up to 8 cm long and rarely more than 3 mm wide, entire or sparingly toothed; uppermost leaves reduced and bractlike. Heads terminating the branches; involucre 7-11 mm tall; florets mostly 5, all ligulate, corolla pink. Achenes 4-6 mm tall, longitudinally ribbed; pappus white, plumose to near the base. See the report text for status of Stephanomeria runcinata for the discussion on possible taxonomic confusion between the two as applied to North Dakota collections.
Flowering Time: July
Habitat Description: Rocky barren or clay hillsides.
Distribution: Eastern Cascades to northwestern Great Plains. Collected in Billings and Slope Counties in North Dakota.

Appendix 7. Preliminary Vascular Flora of Theodore Roosevelt National Park

Family/Scientific Name[1]	Common Name[2]	Unit[3]	Phenology[4]	Habitat[5]	Source[6]
Aceraceae					
Acer negundo	Box elder	N,S	May	PDJS	TRNP
Alismaceae					
Alisma gramineum	Water plaintain	N	July	MARSH	TRNP
Sagittaria cuneata	Arrowhead	N	July	MARSH	TRNP
Amaranthaceae					
Amaranthus albus	Tumbleweed	S	June-Aug	MAN, BAD	TRNP
Anacardiaceae					
Rhus trilobata	Skunkbush, Fragrant sumac	N,S	May	HRD,SCORIA	TRNP
Toxicodendron rydbergii	Poison ivy	N,S	May	HRD	TRNP
Apiaceae					
Cicuta maculata	Water hemlock				O
Cymopterus acaulis	Cymopteris	N	May	PRAIRIE	TRNP
Lomatium foeniculaceum	Wild parsley	N,S	May	PRAIRIE	TRNP
Lomatium orientale	Wild parsley	N,S	May	PRAIRIE	TRNP
Musineon divaricatum	Wild parsley	N,S	May	PRAIRIE,AC	TRNP
Osmorhiza longistylis	Sweet cicely	N	May	HRD	TRNP
Sanicula marilandica	Black snakeroot	N,S	May	HRD	TRNP
Apocynaceae					
Apocynum androsaemifolium	Spreading dogbane	N,S	June	ASSV,BRUSH	TRNP
Apocynum cannibinum	Indian hemp dogbane	S	June-July		TRNP
Araliaceae					
Aralia nudicaulis	Wild sasparilla	N,S	May	HRD,PTBO	TRNP
Asclepiaceae					
Asclepias lanuginosa	Wooly milkweed	S	June	SCBG,SCOR	UND
Asclepias speciosa	Showy milkweed	N,S	June	EDGE	TRNP
Asclepias verticillata	Whorled milkweed	N,S	July	GRSS	TRNP
Asclepias viridiflora	Green milkweed	N,S	June	EDGE,ASSC	TRNP

Family/Scientific Name[1]	Common Name[2]	Unit[3]	Phenology[4]	Habitat[5]	Source[6]
Asteraceae					
Achillea millefolium	Yarrow	N,S	May	ASSC,SCBG,AR	TRNP
Agoseris glauca	False dandelion	S	May	PRAIRIE	TRNP
Ambrosia psilostachya	Western				
Ambrosia trifida	Giant ragweed	N,S	July	EDGE,HRD	TRNP
Antennaria microphylla	Pink pussytoes	N,S	May	AS	TRNP
Antennaria neglecta	Field pussytoes	S			O
Antennaria neodioica	Northern pussytoes	S			UND
Antennaria parlinii	Plainleaf pussytoes	S		PRAIRIE	TRNP
Arctium minus	Burdock	N	Aug	SEEP	O
Arnica fulgens	Arnica	N,S	May	ASSV	TRNP
Artemisia campestris	Western sage	S	Aug	SCORIA,SCBG	O
Artemisia cana	Silver sage	N,S	Aug	AC, ATAC	TRNP
Artemisia dracunculus	Silky wormwood	S	Aug	PRAIRIE	TRNP
Artemisia frigida	Fringed sage	N,S	Aug	ASSC,SCBG	TRNP
Artemisia longifolia	Long-leaved sage	N,S	Aug	BAD	TRNP
Artemisia ludoviciana	White sage	N,S	Aug	BAD, AC	TRNP
Artemisia tridentata	Big sagebrush	N,S	Aug	ATAC, ATBG	TRNP
Artemsia biennis	Wormwood	S	Aug	RIVER	TRNP
Aster ericoides	White aster	N,S	July-Aug	RIVER, GRSS	TRNP
Aster falcatus	Aster	S			O
Aster hesperius	Panicled aster	S			O
Aster laevis	Smooth blue aster	S			O
Aster oblongifolius	Aromatic aster	N,S	July-Aug	PRAIRIE	TRNP
Aster simplex	Panicled aster	N,S	July-Aug	PRAIRIE	TRNP
Bidens frondosa	Beggarsticks				TRNP
Centaurea maculosa	Spotted knapweed	S	July		TRNP
Centaurea repens	Russian knapweed	S	June-July	GRSS,BRUSH	TRNP
Chrysopsis villosa	Golden aster	N,S	June-Aug	SCBG,RIVER	TRNP
Chrysothamnus nauseosus	Rabbitbrush	N,S	Aug-Sept	BAD	TRNP
Cirsium arvense	Canada thistle	N,S	June-July	MARSH,PDT,MAN	TRNP
Cirsium flodmanii	Flodman's thistle	N	June-July	PRAIRIE	TRNP
Cirsium undulatum	Prairie thistle	S		PRAIRIE	TRNP
Conyza canadensis	Horseweed	N,S	July-Aug	RIVER	TRNP
Conyza ramosissima	Spreading horseweed	S			O
Crepis occidentalis	Hawk's beard	N	June	AGSC	TRNP
Crepis runcinata	Hawk's beard	S	June	SEEP	TRNP
Dyssodia papposa	Fetid marigold	N,S	June	PDT,EDGE	TRNP
Echinacea angustifolia	Purple coneflower	N,S	July	SCBG,AS,ASSC	TRNP

