Badlands National Park

Pennington, Jackson, and Shannon Counties, South Dakota

Integrated Weed Management Plan and Environmental Assessment

March 2003

Recommended:

_____ _____

Resource Management Specialist, Badlands Date

Concurred:

_____ _____

Chief of Resource Management, Badlands Date

_____ _____

Midwest Region IPM Specialist Date

Approved:

_____ _____

Superintendent Date

(Following public review, the original signed copy of this plan and a Finding of No Significant Impact will be kept on file at Badlands National Park)

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Badlands National Park
Integrated Weed Management Plan and Environmental Assessment
Executive Summary

Badlands National Park's mixed grass prairie ecosystem is one of the largest and finest remnants in the National Park System hosting many species of plants and animals, including some non-native plant species that interfere with park management objectives. The establishment of weeds can displace native species, poison wildlife, degrade critical wildlife habitat, and interfere with visitor enjoyment. Furthermore, weeds originating in the park may invade surrounding lands, thus causing economic hardship for private landowners and interfering with management of other public lands. For the last twenty years, the park has undertaken a number of short-term treatment programs to address specific weed species in specific locations. These sporadic efforts have resulted in inconsistent control and weeds continue to plague the park. The purpose of this plan is to prescribe a long-term integrated weed management program for the park.

This Integrated Weed Management Plan and Environmental Assessment will:

1) Describe a comprehensive weed management program that includes prevention, early detection and eradication, treatment of established populations, and restoration.
2) Evaluate weed species based on the invasiveness of the weed species and the feasibility of control using the Alien Plant Ranking System.
3) Analyze three possible management alternatives
4) Complete an Environmental Assessment, consistent with the National Environmental Policy Act (42 U.S.C. 4321 et.seq.) and NPS policies.

Alternative A: No Action.
This alternative would be a continuation of the park's existing weed management program and would generally be reactive rather than proactive. Control efforts would continue to focus on state or county declared noxious weed species. Each species would be treated on a case-by-case basis using chemical, mechanical, and/or biological controls. Fire would be used to opportunistically treat cool season exotic grass species.

Alternative B: Proactive management without aerial application.
Under this alternative, the Alien Plant Ranking System would be used to prioritize weed management efforts. A comprehensive management program would include prevention, early detection and eradication, chemical control, biological control, mechanical control, fire and research. Aerial application of herbicide is not included in this alternative.

Alternative C: Proactive management with limited aerial application.
This is the agency's preferred alternative. It is identical to Alternative B except it allows for aerial application of herbicide to contain and reduce weed populations that cannot be effectively treated with other chemical application methods as defined by specific criteria.

This Integrated Weed Management Plan and Environmental Assessment analyzes all three alternatives and their potential impacts upon the human and natural environments. This document will be available to the public for a 30-day review in March 2003. If no substantial comments or new information are received during that time, a finding of no significant impact would be issued and the plan would be implemented as written.

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Document Preparers:

Sandee Dingman, Natural Resource Specialist, Badlands National Park (Lead Preparer)
Doug Albertson, Ferret Biologist, Badlands National Park
Rachel Benton, Paleontologist, Badlands National Park
Melanie Berg, Park Ranger (Wilderness), Badlands National Park
Eddie Childers, Wildlife Biologist, Badlands National Park
Marianne Mills, Cultural Resource Manager, Badlands National Park

Substantial Contributions:

Mike Carlbom, Fire Technician, Badlands National Park
Scott Guffey, Weed and Pest Supervisor, Pennington County
Marcia Huether, Chief of Administration, Badlands National Park
Dan Johnson, Supervisory Park Ranger (Interpretation), Badlands National Park
Brian Kenner, Chief of Resource Management, Badlands National Park
Ron Moerhing, Weed and Pest Supervisor, South Dakota Dept. of Agriculture
Irving Provost, Pesticide Enforcement Officer, Oglala Sioux Tribe
Mark Slovek, Biological Technician, Badlands National Park
William Supernaugh, Superintendent, Badlands National Park
Lee Vaughan, Biological Technician, Badlands National Park
Linda Williams, Resource Management Clerk, Badlands National Park

I. Introduction

A. Park History and Purpose

B. Purpose and Need for a Weed Management Plan

C. Scope of this Weed Management Plan

D. Affected Environment (figure 1)
- Vegetation
- Wildlife
- Threatened and Endangered Species
- Paleontological Resources
- Water Resources
- Wilderness
- Cultural Resources – Archaeology
- Cultural Resources – Landscapes
- Cultural Resources – Ethnography

I. A. Park History and Purpose

Badlands National Park is located in southwestern South Dakota, 70 miles east of Rapid City. The park consists of three units totaling approximately 244,000 acres. The North Unit, which is the best known and most accessible, includes the 64,144 acre Badlands Wilderness Area. The Stronghold and Palmer Creek Units are located within the Pine Ridge Indian Reservation and are managed by the National Park Service under a Memorandum of Agreement with the Oglala Sioux Tribe. In 2002, the park hosted approximately one million visitors, most between Memorial Day and Labor Day.

Badlands National Monument was originally authorized by the US Congress in 1929, and established by Presidential proclamation in 1939 after certain requirements were met by the State of South Dakota. The original Monument boundaries are generally referred to as the North Unit. In 1968, portions of the former Badlands Bombing Range, located within Pine Ridge Indian Reservation, were added to the National Monument by public law and became known as the Stronghold and Palmer Creek Units. In 1976, public law designated the 64,144-acre Badlands Wilderness Area, sometimes erroneously referred to as the Sage Creek Wilderness Area. Badlands National Monument was re-designated Badlands National Park by Congressional Act in 1978.

Throughout this seventy-three year history, the purposes of Badlands National Park have continued to evolve, generally around the themes of fossils, geology, prairie, and people. Today, the following park purposes are recognized:

- Protect the unique landforms and scenery of the White River Badlands for the benefit, education and inspiration of the public,
- Preserve, interpret, and provide for scientific research, the paleontological and geological resources of the White River Badlands,
- Preserve the flora, fauna and natural processes of the mixed grass prairie ecosystem,
- Preserve the Badlands Wilderness Area and associated wilderness values, and
- Interpret the history of the Lakota Nation

I. B. Purpose and Need for a Weed Management Plan

The park's mixed grass prairie ecosystem is one of the largest and finest remnants in the United States and is the largest in the National Park Service. This grassland hosts many species of plants and animals, including some non-native plant species that interfere with park management objectives. These non-native, invasive plants are weeds. The establishment of some weeds displaces native species, while other species poison wildlife, degrade critical wildlife habitat, and interfere with visitor enjoyment. Furthermore, weeds originating in the park may invade surrounding lands, thus causing economic hardship for private landowners and interfering with management of other public lands. For the last twenty years, the park has undertaken a number of short-term treatment programs to address specific weed species in specific locations. These sporadic efforts have resulted in inconsistent control and weeds continue to plague the park. The purpose of this plan is to prescribe a long-term management program that would reduce the impact of weeds on the park's prairie ecosystem.

I. C. Scope of the Weed Management Plan

This Integrated Weed Management Plan and Environmental Assessment will:

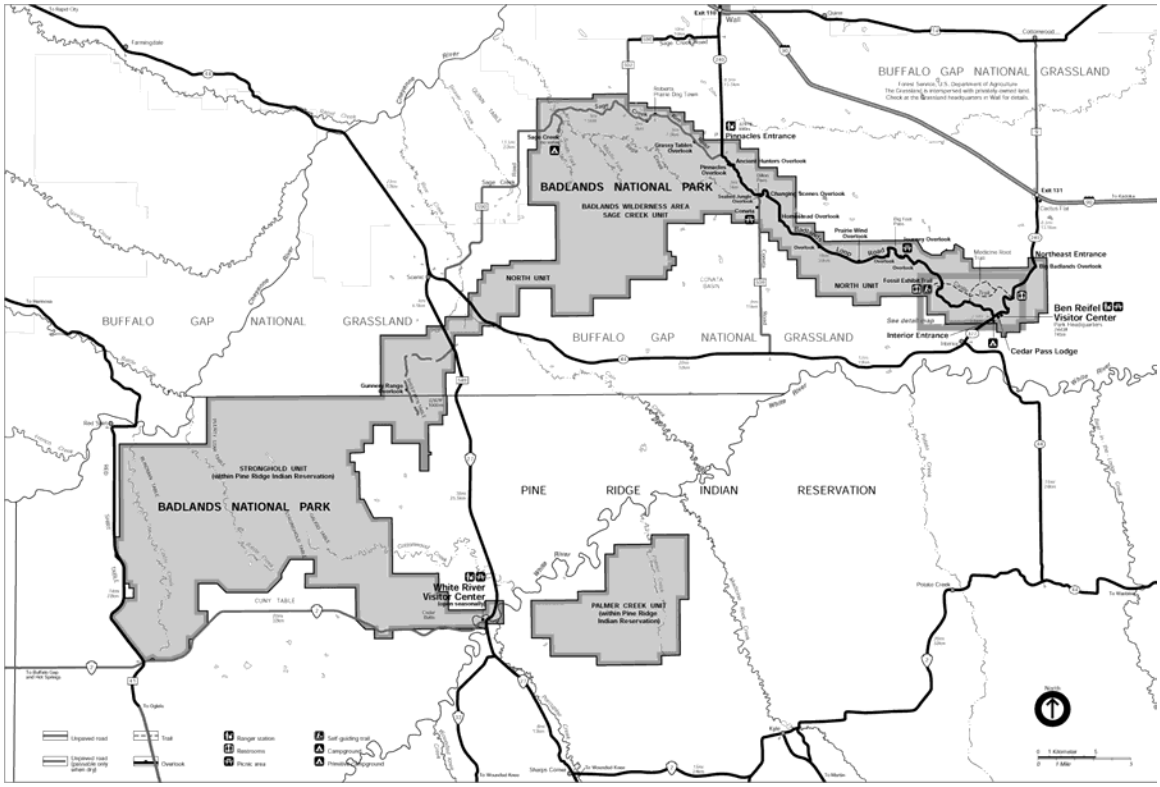
1) Describe a comprehensive weed management program that includes prevention, early detection and eradication, treatment of established populations, and restoration.
2) Evaluate weed species based on the invasiveness of the weed species and the feasibility of control using the Alien Plant Ranking System.
3) Analyze three possible management alternatives - two based on the results of the Alien Plant Ranking System and one no action alternative.
4) Complete an Environmental Assessment, consistent with the National Environmental Policy Act (42 U.S.C. 4321 et.seq.) and NPS policies.

Below is a list of issues identified by the public, cooperators, and the National Park Service that are addressed in this Integrated Weed Management Plan and Environmental Assessment.

- If weeds are not controlled, prairie dog densities decline and ferret habitat would be lost, jeopardizing ferret reintroduction efforts.
- If weeds are not controlled, the seed would continue to spread onto adjacent lands and cause economic losses for agricultural producers.
- If weeds are not controlled, native plant species would be displaced and the ecological integrity of the prairie would degrade.
- If weeds are not controlled, the visitors would see an altered landscape instead of the native prairie.
- Biological control insects may become pests themselves.
- Herbicides and biological control may affect threatened, endangered, and rare plant and animals species in the park.
- Herbicides may affect water quality and aquatic species, directly or through leaching.
- Herbicides and biological control may affect non-targeted native plant and animal species that may be present in and around the treatment area, particularly with aerial application of herbicide.
- Herbicides may pose a risk to native organisms. Chemicals are added to the environment for a long term, including active ingredients, break down products, new compounds formed through new chemical reactions, carriers, and ingredients added for other purposes.
- Herbicides may pose a health risk to applicators and the public.
- Treatment methods may conflict with Wilderness values.
- ATV's applying herbicides may damage archaeological or paleontological resources.
- Aerial application may impact visitor experience through temporary closures.
- Aerial application may impact visitor experience through noise intrusion.
- Motorized equipment may disturb wildlife.

I. D. Affected Environment

Figure 1: Badlands National Park occupies 244,000 acres, including the 64,144-acre Badlands Wilderness Area in the North Unit and the 122,000-acre Stronghold District located inside Pine Ridge Reservation.



Vegetation

Badlands mixed grass prairie vegetation is characteristically diverse and found throughout the Park. The basis for the difference between pre-settlement vegetation composition and current conditions is found in past livestock grazing practices, elimination and reduction of native wildlife and suppression of fire. With the elimination of livestock grazing, managed cultivation, and concentrated resource management efforts, the current vegetative mix largely reflects what is believed to have naturally existed prior to the influx of the European settlers in the park locale.

Completed in 1999, the park's Vegetation Map project classified and digitally mapped 0.9 million acres including the entire park and surrounding areas. Vegetation map classes were determined through extensive field reconnaissance, data collection, and analysis in accordance with the National Vegetation Classification System. The vegetation map was created from photographic interpretation of 1997, 1:12,000 scale color infrared aerial photography. The National Vegetation Classification System for the Badlands study area includes twenty-eight natural and semi-natural associations and two complexes. The natural associations are comprised of four woodland, ten shrubland, six upland herbaceous/grassland, four wetland and four sparse vegetation types. The

semi-natural associations are comprised of one woodland type and three grassland types (Von Loh et al. 1999).

