ECOLOGICAL EVALUATION OF THE POTENTIAL DOWNS RESEARCH NATURAL AREA WITHIN THE THUNDER BASIN NATIONAL GRASSLAND, CONVERSE COUNTY, WYOMING

Prepared for
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INTRODUCTION

The potential Downs Research Natural Area (RNA) is located in the Cheyenne River Basin of northeastern Wyoming. The area includes broad ridge-tops, gentle slopes, and shallow draws. The potential RNA is in the Thunder Basin National Grassland and is currently used primarily for livestock grazing.

In 1997, The Nature Conservancy entered a contract with the USDA Forest Service, Nebraska National Forest, to prepare ecological evaluations of areas in the Thunder Basin National Grassland and other national grasslands for use by the Forest Service in examining the suitability of the areas as research natural areas. The evaluation of the Downs area was done by the Wyoming Natural Diversity Database. This report presents the results of that evaluation.

Land Management Planning

In 1997, an interdisciplinary team from the Thunder Basin National Grassland selected the Downs area as a potential RNA for possible analysis during revision of the Land and Resource Management Plan. This ecological evaluation is intended to aid the Forest Service staff in that analysis.

OBJECTIVES

One of the primary objectives of research natural areas is to "...preserve a wide spectrum of pristine representative areas that typify important forest, shrubland, grassland, alpine, aquatic, geologic and similar natural situations..." (Forest Service Manual 4063.02).

The objectives of a Downs RNA would be to 1) maintain a reference area for (a) monitoring effects of resource management techniques and practices applied to similar ecosystems, (b) comparing results from manipulative research, and (c) determining range of natural variability; 2) protect elements of biological diversity; 3) provide a site for non-manipulative scientific research; and 4) provide on-site and extension educational opportunities.

PRINCIPAL DISTINGUISHING FEATURES

The principal distinguishing features of the potential Downs RNA are grasslands dominated by western wheatgrass and blue grama growing on fine-textured soils, grasslands of needle-and-thread and blue grama growing on coarser-textured soils of ridge-tops, and sparse shrublands growing on clay slopes.

LOCATION

The potential Downs RNA is located within the Thunder Basin National Grassland in northeastern Wyoming (Figure 1). The approximate center of the potential RNA is at latitude 43°10'30"N and longitude 105°03'55"W.

The potential RNA includes all or parts of the following sections (all on the 6th Principal Meridian): Township 37 North, Range 68 West, Sections 7, 17, 18, 19, 20, 21, 28.

Boundary (See Figure 1).

The proposed boundary of the potential Downs RNA follows a drainage divide on the northeast and land ownership boundaries on the east, south, west, and north.

Area

The total area of the potential Downs RNA is ca. 3509 acres (1420 ha).

Elevation

The elevation of the potential Downs RNA ranges from ca. 4600 feet (1402 m) to 4920 feet (1500 m) along the drainage divide in the center.

Access

The potential RNA is inaccessible on public roads and may be reached only with the permission of the owners of the adjacent private lands. From Bill, Wyoming, travel east three miles (4.8 km) on Converse County Road 38 to the intersection with Grassland Road 958, thence east on Grassland Road 958 ca. 6 miles (9.6 km) to the intersection with a private, graveled road leading to the south. Travel beyond this point requires the permission of the land owner. From that intersection, travel south and ca. 4 miles (6.4 km), crossing Dry Creek, to the northeastern corner of the potential RNA. The eastern boundary of the RNA is accessible from a bladed road.

Ecoregion

The potential Downs RNA lies within the Great Plains-Palouse Dry Steppe Province, Powder River Basin Section, Southern Powder River Basin-Scoria Hills Subsection (331Gf) of the ecoregion classification of Bailey et al. (1994) (Freeouf 1996).

Maps

USDA Forest Service 1/2 inch = 1 mile scale map of the Thunder Basin National Grassland.

USDI Geological Survey 7.5 minute Topographic Quadrangle Map: Colter Draw, Wyo.

VEGETATION

Description

The potential Downs RNA contains the following plant associations. Synonyms are shown in Appendix 4. Data from sample plots are shown in Appendix 3.

Upland vegetation

Grasslands dominated or co-dominated by western wheatgrass (Elymus smithii) are the major community types in the area. Throughout, the western wheatgrass-blue grama type is a major type, growing on slopes and ridge-tops, primarily on fine-textured soils. Western wheatgrass-green needlegrass vegetation occupies most of the draws throughout the potential RNA. In both types, Wyoming big sagebrush, black greasewood, and Nuttall's saltbush often are present.

In the southwestern corner of the potential RNA, the broad ridge-tops with coarser-textured soils are vegetated principally with the needle-and-thread - blue grama/threadleaf sedge type. Wyoming big sagebrush is present, usually as scattered shrubs.

Sparse shrublands, in which shrubs contribute at least 10% of the canopy cover, also are common in the potential RNA, although they cover less area than do the grasslands. Stands of all three shrub types merge with the grassland vegetation. Patches of black greasewood/western wheatgrass vegetation grow on the edges of draws and on benches within the grassland matrix, especially in the southeastern part of the area. Nuttall's saltbush/western wheatgrass stands also occur as small patches in the grassland matrix, especially along the south-facing escarpment that runs across the south-central part of the potential RNA. Patches of Wyoming big sagebrush/mixed grass vegetation constitute the third shrub type, and are scattered throughout the area.

Sparsely-vegetated clay slopes are common throughout the potential RNA. They are of limited extent in most of the area,

but much of the south-facing escarpment consists of sparsely-vegetated slopes.

Riparian vegetation

Riparian vegetation is limited to fringes of the leafy bulrush type in the larger draws, and patches of cattail on the fringes of a few of the reservoirs.

Area by Type

Complexes of communities were mapped on a 1:24,000-scale topographic map using aerial photos and field reconnaissance, and the area of each complex in the potential RNA was estimated from the map with a digital planimeter. The vegetation maps show complexes because delineating stands of individual communities was impossible. The relative importance of each plant association within each complex is indicated in the legend for Figure 1 (M = major association, m = minor association). Synonyms for the plant community types listed in Table 2 are shown in Appendix 4.