Family/Scientific Name[1]	Common Name[2]	Unit[3]	Phenology[4]	Habitat[5]	Source[6]
Asteraceae (Cont'd)					
Erigeron glabellus	Smooth fleabane	N,S	June	PTBO,ASSV,JSOM	TRNP
Erigeron philadelphicus	Philadelphia fleabane	N,S	July	SCORIA	TRNP
Erigeron pumilus	Fleabane	N,S	May-June	BAD,SCBG	TRNP
Erigeron strigosus	Daisy fleabane	N,S	July	ASSV	TRNP
Gaillardia aristata	Gaillardia	N,S	June	PRAIRIE	TRNP
Grindelia squarrosa	Gumweed	N,S	Aug	EDGE,MAN,AR,PDT	TRNP
Gutierrezia sarothrae	Broom snakeweed	N,S	Aug	BAD,SCBG	TRNP
Haplopappus armerioides	Goldenweed	N	May	BAD	TRNP
Haplopappus lanceolatus	Goldenweed	S	July	PRAIRIE	TRNP
Haplopappus spinulosus	Cutleaf ironplant	N,S	July	PRAIRIE	TRNP
Heliahthus maximilianii	Maximilian's sunflower	N,S	July	PRAIRIE	TRNP
Helianthus annuus	Common sunflower	S	July-Aug	EDGE,MAN	TRNP
Helianthus petiolaris	Plains sunflower	N,S	June	RIVER, PRAIRIE	TRNP
Helianthus rigidus	Stiff-leaved sunflower	N,S	July	EDGE	TRNP
Hymenopappus filifolius	Hymenopappus	N,S	June	BAD	TRNP
Hymenoxys acaulis	Stemless hymenoxys	N,S	June	AS,SCORIA	TRNP
Hymenoxys richardsonii	Colorado rubberplant	N,S	June	PRAIRIE	TRNP
Iva axillaris	Poverty weed	N,S	May	BAD	TRNP
Iva xanthifolia	Marsh elder	S			TRNP
Kuhnia eupatorioides	False boneset	N,S	July	SCORIA	TRNP
Lactuca lucoviciana	Western lettuce	S			TRNP
Lactuca oblongifolia	Blue lettuce	N,S	June	PRAIRIE	TRNP
Lactuca serriola	Prickly lettuce	N	July	MARSH	TRNP
Liatris punctata	Blazing star	N,S	Aug	PRAIRIE	TRNP
Lygodesmia juncea	Skeletonweed	N,S	July	PRAIRIE	TRNP
Machaeranthera canescens	Hoary aster	S	July-Aug	PRAIRIE	TRNP
Machaeranthera grindelliodes	Goldenweed	S			UND
Microseris cuspidata	Microseris	N	May	PRAIRIE	TRNP
Picradeniopsis oppositifolia	Picradeniopsis	S			TRNP
Ratibida columnifera	Long-headed coneflower	N,S	June	EDGE	TRNP
Rudbeckia serotina	Black-eyed susan	S			UND
Senecio canus	Gray ragwort	N,S	June	PRAIRIE,SCORIA	TRNP
Senecio intergerrimus	Ragwort	N	June	PRAIRIE	TRNP
Senecio plattensis	Prairie ragwort	S	May-June	PRAIRIE	TRNP
Solidago canadensis	Canada goldenrod	S			TRNP
Solidago gigantea	Smooth goldenrod	N	July	EDGE	TRNP
Solidago missouriensis	Early goldenrod	N,S	July	PRAIRIE,MARSH	TRNP

Family/Scientific Name[1]	Common Name[2]	Unit[3]	Phenology[4]	Habitat[5]	Source[6]
Asteraceae (Cont'd)					
Solidago mollis	Soft goldenrod	N,S	Aug	PRAIRIE	TRNP
Solidago nemoralis	Gray goldenrod	N,S	Aug	PRAIRIE	TRNP
Solidago ptarmicoides	Sneezewort aster	N,S	Aug	PRAIRIE	TRNP
Solidago rigida	Stiff goldenrod	N	Aug	PRAIRIE	TRNP
Sonchus arvensis	Sow thistle	N,S	July	RIVER	TRNP
Stephanomeria runcinata	Desert wirelettuce	N,S	July	BAD,SCORIA	TRNP
Taraxacum officinale	Dandelion	N,S	May	EDGE	O
Thelesperma subnudum	Greenthread				O
Townsendia exscapa	Easter daisy	S	May-June		O
Tragopogon dubius	Goatsbeard, Salsify	N,S	May	EDGE	TRNP
Verbesina encelioides	Golden crownbeard	S	July-Aug	PDT	TRNP
Xanthium strumarium	Cocklebur	N,S	Aug	RIVER,EDGE	TRNP
Betulaceae					
Betula occidentalis	River birch	N,S	May	PTBO	TRNP
Betula papyrifera	Paper birch	N	May	PTBO	O
Corylus cornuta	Beaked hazel	N	May	PTBO	O
Boraginaceae					
Asperugo procumbens	Catchweed	S	June	MAN	TRNP
Cryptantha celosioides	Butte candle	N,S	May-June	BAD	TRNP
Hackelia deflexa	Wood stickweed	N	July	SEEP	TRNP
Hackelia floribunda	Large-flowered stickseed	S			TRNP
Lappula echinata	Blue stickseed	N,S	June	ASSV,AC,PDT	TRNP
Lappula redowski	Redowski's stickseed	S	June	BAD	TRNP
Lappula texana	Stickseed	S	June	ASSC	TRNP
Lithospermum cancescens	Hoary puccoon	S	May		TRNP
Lithospermum incisum	Narrow-leaved puccoon	N,S	May		TRNP
Mertensia lanceolata	Bluebells	N,S	May		TRNP
Brassicaceae					
Arabis divaricarpa	Rock cress	N	May	PRAIRIE	TRNP
Arabis hirsuta	Rock cress				TRNP
Arabis holboellii	Rock cress	N,S	May	PDJS,	TRNP
Camelina microcarpa	False flax	N,S	June	SCBG,RIVER	TRNP
Capsella bursa-pastoris	Shepherd's purse	N	May	EDGE	TRNP
Chorispora tenella	Blue mustard	N	June	RIVER	TRNP