Woodlands occupy 3,565 acres (1,443 ha) and are minor components of the regional vegetation, covering approximately 1.5% of the park. These are generally restricted to floodplains, drainage bottoms, toeslopes of sandhills, draws associated with eroding buttes, and slumps on butte and cliff faces. Rocky Mountain juniper (*Juniperus scopulorum*) forms the most common woodland in the project area, occurring as its purest form on drier slopes, along butte edges, and in upper draws. A special habitat occupied by Rocky Mountain juniper is a side-slope slump, where additional moisture collects following landslides.

Rocky Mountain juniper often intergrades with other woodlands, especially ponderosa pine (*Pinus ponderosa*) and green ash (*Fraxinus pennsylvanica*). Ponderosa pine woodlands occur in the upper elevations of the South Unit, where cover values for ponderosa pine and Rocky Mountain juniper are often nearly equal. Throughout the Park's lower elevations, Rocky Mountain juniper and hardwood trees also intermix along a broad gradient, with hardwoods occupying sites with more soil moisture. Green ash and American elm (*Ulmus americana*) are the most common hardwood trees present, occupying bottoms of draws, river floodplains, and toeslopes of sand hills. The upper portion of hardwood draws is commonly dominated by various shrub species, particularly American plum (*Prunus americana*) and western snowberry (*Symphoricarpos occidentalis*).

Wetter sites with high soil moisture within the park support stands of Eastern or plains cottonwood (*Populus deltoides*) trees. Along with peachleaf willow (*Salix amygdaloides*), these typically occur within the Park as small clumps along minor streams, around seeps, springs, and around ponds.

Shrublands occupy 10,073 acres (4,076 ha) and compose approximately 4.2% of the park's area. Shrublands occur mainly along river and creek floodplains, and on sand deposits, slopes with more soil moisture, and draws. The most widespread of all shrublands is silver sagebrush (*Artemisia cana*), which occurs regularly on floodplains and adjacent slopes. Silver sagebrush is usually found sparsely scattered throughout western wheatgrass (*Pascopyrum smithii*) grasslands. In certain areas it may become quite dense or intermingle with other shrubs.

Sand hills support extensive stands of sand sagebrush shrubland (*Artemisia filifolia*), particularly in the southern half of the park and project area. Where sand hills are reduced to sandy ridges or flats, stands of yucca (*Yucca glauca*) may replace or intermingle with sand sagebrush. Most yucca stands are located along the margins of buttes, on low sandy ridges, and on dry canyonsides.

Draws, swales, slopes, and drainages throughout the study area provide enough moisture to sustain patches of various broad-leaved shrubs, in addition to the silver sagebrush described above. Among the more common are western snowberry, American plum, and occasional three-leaved sumac (*Rhus trilobata*). Western snowberry is the most prevalent; occurring as relatively small stands or clones at the heads of draws or covering low swales. American plum often occurs adjacent to western snowberry or within openings of green ash. American plum typically grows in clumps that

produce almost impenetrable thickets. Three-leaved sumac is present at the park as both very dense (moist conditions) and very sparse (dry condition) shrubland types. Typically, this shrubland occurs as sparse stands along the rims of buttes.

The remaining shrublands represent relatively rare types found only in a few locations in and around the park. Sandbar willow shrublands grow in saturated ox-bows or cut-banks of Sage Creek in the North Unit and Fog Creek in the South Unit. Habitat similar to and slightly drier than that of sandbar willow may contain clumps of silver buffaloberry (*Shepherdia argentea*). Greasewood shrublands are known only from two small patches on Cuny Table in the South Unit and a small hilltop in the Badlands Wilderness Area of the North Unit. Finally, rabbitbrush (*Chrysothamnus nauseosus*) shrubs become dominant in disturbed sites throughout the project area, such as areas of road-construction.

Sparse vegetation can be found within areas of established prairie dog towns, covering approximately two percent of the park. Prairie dog towns occupy deeper soils on large flats dissected by drainages, such as in the Conata Basin. Prairie dogs through their cycle of burrow establishment, grazing, and burrow abandonment, may alter grassland vegetation types over time. This constant use causes the native vegetation to revert back to an early successional state dominated by annual forbs, many of which are non-native weeds. The soil disturbance associated with prairie dog towns also provides more opportunities for the most troublesome weeds to invade and some of the parks prairie dog towns have become infested with Canada thistle and yellow sweetclover. There are approximately 5000 acres of prairie dog towns in the park, of which about 2500 acres are infested with Canada thistle.

There is a diverse grassland mixture that intermingles in small units across the landscape, occupying approximately forty-five percent of the park. Western wheatgrass is the predominant grass occurring in the project area. This sod-forming grass thrives on clayey soils where it ranges from almost pure, monotypic stands on clay to a true mixed grass prairie on silty/sandy clays or loamy clays. Common associated species include various forbs and grasses such as prairie coneflower (*Ratibida columnifera*), white milkwort (*Polygala alba*), needle-and-thread (*Stipa comata*), and prairie dropseed (*Sporobolus heterolepis*).

Two non-native annual grasses, Japanese brome (*Bromus japonicus*) and downy brome (*B. tectorum*) are also usually present to some degree in all grassland associations, especially western wheatgrass stands. Western wheatgrass also tends to be replaced by blue grama in drier areas or places with increased grazing. This shorter grass often grows in association with needle-and-thread and threadleaf sedge (*Carex filifolia*), especially around the extremely dry edges of buttes and small tables. On gravelly soils, side draws, and broad swales, little bluestem becomes dominant, often in association with side-oats grama (*Bouteloua curtipendula*).

Unique and predictable grassland associations for this project include switchgrass, which occurs in very wet, shallow basins, and western wheatgrass / green needlegrass, which is present on selected hills, slopes, and buttes. The western wheatgrass / green needlegrass association is present on small rises and slopes of the North Unit and in somewhat flat sites with more soil moisture on buttes in the South Unit.

Prior to the Park's establishment agricultural or transportation activity disturbed approximately 5,100 acres that has been primarily re-vegetated by non-native grass species. Representative locations include road corridors in the Park seeded with smooth brome (*Bromus inermis*), old fields in the North Unit seeded with crested wheatgrass (*Agropyron cristatum*), and old pastures on Sheep Mountain Table grazed by sheep and invaded by Kentucky bluegrass (*Poa pratensis*). Other relatively common non-native species found in various disturbed sites include alfalfa (*Medicago sativa*), Canada thistle (*Cirsium arvense*), and giant ragweed (*Ambrosia trifida*). A biennial, yellow sweetclover (*Melilotus officianalis*) is an exotic that is widespread within the North Unit of the Park.

Approximately 109,715 acres of the park remain unvegetated or sparsely vegetated. Drought-tolerant shrubs such as silverscale saltbush (*Atriplex argentea*) and broom snakeweed (*Gutierrezia sarothrae*) and annual forbs can be found dispersed throughout variable badland environments/habitats (Von Loh et al. 1999).

Wildlife

There are a variety of wildlife resources that occupy woodlands, shrublands, and grasslands of Badlands National Park, including small mammals, ungulates, birds, reptiles, amphibians and invertebrates. There are at least fifty-five documented mammalian species within the park including five species of ungulates, more than 120 species of birds, over nineteen species of reptiles and amphibians, twenty-eight known species of lepidoptera along with numerous other arthropod species.

Common small mammal species observed include the least chipmunk (*Eutamius minimus)*, eastern cottontail rabbit (*Sylvilagus floridus*), thirteen lined ground squirrel (*Spermophilus tridecemlineatus*), black-tailed prairie dog (*Cynomys ludovicanus*), deer mouse (*Peromyscus maniculatus*) and muskrat (*Ondontra zibehicus*) and numerous other smaller rodents. Common meso-carnivores include the coyote (*Canis latrans*), bobcat (*Felis rufus*), red fox (*Vulpes vulpes*) and American badger (*Taxidea taxus*).

Ungulates within the park include mule deer (*Odocoileus hemionus)*, white-tailed deer (*O. virginianus)*, pronghorn antelope (*Antilocapra americana)*, bison (*Bison bison)*, and Rocky Mountain bighorn sheep (*Ovis canadensis canadensis*). Bison were restored to the park in 1963 and now number more than 700 animals. Bighorn sheep were also restored to the park in 1967 to fill the ecological niche formerly occupied by the now extinct Audubon's bighorn sheep. There are currently between forty-eight and seventy-four animals. In order to boost the population's genetics and reproductive capabilities the park is currently searching for other animals to translocate to Badlands National Pak

Common amphibians found within Badlands National Park include the Plains spadefoot toad (*Scaphiopus bombifrons*), Great Plains toad (*Cognatus bufonidae*) and the chorus frog (*Pseudacris triseriata*). Some common reptiles include the red-sided garter snake (Thamnophis sirtalis), western plains garter (*Thamnophis radix*), western plains hinges (*Heterodox nascius*), bullsnake (*Pituophis melanoleuc*) and prairie rattlesnake (*Crotalus viridis*).

Common bird species within Badlands National Park include the Northern Harrier (*Circus cyaneus*), Ferruginous Hawk (*Buteo regalis*) , Red-tailed Hawk (*Buteo jamaicensis*), Prairie falcon (*Falco mexicanus*), Sharp-tailed Grouse (*Tympanuchus phasianellus*), Killdeer *(Charadrius vociferus*), Mourning Dove (*Zenaida macroura*), Burrowing Owl (*Athene cunicularria*), Red-headed Woodpecker (*Melanerpes erythrocephalus*), Yellow-shafted Flicker (*Colaptes auratus*), Eastern Kingbird (*Tyrannus tyrannus*), Bell's Vireo (*Vireo bellii*), Warbling Vireo (*Vireo gilvus*), black-billed Magpie (*Pica pica*), American Crow (*Corvus brachyrhynchos*) Bank Swallow (*Riparia riparia*), Cliff Swallow (*Hirundo pyrrhonota*), Barn Swallow (*Hirundo rustica*), Mountain Bluebird (*Sialia currucioides*), American Robin (*Turdus migratorius*), Field sparrow *(Spizella pusilla*), Dickcisssel (*Spiza americana*), and Red-winged Blackbird (*Agelaius phoeniceus*).

Common butterfly species found within Badlands National Park include the Eastern Tiger Swallowtail (*Pterourus glaucus*), checkered white (*Pontia protodice*), cabbage white *(Pieris rapae*), clouded sulphur (*Colias philodice*), Striped Hairstreak (*Satyrium liparops*), Melissa Blue (*Lycaeides melissa*), Regal Fritillary (*Speyeria idalia*), Atlantis Fritillary (*Speyeria atlantis*), Variegated Fritillary (*Euptoieta claudia*), Pearl Crescent (*Phyciodes tharos*), Wiedemer's Admiral (*Basilarchia weidemeyerii*), Viceroy (*Basilarchia archippus*), Mourning Cloak (*Nymphalis antiopa*), Red admiral (*Vanessa atalanta*), Painted Lady (*Vanessa cardui*), Hackberry Emperor (*Asterocampa celtis*), Common Wood Nymph (*Cercyonis pegala*) Common Checked Skipper (*Pyrgus communis*) and the Delaware Skipper (*Anatrytone logan*). Several species of grasshoppers and crickets (Orthoptera) along with elm leaf beetles (*Pyrrhalta luteola*) and elm bark beetles (*Scolytus multistriatus*) are also common within Badlands National Park.

Threatened and Endangered Species

Several federal-listed species are known to exist in and around the Badlands National Park area and utilize a variety of habitats within the system. The threatened bald eagle (*Haliaeetus leucocephalus*) is a migrant or winter resident in mature riparian timber along rivers, and occasionally uses prairie dog colonies as feeding sites. The endangered whooping crane (*Grus americana*) makes use of shallow, sparsely vegetated wetlands, wet meadows, and agricultural fields during spring and fall migrations. The threatened peregrine falcon (*Falco peregrinus*) may nest on shelves or in crevices in the rugged badlands features. Little is known about the current population densities of these birds in the Badlands, other than occasional sightings of individuals. The endangered gray wolf (*Canis lupus*) is no longer found in the park area, or the State of South Dakota. The endangered American burying beetle (*Nicrophorus americanus*) was historically found in the area, but it is unlikely that it is found within Badlands National Park since it generally requires the moist loam soils that are found further east. The black-tailed prairie dog (*Cynomys ludovicanus*) is a social, burrowing, resident rodent species that utilizes low lying, grassland areas within the local landscape in fragmented towns that cover approximately two percent of the total park acreage. It is currently considered a candidate species as "warranted but precluded from listing" by the U.S. Fish and Wildlife Service while state working groups develop individual management plans to ensure its survival as a species. Future management of prairie dogs will have to consider this candidate status designation and the associated protection it affords. The Buffalo Gap National Grassland/Badlands National Park

population of prairie dogs is one of the largest in South Dakota, which makes it essential to the endangered black-footed ferret (*Mustela nigripes),* a nocturnal member of the weasel family and resident obligate of the prairie dog town ecosystem.

Black-footed ferret reintroductions occurred in Badlands National Park from 1994-1999. Current population estimates are between fifteen and thirty individuals within Badlands National Park and an additional 200 individuals on the surrounding Buffalo Gap National Grasslands. This is the largest free-ranging wild population of black-footed ferrets in North America.