Areas of complexes of Kuchler (1966) types were estimated by summing the areas of the plant community types corresponding to the different Kuchler types.

Table 1. Areas of complexes of Kuchler Types (Kuchler 1966) in the potential Downs RNA.

Cover Type	Acres	Hectares
Type 59 Wheatgrass-needlegrass grassland (M) with Type 57 Grama-needlegrass-wheatgrass grassland(m), Type 62 Bluestem-grama grassland (m), and Type 50 Wheatgrass-needlegrass shrubsteppe (m)	485	196
Type 57 Grama-needlegrass-wheatgrass grassland (M) with Type 59 Wheatgrass-needlegrass grassland (m) and Type 50 Wheatgrass-needlegrass shrubsteppe (m)	3024	1224

Table 2. Areas of complexes of plant community types in the potential Downs RNA. See Figure 1. See synonyms in Appendix 4.

Association	Acres	Hectares
Needle-and-thread - blue grama/ threadleaf sedge (M) with Western wheatgrass-blue grama (m), Western wheatgrass-green needle-grass (m), Wyoming big sagebrush/ Mixed grass (m), and Leafy bulrush (m)	485	196
Western wheatgrass-blue grama (M) and Western wheatgrass-green needlegrass (M) with Needle-and-thread - blue grama/threadleaf sedge (m), Black greasewood/ western wheatgrass (m), Nuttall's saltbush/western wheatgrass (m), Leafy bulrush (m), and Sparsely-vegetated slopes (m)	1662	673
Western wheatgrass-blue grama (M) and Black greasewood/western wheatgrass (M) with Western wheat-grass-green needlegrass (m), Needle-and-thread - blue grama/ threadleaf sedge (m), Nuttall's saltbush/western wheatgrass (m), Leafy bulrush (m), and Sparsely-vegetated slopes (m)	1362	551

PHYSICAL AND CLIMATIC CONDITIONS

Physical Setting

The potential Downs RNA is located on the drainage divide between Dry Creek to the north and Lightning Creek to the south. The divide crosses the area from west-southwest to east-northeast, separating the area into two parts. In the southeastern part, constituting about one-third of the potential RNA, the landscape is dissected by ephemeral streams flowing southeast. In the northwestern two-thirds of the potential RNA, the ephemeral streams flow northwest and the landscape is less dissected.

Geology

Bedrock in the potential RNA is dark gray clay shale and concretionary sandstone of the Lebo Member of the Paleocene-aged Fort Union Formation (Love and Christiansen 1985). Shale predominates, but the two rock types form a fine-grained mosaic of substrates of different textures. The southeastern third of the potential RNA contains less sandstone (and, consequently, less coarse-textured substrate) than does the northwestern two-thirds of the area.

DESCRIPTION OF VALUES

Vegetation Types

See Table 1 for a list of the Kuchler (1966) vegetation types present in the area and the estimated acreage of each, and Table 2 for a list of the plant community types present.

Flora

Threatened, Endangered, and Sensitive Plant Species

No federally listed Threatened or Endangered plant species, or species on the USDA Forest Service Region Two Sensitive Species List (Estill 1993) are known from the potential Downs RNA.

Plant Species List

The following species were identified during field work in the potential Downs RNA.

Table 3. Vascular Plants of the potential Downs RNA. Nomenclature for scientific names is based on Dorn (1992). Family acronyms are from Weber (1982). Family taxonomy follows Dorn (1992). !" before a name indicates an exotic species.

Scientific Name	Common Name	Family
SHRUBS		
Artemisia cana ssp. cana	Basin silver sagebrush	AST
Artemisia longifolia?	Longleaf sagebrush	AST
Artemisia pedatifida	Birdsfoot sagebrush	AST
Artemisia tridentata ssp. wyomingensis	Wyoming big sagebrush	AST
Atriplex canescens	Four-wing saltbush	CHN
Atriplex gardneri	Nuttall's or Gardner's saltbush	CHN

Chrysothamnus nauseosus	Rubber rabbitbrush	AST
Rhus trilobata	Skunkbush sumac	ANA
Rosa woodsii	Wood's rose	ROS
Sarcobatus vermiculatus	Black greasewood	CHN
Symphoricarpos sp.	Snowberry	CPR
Yucca glauca	Soapweed yucca	AGV
GRAMINOIDS		
Aristida purpurea var. longiseta	Fendler threeawn	POA
Bouteloua gracilis	Blue grama	POA
!Bromus commutatus	Meadow brome	POA
!Bromus tectorum	Cheatgrass	POA
Calamovilfa longifolia	Prairie sandreed	POA
Carex eleocharis = C. stenophylla	Needleleaf sedge	CYP
Carex filifolia	Threadleaf sedge	CYP
Elymus smithii	Western wheatgrass	POA
Elymus trachycaulus var. trachycaulus	Slender wheatgrass	POA
Festuca octoflora	Sixweeks fescue	POA
Koeleria macrantha	Prairie junegrass	POA
Oryzopsis hymenoides	Indian ricegrass	POA
Poa juncifolia var. ampla	Alkali bluegrass	POA
Poa pratensis	Kentucky bluegrass	POA
Poa secunda	Sandberg bluegrass	POA
Schizachyrium scoparium	Little bluestem	POA
Stipa comata	Needle-and-thread	POA
Stipa viridula	Green needlegrass	POA
FORBS		
Agoseris sp.	Agoseris	AST
Allium sp.	Onion	LIL
!Alyssum desertorum	Desert madwort	BRA
Amaranthus sp.	Amaranth	AMA
Arenaria hookeri	Hooker's sandwort	CRY
Artemisia frigida	Fringed sagewort	AST
Artemisia ludoviciana	Lousiana sagewort	AST
Aster falcatus	Cluster aster	AST
Astragalus bisulcatus	Two-grooved milkvetch	FAB
Astragalus miser var. decumbens	Weedy milkvetch	FAB
Astragalus sp.	Milkvetch	FAB
Atriplex sp.	Saltweed	CHN
Calochortus sp.	Mariposa lily	LIL
!Camelina microcarpa	Littlepod falseflax	BRA
Chenopodium sp.	Goosefoot	CHN
Cirsium sp.	Thistle	AST
Collomia linearis	Narrowleaf collomia	PLM
Comandra umbellata	Bastard toadflax	SAN
Crepis intermedia	Limestone hawksbeard	AST
Cryptantha celosioides	Buttercandle	BOR