Family/Scientific Name[1]	Common Name[2]	Unit[3]	Phenology[4]	Habitat[5]	Source[6]
Brassicaceae (Cont'd)					
Conringia orientalis	Hare's-ear mustard	N	June	SCORIA,AC	TRNP
Descurainia pinnata	Tansy mustard	S	June-July	RIVER	TRNP
Descurainia sophia	Flixweed	N,S	May	PDJS	TRNP
Draba nemorosa	White whitlowwort	N,S	May	PRAIRIE	TRNP
Draba reptans	Whitlowwort	N,S	May	PDT	TRNP
Erysimum asperum	Western wallflower	N,S	May	PRAIRIE	TRNP
Erysimum cheiranthoides	Wormseed wallflower	N,S	July	SCORIA	TRNP
Erysimum inconspicuum	Smallflower wallflower	S			UND
Lepidium densiflorum	Peppergrass	N,S	May	EDGE	TRNP
Lepidium perfoliatum	Heart-leaved peppergrass	N,S	May	EDGE,INT	TRNP
Lesquerella alpina	Bladderpod	N,S	May-June	SCORIA,SCBG,BAD	TRNP
Lesquerella arenosa	Bladderpod	S			O
Lesquerella ludovidiana	Bladderpod	N,S	May	BAD	TRNP
Physaria brassicoides	Mustard twinpod	S	May	SCBG,BAD	TRNP
Rorippa palustris	Yellow rocket	N	June	MARSH	TRNP
Sisymbrium altissumum	Tumbling mustard	N,S	May-June	RIVER,MAN	TRNP
Stanleya pinnata	Prince's plume	S	June	BAD	TRNP
Thlaspi arvense	Pennycress	N,S	May	PDT,RIVER,COT	TRNP
Cactaceae					
Coryphantha missouriensis	Missouri ballcactus	N,S	May	ASSV,ASSC	TRNP
Coryphantha vivipara	Common ballcactus	N,S	June	ASSC	TRNP
Opuntia fragilis	Small prickly pear	N,S	June	ASSV,ATAC	O
Opuntia polyacantha	Prickly pear	N,S	June	ASSV,ATAC	TRNP
Callitrichaceae					
Callitriche hermaphroditica	Water starwort	N	June	MARSH	TRNP
Campanulaceae					
Campanula rotundifolia	Harebell	N,S	July	BAD,SCBG	TRNP
Triodanis leptocarpa	Venus' looking glass	S	June	ASSV	TRNP
Capparaceae					
Polanisia dodecandra	Clammyweed	N,S	June	SCORIA	TRNP

Family/Scientific Name[1]	Common Name[2]	Unit[3]	Phenology[4]	Habitat[5]	Source[6]
Caprifoliaceae					
Symphoricarpos albus	Snowberry	N	July	PDBO	O
Symphoricarpos occidentalis	Buckbrush	N,S	July	BRUSH,HRD,PD	TRNP
Viburnum lentago	Nannyberry	N			O
Caryophyllaceae					
Alyssum dessortum	Alyssum	N	May	BAD	TRNP
Arenaria lateriflora	Sandwort	N,S	May-June	PTBO,HRD	TRNP
Cerastium arvensee	Prairie chickweed	N,S	May	HRD	TRNP
Cerastium nutans	Nodding chickweed	S			TRNP
Paronychia sessiliflora	Whitlowwort	S	June-July	AC,SCORIA	TRNP
Silene antirrhina	Sleepy catchfly	S	June	ASSV	TRNP
Silene cserei	Smooth catchfly	N	July	RIVER	O
Silene pratensis	White campion	N,S	June	EDGE	TRNP
Celastraceae					
Celastrus scandens	Bittersweet	N,S	June	HRD	TRNP
Chenopodiaceae					
Atriplex argentea	Silverscale	N,S	July	ATAC	TRNP
Atriplex canescens	Four-wing saltbush	S	June	BAD	TRNP
Atriplex confertifolia	Spiny saltbush	S		BAD	TRNP
Atriplex dioica	Rillscale	N,S	June	BAD	TRNP
Atriplex nuttallii	Saltbush	N,S	June	BAD	UND
Atriplex subspicata	Spearscale	S			O
Ceratoides lanata	Winterfat	N,S	May	BAD,ASSC	TRNP
Chenopodium album	Lamb's quarters	S	July	SCORIA	TRNP
Chenopodium berlandieri	Lamb's quarters	N,S	July	PRAIRIE	O
Chenopodium fremontii	Goosefoot	S	July	RIVER,SCORIA	TRNP
Chenopodium gigantospermum	Maple-leaved goosefoot	N	June	MARSH	TRNP
Chenopodium glaucum	Oak-leaved goosefoot	S	July	SEEP	TRNP
Chenopodium leptophyllum	Narrow-leaved goosefoot	S	July	RIVER,SCORIA	TRNP
Chenopodium praetoricola	Goosefoot	S	July	SCORIA	TRNP
Chenopodium subglabrum	Smooth goosefoot	S	June-July	RIVER	TRNP
Kochia scoparia	Burning bush	N,S	June	RIVER,ASSV	TRNP
Monolepis nuttalliana	Poverty weed	N,S	June	BAD	TRNP

Family/Scientific Name[1]	Common Name[2]	Unit[3]	Phenology[4]	Habitat[5]	Source[6]
Chenopodiaceae (Cont'd)					
Salsola kali	Russian thistle	N,S	June	BAD	TRNP
Sarcobatus vermiculatus	Greasewood	N,S	June	BAD,ATAC	TRNP
Suaeda depressa	Sea blite	S	July	BAD	UND
Suaeda moquinii	Seepweed	S	June	BAD, RIVER	TRNP
Commelinaceae					
Tradescantia bracteata	Spiderwort	N,S	June	AC	TRNP
Convoluvaceae					
Calystegia sepium	Hedge bindweed	N	July	EDGE	TRNP
Convoluvus arvensis	Field bindweed	N,S	July	PDT,EDGE	TRNP
Cornaceae					
Cornus stolonifera	Red osier dogwood	N,S	May	PTBO	TRNP
Cuscutaceae					
Cuscuta gronovii	Gronovius' dodder	N	July	COT	TRNP
Cuscuta pentagona	Field dodder	S	July	RIVER	TRNP
Cyperaceae					
Carex atherodes	Sedge	N,S	June	MARSH	TRNP
Carex brevior	Sedge	N,S	June	RIVER,ASSC	TRNP
Carex cristatella	Sedge	S	July	ASSC	TRNP
Carex eburnea	Sedge	S	June	JSOM	TRNP
Carex eleocharis	Sedge	N,S	May	PRAIRIE	TRNP
Carex emoryi	Sedge	N	June	MARSH	TRNP
Carex filifolia	Needle-leaved sedge	N,S	May	PRAIRIE	TRNP
Carex gravida	Sedge	N,S	June	MARSH,HRD	TRNP
Carex hallii	Sedge	S	July	SEEP	TRNP
Carex heliophila	Sedge	N,S	May	PRAIRIE	TRNP
Carex lanuginosa	Sedge	S	June	SEEP	TRNP
Carex saximontana	Sedge	N			O
Carex sprengelii	Sedge	N	May-June	PTBO,HRD	TRNP
Carex stricta	Sedge	N	May	MARSH	TRNP
Carex torreyi	Sedge	N	June	PRAIRIE	TRNP
Carex vulpinoidea	Sedge				TRNP
Eleocharis acicularis	Spikerush	N	July	MARSH	TRNP