NPS policy directs National Parks to give State-listed species the same consideration as Federal-listed species. The South Dakota state-threatened swift fox (*Vulpes velox*) is a small canine that utilizes open grasslands and dens in burrows, generally in and around prairie dog towns. Swift fox are known to reside locally, but population status is unknown. The swift fox is not a federally listed species. There are occasional sightings of mountain lions (*Felis concolor*), a state threatened species. The population is likely expanding out from the Black Hills along the Cheyenne River drainage. Five state-listed rare plants are known to occur in and around the park and grow in open dry plains: Dakota buckwheat (*Eriogonum visheri*), Barr's milkvetch (*Astragalus barrii*), and Secund bladderpod (*Lesquerella arenosa var. argillosa*) are endemic to the region, Easter daisy (*Townsendia exscapa*) and largeflower townsend-daisy (*Townsendia grandiflora*) may occur in the park at the edge of their range. None of the species are known to occur in association with targeted weed species.

Paleontological Resources

The White River Badlands contain the largest assembly of known late Eocene and Oligocene mammal fossils. The area is the birthplace of vertebrate paleontology in North America beginning with the description of a titanothere mandible in 1846 by Dr. Hiram Prout. Since then numerous important finds from the area have served to define the geologic period. Oligocene fossil remains include camels, three-toed horses, oreodonts, antelope-like animals, rhinoceroses, false deer, rabbits, beavers, creodonts, land turtles, rodents and birds.

Marine fossils are found in deposits of an ancient sea that existed in the region some sixty-five to eighty million years ago during the Cretaceous period. Fossils found in the Pierre Shale and Fox Hills Formations include ammonites, nautiloids, fish, marine reptiles and turtles.

The spectacular vertebrate fossils preserved within the White River Badlands have been studied extensively since 1846 and are included in museum collections throughout the world. Small percentages of the Badlands National Park have been surveyed for fossil resources. Most of these areas consist of historic research sites (Clark et al. 1967) and small-scale projects completed by individual contracts and paleontological interns (Terry 1995, Cicimurri 1995, Lala 1996, Martin and McConnell 1998, Martin and DiBenedetto 1997,1998). A pre-construction survey was completed along the Badlands Loop Road in 1996, 1997 and 1998 (Benton 1998). A three-year baseline survey of fossil bone beds in the Scenic Member of the Brule Formation began in the summer of 2000. Very little paleontological data has been entered into the park Geographic Information System

(GIS). More paleontological sites will be recorded in GIS once the program has fully expanded.

Water Resources

The uplift of the Black Hills occurred about sixty million years ago. Streams from the Black Hills region carried sediments into a large structural basin that defines the Badlands today. Between 500,000 and one million years ago, the main deposition of sediments ended as a result of the capture of Black Hills drainages by the Cheyenne River. Starved of sediments, erosion became the dominant geologic process for the land surface of Badlands National Park (Gries 1996).

The Badlands Wall divides the drainage of the park between the upper grasslands drainage by Sage Creek (Cheyenne River drainage basin) and the Bad River, and the lower grasslands drainage by the White River (Froiland 1990). The greatest volume of sediment eroded from the Badlands Wall flows into the White River. Both the White River and the Cheyenne River are listed in the National Rivers Inventory, a register of rivers that may be eligible for inclusion in the National Wild and Scenic River System. These rivers were included on the National Rivers Inventory based on the degree to which they are free-flowing, the degree to which the rivers and their corridors are undeveloped, and the outstanding natural and cultural characteristics of the rivers and their immediate environments.

A significant part of annual precipitation at Badlands National Park comes in the form of intense summer thunderstorms. The low permeability and low moisture capacity cause the majority of precipitation to flow overland instead of infiltrating in the soil. As the clay swells, infiltration of rainfall rapidly decreases and the percent of rainfall transformed into overland runoff increases. High volumes of overland flow in conjunction with steep slopes erode the poorly indurated bedrock into the pinnacles erosional gullies and arroyos unique to Badlands National Park (Fontaine 2001).

Two hyrologically dissimilar terraines are found at Badlands National Park. North of the Badlands Loop Road (the upper prairie) is a broad flat mesa supporting a short to medium grass prairie, which protects friable underlying bedrock from erosion. The drainage in these areas is well defined by ephemeral streams and wetlands areas leading to artificial wildlife impoundments. In contrast, the "lower prairie" exhibits classical badlands features of eroded remnant surfaces, dissected by gullies and arroyos, supporting sparse vegetation. Drainage patterns in these areas are defined by erosive channels, draining into intermittent streams flowing ultimately into the White River to the south (Fontaine and Tinant 2001). In structurally disturbed areas, ground water travels to the surface in the form of springs. An example of this is found in the park at the Civilian Conservation Corps (CCC) spring.

Water for park facilities comes from a recently constructed rural water distribution system known as the West River Lyman/Jones Mni Wiconi Water Project (Black and Veatch 1998). However, many local ranches are served by shallow groundwater wells within the White River Alluvial aquifer. There are several stock ponds that provide water for wildlife in the Badlands Wilderness Area. The water quality in the area varies seasonally and from stream to stream. There is no regular monitoring program for

determining the causes of water quality fluctuation. In the near future, it is expected that treated water from the Missouri River would be available to selected areas of the park from.

There are two regulatory floodplains within the park. The White River, a perennial stream, has a 100-year flood elevation of 2,615 feet above sea level and 500-year flood elevation of 2,617 feet above sea level. Sage Creek, a semi-perennial stream has a 100-year flood elevation of 2,529 feet above sea level (Martin 2001)

Wetlands are rare in the badlands landscape and are generally confined to ephemeral drainage channels, floodplains and two spring complexes. The two spring complexes are found along the edge of Quinn Table along the northwest boundary of the park and Cuny Table along the southern boundary of the park. In both cases, the recharge area is primarily outside the park on large tables capped by windblown soils. The floodplains with wetland characteristics are associated with the White River, Sage Creek, and ephemeral tributaries to these two bodies of water. The park's vegetation map shows four vegetation classes that are associated with vegetated wetlands: Switchgrass Grassland, occupying 443 acres; Emergent Wetland Grassland, occupying 591 acres; Sandbar Willow Temporarily Flooded Shrubland, occupying thirteen acres, and Eastern Cottonwood – Peachleaf Willow/Sandbar Willow Shrubland, occupying 130 acres.

Wilderness

Wilderness was designated in Badlands National Park in 1976 (PL 94-567). The Badlands Wilderness Area (Wilderness) encompasses nearly 64,250 acres in two units, the Sage Creek Unit (approximately 54,000 acres) and the Conata Unit (approximately 10,000 acres).

The Wilderness contains extensive badlands features and expanses of rolling prairie. Most visitors only view the Wilderness from viewpoints along the Loop and Sage Creek roads. No permits are required for entering the Wilderness, but due to the high summer temperatures and limited water sources, visitation is quite low and limited mostly to the Sage Creek Unit. For those who are adventurous and prepared, day-hiking, overnight backpack trips and horseback riding are enjoyed in the Wilderness. The Sage Creek Road is the primary access point for hikers and horse users venturing into the Wilderness, particularly the primitive automobile-access Sage Creek campground and Badlands Wilderness Overlook.

There are no trails or facilities in the Wilderness. Although due to the great sight distances, human intrusions such as ranch buildings and communication towers located outside the park can be seen from several areas within the Wilderness. Also vehicles on roads can be seen from parts of the Wilderness. Both Wilderness units are fenced along the park boundary where necessary to keep bison in and cattle out. Pre-existing water impoundments are considered essential to maintaining the bison herd and bighorn sheep populations, so currently explosives are used in the Wilderness to clear sediments from impoundments identified as wildlife watering sources. The retention and maintenance of these impoundments was specifically addressed in both a Senate Report and the original Wilderness Recommendation (National Park Service 1972, U.S. Congress 1976).

Overall, human presence in the Wilderness is very limited, and the chance of one visitor group encountering another in the core of the Sage Creek Unit is slight. The greatest human presence is likely management activities in the form of paleontological research, exotic plant control, and black-footed ferret monitoring. Previously, (1993-1999) intensive management for black-footed ferret re-introductions (predator exclosures around prairie dog towns) and associated research (exclosures for determining the effects of prairie dogs on vegetation), as well as pre-Wilderness homestead barbed wire fencing, were the greatest intrusions on the wilderness character. With ferret re-introduction success, the predator exclosures have been removed, although researchers still have several sets of large fenced exclosures in place. Barbed wire from homesteads is presently in the final phase of removal. There is little remaining evidence of the cattle grazing, haying and homesteading that existed in the area in the earlier part of the 20th century.

Wilderness attributes, such as opportunities for solitude and self-discovery, night sky viewing, and natural sounds and odors, are well preserved within the Wilderness, particularly the larger and more rugged Sage Creek Unit.

Cultural Resources - Archaeology

Badlands National Park lies in the Plains Culture Area. Archaeologists have defined the Plains Culture on the basis of the character of material remains from prehistoric sites and have outlined a sequence of changes in those remains. Documentation of these changes in association with materials that can be dated using absolute dating techniques (e.g. radiocarbon) has allowed archaeologists to assign a general time frame to variations in the material culture. Using these and other techniques, a broad sequence of culture history has been defined for the region and divided into four periods and/or cultural affiliations: Paleo-Indian (11,500 to 8,000 BP), Plains Archaic Tradition (8,000 to 1,500 BP), Late Prehistoric Period (1,500 BP to 1700s), and Protohistoric/Historic Period (1675 to1920s).

Currently ten percent of the land area within the Pinnacles and Cedar Pass Districts has been surveyed for archeological resources. Fieldwork for this survey was completed in 2000 as part of a five year study being conducted jointly by Augustana College and the NPS Midwest Regional Archeological Center. Prior to this survey, less than one percent of the total land area within the park had been surveyed for archeological resources. Less than one percent of the Stronghold District has been surveyed for archaeological resources. Most of the prior archeological surveys conducted in the park (Beaubien, 1953; Taylor, 1961; Britte, 1970; Kay, 1974; Falk, 1976; and Anderson, 1978) have been on a specific project-related basis in response to construction needs. The only exception to this is Britte's (1970) study at Site 39JK2. As of January, 2001 only 283 sites have been identified. Site types are primarily lithic and artifact scatters. There are two identified historic farmsteads and two structures with wooden remnants. Due to homesteading in the early 1900s, scatters of historic materials dot the prairie landscape, particularly in the Sage Creek area; 236 sites have fair to good documentation on file while forty-seven are considered poorly documented. There are ninety sites considered to be in fair to good condition, ten in poor condition or have been destroyed, and 183 lack site condition evaluations.

All archeological sites within the park are protected by federal legislation (Antiquities Act of 1906, 1979 Archeological Resources Protection Act, Executive Order 11593), Section 110 of the National Historic Protection Act and their management is guided by *NPS-28: Cultural Resource Management Guideline*. Further survey and evaluation of the park's archeological resources may also yield archeological remains that warrant future nominations to the National Register. One site, 39JK4, known as the Johnny Site, is the only site in the park that has been evaluated for National Register consideration. It was found eligible and was placed on the National Register (Jones 1996, Littlefield 2000). Badlands National Park archeological sites are described and located in the *Cultural Sites Inventory* book maintained in the Chief of Resource Education's office at Cedar Pass. The weed management team should consult the Inventory and the Cultural Component of the Resource Management Plan when planning mechanical treatment or fire. The potential for adverse impacts to cultural resources would be evaluated prior to prescribed burning during development of each burn plan and based upon consultation with the State Historic Preservation Office, steps would be taken to avoid, minimize, and mitigate impacts to archaeological resources.

Cultural Resources – Landscapes

The park has not yet been inventoried for cultural landscapes. It is scheduled to be inventoried in 2004 as a part of the Midwest Region's Cultural Landscapes Inventory Plan. Park staff has identified five possible cultural landscapes:

- The route of Bigfoot's band through the White River Badlands to Wounded Knee,
- The historic fossil collecting camps,
- The Fort Pierre to Fort Laramie Road,
- The cluster of homesteads found in the Sage Creek basin, and
- The site of one of the last known Ghost Dances, conducted on Stronghold Table in 1890.

Cultural Resources – Ethnography

American Indians use many areas within the park as spiritual sites. Activity at these sites usually consist of small offerings, usually small packets of tobacco, tied to a tree or bush. Tables, primarily those in the South Unit, are ethnobotanically important to the neighboring Lakota of the Oglala Sioux Tribe as places to gather plants for traditional purposes as provided for in the Superintendent’s Compendium. (White 2001) Park staff is aware of the general areas where such activities take place.

II. Legal Authorities and Policies

A. Federal Regulations and Guidelines

B. NPS Guidelines
- Definition of Native and Exotic Species
- Management of Exotic Species
- Removal of Exotic Species Already Present
- Pest Management
- Pests
- Integrated Pest Management Program
- Pesticide Use
- Biological Control Agents and Bio-engineered Products
- Pesticide Purchase and Storage

C. State Regulations

D. Tribal Regulations
- Oglala Sioux Tribe Pesticide Code and Certification Plan
- Oglala Sioux Tribe Environmental Review Ordinance
- Oglala Sioux tribe Ordnance Ordinance
- Oglala Sioux Tribe Ground Water Protection Plan

II. A. Federal Regulations and Guidelines

The Federal Insecticide, Fungicide and Rodenticide Act (FIFRA) and the regulations established by the Environmental Protection Agency (40 Code of Federal Regulations (CFR) 116-117, 165, 170-172) are the primary guidance governing pesticide registration, pesticide usage, the training and certification of pesticide applicators, and the criminal and civil penalties associated with the misuse of pesticides. FIFRA also delegates the enforcement of FIFRA to the individual states.