Dalea candida	Slender white prairieclover	FAB
Descurainia pinnata	Western tansymustard	BRA
!Descurainia sophia	Herb sophia (flixweed)	BRA
Erigeron nematophyllus	Needleleaf fleabane	AST
Erigeron sp.	Fleabane	AST
Eriogonum sp.	Buckwheat	PLG
!Filago arvensis	Field cottonrose	AST
Gaura coccinea	Scarlet beeblossom	ONA
Grindelia squarrosa var. serrulata	Curleycup gumweed	AST
Gutierrezia sarothrae	Broom snakeweed	AST
Haplopappus armerioides?	Thrifty goldenweed	AST
Haplopappus multicaulis	Branched goldenweed	AST
Heterotheca villosa	Hairy goldenaster	AST
Hymenopappus polycephalus	Many-headed hymenopappus	AST
Hymenoxys acaulis	Stemless hymenoxys	AST
Ipomopsis sp.	Gilia	PLM
!Lactuca serriola	Prickly lettuce	AST
Lappula redowskii	Desert stickseed	BOR
Lupinus pusillus	Rusty lupine	FAB
Lygodesmia sp.	Skeletonplant	AST
Machaeranthera grindelioides = Haplopappus nuttallii	Nuttall's goldenweed	AST
!Melilotus officinalis	Yellow sweetclover	FAB
Musineon divaricatum	Leafy wildparsely	API
Oenothera sp.	Evening primrose	ONA
Opuntia polyacantha	Plains pricklypear	CAC
Orobanche sp.	Broomrape	ORO
Penstemon sp.	Penstemon	SCR
Phlox hoodii	Hood's phlox	PLM
Plantago patagonica var. spinulosa	Woolly plaintain	PTG
!Polygonum aviculare	Prostrate knotweed	PLG
Psoralidium lanceolatum	Lemon scurfpea	FAB
Rumex sp.	Dock	PLG
Senecio canus?	Woolly groundsel	AST
Sphaeralcea coccinea	Scarlet globemallow	MAL
!Taraxacum officinale	Common dandelion	AST
Thermopsis rhombifolia	Prairie thermopsis	FAB
!Tragopogon dubius	Yellow salsify	AST
Vicia americana	American vetch	FAB
Xanthium strumarium	Cocklebur	AST
Zigadenus venenosus	Grassy deathcamas	LIL

Fauna

Threatened, Endangered, and Sensitive Vertebrates

No federally listed Threatened, Endangered, or Candidate vertebrate species are known to occur in the potential Downs RNA.

Animal Species List

The field work in the potential Downs RNA did not include identification of the animal species present.

Lands

The potential Downs RNA is national grassland. Adjoining lands are national grassland to the northeast, public land to the southwest, and private land to the south, west, and north.

SUITABILITY FOR RESEARCH NATURAL AREA SELECTION

An area is suitable for designation as a research natural area according to how well it meets four criteria: quality, condition, viability, and defensibility (USDA Forest Service 1993). Each criterion is briefly defined below, and the information collected during field work that is pertinent to each criterion is described.

Quality: the degree to which the potential RNA represents the range in variability within the ecosystem types that it contains.

The main ecosystem in the potential Downs RNA is the mix of grassland and shrub-steppe types growing on the rolling plains and the south-facing escarpment. The composition and structure of the vegetation varies with substrates and topographic position: grassland dominated by needle-and-thread (*Stipa comata*)and blue grama (*Bouteloua gracilis*) dominates on coarser soils in the southwestern corner and occurs in patches in the northern part of the area; finer-textured soils support grasslands dominated by western wheatgrass(*Pascopyrum smithii*)and blue grama, and shrublands of Wyoming big sagebrush (*Artemisia tridentata ssp. wyomingensis*) and black greaswood (*Sarcobatus vermiculatus*); and the steep slopes of the escarpment in the center of the area support sparse vegetation of Nuttall saltbush (*Atriplex gardneri*). This mix of plant association appears to represent the vegetation of the region's rolling sedimentary plains.

Condition: the degree to which the potential RNA has been altered from presettlement conditions.

-- Exotic Species

Biennial brome grasses are common throughout the grasslands and shrublands of the potential RNA,and dominate some patches; *Bromus commutatus* or *Bromus japonicus* is the major species on finer-textured soils (in western wheatgrass grassland), and *B. tectorum* is the major species on coarser-textured soils (in the needle-and-thread - blue grama grassland).

-- Structures

A barbed-wire fence crosses the center of the potential RNA. Two-track roads run throughout the area, and a bladed road runs along the eastern and northern boundary. Six reservoirs, none larger than ca. 1 acre (0.4 ha)have been created in draws in the area. None of these structures appear to have a significant effect on the ecosystem of the potential RNA.

-- Ecological processes

Grazing by large mammals was undoubtedly a major ecological factor influencing the composition of the vegetation in the Cheyenne River Basin before settlement by whites. Bison abounded in eastern Wyoming (Dorn 1986, Long 1965), but free-ranging bison were gone from the area by the latter 19th century. Elk were present in the Cheyenne River Basin before white settlement (Dorn 1986), but probably were much less abundant than were bison (Long 1965) and hence had less influence on the ecosystems. Elk still inhabit parts of the Cheyenne River Basin. Pronghorn were abundant in eastern Wyoming in pre-settlement times (Long 1965) and still are common. Domestic livestock graze the potential RNA now and may influence the composition of the vegetation, but the extent to which domestic livestock have replaced bison and elk as an ecological factor in the potential RNA is unclear, as it is in much of the Great Plains (Hartnett et al. 1997). No areas were noted during field survey where livestock grazing had any deleterious effects.