Family/Scientific Name[1]	Common Name[2]	Unit[3]	Phenology[4]	Habitat[5]	Source[6]
Cyperaceae (Cont'd)					
Eleocharis compressa	Spikerush	S	June	SEEP	TRNP
Eleocharis erythopoda	Spikerush	N	July	RIVER	TRNP
Scirpus acutus	Hardstem bulrush				TRNP
Scirpus atrovirens	Bulrush	S	July	SEEP	TRNP
Scirpus fluviatilis	Softstem bulrush	N	June	MARSH	TRNP
Scirpus maritimus	Prairie bulrush	S	June	SEEP	TRNP
Scirpus pungens	Chairmakers bulrush	N	June	SEEP	TRNP
Scirpus torreyi	Bulrush	S	July	SEEP	TRNP
Scirpus validus	Common bulrush	N	July	MARSH	TRNP
Elaeagnaceae					
Elaeagnus angustifolia	Russian olive	S			TRNP
Elaeagnus commutata	Silverberry				TRNP
Shepherdia argentea	Buffaloberry	N,S		PRAIRIE,SCORIA	TRNP
Equisetaceae					
Equisetum arvense	Field horsetail	N,S	June	RIVER	TRNP
Equisetum laevigatum	Horsetail	N,S	June	RIVER	TRNP
Ericaceae					
Arctostaphylos uva-ursi	Bearberry	N,S	May	PTBO	TRNP
Euphorbiaceae					
Euphobia missuricaa	Missouri spurge	N,S	June	BAD,AC	TRNP
Euphorbia esula	Leafy spurge	N,S	June-July		TRNP
Euphorbia glyptosperma	Ridge-seeded spurge				TRNP
Euphorbia robusta	Shrubby spurge	S	June	BAD	TRNP
Euphorbia serpens	Round-leaved spurge	N,S	June	BAD	TRNP
Euphorbia serpyllifolia	Thyme-leaved spurge				TRNP
Euphorbia x pseudovirgata	Hybrid leafy spurge	N	June-July		O
Euphrobia spathulata	Spurge	N,S	May-June	ASSV	TRNP

Family/Scientific Name[1]	Common Name[2]	Unit[3]	Phenology[4]	Habitat[5]	Source[6]
Fabaceae					
Astragalus pectinatus	Tine-leaved milkvetch	N,S	May	PRAIRIE	TRNP
Astragalus tenelllus	Pulse milkvetch	N,S	June	AS,BAD	TRNP
Astragalus adsurgens	Standing milkvetch	N,S	May-June	AS	TRNP
Astragalus agrestis	Field milkvetch	N,S	June	ASJH	TRNP
Astragalus bisulcatus	Two-grooved milkvetch	N,S	June	PRAIRIE	TRNP
Astragalus ceramicus	Painted milkvetch				TRNP
Astragalus crassicarpus	Ground plum	N,S	May-June	ASJH	TRNP
Astragalus flexuosus	Pliant milkvetch	N,S	June	AS	TRNP
Astragalus gilviflorus	Plains orophaca	N,S	May	PRAIRIE	TRNP
Astragalus lotiflorus	Lotus milkvetch	S		RIVER	TRNP
Astragalus missouriensis	Missouri milkvetch	S			TRNP
Astragalus purshii	Pursh' milkvetch	N	May	PRAIRIE	TRNP
Astragalus racemosus	Alkali milkvetch	N	June	EDGE	TRNP
Astragalus spatulatus	Draba milkvetch	S	May-June	SCBG	TRNP
Dalea candida	White prairie clover	N,S	June-July	AS,BAD	TRNP
Dalea enneandrea	Nine-anthered dalea	S	July	AS	TRNP
Dalea purpurea	Purple prairie clover	N,S	July	PRAIRIE	TRNP
Glycyrrhiza lepidota	Wild licorice	N,S	June	MARSH,PDJS	TRNP
Hedysarum boreale	Sweet vetch	N,S	June	RIVER,ASSC	TRNP
Lotus purshianus	Prairie trefoil	N,S	June	EDGE,HRD	TRNP
Lupinus argenteus	Silvery milkvetch	N,S	June	AC	TRNP
Lupinus pusillus	Small lupine	S	June-July	BAD	TRNP
Medicago lupulina	Black medick	N,S	July	EDGE	TRNP
Medicago sativa	Alfalfa	N,S	July	MAN,INTR	TRNP
Melilotus alba	White sweet clover	N,S	June		TRNP
Melilotus officinalis	Yellow sweet clover	N,S	June	RIVER	TRNP
Oxytropis gracilis	Slender locoweed	N,S	May-June	PRAIRIE	TRNP
Oxytropis lambertii	Purple locoweed	N,S	May-June	PRAIRIE,JSOM	TRNP
Oxytropis sericea	White locoweed	S	May	PRAIRIE	TRNP
Psoralea argophylla	Silver leaf	N,S	June	PRAIRIE	TRNP
Psoralea exculenta	Indian breadroot, Tipsin	N,S	June	PRAIRIE	TRNP
Psroalea lanceolata	Lemon scurf pea	N,S	June	RIVER,PDJS	TRNP
Themopsis rhombifolia	Golden pea	N,S	May	BAD,SCORIA,PRAIRIE	TRNP
Trifolium repens	White clover	N	June	MAN	TRNP
Vicia americana	American vetch	N,S	May-June	PRAIRIE,JSOM	TRNP
Vicia sativa	Common vetch	N	May	PRAIRIE	TRNP