Under the Occupational Health and Safety (OSHA) Hazard Communication Standard (29 CFR 1910.1200), employers must provide workers with training, protective equipment, and information about hazardous substances. The employer is also required to maintain Material Safety Data Sheets about these substances and to provide the employee with a copy of the sheets if they are requested.

Section 2 of Executive Order 13112 on Invasive Species, signed February 1999, directs federal agencies to identify actions that may affect the status of invasive species and take action to: (i) prevent the introduction of invasive species; (ii) detect and respond rapidly to and control populations of such species in a cost- effective and environmentally sound manner; (iii) monitor invasive species populations accurately and reliably; (iv) provide for restoration of native species and habitat conditions in ecosystems that have been invaded; (v) conduct research on invasive species and develop technologies to prevent introduction and provide for environmentally sound control of invasive species; and (vi) promote public education on invasive species and the means to address them. This Executive Order also established the Invasive Species Council and authorized them to develop and implement a National Invasive Species Management Plan. The Badlands Weed Management Plan and Environmental Assessment is consistent with the National Invasive Species Management Plan.

II. B. NPS Guidelines

This plan describes a weed management strategy that is consistent with 2001 NPS Management Policies (National Park Service 2001*a*). The most relevant sections are provided below.

<u>Definition of Native and Exotic Species (4.4.1.3)</u>

“Native species” are defined as all species that have occurred or now occur as a result of natural processes on lands designated as units of the national park system. Native species in a place are evolving in concert with each other. “Exotic species” are those species that occupy or could occupy park lands directly or indirectly as the result of deliberate or accidental human activities. Exotic species are also commonly referred to as non- native, alien, or invasive species. Because an exotic species did not evolve in concert with the species native to the place, the exotic species is not a natural component of the natural ecosystem at that place.

Management of Exotic Species (4.4.4)

Exotic species will not be allowed to displace native species if displacement can be prevented.

Removal of Exotic Species Already Present (4.4.4.2)

All exotic plant and animal species that are not maintained to meet an identified park purpose will be managed— up to and including eradication— if (1) control is prudent and feasible, and (2) the exotic species:

- Interferes with natural processes and the perpetuation of natural features, native species or natural habitats; or
- Disrupts the genetic integrity of native species; or
- Disrupts the accurate presentation of a cultural landscape; or
- Damages cultural resources; or
- Significantly hampers the management of park or adjacent lands; or
- Poses a public health hazard as advised by the U. S. Public Health Service (which includes the Centers for Disease Control and the NPS Public Health Program); or
- Creates a hazard to public safety.

High priority will be given to managing exotic species that have, or potentially could have, a substantial impact on park resources, and that can reasonably be expected to be successfully controllable. Lower priority will be given to exotic species that have almost no impact on park resources or that probably cannot be successfully controlled. The decision to initiate management should be based on a determination that the species is exotic. For a species determined to be exotic and where management appears to be feasible and effective superintendents should: (1) evaluate the species' current or potential impact on park resources, (2) develop and implement exotic species management plans according to established planning procedures, (3) consult, as appropriate, with federal and state agencies, and (4) invite public review and comment, where appropriate. Programs to manage exotic species will be designed to avoid causing significant damage to native species, natural ecological communities, natural ecological processes, cultural resources, and human health and safety.

Pest Management (4.4.5)

All park employees, concessionaires, contractors, permittees, licensees, and visitors on all lands managed or regulated by the National Park Service will comply with NPS pest management policies.

Pests (4.4.5.1)

Pests are living organisms that interfere with the purposes or management objectives of a specific site within a park, or that jeopardize human health or safety. Decisions that concern whether or not to manage a pest or pest population will be influenced by whether the pest is an exotic or a native species. Exotic pests will be managed

according to the exotic species policies in section 4. 4. 4. Native pests will be allowed to function unimpeded, except as noted below. Many fungi, insects, rodents, disease organisms, and other organisms that may be perceived as pests are, in fact, native organisms existing under natural conditions and are natural elements of the ecosystem. Also, native pests that were evident in pesticide- free times are traditional elements in park cultural settings.

The Service may control native pests to:

- Conserve threatened, rare, or endangered species, or unique specimens or communities;
- Preserve, maintain, or restore the ecosystem;
- Preserve, maintain, or restore the historical integrity of cultural resources;
- Conserve and protect plants, animals, and facilities in developed areas;
- Prevent outbreaks of a pest from invading uninfested areas outside the park; or
- Manage a human health hazard when advised to do so by the U. S. Public Health Service (which includes the Centers for Disease Control and the NPS Public Health Program), or to otherwise protect against a significant threat to human safety.

Integrated Pest Management Program (4.4.5.2)

The Service conducts an integrated pest management (IPM) program to reduce risks to the public, park resources, and the environment from pests and pest- related management strategies. IPM is a decision- making process that coordinates knowledge of pest biology, the environment, and available technology to prevent unacceptable levels of pest damage, by cost- effective means, while posing the least possible risk to people, resources, and the environment.

The Service, and each park unit, will use an IPM approach to address pest issues. Proposed pest management activities must be conducted according to the IPM process prescribed in Director's Order #77- 7: Integrated Pest Management. Pest issues will be reviewed on a case- by- case basis. Controversial issues, or those that have potential to negatively impact the environment, must be addressed through established planning procedures and be included in an approved park management or IPM plan. Integrated Pest Management procedures will be used to determine when to implement pest management actions, and which combination of strategies will be most effective for each pest situation. Under the Service's IPM program, all pesticide use on lands managed or regulated by the Service, whether that use was authorized or unauthorized, must be reported annually.

Pesticide Use (4.4.5.3)

A pesticide, as defined by the Federal Insecticide, Fungicide and Rodenticide Act, is any substance or mixture that is used in any manner to destroy, repel, or control the growth of any viral, microbial, plant, or animal pest. Except as identified in the next paragraph, all prospective users of pesticides in parks must submit pesticide use requests, which will be reviewed on a case-by- case basis at the regional office or Washington Office level, taking into account environmental effects, cost and staffing, and other relevant

considerations. The decision to incorporate a chemical, biological, or bio- engineered pesticide into a management strategy will be based on a determination by a designated IPM specialist that it is necessary, and that all other available options are either not acceptable or not feasible.

As one of the primary purposes of the process is to protect employees, insect repellents, bear deterrent sprays, and insecticides applied to persons or to livestock must conform to NPS policies and approval procedures, except that pesticides used under the following conditions do not require approval:

- Cleansers and disinfectants used in restrooms and restaurants;
- Personal insect repellents, insecticides, and bear deterrent sprays that employees or park visitors personally obtain and use to meet personal needs; or
- Insect repellents and insecticides applied to personally owned pets, pack and saddle stock.

Biological Control Agents and Bio-engineered Products (4.4.5.4)

The application or release of any bio- control agent or bio-engineered product relating to pest management activities must be reviewed by designated IPM specialists in accordance with Director's Order #77- 7, and conform to the exotic species policies in section 4.4.4.

Pesticide Purchase and Storage (4.4.5.5.)

Stockpiling pesticides should be avoided to the extent possible. No pesticides may be purchased unless they are authorized and are expected to be used within one year from the date of purchase. Pesticide storage, transport, and disposal will comply with procedures established by the Environmental Protection Agency, the individual states in which parks are located, and Director's Order #30A: Hazardous and Solid Waste Management, Director's Order #77- 1: Wetland Protection, and Director's Order #77- 7.

II. C. State Regulations

Under state law, the State of South Dakota must maintain a list of state declared noxious weeds and counties may declare additional species as local noxious weeds. As of the date of this plan, the following species were state declared noxious weeds: Field bindweed, Canada thistle, leafy spurge, perennial sow thistle, hoary cress, Russian knapweed, and purple loosestrife. Of the three counties that Badlands National Park occurs within, only Pennington County has listed additional species as locally declared noxious weeds: Houndstongue, Dalmation toadflax, spotted knapweed, puncturevine, common tansy, and saltcedar.

Implementation of this Integrated Weed Management Plan will conform with those State laws pertinent to pesticide applicator certification, including testing, reporting, and inspection requirements (38 South Dakota State Code 20-22).

II. D. Tribal Regulations

Approximately 122,000 acres of Badlands National Park is tribal land located on the Pine Ridge Reservation of the Oglala Sioux Tribe (OST) administered for park purposes by the National Park Service under a Memorandum of Agreement. Weed management activities on Tribal lands will conform to the following Tribal Ordinances: Pesticide Code (Oglala Sioux Tribe 1991), Ordnance Ordinance (Oglala Sioux Tribe 1996), and Environmental Ordinance (Oglala Sioux Tribe 1998) as well as the Tribe's Ground Water Protection Plan (Oglala Sioux Tribe 1997).

Oglala Sioux Tribal Pesticide Code and Certification Plan (Ordinance No. 91-13)

All weed management activities located on these lands, the park's South Unit, will conform with the OST Pesticide Code and Certification Plan (Oglala Sioux Tribe 1991). The pesticide code conforms to the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA). The Tribe is authorized by the Environmental Protection Agency to certify private and commercial pesticide applicators pursuant to Section 11, paragraph (a) (2) of FIFRA of 1972 as amended [Public Law 92-516] and the regulations promulgated thereunder [40 CFR part 171]. The Tribal Council has designated the OST Land and Natural Resources Committee as the Lead Agency responsible for administering the Tribal Pesticide Code and Certification Plan. This Badlands National Park Integrated Weed Management Plan and Environmental Assessment was developed in cooperation with the Tribe's Pesticide Enforcement Officer. Concurrent with public review, this Integrated Weed Management Plan and Environmental Assessment will be submitted for review by the OST Land and Natural Resources Committee.

Oglala Sioux Tribe Environmental Review Ordinance (Ordinance No. 98-08)

This ordinance requires that proposed actions within the Reservation that may have an effect on the health and environment be presented for review and input by the Tribe's Environmental Health Technical Team. Concurrent with public review, this Integrated Weed Management Plan and Environmental Assessment will be submitted for review by the OST Environmental Health Technical Team.

Oglala Sioux Tribe Ordnance Ordinance (Ordinance No. 96-19)

This ordinance requires that planning activities on the former Badlands Bombing Range area seek clearance from the Badlands Bombing Range Project and OST Land Committee before initiating activity. Concurrent with public review, this Integrated Weed Management Plan and Environmental Assessment will be submitted for review by the Badlands Bombing Range Project Office.

Oglala Sioux Tribe Ground Water Protection Plan

All weed management activities located on the park's South Unit will conform to the OST Ground Water Protection Plan (Oglala Sioux Tribe 1997). Maintaining high quality

ground water and protecting that ground water from contamination is the goal and basis for planning the OST Ground Water Protection Plan. The Tribal Council has designated the OST Natural Resources Regulatory Agency as the Lead Agency responsible for administering the Ground Water Protection Plan in cooperation with the Lands Committee and the Tribal Council. The environmental consequences section of this Weed Management Plan and Environmental Assessment includes a general analysis of impacts to water quality for each alternative considered. Furthermore, Appendix C is an analysis of soils vulnerability and proposed best management practices for chemical use in certain areas of the South Unit as required by the Ground Water Protection Plan. This portion of the plan was developed in cooperation with the Oglala Sioux Tribe Pesticide Enforcement Officer. Concurrent with public review, this Integrated Weed Management Plan and Environmental Assessment will be submitted for review by OST Natural Resources Regulatory Agency.

III. Weed Prioritization for Treatment

A. Alien Plant Ranking System
   1. Program description
   2. Species analyzed (table 1)
   3. Analysis methods

B. Analysis results
   1. Rank by Impact (table 2)
   2. Rank by Pest (table 3)
   3. Rank by Control (table 4)
   4. Quadrants (figure 2)
      - Quadrat 1 – High Impact, Hard to Control
      - Quadrat 2 – High Impact, Easy to Control
      - Quadrat 3 – Low Impact, Easy to Control
      - Quadrat 4 – Low Impact, Hard to Control

III. A. Alien Plant Ranking System

III. A. 1. Program description

The Alien Plants Ranking System (APRS) is a computer-implemented system to help land managers make difficult decisions concerning invasive nonnative plants. The management of invasive plants is difficult, expensive, and requires a long-term commitment. Therefore, land managers must focus their limited resources, targeting the species that cause major impacts or threats to resources within their management, or the species that impede attainment of management goals. APRS provides an analytical tool to separate the innocuous species from the invasive ones. APRS not only helps identify those species that currently impact a site, but also those that have a high potential do so in the future. Finally, the system addresses the feasibility of control of each species, enabling the manager to weigh the costs of control against the level of impact (APRS Implementation Team 2000).

APRS was used to analyze plants for integrated weed management at Badlands National Park. This analysis provides the basis for treatment priority for Alternatives 2 and 3 presented in this plan.

III. A. 2. Species analyzed

The vascular plant inventory for Badlands National Park includes 457 species and is thought to be more than ninety percent complete. Of those 457 species, seventy-one species are exotic. All known exotic plant species were considered. This list of seventy-one species has been compiled over years from various research studies conducted in the park and is part of the park's herbarium database of museum vouchers. In addition to the seventy-one species reported to occur in the park, it was decided to include three noxious species that currently do not occur in the park but are expected to invade the park during the life of this management plan. Those three species are leafy spurge (*Euphorbia esula*), hoary cress (*Cardaria draba*) and Dalmation toadflax (*Linaria dalmatica*). In total, seventy-four species were considered for possible analysis in the Alien Plant Ranking System (APRS).