Black-tailed prairie dogs (*Cynomys ludovicianus*) exert a strong influence on the species composition and the processes in grassland ecosystems in the Great Plains (Coppock et al. 1983). The species occurs throughout eastern Wyoming (Clark and Stromberg 1987). The grasslands in the northen part of the potential Downs RNA appear to provide suitable habitat for this species, so prairie dogs probably used the area at least intermittently before settlement.

Outbreaks of grasshoppers are a disturbance known to have large effects on the grasslands of the Great Plains (Knight 1994, Chapter 5). Although no information was encountered regarding grasshoppers in the potential Downs RNA or the immediate area, grasshopper outbreaks are known from northeastern Wyoming (Allred 1941) and undoubtedly affected the potential RNA. The effects that grasshopper control programs have had on the potential RNA are unknown.

Fires are known to have burned in the Cheyenne River Basin before white settlement (Dorn 1986) and fires undoubtedly influenced the ecosystems in the potential RNA. Wildfires still burn in the Great Plains of eastern Wyoming, but fire suppression is the general policy in the region. The degree to which that policy has altered the ecosystems in the potential Downs RNA is unclear.

Viability: the prospect for long-term maintenance of the ecosystem types in the area and the survival of their constituent species.

No immediate threats to the maintenance of the ecosystems or the survival of the constituent species in the potential RNA were noted during field work. Long-term maintenance of the ecosystems in a condition similar to the pre-settlement condition will require that the ecological processes that shaped those ecosystems continue to exert an influence. Of those processes, the ones that managers are most likely to control are grazing by large mammals, burrowing and grazing by prairie dogs, and fire. The size of the potential RNA will complicate management of these processes: the area is too small to support populations of pronghorn, elk, and mule deer (and their predators), which will use the potential RNA as part of a larger range. Similarly, when considered as livestock range, the potential RNA must be viewed as part of a larger area. Moreover, the effects of different grazing management practices on the composition and diversity of native plant associations is largely unknown (Hartnett et al. 1997).

The area may be large enough to support a black-tailed prairie dog town entirely within its boundary, should a town become established, although the prairie dogs likely would move onto adjacent lands outside the potential RNA. The presence of private lands around the area will complicate management for prairie dogs. Allowing outbreaks of grasshoppers to exert an influence on the ecosystems of the potential RNA will also be a problem for managers: the area is too small to contain this ecological process, and allowing grasshoppers to affect a larger area may be impracticable.

Managers may be able to delineate burn units entirely within the potential RNA, but the area's topography will make it

difficult to prevent fires near the potential RNA's boundary from spreading to adjacent lands. The presence of the biennial brome grasses will complicate the use of fire as a tool to maintain the ecosystems in the potential RNA, because the exotic bromes may increase or decrease in abundance, depending on the season of burning (The Nature Conservancy 1989). Consequently, while fire may promote the viability of some ecosystems in the potential RNA, it may also constitute a threat to the viability of others by promoting the increase in exotic plants.

Defensibility: the extent to which the area can be protected from extrinsic, anthropogenic factors that might worsen the condition of the area or threaten the viability of the ecosystems present.

The major potential threats to the potential Downs RNA appear to be oil or gas exploration and development and poorly managed livestock grazing, both of which might be avoided by the appropriate regulations and management practices. The area is located at considerable distance from population centers and is surrounded by private lands, so heavy human use is unlikely to pose a threat to the area.

Degree to Which the Potential RNA Meets Criteria

The potential Downs RNA appears to contain a mix of grassland and shrub-steppe plant associations representative of the region. The condition of the ecosystem in the potential RNA has been compromised to some extent by exotic brome grasses, which contribute substantial cover to the vegetation and co-dominate or dominate some patches. The amount of these exotic species, however, appears to be typical of the region. The viability of the ecosystems in the area can probably be assured if livestock continue to be managed to prevent repeated, excessive grazing; if wildlife (including prairie dogs) are allowed to use the area; and if a prescribed fire program can be implemented. The size of the area and the proximity of private lands may pose a problem for managers in implementing the appropriate management practices. Given the isolation of the potential RNA, and the lack of obvious attractions other than big-game habitat, the only serious threat to the defensibility of the area likely to develop in the future is oil and gas development, which might be minimized with the appropriate regulations on surface disturbance.

IMPACTS AND POSSIBLE CONFLICTS

This section is limited to the conflicts obvious from field survey and from conversations with USDA Forest Service staff.

Mineral Resources

The potential RNA contains two oil well sites, one of which is inactive and has been reclaimed. Uranium claim stakes were noted during the field survey. None of these disturbances appear to have had any effect on the area, but they may indicate conflicts between mineral resources and RNA designation.

Grazing

The northern portion of the potential Downs RNA is part of the South Dry Creek Pasture of grazing allotment #219, and the southern portion is part of the Colter Draw (Winter) Pasture of allotment #206. There is no apparent reason why livestock grazing *per se* would conflict with RNA designation, given that the ecosystems in the potential RNA evolved with ungulate grazing. No evidence was observed during the 1997 field survey of deleterious effects of livestock grazing.

Timber

The potential RNA contains no trees.

Watershed Values

Six small reservoirs are located in the area, but they appear to have little impact. The use of heavy equipment to maintain or repair the dams and dikes might conflict with management of the area as a research natural area.

Recreation Values

The potential RNA contains no developed recreation areas, and the private lands surrounding the area undoubtedly keep most potential recreational users out of the area. Existing and potential recreational use probably is limited to hunting during the fall, and the impacts from this hunting likely are just use of the two-track roads.

Wildlife and Plant Values

No evidence was observed during the field survey to suggest that management of the area as a research natural area apparently would conflict with the wildlife or plant values therein.

Transportation Values

The potential RNA contains no maintained roads, but several two-track roads provide vehicle access to most of the area. Given the lack of public access to the area, these roads probably receive limited use during the fall hunting season and during the winter for livestock management.