Family/Scientific Name[1]	Common Name[2]	Unit[3]	Phenology[4]	Habitat[5]	Source[6]
Fagaceae					
Quercus macrocarpa	Bur oak				TRNP
Gentianaceae					
Gentianella affinis	Gentianella	N	Aug	JSOM	TRNP
Geraniaceae					
Geranium carolinianum	Carolina cranesbill	N	June	MARSH	TRNP
Grossulariaceae					
Ribes americanum	Black currant	N,S	May	HRD	TRNP
Ribes odoratum	Golden currant	N,S	May	SCORIA	TRNP
Ribes setosum	Bristly gooseberry	N,S	May	SCORIA,SEEP	TRNP
Haloragaceae					
Myriophyllum exalbescens	Water milfoil	N	July	MARSH	TRNP
Hydropyllaceae					
Phacelia hastata	Scorpion weed	N,S	June	SCORIA	TRNP
Iridaceae					
Sisyrinchium angustifolium	Blue-eyed grass	S			TRNP
Juncaceae					
Juncus balticus	Baltic rush	N,S	May	RIVER	TRNP
Juncus bufonis	Frog rush	N	July	RIVER	TRNP
Juncus effusus	Common rush	N	June	MARSH	TRNP
Juncus interior	Inland rush	N,S	June	HRD	TRNP
Juncaginaceae					
Triglochin maritimum	Arrowgrass	N,S	May	SEEP	TRNP

Family/Scientific Name[1]	Common Name[2]	Unit[3]	Phenology[4]	Habitat[5]	Source[6]
Lamiaceae					
Agastache foeniculum	Lavender hyssop	N	July	HRD	TRNP
Hedeoma drummondii	Drummond's false pennyroyal	N,S	May	SCORIA	TRNP
Hedeoma hispidum	Rough false pennyroyal	N,S	June	PDJS,ASSC	TRNP
Lycopus americanus	American bugleweed	N	July	MARSH	TRNP
Lycopus asper	Rough bugleweed	N	July	MARSH	TRNP
Mentha arvensis	Wild mint	N	July	MARSH	TRNP
Monarda fistulosa	Wild bergamot	N,S	July	BRUSH,PRAIRIE	TRNP
Nepetea cataria	Catnip				TRNP
Salvia reflexa	Lance-leaved sage				TRNP
Teucrinum canadense	Germander	N	July	MARSH	TRNP
Liliaceae					
Allium textile	White wild onion	N,S	May	AC,ASSV	TRNP
Asparagus officinalis	Asparagus	S,N			TRNP
Calochortus nuttallii	Sago lily	N,S	June	AC,ASSV	TRNP
Disporum trachycarpum	Fairybells	N,S	May	PTBO	TRNP
Fritillaria atropurpurea	Leopard lily	N,S	May	PRAIRIE	TRNP
Lilium philadelphicum	Wild lily	N,S	June	PRAIRIE	TRNP
Polygonatum commutatum	Solomon's seal	N,S	June	HRD	TRNP
Smilacina stellata	False Solomon's seal	N,S	May	JSOM,HRD	TRNP
Smilax herbacea	Carrion flower	N,S	June	HRD	TRNP
Yucca glauca	Yucca	N,S	June	PRAIRIE	TRNP
Zigadenus venosus	White camas				O
Linaceae					
Linum perenne	Blue flax	N,S	May	PRAIRIE	TRNP
Linum rigidum	Yellow flax	N,S	May-June	PRAIRIE, RIVER	TRNP
Loasaceae					
Mentzelia decapetala	Evening star	N,S	July	SCORIA	TRNP
Mentzelia dispersa	Stickleaf	S	June-July	SCORIA	TRNP
Malvaceae					
Malva parvifolia	Mallow	N	July	EDGE	TRNP
Sphaeralcea coccinea	Scarlet globemallow	N,S	June	PRAIRIE	TRNP

Family/Scientific Name[1]	Common Name[2]	Unit[3]	Phenology[4]	Habitat[5]	Source[6]
Moraceae					
Humulus lupulus	Hops	N,S	June	HRD	TRNP
Nyctaginaceae					
Mirabilis albida	White four o'clock	S	June-July	SCORIA	TRNP
Mirabilis linearis	Narrowleaf four o'clock	N	July	PDT	TRNP
Mirabilis nyctaginea	Wild four o'clock	N,S	June	RIVER	TRNP
Tripterocalyx micranthus	Sand puffs	N,S	June-July	RIVER	TRNP
Olaceae					
Fraxinus pennsylvanica	Green ash	N,S		HRD,PDJS	TRNP
Onagraceae					
Calylophus serrulatus	Tooth-leaved primrose	N,S	June	AS,RIVER	TRNP
Epilobium ciliatum	Willow herb				TRNP
Epilobium paniculatum	Willow herb	N	July	SEEP	TRNP
Gaura coccinea	Scarlet gaura	N,S	May-June	SCBG	TRNP
Oenother albicaulis	White-stemmed primrose	N,S	June	STBG	TRNP
Oenothera caespitosa	Gumbo lily	N,S	May	BAD	TRNP
Oenothera laciniata	Cut-leaved evening primrose	S	July	RIVER	KU
Oenothera nuttallii	Nuttall's primrose	N,S	July	RIVER,PRAIRIE	TRNP
Oenothera pallida	Pale primrose				TRNP
Oenothera villosa	Common evening primrose	N,S	June-July	RIVER	TRNP
Orobanchaceae					
Orobanche fasciculata	Broomrape	N,S	June	ATAC,BAD	TRNP
Orobanche ludoviciana	Broomrape	N	July	AC	TRNP
Orobanche multiflora	Yellow broomrape	N	July	AC	USD
Oxalidaceae					
Oxalis stricta	Wood sorrel	S,N			TRNP
Pinaceae					
Juniperus communis	Common juniper	S		JSOM	TRNP
Juniperus horizontalis	Creeping juniper	N,S		SCORIA	TRNP
Juniperus scopulorum	Rocky Mountain juniper	N,S		JSOM,PDJS	TRNP
Pinus ponderosa	Ponderosa pine	S		SCORIA	TRNP