Starting with a list of weed species known to occur in and around the park, all perennials and biennials were chosen for analysis due to their persistence and the potential for both seed and vegetative propagation. Annuals were considered on a species by species basis. The vast majority of annual weed species occurs in very limited distributions, primarily associated with disturbed areas. Most of the species have been in the area for a long time and are likely to continue to exist in disturbed areas, posing little threat to native species. However, there are four annual species that interfere with a management purpose and were included in the APRS analysis. Japanese brome (*Bromus japonicus*) and downy brome (*Bromus tectorum*) are very common along foot and game trails and have both demonstrated an ability to spread into native prairie where they directly compete with native species. Halogeton (*Halogeton glomeratus*) is common on badland features in the Cedar Pass area and is poisonous to ungulates. At high density it may pose a risk to the park's bighorn sheep population. Puncturevine (*Tribulus terrestris*) is common along the edges of park's gravel roads and frequently causes flat tires on bikes

used by park visitors, thus interfering with the visitor experience. In total, forty-two species were analyzed.

III. A. 3. Analysis methods

Data regarding species biology was gathered from the APRS factsheets and other reference materials (Johnson 1999, McGregor 1986, Stubbendieck 1995, Whitson 1991). Data regarding species distribution and habit in Badlands was gathered from site specific reports and local knowledge of resource management staff and researchers. Due to the difficulty in accessing much of the park and the dynamic nature of the annual precipitation, the distribution and habit may contain inaccuracies but represents the best information currently available.

Table 1. List of all exotic plant species known and expected to occur in Badlands National Park. The APRS column indicates whether the species was included for analysis with the Alien Plant Ranking System process for Badlands National Park.

Scientific Name	Common Name	Family	Life History	APRS
Agropyron cristatum	crested wheatgrass	Poaceae	Perennial grass	yes
Agropyron intermedium	intermediate wheatgrass	Poaceae	Perennial grass	yes
Amaranthus hybridus	slender pigweed	Amaranthaceae	annual forb	no
Anthemis cotula	mayweed camomile	Asteraceae	annual forb	no
Arctium lappa	burdock	Asteraceae	Biennial forb	yes
Asparagus officinalis	garden asparagus	Liliaceae	Perennial forb	yes
Brassica nigra	black mustard	Brassicaceae	annual forb	no
Bromus inermis	smooth brome	Poaceae	Perennial grass	yes
Bromus japonicus	Japanese brome [1]	Poaceae	annual grass	yes
Bromus squarrosus	brome	Poaceae	annual grass	no
Bromus tectorum	downy brome [1]	Poaceae	annual grass	yes
Camelina microcarpa	small-seeded false flax	Brassicaceae	annual forb	no
Capsella bursa-pastoris	shepherd's purse	Brassicaceae	annual forb	no
Cardaria draba	hoary cress [2, 3]	Brassicaceae	Perennial forb	yes
Carduus nuttans	musk thistle	Asteraceae	Biennial forb	yes
Centaurea cyanus	cornflower	Asteraceae	annual forb	no
Centaurea maculosa	spotted knapweed [3]	Asteraceae	Biennial forb	yes
Centaurea repens	Russian knapweed [3]	Asteraceae	Perennial forb	yes
Cerastium vulgatum	mouseear chickweed	Caryophyllaceae	Perennial forb	yes
Chenopodium album	lamb's quarter	Chenopodiaceae	annual forb	no
Chenopodium capitatum	strawberry blite	Chenopodiaceae	annual forb	no
Chenopodium leptophyllum	goosefoot	Chenopodiaceae	annual forb	no
Cirsium arvense	Canada thistle [3]	Asteraceae	Perennial forb	yes
Cirsium vulgare	bull thistle	Asteraceae	Biennial forb	yes
Conringia orientalis	hare's-ear mustard	Brassicaceae	annual forb	no
Convolvulus arvensis	field bindweed [3]	Convolvulaceae	Perennial forb	yes
Cynoglossum officinale	houndstongue [3]	Boraginaceae	Biennial forb	yes
Dactylis glomerata	orchard grass	Poaceae	Perennial forb	yes
Descurainia sophia	flixweed tansy mustard	Brassicaceae	annual forb	no
Echinochloa crusgalli	barnyard grass	Poaceae	annual forb	no
Elaeagnus angustifolia	Russian olive	Elaeagnaceae	Perennial tree	yes
Elytrigia repens	quackgrass	Poaceae	Perennial grass	yes
Eragrostis cilianensis	stinkgrass	Poaceae	annual grass	no
Euphorbia esula	leafy spurge [2, 3]	Euphorbiaceae	Perennial forb	yes

Festuca pratensis	meadow fescue	Poaceae	Perennial grass	yes
Halogeton glomeratus	common halogeton [1]	Chenopodiaceae	annual forb	yes
Hesperis matronalis	dame's rocket	Brassicaceae	Biennial forb	yes
Hyoscyamus niger	black henbane	Solanaceae	Biennial forb	yes
Kochia scoparia	kochia	Chenopodiaceae	annual forb	no
Lactuca serriola	prickly lettuce	Asteraceae	annual forb	no
Lappula echinata	blue stickseed	Boraginaceae	annual forb	no
Lepidium perfoliatum	clasping peppergrass	Brassicaceae	annual forb	no
Linaria dalmatica	dalmation toadflax [2, 3]	Scrophulariaceae	Perennial forb	yes
Malva neglecta	common mallow	Malvaceae	annual forb	no
Malva rotundifolia	common mallow	Malvaceae	annual forb	no
Medicago lupulina	black medic	Fabaceae	annual forb	no
Medicago sativa	alfalfa	Fabaceae	Perennial forb	yes
Melilotus alba	white sweetclover	Fabaceae	Biennial forb	yes
Melilotus officinalis	yellow sweetclover	Fabaceae	Biennial forb	yes
Nepeta cataria	catnip	Lamiaceae	Perennial forb	yes
Phleum pratense	Timothy grass	Poaceae	Perennial grass	yes
Poa palustris	fowl bluegrass	Poaceae	Perennial grass	yes
Poa pratensis	Kentucky bluegrass	Poaceae	Perennial grass	yes
Polygonum convolvulus	climbing buckwheat	Polygonaceae	annual forb	no
Portulaca oleracea	common purslane	Portulacaceae	annual forb	no
Rumex stenophyllus	dock	Polygonaceae	Perennial forb	yes
Salsola iberica	Russian-thistle	Chenopodiaceae	annual forb	no
Setaria glauca	yellow foxtail	Poaceae	annual grass	no
Setaria viridis	green foxtail	Poaceae	annual grass	no
Sisymbrium altissimum	tumblemustard	Brassicaceae	annual forb	no
Sonchus arvensis	perennial sow thistle [3]	Asteraceae	Perennial forb	yes
Stellaria media	common chickweed	Caryophyllaceae	annual forb	no
Tamarix parviflora	saltcedar	Tamaricaceae	Perennial tree	yes
Taraxacum officinale	common dandelion	Asteraceae	Perennial forb	yes
Thlaspi arvense	field pennycress	Brassicaceae	annual forb	no
Tragopogon dubius	western salsify	Asteraceae	Biennial forb	yes
Tragopogon porrifolius	vegetable oyster	Asteraceae	Biennial forb	yes
Tragopogon pratensis	meadow salsify	Asteraceae	Biennial forb	yes
Tribulus terrestris	puncturevine [1, 3]	Zygophyllaceae	annual forb	yes
Trifolium dubium	small hop-clover	Fabaceae	annual forb	no
Trifolium hybridum	alsike clover	Fabaceae	Perennial forb	yes
Trifolium pratense	red clover	Fabaceae	Perennial forb	yes
Verbascum thapsus	common mullein	Scrophulariaceae	Biennial forb	yes
Veronica arvensis	corn speedwell	Scrophulariaceae	annual forb	no

[1] denotes annual species with management implications
[2] denotes species that do not currently occur in the park but are found nearby
[3] denotes species is on state or county noxious weed list

III. B. Analysis Results

Tables 2, 3, and 4 summarize the results of the analysis, ranked by impact, pest, and control, respectively. Data by species and other background information can be found in Appendix B. If Alternative 2 or 3 is implemented, new weed species will be analyzed the same way, and the Appendix will be updated periodically.

Table 2: Species ranked by impact. This ranking is based on the present degree and extent of impact caused by the weed. Impacts of Leafy spurge, Dalmation toadflax, and hoary cress were based on the impacts of these species on adjacent lands as these species have not yet invaded the park.

Species	Pest	Impact	Control
Canada thistle (*Cirsium arvense*)	79	95	64
yellow sweetclover (*Melilotus officinalis*)	76	78	87
smooth brome (*Bromus inermis*)	76	65	59
Kentucky bluegrass (*Poa pratensis*)	60	56	63
leafy spurge (*Euphorbia esula*)	86	55	32
musk thistle (*Carduus nutans*)	40	45	40
Japanese brome (*Bromus japonicus*)	44	42	49
downy brome (*Bromus tectorum*)	60	42	51
Russian knapweed (*Centaurea repens*)	68	40	51
common mullein (*Verbascum thapsus*)	35	36	51
bull thistle (*Cirsium vulgare*)	37	35	43
saltcedar (*Tamarix parviflora*)	70	29	61
common salsify (*Tragopogon porrifolius*)	24	25	33
meadow salsify (*Tragopogon pratensis*)	24	25	29
crested wheatgrass (*Agropyron cristatum*)	57	25	60
spotted knapweed (*Centaurea maculosa*)	41	24	19
alfalfa (*Medicago sativa*)	44	20	39
field bindweed (*Convolvulus arvensis*)	62	20	76
catnip (*Nepeta cataria*)	41	16	32
Russian olive (*Elaeagnus angustifolia*)	44	16	47
white sweetclover (*Melilotus alba*)	56	15	51
western salsify (*Tragopogon dubius*)	29	15	49
halogeton (*Halogeton glomeratus*)	25	15	51
perennial sow thistle (*Sonchus arvensis*)	52	15	52
orchardgrass (*Dactylis glomerata*)	21	13	41
puncturevine (*Tribulus terrestris*)	38	11	40
timothy grass (*Phleum pratense*)	29	11	44
intermediate wheatgrass (*Agropyron intermedium*)	30	11	31
quackgrass (*Elytrigia repens*)	35	11	27
meadow fescue (*Festuca pratensis*)	25	11	36
hoary cress (*Cardaria draba*)	70	11	51
houndstongue (*Cynoglossum officinale*)	41	11	41
dandelion (*Taraxacum officinale*)	43	9	60
asparagus (*Asparagus officinalis*)	19	5	21
dalmation toadflax (*Linaria dalmatica*)	43	5	36
dame's rocket (*Hesperis matronalis*)	24	4	41
alsike clover (*Trifolium hybridum*)	33	4	41
red clover (*Trifolium pratense*)	41	4	37
mouseear chickweed (*Cerastium vulgatum*)	37	4	48
curly dock (*Rumex stenophyllus*)	33	4	27
burdock (*Arctium lappa*)	40	4	44
black henbane (*Hyoscyamus niger*)	40	4	35

Table 3: Species ranked by pest. This ranking is based on the life history traits that pre-adapt a species to become a problem and its known impacts in other areas.

Species	Pest	Impact	Control
leafy spurge (*Euphorbia esula*)	86	55	32
Canada thistle (*Cirsium arvense*)	79	95	64
smooth brome (*Bromus inermis*)	76	65	59
yellow sweetclover (*Melilotus officinalis*)	76	78	87
saltcedar (*Tamarix parviflora*)	70	29	61
hoary cress (*Cardaria draba*)	70	11	51
Russian knapweed (*Centaurea repens*)	68	40	51
field bindweed (*Convolvulus arvensis*)	62	20	76
Kentucky bluegrass (*Poa pratensis*)	60	56	63
downy brome (*Bromus tectorum*)	60	42	51
crested wheatgrass (*Agropyron cristatum*)	57	25	60
white sweetclover (*Melilotus alba*)	56	15	51
perennial sow thistle (*Sonchus arvensis*)	52	15	52
Russian olive (*Elaeagnus angustifolia*)	44	16	47
alfalfa (*Medicago sativa*)	44	20	39
Japanese brome (*Bromus japonicus*)	44	42	49
dalmation toadflax (*Linaria dalmatica*)	43	5	36
dandelion (*Taraxacum officinale*)	43	9	60
catnip (*Nepeta cataria*)	41	16	32
spotted knapweed (*Centaurea maculosa*)	41	24	19
red clover (*Trifolium pratense*)	41	4	37
houndstongue (*Cynoglossum officinale*)	41	11	41
burdock (*Arctium lappa*)	40	4	44
musk thistle (*Carduus nutans*)	40	45	40
black henbane (*Hyoscyamus niger*)	40	4	35
puncturevine (*Tribulus terrestris*)	38	11	40
mouseear chickweed (*Cerastium vulgatum*)	37	4	48
bull thistle (*Cirsium vulgare*)	37	35	43
common mullein (*Verbascum thapsus*)	35	36	51
quackgrass (*Elytrigia repens*)	35	11	27
alsike clover (*Trifolium hybridum*)	33	4	41
curly dock (*Rumex stenophyllus*)	33	4	27
intermediate wheatgrass (*Agropyron intermedium*)	30	11	31
timothy grass (*Phleum pratense*)	29	11	44
western salsify (*Tragopogon dubius*)	29	15	49
meadow fescue (*Festuca pratensis*)	25	11	36
halogeton (*Halogeton glomeratus*)	25	15	51
dame's rocket (*Hesperis matronalis*)	24	4	41
meadow salsify (*Tragopogon pratensis*)	24	25	29
common salsify (*Tragopogon porrifolius*)	24	25	33
orchardgrass (*Dactylis glomerata*)	21	13	41
asparagus (*Asparagus officinalis*)	19	5	21