MANAGEMENT CONCERNS

No signs were observed during the field survey to suggest that establishment of a Downs RNA would conflict with other uses of the area. RNA establishment might require a change in grazing management and conflict with possible future mineral development. Management of ecological processes such as fire and prairie dogs could be complicated because of concerns about the impacts to lands outside the RNA.

REFERENCES

Allred, B.W. 1941. Grasshoppers and their effects on sagebrush on the Little Powder River in Wyoming and Montana. Ecology 22:387-392.

Bailey, R. G. et al. 1994. Ecoregions and subregions of the United States. 1:7,500,000-scale map. USDA Forest Service.

Clark, T. W. and M. R. Stromberg. 1987. Mammals in Wyoming. Museum of Natural History, University of Kansas, Lawrence, KS. 314 pp.

Coppock, D.L., J.K. Detling, J.E. Ellis, and M.I. Dyer. 1983. Plant-herbivore interactions in a North American mixed-grass prairie. I. Effects of black-tailed prairie dogs on intraseasonal aboveground plant biomass and nutrient dynamics and plant species diversity. Oecologia 56:1-9.

Dorn, R.D. (compiler). 1986. The Wyoming landscape, 1805 - 1878. Mountain West Publishing, Cheyenne WY. 94 pp.

Dorn, R. D. 1992. Vascular Plants of Wyoming, second edition. Mountain West Publishing, Cheyenne, WY. 340 pp.

Estill, E. 1993. Interim directive 2600-93-1. USDA Forest Service Region 2, Denver, CO. (Interim directive establishing Sensitive species in Region 2).

Federal Geographic Data Committee. 1997. National vegetation classification standard. FGDC-STD-005. Vegetation subcommittee, June 1997.

Freeouf, Jerry A. (editor). 1996. Ecoregions and subregions of Region 2 - subsections, State of Wyoming. 1:1,000,000-scale map prepared by USDA Forest Service, Natural Resource Information Team. Revised May 1996.

Hartnett, D.C., A. A. Steuter, and K.R. Hickman. 1997. Comparative ecology of native and introduced ungulates. Pp. 72-101 in: Knopf, Fritz L. and Fred B. Samson (editors). Ecology and conservation of Great Plains vertebrates. Ecological studies 125. Springer-Verlag, New York. 320 pp.

Johnston, B.C. 1987. Plant Associations of Region Two. Edition 4. USDA Forest Service Rocky Mountain Region. R2-ECOL-87-2. Lakewood CO. 429 pp.

Knight, D.H. 1994. Mountains and plains: the ecology of Wyoming landscapes. Yale University Press, New Haven CT. 338 pp.

Kuchler, A. W. 1966. Potential natural vegetation. Pp. 90-91 in: Gerlach, A. D. (ed.). 1970. The national atlas of the United States of America. USDI Geological Survey, Washington, DC.

Long, C.A. 1965. The mammals of Wyoming. University of Kansas Publications, Museum of Natural History 14(18): 493-758.

Love, J. D. and A. C. Christiansen. 1985. Geologic Map of Wyoming. USDI Geological Survey, Reston, VA. 1:500,000 scale.

The Nature Conservancy. 1989. Draft element stewardship abstract for Bromus tectorum: cheatgrass, downy brome. The Nature Conservancy, Arlington VA. Unpublished.

The Nature Conservancy. 1997 International classification of ecological communities: terrestrial vegetation of the United States. The Nature Conservancy Ecology Working Group, Arlington VA. In prep.

Thilenius, J.F., G.R. Brown, and A.L. Medina. 1995. Vegetation on semi-arid rangelands, Cheyenne River Basin, Wyoming. USDA Forest Service General Technical Report RM-GTR-263. Rocky Mountain Forest and Range Experiment Station, Fort Collins CO. 60 pp.

USDA Forest Service. 1993. Research Natural Area Guide for the Rocky Mountain Region, USDA Forest Service, review draft. Rocky Mountain Region, Lakewood, CO. 38 pp.

Weber, W. A. 1982. Mnemonic three-letter acronyms for the families of vascular plants: a device for more effective herbarium curation. Taxon 31 (1): 74-88.

Appendix 1. Maps of the potential Downs Research Natural Area.

Figure 1. Contour map showing complexes of plant community types in the potential Downs RNA. Major types in each complex are indicated by (M) after the name, and minor types by (m).

Community Types	Map Symbol
Needle-and-thread - blue grama/ threadleaf sedge (M) with Western wheatgrass-blue grama (m), Western wheatgrass-green needle-grass (m), Wyoming big sagebrush/ Mixed grass (m), and Leafy bulrush (m)	A
Western wheatgrass-blue grama (M) and Western wheatgrass-green needlegrass (M) with Needle-and-thread - blue grama/threadleaf sedge (m), Black greasewood/ western wheatgrass (m), Nuttall's saltbush/western wheatgrass (m), Leafy bulrush (m), and Sparsely-vegetated slopes (m)	B
Western wheatgrass-blue grama (M) and Black greasewood/western wheatgrass (M) with Western wheat-grass-green needlegrass (m), Needle-and-thread - blue grama/ threadleaf sedge (m), Nuttall's saltbush/western wheatgrass (m), Leafy bulrush (m), and Sparsely-vegetated slopes (m)	C

Potential RNA boundary

Fence

Active oil well site

Reclaimed oil well site

Reservoir

Sample plot

Vegetation description location

Appendix 2. Photographs from the potential Downs RNA.

Appendix 3. Canopy cover of plants in plots and at one vegetation description location in the potential Downs Research Natural Area.

In all of the tables in this appendix, the cover values for species are midpoints of the following cover classes:

Cover Value	Range of Canopy Cover
1	<1%
3	1% - 5%
10	5% - 15%
20	15% - 25%
30	25% - 35%
40	35% - 45%
50	45% - 55%
60	55% - 65%
70	65% - 75%
80	75% - 85%
90	85% - 95%
97	95% - 100%

The vegetation description is for a part of a stand and was not made for a formal sample plot. The species in each stratum of the vegetation are listed approximately in order from those with the most canopy cover to those with the least.