Family/Scientific Name[1]	Common Name[2]	Unit[3]	Phenology[4]	Habitat[5]	Source[6]
Plantaginaceae					
Plantago elongata	Slender plantain	N,S	May-June	ASSV	TRNP
Plantago major	Common plantain	N,S	June	MAN,SEEP	TRNP
Plantago patagonica	Buckhorn	N,S	June	PDT,PRAIRIE,AC	TRNP
Poaceae					
Agrohordeum macounii	Agrohordeum	S	June	PRAIRIE	TRNP
Agropyron caninum	Slender wheatgrass	N,S	June	RIVER,ATAC	TRNP
Agropyron cristatum	Crested wheatgrass	N,S		MAN,INTR	TRNP
Agropyron dasystachyum	Thickspike wheatgrass	N	June	SEEP	TRNP
Agropyron repens	Quackgrass				O
Agropyron smithii	Western wheatgrass	N,S	June	ASSC,ASSV	TRNP
Agropyron spicatum	Bluebunch wheatgrass	S	June	SCORIA	TRNP
Agrostis scabra	Ticklegrass	N,S	July	MARSH,WALLOW,RIVER	TRNP
Alopecurus aequalis	Foxtail	N,S	July	RIVER,MARSH	TRNP
Andropogon gerardii	Big bluestem	N,S	Aug	ASSV	TRNP
Andropogon hallii	Sandhills bluestem	S	Aug	SCBG	TRNP
Andropogon scoparius	Little bluestem	N,S	Aug	AS,ASJH	TRNP
Aristida purpurea	Red three-awn	N	June	PRAIRIE	TRNP
Beckmannia syzigachne	Sloughgrass	N	June	MARSH	TRNP
Bouteloua curtipendula	Side-oats grama	N,S	June	AS	TRNP
Bouteloua gracilis	Blue grama	N,S	June	SCBG,ATBG	TRNP
Bromus inermis	Smooth brome	N,S	May	EDGE,MAN	TRNP
Bromus japonicus	Japanese brome	N,S	May	EDGE	TRNP
Bromus tectorum	Downy brome	N,S	June		TRNP
Bromus ciliatus	Fringed brome	N			O
Buchloe dactyloides	Buffalo grass	N,S	July	EDGE	TRNP
Calamagrosits stricta	Reedgrass	S			UND
Calamagrostis montanensis	Plains reedgrass	S		PRAIRIE	TRNP
Calamovilfa longifolia	Prairie sandreed	N,S	July	BAD,PRAIRIE	UND
Cinna latifolia	Drooping woodreed	N		HRD	TRNP
Dichanthelium acuminatum	Dichanthelium				TRNP
Dichanthelium oligosanthes	Dichanthelium				TRNP
Distichilis spicata	Saltgrass	N,S	June	BAD,SEEP	TRNP
Echinochloa crusgallii	Barnyard grass	S		RIVER	TRNP
Elymus canadensis	Canada wild rye	N,S		RIVER	TRNP
Elymus villosus	Hairy wild rye	N		HRD,PTBO	O
Elymus virginicus	Virginia wild rye	N,S	July	RIVER	TRNP

Family/Scientific Name[1]	Common Name[2]	Unit[3]	Phenology[4]	Habitat[5]	Source[6]
Poaceae (Cont'd)					
Festuca octoflora	Six-weeks fescue	S,N			TRNP
Festuca ovina	Sheep fescue	N,S	June	PRAIRIE,MARSH	TRNP
Glyceria grandis	Mannagrass	N	June	MARSH	TRNP
Glyceria striata	Fowl mannagrass	S	June	SEEP	TRNP
Hordeum pusillum	Little barley	N,S	June	ASSV	TRNP
Hordeum jubatum	Foxtail barley	N,S	June	SEEP,ASSV,BAD,AC	TRNP
Koeleria pyramidata	Junegrass	N,S	June	PRAIRIE	TRNP
Muhlenbergia asperifolia	Scratchgrass	N,S	July	RIVER,SEEP	TRNP
Muhlenbergia cuspidata	Plains muhly	N,S	July	SCBG,SCORIA	TRNP
Muhlenbergia mexicana	Wirestem muhly	N		HRD	O
Muhlenbergia racemosa	Mat muhly	N			TRNP
Muhlenbergia richardsonis	Muhly grass	N	July	MARSH	TRNP
Munroa squarrosa	False buffalo grass	S	June	BAD	TRNP
Oryzopsis hymenoides	Indian ricegrass	N,S	May	BAD,RIVER	TRNP
Oryzopsis micrantha	Little ricegrass	N,S	June	JSOM	TRNP
Panicum capillare	Witchgrass	N,S	June	RIVER	TRNP
Panicum virgatum	Switchgrass	N,S	July-Aug	MARCH,RIVER	O
Phragmites australis	Common reed	N	Aug	MARSH,SEEP	TRNP
Poa arida	Plains bluegrass	S	June	ASSV	TRNP
Poa bulbosa	Bulbous bluegrass	S		MAN	NDSU?
Poa canbyi	Canby's bluegrassS	N,S	May	MARSH	TRNP
Poa compressa	Canada bluegrass	NS	June	PRAIRIE,HRD,SEEP	TRNP
Poa cusickii	Cusick;s bluegrass	S			UND
Poa glaucifolia	Glaaucous bluegrass	N	June	SEEP	TRNP
Poa interior	Inland bluegrass	N,S	June-July	HRD	TRNP
Poa juncifolia	Bluegrass				TRNP
Poa palustris	Fowl bluegrass	N,S	June-July	RIVER	TRNP
Poa pratensis	Kentucky bluegrass	N,S	June	EDGE,MAN	TRNP
Poa secunda	Western bluegrass	S			TRNP
Puccinellia nuttalliana	Alkali grass	N,S	June	SEEP,BAD	TRNP
Schedonnardus paniculatus	Tumblegrass	S		BAD	TRNP
Schizachne purpurascens	False melic	N		PTBO	O
Scolochloa festucacea	Sprangletop				O
Setaria viridis	Green foxtail	N	July	BAD	TRNP
Sitanion hystrix	Bottlebrush squirreltail	N,S	June	BAD	TRNP
Spartina gracilis	Alkali cordgrass	N,S	June	BAD	TRNP