Table 4: Species ranked by difficulty to control. This ranking is based on the effectiveness of known control methods, the undesirable side of effects of using those controls, and the potential to develop new biological controls (insects or other living agents that disrupt the lifecycle of the weeds)

Species	Impact	Pest	Control
yellow sweetclover (*Melilotus officinalis*)	76	78	87
field bindweed (*Convolvulus arvensis*)	62	20	76
Canada thistle (*Cirsium arvense*)	79	95	64
Kentucky bluegrass (*Poa pratensis*)	60	56	63
saltcedar (*Tamarix parviflora*)	70	29	61
crested wheatgrass (*Agropyron cristatum*)	57	25	60
dandelion (*Taraxacum officinale*)	43	9	60
smooth brome (*Bromus inermis*)	76	65	59
perennial sow thistle (*Sonchus arvensis*)	52	15	52
halogeton (*Halogeton glomeratus*)	25	15	51
white sweetclover (*Melilotus alba*)	56	15	51
downy brome (*Bromus tectorum*)	60	42	51
common mullein (*Verbascum thapsus*)	35	36	51
Russian knapweed (*Centaurea repens*)	68	40	51
hoary cress (*Cardaria draba*)	70	11	51
western salsify (*Tragopogon dubius*)	29	15	49
Japanese brome (*Bromus japonicus*)	44	42	49
mouseear chickweed (*Cerastium vulgatum*)	37	4	48
Russian olive (*Elaeagnus angustifolia*)	44	16	47
burdock (*Arctium lappa*)	40	4	44
timothy grass (*Phleum pratense*)	29	11	44
bull thistle (*Cirsium vulgare*)	37	35	43
dame's rocket (*Hesperis matronalis*)	24	4	41
alsike clover (*Trifolium hybridum*)	33	4	41
orchardgrass (*Dactylis glomerata*)	21	13	41
houndstongue (*Cynoglossum officinale*)	41	11	41
puncturevine (*Tribulus terrestris*)	38	11	40
musk thistle (*Carduus nutans*)	40	45	40
alfalfa (*Medicago sativa*)	44	20	39
red clover (*Trifolium pratense*)	41	4	37
Dalmation toadflax (*Linaria dalmatica*)	43	5	36
meadow fescue (*Festuca pratensis*)	25	11	36
black henbane (*Hyoscyamus niger*)	40	4	35
common salsify (*Tragopogon porrifolius*)	24	25	33
catnip (*Nepeta cataria*)	41	16	32
leafy spurge (*Euphorbia esula*)	86	55	32
intermediate wheatgrass (*Agropyron intermedium*)	30	11	31
meadow salsify (*Tragopogon pratensis*)	24	25	29
curly dock (*Rumex stenophyllus*)	33	4	27
quackgrass (*Elytrigia repens*)	35	11	27
asparagus (*Asparagus officinalis*)	19	5	21
spotted knapweed (*Centaurea maculosa*)	41	24	19

Figure 2: Grouping of weed species as analyzed by the Alien Plant Ranking System.

Quadrant 2: high impact, easy to control leafy spurge (*Euphorbia esula*)	**Quadrant 1: High impact, hard to control** Canada thistle (*Cirsium arvense*) yellow sweetclover (*Melilotus officianalis*) smooth brome (*Bromus inermis*) Kentucky bluegrass (*Poa pratensis*)
Quadrant 3: low impact, easy to control musk thistle (*Carduus nutans*) bull thistle (*Cirsium vulgare*) spotted knapweed (*Centaurea maculosa*) meadow salsify (*Tragopogon pratensis*) common salsify (*Tragopogon porrifolius*) western salsify (*Tragopogon dubius*) alfalfa (*Medicago sativa*) Russian olive (*Elaeagnus angustifolia*) catnip (*Nepeta cataria*) orchardgrass (*Dactylis glomerata*) quackgrass (*Elytrigia repens*) intermediate wheatgrass (*Agropyron intermedium*) meadow fescue (*Festuca pratensis)* puncturevine (*Tribulus terrestris*) timothy grass (*Phleum pratense*) dalmation Toadflax (*Linaria dalmatica*) houndstongue (*Cynoglossum officinale*) mouseear chickweed (*Cerastium vulgatum*) burdock (*Actium lappa*) dame's rocket (*Hesperis matronalis*) alsike clover (*Trifolium hybridum*) red clover (*Trifolium pratense*) black henbane (*Hyoscyamus niger*) curly dock (*Rumex stenophyllus*) asparagus (*Asparagus officinalis*)	**Quadrant 4: low impact, hard to control** Japanese brome (*Bromus japonicus*) downy brome (*Bromus tectorum*) Russian knapweed (*Centaurea repens*) common mullein (*Verbascum thapsus*) saltcedar (*Tamarix parvifolia*) crested wheatgrass (*Agropyron cristatum*) field bindweed (*Convolvulus arvensis*) halogeton (*Halogeton glomeratus*) white sweetclover (*Melilotus alba*) hoary cress (*Cardaria draba*) perennial sow thistle (*Sonchus arvensis*) dandelion (*Taraxacum officinale*)

Quadrant 1 – High Impact, Hard to Control

Four species scored in this quadrant. These species are considered to be of high concern for management. These species are difficult and expensive to control. Generally, these are species that are currently causing impacts to the park's resources, have innate life history characteristics that promote rapid increase and spread, and require a long-term commitment to control. Effective chemical treatments and less effective biological controls are available for Canada thistle. Literature indicates that smooth brome and Kentucky bluegrass may be reduced or eradicated with an aggressive spring season prescribed fire program followed by herbicide treatment and inter-seeding with native grass species. The literature also indicates that yellow sweetclover has a variable response to fire, but in some cases may be controlled with prescribed burning. More research is needed to determine the feasibility of controlling yellow sweetclover because it is so pervasive in the park and surrounding lands.

Quadrant 2 – High Impact, Easy to Control

One species scored in this quadrant. This species, leafy spurge, is not yet in the park, but is found nearby. Once established it has high impact on native plants and wildlife, and grows very aggressively. In recent years, very effective chemical and biological controls have been developed for this species. This provides two effective means of control if this species invades the park and is detected early.

Quadrant 3 – Low Impact, Easy to Control

Twenty-five species scored in this quadrant. These species are typical of frequently or highly disturbed areas, such as lawns, parking lots, and work areas. Their presence indicates disturbance; but it is unlikely that the source of disturbance (ie. park visitors or maintenance activities) would be removed. These species typically do not invade native grasslands. Overall, these are of low management concern, but may require treatment in special situations. They are generally responsive to chemical and/or mechanical treatments. Biological controls are generally not available for these species.

Quadrant 4 – Low Impact, Hard to Control

Twelve species scored in this quadrant. These species currently have a limited distribution in the park, but are known to cause serious impacts in similar areas. They are not presently causing serious impacts, but they have the potential to cause significant problems because their life history generally correlates with highly invasive species. Some of these species are of special concern due to known threats to sensitive resources, such as saltcedar that may drawdown surface and groundwater and halogeton that may poison ungulates. This group is diverse in its responsiveness to various treatments, but as a whole these species are relatively hard to control. Biological controls are available for some species.

IV. Environmental Analysis

A. Alternatives
   1. No action
   2. Proactive management without aerial application (table 5)
   3. Preferred Alternative: Proactive management with limited aerial application (table 6)
   4. Comparison of Alternatives (table 7)

B. Alternatives Considered but Rejected
   1. No weed management effort
   2. Biological only, chemical only, or mechanical only

C. Environmental Consequences
   1. Impact topics considered
   2. Issues and impacts considered but not further addressed in this EA
   3. Impact analysis by impact topic
      - Vegetation
      - Wildlife
      - Threatened and Endangered Species
      - Paleontological Resources
      - Water Resources
      - Wilderness
      - Cultural Resources
   4. Impact matrix (table 8)
   5. Environmentally preferred alternative
   6. Impairment
   7. Cumulative Impacts

D. Coordination and Consultation
   1. Summary of Public Involvement
   2. Oglala Sioux Tribe
   3. US Forest Service, Buffalo Gap National Grasslands
   4. US Fish and Wildlife Service
   5. Bureau of Indian Affairs
   6. State Historic Preservation Office
   7. South Dakota Game, Fish, and Parks
   8. South Dakota Department of Agriculture
   9. Pennington County
   10. Jackson County
   11. Shannon County
   12. Badlands Weed Management Area

IV. A. Alternatives

IV.A. 1. Alternative 1: No Action

This would be a continuation of the park's existing weed management program. The Alien Plant Ranking System would not be used to prioritize weed management efforts. Control efforts would continue to focus on state or county declared noxious weed species, namely field bindweed, Canada thistle, perennial sow thistle, hoary cress, Russian knapweed, spotted knapweed, and puncturevine. Leafy spurge, houndstongue, and Dalmation toadflax would be treated if or when they invade the park. Each species would be treated on a case-by-case basis using chemical, mechanical, or biological control methods. Fire would continue to be used to the extent that it meets the fire program goals of reducing hazard fuels along the park boundaries. Annual pesticide use proposals would be submitted for proposed herbicide use and would be granted or denied on an annual basis. Currently, the herbicides used are picloram, glyphosate, clopyralid, and 2-4,D. Herbicides are applied to small areas by ATV sprayer, horse-mounted sprayer, or backpack sprayer. ATV application involves a four-wheel ATV with a mounted 40 gallon spray tank with an electric pump which can dispense chemical through a spray wand for directed spot treatment or through boomless sprayer nozzles for 20' swath spraying. Horse-mounted application involves a horse or mule carrying four 5-gallon sealed canisters in a specially designed packsaddle, and application is made by a person on foot or horseback leading the pack animal and applying directed chemical spray with a spray wand pressurized by a mounted CO2 canister. Backpack application involves a five gallon backpack carried on the back of the applicator and application is made with a spray wand pressurized with a handpump.

Biological controls would continue to be used and managed. Species currently used for Canada thistle control are *Larinus planus*, *Hadroplontus litura*, and *Urophora cardui*. Any new biocontrol agents would be considered independently.

Because this is a no action alternative, existing activities would continue to be limited in scope and effect. In order to meet the categorical exclusion, "E (3) Removal of individual members of a non-threatened/endangered species or populations of pests and exotic plants that pose an imminent danger to visitors or an immediate threat to park resources." Under the National Environmental Policy Act, programmatic, long-term, or large-scale treatments would require separate analysis in an Environmental Assessment or Environmental Impact Statement. Preparation of the analysis is time consuming and would delay more aggressive treatment for several months or years.

Fire would be used as described in the preferred alternative of the park's Draft Fire Management Plan (NPS 2001*c*). This action includes the use of prescribed fire for fuel reduction, removal of weeds, and rejuvenation of native prairie with an average of 4000 acres per year planned for implementation over a 15 year period. This action also includes suppression of unplanned ignitions except for those designated as fire use. Fire use would be allowed within an area of approximately 53,400 acres located in the interior of the Badlands Wilderness Area. In this fire use zone, naturally ignited wildland fires would be allowed to burn and interact with the fire dependent communities to maintain the natural variability of the ecosystem. Not more than 10,000 contiguous acres of suppression, prescribed fire and wildland fire use acres combined would be allowed in

a given growing season in order to assure adequate forage during the winter season for the park's bison herd. Cool season exotic grass species, such as smooth brome, Kentucky bluegrass, and crested wheatgrass would continue to be treated opportunistically with spring prescribed fire as part of the park's on-going fire management program to reduce hazard fuels. Although generally this program does not accommodate consecutive year burns, a single year burn can at least reduce seed production for that year. Treated areas would be re-seeded with native grass species as funding and time allow.

Efforts to prevent invasion of new weeds or spread of existing weeds would generally be limited to existing or previously planned visitor awareness/public education activities. There would be no comprehensive effort directed toward prevention or early detection and eradication. The following visitor awareness/public education activities are either on-going or planned.

- "Focus on Plant Diversity Week" would continue each summer. This event includes resource education programs, exhibits, and public outreach highlighting native plant communities and their threats, including weeds. On average these programs reach 20,000-30,000 visitors each year.
- An article would continue to be included in each year's "Prairie Preamble" Activity Guide that focuses on native prairie and their threats, including weeds. This publication has an annual circulation of 250,000.
- An article about invasive species would continue to be included on the park's website. This website receives approximately 681,000 hits annually.
- "Badlands In Your Classroom" curricula-based education programs would continue to be offered in area schools, reaching about 10,000 students per year. Invasive plants are a theme in the "Prairie Futures" programs presented to high school students.
- Wayside exhibits at the Prairie Winds overlook would be updated to include information on both native and invasive plant species.
- A site bulletin on introduced species and their reduction and/or eradication would be produced and distributed.
- A touchscreen learning herbarium would be installed in the visitor center to help visitors identify plants, including weed species.
- The premier issue of Badlands Nature Notes would be published, focusing on ecological restoration at Badlands and a significant piece on weed management. This document would be sold to the general public by the Badlands Natural History Association and given to the members of the organization.
- The park would continue its involvement with the interagency Badlands Weed Management Area. One role of the Weed Management Area is to offer seminars and/or training opportunities to promote weed identification and management on park and surrounding lands.
- Press releases would continue to be produced pre-season and post-season to inform the public of the park's weed management plans and successes.