Locations of sample plots and of the vegetation description are shown on Figure 1.

Table 3-1. Canopy cover of plants in the western wheatgrass-green needlegrass sample plots from the potential Downs RNA.

	Plot/Association*		
	1	2	3
	Elysmi/ Stivir	Elysmi/ Stivir	Elysmi/ Stivir?
Species			
DWARF SHRUBS			
Artemisia longifolia?			1
Artemisia tridentata ssp. wyomingensis		10	1
Chrysothamnus nauseosus		1	1
Rosa woodsii	10	1	1
GRAMINOIDS			
!Bromus commutatus	20	70	3
Calamovilfa longifolia			40
Carex filifolia		1	
Elymus smithii	30	50	40
Elymus trachycaulus var. trachycaulus			1
Festuca octoflora		1	
Koeleria macrantha	1	1	1
Poa juncifolia var. ampla	20	10	10
!Poa pratensis	20	1	3
Stipa comata		1	
Stipa viridula	3	20	10
FORBS			
Agoseris sp.		1	1
!Alyssum desertorum		1	
Arenaria hookeri		1	1
Artemisia ludoviciana	1		
Aster falcatus	1		10
Calochortus sp.		1	
!Camelina microcarpa		1	1
Collomia linearis		1	1
Comandra umbellata		1	1
Crepis intermedia		1	
Descurainia pinnata			1
!Descurainia sophia		1	
Erigeron nematophyllus		1	
Eriogonum sp.			1
!Filago arvensis	1		
Grindelia squarrosa var. serrulata			1
Gutierrezia sarothrae		1	

Lactuca sp.	1		
Lupinus pusillus		1	
!Melilotus officinalis	1	1	1
Musineon divaricatum		1	
Opuntia polyacantha		1	1
Phlox hoodii		1	
Plantago patagonica var. spinulosa		1	
!Taraxacum officinale	1	1	
Thermopsis rhombifolia	20		1
!Tragopogon dubius	1	1	1
Vicia americana	1	1	
Xanthium strumarium	1		
Zigadenus venenosus		1	
GROUND COVER			
Bare ground	20	40	50
Gravel			1
Rock			1
Litter	76	55	45
Wood			
Moss & lichen			1
Basal vegetation	4	5	4

Association acronyms:

Elysmi-Stivir = Western wheatgrass-green needlegrass (Elymus smithii-Stipa viridula)

Notes:

Plot 305: 4 m x 25 m, in bottom of draw, representing one stand of this vegetation type, which covers 5% - 10% of the potential RNA. Surface soil is clay developed in alluvium. Photo 97GJ2.7.

Plot 321: 10 m x 50 m, on slope, representing one stand of this vegetation type, which covers 5%-10% of the landscape. Surface soil is clay developed in shale bedrock. Photo 97GJ2.12.

Plot 322: 10 m x 30 m, on middle of slope. Surface soil is clay developed in shale bedrock. Photo 97GJ2.13.

Table 3-2. Canopy cover of plants in western wheatgrass-dominated sample plots from the potential Downs RNA.

	Plot/Association*					
	4	5	6	7	8	9
Species	Elysmi-Bougra	Elysmi-Bougra	Elymsi-Bougra	Atrgra/Elysmi?	Atrgra/Elysmi?	Sarver/Elysmi?
DWARF SHRUBS						
Artemisia longifolia?					3	
Artemisia tridentata ssp. wyomingensis	10	1	3	1	1	10
Atriplex gardneri		1	1	20	3	1
Chrysothamnus nauseosus		1	1		1	1
Sarcobatus vermiculatus		3				10
Yucca glauca						1
GRAMINOIDS						
Aristida purpurea var. longiseta		1				
Bouteloua gracilis	10	3	1			3
!Bromus commutatus	1	1	1	20	1	20
!Bromus tectorum					10	1
Elymus smithii	20	10	40	20	40	30
Koeleria macrantha	3	3	1			1
Oryzopsis hymenoides	1			1	1	
Poa juncifolia var. ampla						3
Poa secunda	3	1		1		
Stipa comata	1	1				1
Stipa viridula						1
FORBS						
Allium sp.						1
!Alyssum desertorum				1		
Amaranthus sp.					1	
Arenaria hookeri	1	3	1			1
Astragalus bisulcatus			1			
Astragalus miser var. decumbens	1					1
Atriplex sp.				1	1	
Calochortus sp.		1				
!Camelina microcarpa		1	1			1
Chenopodium sp.					1	
Comandra umbellata	1	1	1			1
Crepis intermedia	1	1				1
Cryptantha celosioides	1	1	1			
Dalea candida			1			
Descurainia pinnata				1		
Erigeron nematophyllus	1	1	1			
Eriogonum sp.			1		1	
Gutierrezia sarothrae	1	1				1

Haplopappus armerioides?		1				
Haplopappus multicaulis	1	1	1			
Heterotheca villosa		1				
Ipomopsis sp.			1			
Lappula redowskii					1	
Machaeranthera grindelioides	1	1				
Musineon divaricatum	1	1	1	1		1
Oenothera sp.			1		1	
Opuntia polyacantha	1	1	1			1
Orobanche sp.	1					1
Penstemon sp.	1					1
Phlox hoodii	3	1				
Polygonum aviculare				1	1	
Psoralidium lanceolatum	1	1	1			
Rumex sp.					1	
Sphaeralcea coccinea	1					1
Thermopsis rhombifolia		3			1	1
!Tragopogon dubius	1	1	1	1		1
Vicia americana	1	1	1	1		1
GROUND COVER						
Bare ground	83	88	87	87	61	84
Gravel	6	1	5	1	25	1
Rock	1	1		1	1	1
Litter	5	7	5	10	10	10
Wood	1	1			1	1
Moss & lichen	1	1	1			
Basal vegetation	3	1	2	1	2	3

Association acronyms:

Atrgar/Elysmi = Nuttall's saltbush/western wheatgrass (Atriplex gardneri/Elymus smithii)

Elysmi-Bougra = Western wheatgrass-blue grama (Elymus smithii-Bouteloua gracilis)

Sarver/Elysmi = black greasewood/western wheatgrass (Sarcobatus vermiculatus/Elymus smithii)

Notes:

Plot 302: 20 m x 20 m, on bench in south-facing slope, representing part of a stand on clay soil. Surface soil is clay; compare with plot 5 on sandy loam. Photo 97GJ2.3

Plot 303: 10 m x 20 m, on bench in south-facing slope, representing part of stand on coarser soil. Surface soil is sandy loam; compare with plot 4 on clay soil. Photo 97GJ2.5.