Family/Scientific Name[1]	Common Name[2]	Unit[3]	Phenology[4]	Habitat[5]	Source[6]
Poaceae (Cont'd)					
Spartina pectinata	Prairie cordgrass	N,S	July	RIVER,MARSH	TRNP
Sphenopholis obtusata	Wedgegrass	S	July	SEEP	TRNP
Sporobolus airoides	Alkali sacaton	S	June-July	BAD	TRNP
Sporobolus cryptandrus	Sand dropseed	N,S	July	RIVER,PRAIRIE	TRNP
Stipa comata	Needle-and-thread	N,S	June	SCBG,ASSC	TRNP
Stipa viridula	Green needlegrass	N,S	June	ASSV,GRS	TRNP
Polemoniaceae					
Collomia linearis	Collomia	N,S	June	AS,RIVER	TRNP
Ipomopsis congesta	Ball-head	S	May-June	AS,SCORIA	TRNP
Navarretia intertexta	Navarretia	N	June	WALLOW	TRNP
Phlox hoodii	Moss phlox	N,S	May	SCBG,SCORIA	TRNP
Polygalaceae					
Polygala alba	White milkwort	N,S	June	PRAIRIE	TRNP
Polygonaceae					
Eriogonum flavum	Sulfer flower	N,S	June	BAD,PRAIRIE,SCORIA	TRNP
Eriogonum pauciflorum	Buckwheat	N,S	June	PRAIRIE	TRNP
Polygonum achoreum	Knotweed	N	July	PRAIRIE	TRNP
Polygonum amphibium	Water smartweed	N	July	MARSH	TRNP
Polygonum arenastrum	Common knotweed	S			TRNP
Polygonum aviculare	Goosefoot	N,S	June	BAD	TRNP
Polygonum convolvulus	Wild buckwheat	N,S	June	WILD BUCKWHEAT	TRNP
Polygonum douglasii	Knotweed				O
Polygonum erectum	Erect knotweed	S	June-July	RIVER,SCORIA	TRNP
Polygonum lapathifolium	Pale smartweed	N,S	July	MARSH	TRNP
Polygonum pensylvanicum	Pennsylvania smartweed				TRNP
Rumex crispus	Curled dock	N,S	July		TRNP
Rumex mexicanus	Mexican dock	N,S	June	RIVER	TRNP
Rumex stenophyllus	Dock				TRNP
Rumex venosus	Wild begonia	N,S	May	RIVER,PDJS	TRNP
Polypodiaceae					
Cystopteris fragilis	Fragile fern	N,S		JSOR,SCORIA	TRNP
Woodsia oregana	Woodsia	N		ACHENBACH	TRNP

Family/Scientific Name[1]	Common Name[2]	Unit[3]	Phenology[4]	Habitat[5]	Source[6]
Potamogetonaceae					
Potamogeton pectinatus	Sago pondweed	N,S	June-July	MARSH,STREAM	TRNP
Potamogeton pusillus	Baby pondweed	N	July	MARSH	TRNP
Potamogeton richardsonii	Claspingleaf pondweed	N	July	MARSH	TRNP
Primulaceae					
Androsace occidentalis	Fairy candelabra	N,S	July	PDT	TRNP
Glaux maritima	Sea milkwort	N,S	June	RIVER	TRNP
Lysimachia ciliata	Fringed loosestrife	N,S	June-July	PTBO,HRD	TRNP
Ranunculaceae					
Anemone canadensis	Canada anemone	N	June	HRD	TRNP
Anemone cylindrica	Cottonweed	N	June	PRAIRIE	TRNP
Anemone patens	Pasque flower, Wild crocus	N,S	April-May	PRAIRIE	TRNP
Anemone virginica	Tall anemone				TRNP
Clematis ligusticifolia	Western virgin's bower	N,S	July	PDJS,RIVER	TRNP
Delphinium bicolor	Little larkspur	S	June	HRD	TRNP
Ranunculus abortivus	Early buttercup		May	HRD	TRNP
Ranunculus cymbalaria	Shore buttercup	N,S	May-June	RIVER,SEEP	TRNP
Ranunculus glaberrimus	Buttercup	S	June	RIVER	TRNP
Ranunculus rhomboides	Prairie buttercup	S	May	PRAIRIE	O
Ranunculus scleratus	Cursed crowfoot	N	July	SEEP	TRNP
Ranunculus subrigidus	White water crowfoot	N	July	MARSH	TRNP
Thalictrum dasycarpum	Tall meadowrue	N		PDJS,RIVER	TRNP
Thalictrum venulosum	Early meadowrue	S			TRNP
Rosaceae					
Agrimonia striata	Striate agrimony	N	July	PDBO	TRNP
Amelanchier alnifolia	Juneberry	N,S	May	HRD,BRUSH,SCORIA	TRNP
Crataegus chrysocarpa	Round-leaved hawthorn	N,S		HRD	TRNP
Fragaria vesca	Wild strawberry	S			UND
Fragaria virginiana	Wild strawberry	N,S	June	HRD	TRNP
Geum aleppicum	Yellow avens				TRNP
Geum triflorum	Torch flower, Old man's whiskers	N,S	May	PRAIRIE	TRNP
Potentilla anserina	Silverweed	N,S	May	RIVER	TRNP
Potentilla arguta	Tall cinquefoil	N,S	June	AS	TRNP
Potentilla concinna	Cinquefoil				O

Family/Scientific Name[1]	Common Name[2]	Unit[3]	Phenology[4]	Habitat[5]	Source[6]
Rosaceae (Cont'd)					
Potentilla fruticosa	Shrubby cinquefoil	N,S	July-Aug	ASJH	TRNP
Potentilla hippiana	Cinquefoil				TRNP
Potentilla norvegica	Norwegian cinquefoil	S			TRNP
Potentilla paradoxa	Bushy cinquefoil	S			UND
Potentilla pensylvanica	Cinquefoil	N	June	PRAIRIE	TRNP
Prunus americana	Wild plum	N,S		HRD	TRNP
Prunus pensylvanica	Pen cherry	N		ACHENBACH	TRNP
Prunus pumila	Sand cherry	S	May	BAD	TRNP
Prunus virginiana	Chokecherry	N,S	May	BRUSH,HRD	TRNP
Rosa arkansana	Prairie rose	N,S	June	PRAIRIE	TRNP
Rosa woodsii	Wood's rose	N,S	July	HRD,PDJS	TRNP
Rubus idaeus	Raspberry	N	July	HRD	TRNP
Rubiaceae					
Galium aparine	Cleavers	N,S	May	PTBO	TRNP
Galium boreale	Northern bedstraw	N,S	June	PRAIRIE	TRNP
Salicaceae					
Populus balsamifera	Balsam poplar				TRNP
Populus deltoides	Cottonwood	N,S		PDJS	TRNP
Populus tremuloides	Trembling aspen	N,S		PTBO	TRNP
Populus x acuminata	Smoothbark cottonwood	S	April	BAD	TRNP
Salix amygdaloides	Peach-leaved willow	N,S	May	WILLOW,RIVER	TRNP
Salix bebbiana	Beaked willow	N,S		WILLOW,RIVER,PDJS	TRNP
Salix eriocephala	Diamond willow				TRNP
Salix exigua	Sandbar willow	N,S	May	WILLOW,RIVER	TRNP
Salix humilus	Prairie willow	N		EDGE	TRNP
Salix lutea	Yellow willow	S			O
Santalaceae					
Commandra umbellata	Bastard toadflax	N,S	May	PRAIRIE	TRNP
Saxifrageceae					
Heuchera richardsonii	Alumroot	N,S	May	PRAIRIE	TRNP