IV. A. 2. Alternative 2: Proactive management without aerial application

Under this alternative, the Alien Plant Ranking System would be used to prioritize weed management efforts as presented in section III of this plan. A comprehensive management program would include prevention, early detection and eradication, chemical control, biological control, mechanical control, cultural treatments (fire), and research.

Prevention would apply to species in all four quadrants with the greatest priority given to those species not yet found in the park: leafy spurge, hoary cress, and Dalmation toadflax. The weed prevention program includes:

- Internal training/awareness for park employees and cooperators
  - Resource Management Specialist would conduct a weed training session for seasonal park employees.
- Stock Use
  - Resource Management Specialist would assist the park's Stock Use Coordinator with revision to the Superintendent's Compendium (regulations established at the discretion of the Park Superintendent) requiring the use of processed, pelletized feed and/or certified weed free hay for three days before and during recreational stock use in the park.
  - Park's Stock Use Coordinator would assure that park stock are fed hay free of noxious weeds, preferably native prairie hay harvested from pastures inspected by park personnel. A Standard Operating Procedure would be written to ensure these mitigating activities are in place.
- Construction
  - Resource Management Specialist would assist the park's Chief of Maintenance with development of standard specifications to require that all fill material brought into the park would come from inspected borrow sites free of noxious weeds. All disturbed ground would be re-vegetated within the growing season with native species or sterile cover species most adapted to site conditions (Redente 1993). A Standard Operating Procedure would be written to ensure these mitigating activities are in place.
  - To the extent practicable, all equipment that is used outside of the park vicinity in areas likely to have high amounts of weed seed (ie. off-road in an area with leafy spurge) would be cleaned prior to or upon entry into the park. Examples include wildland fire trucks, trailers hauling weed treatment equipment, and construction equipment.
- Visitor Awareness/Public Education
  - "Focus on Plant Diversity Week" would continue each summer. This event includes resource education programs, exhibits, and public outreach highlighting native plant communities and their threats, including weeds. On average these programs reach 20,000-30,000 visitors each year.
  - An article would continue to be included in each year's "Prairie Preamble" Activity Guide that focuses on native prairie and their threats, including weeds. This publication has an annual circulation of 250,000.
  - An article about invasive species would continue to be included on the park's website. This website receives approximately 681,000 hits annually.

  - "Badlands In Your Classroom" curricula-based education programs would continue to be offered in area schools, reaching about 10,000 students per year. Invasive plants are a theme in the "Prairie Futures" programs presented to high school students.
  - Wayside exhibits at the Prairie Winds overlook would be updated to include information on both native and invasive plant species.
  - A site bulletin on introduced species and their reduction and/or eradication would be produced and distributed.
  - A touchscreen learning herbarium would be installed in the visitor center to help visitors identify plants, including weed species.
  - The premier issue of Badlands Nature Notes would be published, focusing on ecological restoration at Badlands and a significant piece on weed management. This document would be sold to the general public by the Badlands Natural History Association and given to the members of the organization.
  - The park would continue its involvement with the interagency Badlands Weed Management Area. One role of the Weed Management Area is to offer seminars and/or training opportunities to promote weed identification and management on park and surrounding lands.
  - Press releases would continue to be produced pre-season and post-season to inform the public of the park's weed management plans and successes.
  - Press releases and/or other public awareness events would be developed for the national Weed Awareness Week in February each year.
- Fire
  - Funding would be sought for increased post-fire monitoring for weed invasion or increase for three years following all fire events. Of particular concern is the potential for fire (natural or prescribed) to spread common mullein.
- Maintenance Activities
  - The Resource Management Specialist would work with the Roads and Trails Foreman to survey weed populations within proposed road grading areas. These populations would be either treated before work begins or would be avoided during work to prevent further spread or re-distribution. A Standard Operating Procedure would be written to ensure these mitigating activities are in place. Resource Management Specialist would work with the Roads and Trails Foreman to modify the existing mowing schedule in order to avoid spreading mature weed seed, particularly from Japanese brome and downy brome, along park trails. A Standard Operating Procedure would be written to ensure these mitigating activities are in place. Re-vegetation Standards
  - The park's Resource Management Specialist and Lead Weed Biotech would develop recommended seed mixes and seeding rates to replant native grass species in areas subjected to ground disturbance and areas where weeds are eradicated and natural colonization is unlikely (Redente 1993). A Standard Operating Procedure would be written to ensure these mitigating activities are in place.

Early detection and eradication would apply to species in all four quadrants with the highest priority given to those species not yet found in the park: leafy spurge, hoary

cress, and Dalmation toadflax and those species found in quadrant 4. The weed early detection and eradication program includes:

- Weed mapping
  - Weed populations within the park would be mapped on a five year rotation. Mapping would be conducted on foot or horseback using a Global Positioning System with a data dictionary. The data dictionary would include species identification, size, and density estimates as well as geographic position.
  - Throughout the Badlands Weed Management Area, weed mapping assistance would be provided to other land owners in the Area.
- Internal training/awareness for park employees and cooperators
  - The Resource Management Specialist would produce and distribute a be-on-the lookout calendar with photos and description of weed species correlated with the time when they are most identifiable. This document would be given to field employees, particularly Resource Education and Resource Protection employees to facilitate weed detection. A form would be developed for employees and cooperators to report suspicious plants to the Resource Management Specialist and/or Lead Weed Biotech. Reported plants would be investigated and treated as appropriate, with the goal of eradication for newly established species or populations.
- Surveillance of areas with high probability for invasion
  - The park's weed crew would conduct annual surveillance of areas most likely to be invaded by weeds, including popular parking lots, campgrounds, stock use areas, park lands adjacent to agricultural fields, and the maintenance yard. Newly established species or populations would be treated as appropriate, with the goal of eradication.

Chemical control would be focused on species in quadrants 1, 2, and 4, and species in quadrant 3 would be treated opportunistically when they interfered with a management goal or occurred within the treatment area of a higher priority species. For example, musk thistle is a quadrant 3 species and Canada thistle is a quadrant 1 species that often grow together and would be treated simultaneously. Herbicide application would target those species that have a proven response to chemical treatment, such as thistles and knapweeds. Chemical treatment may also be synchronized with other treatments for integrated control, such as herbicide application following prescribed fire. Herbicides would be applied using ATV sprayers, horse-mounted sprayers, backpack sprayers, and time-release granulars. ATV-mounted boomless sprayers would be used in non-Wilderness. Efforts would be made to minimize the number of trips across the prairie and reduce the visibility of the tracks in approximately 177,500 acres, containing approximately 7,200 acres of weeds. Horse-mounted sprayers and backpack sprayers would be used in Wilderness areas and in high visibility areas such as near visitor centers and campgrounds. In total, horse-mounted and backpack sprayers would be used to apply herbicide in approximately 66,000 acres, containing approximately 2,700 acres of weeds. Time release granulars could be used in areas not accessible to ATV's or horses, and difficult to access on foot with a backpack sprayer. Examples of such places include tops of tall sod tables (small grassy pedestals with steep unvegetated sides) and in isolated juniper slumps. The sites would be accessed via hiking. In total, granulars would likely be used on approximately 500 acres, containing approximately 100 acres of weeds. If woody species such as saltcedar and Russian olive invaded the

park and became a management concern, they would be treated using cut-stump methods with an approved herbicide.

Approximate costs of treatment have been calculated for each application method, although costs could vary widely based on travel distance to the treatment areas. Cost estimates include the cost of chemical, salary, and operation/maintenance of application equipment. The time required for application by each method was based on practical experience with each piece of equipment. Application with all-terrain vehicles and boomless sprayer costs approximately $48/acre. Assuming each ATV spray unit can treat 32 acres per day, 225 days would be needed to treat all 7,200 acres of weeds and would cost $345,600. Application with horse mounted sprayer unit costs approximately $56/acre. Assuming each horse-mounted sprayer unit can treat ten acres per day, 270 days would be needed to treat all 2700 acres and would cost $151,200. Application with backpack sprayers or time-release granulars costs approximately $378/acre. Assuming each backpack applicator can treat 0.3 acres a day, 333 days would be needed to treat all 100 acres and would cost $37,800. In total, Alternative 2 would cost $534,600 and require 828 days to treat 10,000 acres of weeds one time. These dollar figures are for comparison purposes only. Realistically, the park's budget for weed control would vary over time based on availability of base funds and project funds.

Actual acres treated with herbicide each year is very dependent upon weather conditions and staffing levels. Rain, wind, and extreme heat all limit the use of herbicides. Based on label recommendations and restrictions, most spraying activities take place in late May through June and again in September, a total of about eight weeks per year. Currently, average staffing level is six seasonal biological technicians each working four, 10-hour days staggered throughout the week to minimize weather-related shut downs. Assuming that only 60% of the time can be spent spraying due to weather conditions, each person would spray approximately 20 days each season. One person spraying one 10 hour workday is a "sprayday". For a six person crew, that's 120 spraydays per season. On average, 60 of those days would likely be spent using ATV spray units at 32 acres per day, 50 of those days would be spent using horse-mounted spray units at 10 acres/day, and 10 of those days would be spent using backpack sprayers (including application of granulars) at 0.3 acres per day. Based on those estimates, there would be 1920 acres treated with ATV, 500 acres treated with horse-mounted sprayers per year, and 3 acres treated with backpack sprayers. Under this alternative, herbicide would be used to treat approximately 2423 acres per year.

Three herbicides would be proposed for four year approvals. Picloram would be used in most areas and is the primary chemical used for fall treatment. Glyphosate labeled for use in aquatic areas would be used near water and clopyralid would be used near trees. This mix of chemicals is the most effective combination for thistles and knapweeds (Redente 1993, Wrage 2001). Clopyralid and picloram are both selective herbicides that affect many broadleaf weeds and woody plants, but generally not grasses. Picloram has a restricted use label because it can persist in the root zone of soil for up to thirteen months after application and is also prone to leaching. It's persistence makes it the most effective herbicide for hard to control perennial weeds such as Canada thistle. Clopyralid does not have a restricted use label because it has limited persistence and is generally not prone to leaching. However, the limited persistence also limits its effectiveness for fall application and makes it less effective on hard to control perennial weeds. The limited persistence also requires more frequent application. Rodeo is a nonselective

herbicide in a formulation that is deemed safe to aquatic environments (Rodeo 1998). Rodeo affects grasses, broadleaf weeds, and woody plants. Rodeo has no persistence, becoming inert upon contact with the soil, thus it is the least effective on hard to control perennial weeds. Personnel with Commercial Pesticide Applicators Certifications would apply all herbicides with calibrated equipment. All applications would be consistent with their labels and reported on a pesticide use log. All pesticide use would be compiled and reported according to agency and state requirements at the end of each calendar year. Other herbicides would be considered for experimental or localized use, and those chemicals would be proposed through the annual pesticide use proposal process required by the NPS to evaluate pesticide use in parks.

Counties would continue to be responsible for weed treatments within their road rights-of-way inside of park boundaries. Currently they all use a combination of picloram and 2-4,D applied with truck mounted boom sprayers. County-applied herbicides would continue to be proposed, evaluated, and approved through the NPS annual pesticide use proposal process.

Table 5: Biological control species in Badlands National Park

Weed species	Insect species	Dates released
Canada thistle	*Urophora cardui, Hadroplontus litura, Larinus planus*	1996, 1999, 2000, 2001, 2002
Musk thistle	*Rhynocyllus conicus*	Colonized from surrounding lands in 1970's
Musk thistle	*Trichosirocalus horridus*	Potential for future release
Knapweeds	*Urophora quadrifasciata/affinis, Metzneria paucipunctella, Larinus minutus, Agapeta zoegana, Cyphocleonus achates*	Potential for future release
Common mullein	*Gymnetron tetrum*	Potential for future release
Dalmation toadflax (not in park currently)	*Brachypterolus pulicarius, Gymnetron antirrhini, Calophasia lunula*	Potential for future release
Leafy spurge (not in park currently)	*Aphthona* spp*, Oberea erythrocephala, Spurgia esulae*	Potential for future release

Biological control would be used for any species for which they are available in order of priority: quadrant 1, 2, 4 and 3. Generally, new populations of biological controls would be established in areas that are inaccessible or poorly accessible for other control methods, such as the interior of the Badlands Wilderness Area. Furthermore, biological controls would only be used on established weed populations that meet the habitat requirements of the insects. Biological controls for Canada thistle have been released in the park since 1996 (Table 5) and those populations would continue to be monitored, augmented, and redistributed. Potential exists for additional biological control species to be released for control of Canada thistle and other weeds. Only those species approved by the USDA Animal and Plant Health Inspection Service would be considered for release in the park and only those species that show no affinity for native plant species would be released. Release of biological control agents would be documented and entered in the park's biological control database. Release sites would be monitored

annually by the most practical and reliable means available. Currently, Canada thistle biological control sites are monitored annually by photopoints to provide a qualitative measure of success. This method would be continued, although other non-destructive monitoring methods could be used as appropriate. Biological control sites would be accessed on foot or horseback.