Plot 311: 10 m x 20 m, representing part of stand on upper slope. Surface soil is clay.

Plot 306: 10 m x 20 m, on upper slope. Surface soil is clay developed in clay shale bedrock. Photo 97GJ2.4.

Plot 313: 20 m x 25 m on upper slope, representing vegetation on clay slopes and benches of south-facing escarpment. Surface soil is clay. Photo 97GJ2.9.

Plot 301: 10 m x 20 m, representing vegetation on south-facing slope and bench. Surface soil is clay on the bench and sandy clay loam on the slope. Photo 97GJ2.2?

Table 3-3. Canopy cover of plants in needle-and-thread-dominated and little bluestem-dominated sample plots from the potential Downs RNA.

	Plot/Association*			
	10	11	12	13
Species	Sticom-Bougra/Carfil?	Sticom-Bougra/Carfil?	Sticom-Bougra/Carfil?	Schsco-Bouspp/Carfil
DWARF SHRUBS				
Artemisia cana ssp. cana			1	
Artemisia pedatifida		1	1	
Artemisia tridentata ssp. wyomingensis	3	3	3	1
Atriplex canescens	1	1	1	
Atriplex gardneri		1		
Chrysothamnus nauseosus	1			1
Rhus trilobata	1			1
Rosa woodsii				1
Sarcobatus vermiculatus	1			1
Symphoricarpos sp.				1
Yucca glauca	1		1	1
GRAMINOIDS				
Aristida purpurea var. longiseta		1		1
Bouteloua gracilis	20	20	30	10
!Bromus commutatus	1			10
!Bromus tectorum			1	1
Calamovilfa longifolia				10
Carex eleocharis			1	
Carex filifolia	10	1	30	10
Elymus smithii	10	10	1	3
Festuca octoflora		3	1	1
Koeleria macrantha	1	20	30	3
Oryzopsis hymenoides				1
Poa secunda	1	1	3	
Schizachyrium scoparium				10
Stipa comata	10	10	20	3
FORBS				
Allium sp.			1	
Arenaria hookeri	1	1	1	1
Artemisia frigida	1	1	1	1
Astragalus bisulcatus				1
Astragalus miser var. decumbens			1	1
Astragalus sp.		1	1	
Calochortus sp.	1			
Camelina microcarpa	1		1	
Cirsium sp.	1		1	1
Comandra umbellata	1	1	1	1

Dalea candida			1	1
Descurainia pinnata				1
Erigeron nematophyllus	1	1	1	1
Erigeron sp.			1	
Eriogonum sp.	1			
Filago arvensis			1	
Gaura coccinea				1
Gutierrezia sarothrae		1		1
Heterotheca villosa	1			
Hymenopappus polycephalus	1	1	1	1
Hymenoxys acaulis				1
Ipomopsis sp.	1	1	1	1
Lupinus pusillus	1	1	1	
Lygodesmia sp.			1	
Machaeranthera grindelioides		1	1	1
Musineon divaricatum		1	1	
Opuntia polyacantha	1	1	1	
Orobanche sp.	1			
Phlox hoodii	1	1	1	
Penstemon sp.		1	1	
Plantago patagonica var. spinulosa		1	1	
Psoralidium lanceolatum	3	1	1	1
Senecio canus?		1	1	
Sphaeralcea coccinea	1	1	1	
Thermopsis rhombifolia	1			1
Tragopogon dubius	1	1	1	
Zigadenus venenosus			1	1
GROUND COVER				
Bare ground	65	57	63	45
Gravel	15	15	1	4
Rock	1	1	1	1
Litter	15	22	30	20
Wood	1	1	1	1
Moss & lichen	1	1	3	1
Basal vegetation	2	3	1	4

Association acronyms:

Schsco-Bouspp/Carfil = Little bluestem-grama/threadleaf sedge (Schizachyrium scoparium-Bouteloua spp./Carex filifolia)

Sticom-Bougra/Carfil = Needle-and-thread - blue grama/threadleaf sedge (Stipa comata-Bouteloua gracilis/Carex filifolia)

Notes:

Plot 304: 5 m x 20 m, on south-facing sandstone outcrop. Surface soil is sandy clay loam.

Plot 323: 20 m x 20 m, representing type on broad ridges and upper slopes. Surface soil is sandy clay.

Plot 331: 20 m x 25 m, representing the vegetation on a broad ridge top. Surface soil is sandy loam. Photo 97GJ2.16.

Plot 312: 10 m x 20 m, representing a patch of this type on a broad ridge top. Surface soil is sandy clay loam developed on sandstone. Photo 97GJ2.11. This type occurs above the shale slope supporting the western wheatgrass-blue grama vegetation sampled by plot 6 and the Nuttall's saltbush/western wheatgrass vegetation represented by plot 8.

LOCATION 1. Draw in southwestern part of area; SW1/4 SE1/4 Sec 19, T37N, R68W.

-VEGETATION TYPE: Leafy bulrush (*Scirpus pungens*)

-ASPECT: Northwest

-TOPOGRAPHIC POSITION: Bottom of narrow draw

-DESCRIPTION: Herbaceous vegetation along channel

Trees:

Shrubs:

Dwarf Shrubs:

Graminoids & Forbs: Scirpus pungens, Eleocharis palustris, Hordeum jubatum, Puccinellia nuttalliana, Juncus balticus.