Family/Scientific Name[1]	Common Name[2]	Unit[3]	Phenology[4]	Habitat[5]	Source[6]
Scrophulariaceae					
Castilleja sessiliflora	Downy paintbrush	N,S	May	PRAIRIE	TRNP
Gratiola neglecta	Hedge hyssop	N	June	WALLOW	TRNP
Linaria vulgaris	Butter and eggs				O
Orthocarpus luteus	Owl clover	N,S	June	PRAIRIE	TRNP
Penstemon albidus	White beardtongue	N,S	May-June	SCBG	TRNP
Penstemon angustifolius	Narrow beardtongue	S	May-June	SCORIA	TRNP
Penstemon eriantherus	Crested beardtongue	N,S	May-June	BAD	TRNP
Penstemon gracilis	Slender beardtongue	N,S	June	PRAIRIE	TRNP
Penstemon nitidus	Blue beardtongue	N,S	May-June	SCORIA,SCBG	TRNP
Veronica peregrina	Speedwell	N	June	PRAIRIE	TRNP
Selaginellaceae					
Selaginella densa	Small clubmoss	N,S		PRAIRIE	TRNP
Solanaceae					
Hyoscyamus niger	Henbane	S		MAN,PDT	TRNP
Physalis heterophylla	Clammy ground cherry	N	July	RIVER	TRNP
Physalis virginaia	Virginia ground cherry				TRNP
Solanum rostratum	Buffalo bur	N,S	June	EDGE	TRNP
Solanum triflorum	Cut-leaved nightshade	N,S	June-July	PDT,MAN,JSOM	TRNP
Typhaceae					
Typha latifolia	Cattail	N	Aug	MARSH	TRNP
Ulmaceae					
Ulmus americana	American elm	S		HRD	TRNP
Urticaceae					
Parietaria pensylvanica	Pellitory	N,S	June	JSOM,BRUSH	TRNP
Urtica dioica	Tall nettle	S			TRNP
Verbenaceae					
Verbena bracteata	Bracted vervain	N	June	EDGE	TRNP
Verbena stricta	Blue vervain	N	July	PRAIRIE	TRNP

Family/Scientific Name[1]	Common Name[2]	Unit[3]	Phenology[4]	Habitat[5]	Source[6]
Violaceae					
Viola adunca	Hook-spurred violet			JSOM	O
Viola canadensis	Wood violet	S	May-June	HRD	TRNP
Viola nuttallii	Nuttall's violet	N,S	May	ASSV	TRNP
Viola pratincola	Blue prairie violet	N			TRNP
Vitaceae					
Parthenocissus inserta	Woodbine	N,S		PDJS,HRD,ACHENBACH	TRNP
Vitis riparia	River grape	N		RIVER	TRNP
Vitis vulpina	Winter grape	N			O
Zannichelliaceae					
Zanichellia palustris	Horned duckweed	N	June	MARSH	TRNP

Plant species listed on Snow et al. list (1985) as suspected of occurring in the Park, but not ever observed or collected.

Alisma subcordatum
Amorpha canescens
Aquilegia canadensis
Asclepias pumila
Astragalus vexilliflexus
Berberis repens
Boisduvalia glabella
Cardaria draba
Chaenactis douglasii
Corylus americana
Erigeron divergens
Gnaphalium palustre
Hesperis matronalis
Leucocrinum montanum
Linum usitatissimum
Mentzelia pumila
Orobanche uniflora
Pellaea glabella
Phlox alyssifolia
Potentilla diversifolia
Psoralea tenuiflora
Ribes missouriense
Salix discolor
Smilacina racemosa
Sparganium eurycarpum
Suckleya suckleyana
Viola pedatifida
Viola sororia

Footnotes

1. All scientific names are based on nomenclature used in ***Flora of the Great Plains*** (1986). It would be appropriate to add taxonomic authority, variety as present in the region, collection distinctions and habitat distinctions between the North and South Units, and any synonyms in an official Park flora. Annotation is also necessary for an official Park flora.

2. Common names are based mainly on Stevens (1960) and ***Flora of the Great Plains*** (1986).

3. The unit is left blank only when published floristic information did not make the distinction.

4. Peak flowering time in the Park is indicated by the month(s) listed.

5. Habitat information is provided within the habitat classification framework of Marlow et al (1984) to the extent that information is available. Habitat type names use the first letters of genus - species names, e.g. *Populus deltoides - Juniperus scopulorum* h.t. = "PDJS." Management unit names use the abbreviations of Marlow et al., e.g. Hardwood Draw = "HRD." The following additions were made to the habitat designations:

   "SEEP" for highly localized groundwater discharge areas.

   "PRAIRIE" for want of distinguishing mixed grass prairie association information.

   "EDGE" for transitional habitat between two habitats, typically roadside areas.

6. Presence of an herbarium voucher specimen in the Park collection is indicated by "TRNP." Presence of an herbarium voucher specimen in other collections is indicated by the institution acronym (Note: Only UND records were searched). Observations of species presence as indicated on the Snow et al. list (1985) or made subsequently are indicated by "O;" these species needing vouchers. Taxa deleted from the previous Snow et al. list were those believed to be in the park, but not observed or collected. This speculative list is separately enumerated at the end.