-NOTES: This type grows in the edge of the channel in wet soil.

Appendix 4. Plant community types in the potential Downs Research Natural Area.

The communities are listed by common name. Citations following the common names refer to these sources:

-- Johnston (1987): equivalent plant association from the list for USDA Forest Service Region 2;
-- The Nature Conservancy (1997): equivalent plant association from the classification of the network of state Natural Heritage Programs and The Nature Conservancy;
-- Thilenius et al. (1995): equivalent vegetation type from this study of the Cheyenne River Basin;
-- Federal Geographic Data Committee (1997): type in the hierarchy of the National Vegetation Classification Standard to which the association belongs;
-- Kuchler (1966): Kuchler vegetation type to which the association belongs.

Wyoming big sagebrush/Mixed grass

-- Johnston (1987): Artemisia tridentata/Elytrigia smithii plant association
-- The Nature Conservancy (1997): Artemisia tridentata ssp. wyomingensis/Mixed grass sparse shrubland
-- Thilenius et al. (1995): Unknown
-- Federal Geographic Data Committee (1997): V.A.7.N.e.; medium-tall, temperate or subpolar, natural/semi-natural grassland with a sparse, microphyllous, evergreen shrub layer
-- Kuchler (1966): Type 50, Wheatgrass-needlegrass shrubsteppe (Agropyron-Stipa-Artemisia)?

Nuttall's saltbush/western wheatgrass

-- Johnston (1987): Atriplex gardneri/Elytrigia smithii plant association
-- The Nature Conservancy (1997): Atriplex gardneri/Pascopyrum smithii dwarf shrubland
-- Thilenius et al. (1995): Unknown
-- Federal Geographic Data Committee (1997): IV.A.2.N.b.; extremely xeromorphic, evergreen, natural/semi-natural dwarf shrubland
-- Kuchler (1966): Type 50, Wheatgrass-needlegrass (Agropyron-Stipa-Artemisia) shrubsteppe?

Black greasewood/western wheatgrass

-- Johnston (1987): Sarcobatus vermiculatus-Artemisia tridentata/Elytrigia smithii plant association
-- The Nature Conservancy (1997): Sarcobatus vermiculatus/Pascopyrum smithii sparse shrubland
-- Thilenius et al. (1995): Sarcobatus vermiculatus/Agropyron smithii-Bouteloua gracilis shrub-steppe

-- Federal Geographic Data Committee (1997): V.A.7.N.g.; medium tall, temperate or subpolar, natural/semi-natural grassland with a sparse, cold-deciduous shrub layer.
-- Kuchler (1966): Type 50, Wheatgrass-needlegrass shrubsteppe (Agropyron-Stipa-Artemisia)

Western wheatgrass-blue grama
-- Johnston (1987): Elytrigia smithii/Bouteloua gracilis plant association?
-- The Nature Conservancy (1997): Pascopyrum smithii-Bouteloua gracilis-Carex filifolia herbaceous vegetation
-- Thilenius et al. (1995): Artemisia tridentata/Agropyron smithii shrub steppe?
-- Federal Geographic Data Committee (1997): V.A.5.N.c.; medium-tall, natural/semi-natural, temperate or subpolar grassland
-- Kuchler (1966): Type 50, Wheatgrass-needlegrass (Agropyron-Stipa-Artemisia) shrubsteppe

Western wheatgrass-green needlegrass
-- Johnston (1987): Elytrigia smithii/Stipa viridula plant association?
-- The Nature Conservancy (1997): Pascopyrum smithii-Nassela viridula herbaceous vegetation
-- Thilenius et al. (1995): Unknown
-- Federal Geographic Data Committee (1997): V.A.5.N.c.; medium-tall, natural/semi-natural, temperate or subpolar grassland
-- Kuchler (1966): Type 59, Wheatgrass-needlegrass (Agropyron-Stipa) grassland

Needle-and-thread - blue grama/threadleaf sedge
-- Johnston (1987): Stipa comata/Bouteloua gracilis plant association?
-- The Nature Conservancy (1997): Stipa comata-Bouteloua gracilis/Carex filifolia herbaceous vegetation
-- Thilenius et al. (1995): Stipa comata-Bouteloua gracilis sodgrass steppe or Bouteloua gracilis-Carex filifolia sodgrass steppe
-- Federal Geographic Data Committee (1997): V.A.5.N.d.; medium-tall bunch, natural/semi-natural, temperate or subpolar grassland
-- Kuchler (1966): Type 57, Grama-needlegrass-wheatgrass (Bouteloua-Stipa-Agropyron) grassland

Little bluestem-grama/threadleaf sedge
-- Johnston (1987): Schizachyrium scoparium/Carex filifolia plant association?
-- The Nature Conservancy (1997): Schizachyrium scoparium-Bouteloua spp./Carex filifolia herbaceous vegetation
-- Thilenius et al. (1995): Schizachyrium scoparium bunchgrass steppe

-- Federal Geographic Data Committee (1997): V.A.5.N.d.; medium-tall bunch, natural/semi-natural, temperate or subpolar grassland
-- Kuchler (1966): Type 62, Bluestem-grama (Andropogon-Bouteloua) grassland or Type 59, Wheatgrass-needlegrass (Agropyron-Stipa) grassland

Leafy bulrush
-- Johnston (1987): Unknown
-- The Nature Conservancy (1997): Scirpus pungens herbaceous vegetation
-- Thilenius et al. (1995): Unknown
-- Federal Geographic Data Committee (1997): V.A.5.N.m.; saturated, temperate or subpolar, natural/semi-natural grassland
-- Kuchler (1966): Type 59, Wheatgrass-needlegrass (Agropyron-Stipa) grassland?

Sparsely-vegetated slopes
-- Johnston (1987): None
-- The Nature Conservancy (1997): None
-- Thilenius et al. (1995): None
-- Federal Geographic Data Committee (1997): VII.C.3.N.b.; dry, natural/semi-natural, sparsely-vegetated, unconsolidated soil slopes.
-- Kuchler (1966): None