Mechanical control would be used as a single control measure or integrated with chemical control for optimal effectiveness. Species in all four quadrants would be considered for mechanical treatment as appropriate; although, it is most practical for biennial forb species that occur in localized dense patches, namely common mullein and spotted knapweed. Mullein is effectively treated by cutting the seedhead off the plant before the seed capsules desiccate and disperse their seed or grubbing the rootcrown of the rosettes (Redente 1993). Spotted knapweed is treated by herbicide application followed by hand pulling (with gloves to protect personnel from potentially dangerous plant extracts). In both cases, control sites would be accessed on foot, horseback, or ATV, depending on the location of the stand. Mechanical treatment is also effective in setting up plants for chemical treatment. Mowing during bud stage could prevent seeding of thistle species and force plants to form new rosettes for fall herbicide application. Control of saltcedar requires mechanical treatment (saw the tree off) followed by a cut-stump chemical treatment. Access for saltcedar control would be on foot, horseback, or ATV depending on the location of the stand.

Fire would be used as described in the preferred alternative of the park's Draft Fire Management Plan (NPS 2001*c*). This action includes the use of prescribed fire for fuel reduction, removal of weeds, and rejuvenation of native prairie with an average of 4000 acres per year planned for implementation over a 15 year period. This action also includes suppression of unplanned ignitions except for those designated as fire use. Fire use would be allowed within an area of approximately 53,400 acres located in the interior of the Badlands Wilderness Area. In this fire use zone, naturally ignited wildland fires would be allowed to burn and interact with the fire dependent communities to maintain the natural variability of the ecosystem. Not more than 10,000 contiguous acres of suppression, prescribed fire and wildland acres combined would be allowed in a given growing season in order to assure adequate forage during the winter season for the park's bison herd. Prescribed fire for weed control would primarily target cool season exotic grasses, namely smooth brome, Kentucky bluegrass, and crested wheatgrass. All three of these species occur in moderate to high densities and can be effectively treated with consecutive spring burns followed by planting of native species (Blankenspoor 1987, FEIS 1996, Kay 1960, Lodge 1960, Nagal 1983, Willson and Stubbendieck 2000). In situations where these species occur as a dense, hardy stand, fire may be followed with a herbicide application to further reduce stand vigor and thus reduce the number of years necessary to control the species through burning (Willson and Stubbendieck 2000). Generally, Japanese brome and downy brome do not occur in the park in densities high enough to be effectively treated with fire, although this method would be applied opportunistically through the burn planning. The literature indicates that Yellow sweetclover may be controlled in a limited geographic area through the use of consecutive year spring fire (FEIS 1996, Heitlinger 1975). However, this plant currently occupies more than 100,000 acres of parkland, thus fire would only be practical to control isolated populations and other methods would be needed for long-term control of this species. Fire may also be used to set up thistle for herbicide application, with burns reducing thatch and making thistle rosettes more receptive to chemical application

during the next growing season. Prescribed burns conducted in late summer and early fall can also be used to rejuvenate native prairie, thus making the native prairie more resistant to weed invasions. Use of fire to control weed species would be fully integrated with the park's prescribed fire program and would meet all requirements of the National Fire Plan and related guidance.

Research sponsored by the park would focus on species in quadrants 1 and 4. A primary purpose of this research would be to advance understanding of the ecology of the weed species in order to develop new control strategies. The highest priority for weed ecology research would be yellow sweetclover, as it is a quadrant 1 species for which there are currently no effective control strategies available for use in the park. Measuring the effectiveness of new treatments would also be the subject of park-sponsored research and would focus on species in quadrant 4, as these species currently have a limited distribution but are known to be hard to control. Non-park sponsored research could be conducted on any weed species. All research projects would be subject to NPS Research and Collecting permit requirements, reviews, conditions, and reports.

IV. A. 3. Alternative 3: Proactive management with limited aerial application (Preferred)

Under this alternative, the Alien Plant Ranking System would be used to prioritize weed management efforts as presented in section III of this plan. A comprehensive management program would include prevention, early detection and eradication, chemical control with aerial application, biological control, mechanical control, cultural treatments (fire), and research. Note that this alternative is identical to Alternative 2, except for the chemical control section.

Prevention would apply to species in all four quadrants with the greatest priority given to those species not yet found in the park: leafy spurge, hoary cress, and Dalmation toadflax. The weed prevention program includes:

- Internal training/awareness for park employees and cooperators
  - Resource Management Specialist would conduct a weed training session for seasonal park employees.
- Stock Use
  - Resource Management Specialist would assist the park's Stock Use Coordinator with revision to the Superintendent's Compendium (rules and regulations enacted by the Park Superintendent) requiring the use of processed, pelletized feed and/or certified weed free hay for three days before and during recreational stock use in the park.
  - Park's Stock Use Coordinator would assure that park stock are fed hay free of noxious weeds, preferably native prairie hay harvested from pastures inspected by park personnel. A Standard Operating Procedure would be written to ensure these mitigating activities are in place. Construction
  - Resource Management Specialist would assist the park's Chief of Maintenance with development of standard specifications to require that all fill material brought into the park would come from inspected borrow sites free of noxious weeds. All disturbed ground would be re-vegetated within the growing season with native species or sterile cover species

most adapted to site conditions (Redente 1993). A Standard Operating Procedure would be written to ensure these mitigating activities are in place.
  - To the extent practicable, all equipment that is used outside of the park vicinity in areas likely to have high amounts of weed seed (ie. off-road in an area with leafy spurge) would be cleaned prior to or upon entry into the park. Examples include wildland fire trucks, trailers hauling weed treatment equipment, and construction equipment.
- Visitor Awareness/Public Education
  - "Focus on Plant Diversity Week" would continue each summer. This event includes resource education programs, exhibits, and public outreach highlighting native plant communities and their threats, including weeds. On average these programs reach 20,000-30,000 visitors each year.
  - An article would continue to be included in each year's "Prairie Preamble" Activity Guide that focuses on native prairie and their threats, including weeds. This publication has an annual circulation of 250,000.
  - An article about invasive species would continue to be included on the park's website. This website receives approximately 681,000 hits annually.
  - "Badlands In Your Classroom" curricula-based education programs would continue to be offered in area schools, reaching about 10,000 students per year. Invasive plants are a theme in the "Prairie Futures" programs presented to high school students.
  - Wayside exhibits at the Prairie Winds overlook would be updated to include information on both native and invasive plant species.
  - A site bulletin on introduced species and their reduction and/or eradication would be produced and distributed.
  - A touchscreen herbarium would be installed in the visitor center to help visitors identify plants, including weed species.
  - The premier issue of Badlands Nature Notes would be published, focusing on ecological restoration at Badlands and a significant piece on weed management. This document would be sold to the general public by the Badlands Natural History Association and given to the members of the organization.
  - The park would continue its involvement with the interagency Badlands Weed Management Area. One role of the Weed Management Area is to offer seminars and/or training opportunities to promote weed identification and management on park and surrounding lands.
  - Press releases would continue to be produced pre-season and post-season to inform the public of the park's weed management plans and successes.
  - Press releases and/or other public awareness events would be developed for the national Weed Awareness Week in February each year.
- Fire
  - Funding would be sought for increased post-fire monitoring for weed invasion or increase for three years following all fire events. Of particular concern is the potential for fire (natural or prescribed) to spread common mullein.
- Maintenance Activities

- The Resource Management Specialist would work with the Roads and Trails Foreman to survey weed populations within proposed road grading areas. These populations would be either treated before work begins or would be avoided during work to prevent further spread or re-distribution. A Standard Operating Procedure would be written to ensure these mitigating activities are in place. Resource Management Specialist would work with the Roads and Trails Foreman to modify the existing mowing schedule in order to avoid spreading mature weed seed, particularly from Japanese brome and downy brome, along park trails. A Standard Operating Procedure would be written to ensure these mitigating activities are in place. Re-vegetation Standards
- The park's Resource Management Specialist and Lead Weed Biotech would incorporate recommended seed mixes and seeding rates to replant native grass species in areas subjected to ground disturbance and areas where weeds are eradicated and natural colonization is unlikely (Redente 1993). A Standard Operating Procedure would be written to ensure these mitigating activities are in place.

Early detection and eradication would apply to species in all four quadrants with the highest priority given to those species not yet found in the park: leafy spurge, hoary cress, and Dalmation toadflax and those species found in quadrant 4. The weed early detection and eradication program includes:

- Weed mapping
  - Weed populations within the park would be mapped on a five year rotation. Mapping would be conducted on foot or horseback using a Global Positioning System with a data dictionary. The data dictionary would include species identification, size, and density estimates as well as geographic position.
  - Throughout the Badlands Weed Management Area, weed mapping assistance would be provided to other land owners in the Area.
- Internal training/awareness for park employees and cooperators
  - The Resource Management Specialist would produce and distribute a be-on-the lookout calendar with photos and description of weed species correlated with the time when they are most identifiable. This document would be given to field employees, particularly Resource Education and Resource Protection employees to facilitate weed detection. A form would be developed for employees and cooperators to report suspicious plants to the Resource Management Specialist and/or Lead Weed Biotech. Reported plants would be investigated and treated as appropriate, with the goal of eradication for newly established species or populations.
- Surveillance of areas with high probability for invasion
  - The park's weed crew would conduct annual surveillance of areas most likely to be invaded by weeds, including popular parking lots, campgrounds, stock use areas, park lands adjacent to agricultural fields, and the maintenance yard. Newly established species or populations would be treated as appropriate, with the goal of eradication.

Chemical control would focus on species in quadrants 1, 2, and 4. Species in quadrant 3 would be treated opportunistically when they interfered with a management goal or occurred within the treatment area of a higher priority species. For example, musk thistle

is a quadrant 3 species and Canada thistle is a quadrant 1 species that often grow together and would be treated simultaneously. Herbicide application would target those species that have a proven response to chemical treatment, such as thistles and knapweeds. Chemical treatment may also be synchronized with other treatments for integrated control, such as herbicide application following prescribed fire. Herbicides would be applied using ATV sprayers, horse-mounted sprayers, backpack sprayers, time-release granulars and aerial application. ATV-mounted boomless sprayers would be used in non-Wilderness areas. Efforts would be made to minimize the number of trips across the prairie and reduce the visibility of the tracks in approximately 177,500 acres, containing approximately 7,200 acres of weeds. Horse-mounted sprayers and backpack sprayers would be used in Wilderness areas and in high visibility areas such as near visitor centers and campgrounds. In total, horse-mounted and backpack sprayers would be used to apply herbicide in approximately 66,000 acres, containing approximately 2,700 acres of weeds (although 1,500 acres of the 2700 acres may be treated aerially as described below). Time release granulars could be used in areas not accessible to ATV's or horses, and difficult to access on foot with a backpack sprayer. Examples of such places include tops of tall sod tables and in isolated juniper slumps. The site would be accessed via hiking. In total, granulars would likely be used on approximately 500 acres, containing approximately 100 acres of weeds. If woody species such as saltcedar and Russian olive invaded the park and became a management concern, they would be treated using cut-stump methods with an approved herbicide.

Approximately 1,500 acres would potentially be treated with herbicide via aerial application by either helicopter or fixed-wing aircraft. The areas to be treated with aerial application would meet the following criteria: a) weed is a quadrant 1 or 2 species; b) weed population is greater than fifty acres in that area; c) weed population is moderate to high density or scattered with dense patches; d) weed population is located in the Wilderness or other areas that are not accessible to ATV's; and e) weed population is more than one mile from the nearest horse trailer access point. In short, aerial application would only be used to contain and reduce populations that cannot be effectively treated with other chemical application methods. Although weed mapping is not complete, four areas infested with Canada thistle have been mapped that would meet the criteria above: 237 acres near Hay Butte, 298 acres near Sage Creek, 430 acres in Burns Basin, and sixty-two acres in Lower Bigfoot. It is anticipated that another 400-500 acres would be identified when mapping efforts are complete. The objective of aerial treatment would be to reduce weed populations to a level that can be maintained through biological controls, mechanical controls, or other chemical application methods. Application rates and procedures would follow label requirements and limitations. Aerial application areas would be marked with flagging and GPS coordinates provided to the pilot to assist with precise chemical application. The chemical selected for aerial application would be the most safe and effective chemical available for that weed species. Not all areas that meet the criteria would necessarily be treated with aerial application, but it could be used if determined to be necessary to prevent spread of the population and funding could be secured. Once a decision is made to use aerial application to control a population, a pesticide use proposal would be submitted for annual approval or denial.

Approximate costs of treatment have been calculated for each application method, although costs could vary widely based on travel distance to the treatment areas. Cost estimates include the cost of chemical, salary, and operation/maintenance of application

equipment. The time required for application by each method was based on practical experience with each piece of equipment. Application with all-terrain vehicles and boomless sprayer costs approximately $48/acre. Assuming each ATV spray unit can treat thirty-two acres per day, 225 days would be needed to treat all 7,200 acres of weeds and would cost $345,600. Aerial application with fixed-wing aircraft costs approximately $50/acre. Assuming an aerial applicator can treat 150 acres per day, ten days would be needed to treat all 1,500 acres of weeds and would cost $75,000. Application with horse mounted sprayer unit costs approximately $56/acre. Assuming each horse-mounted sprayer unit can treat ten acres per day, 120 days would be needed to treat all 1,200 acres and would cost $67,200. Application with backpack sprayers or time-release granulars costs approximately $378/acre. Assuming each backpack applicator can treat 0.3 acres a day, 333 days would be needed to treat all 100 acres and would cost $37,800. In total, Alternative 3 would cost $525,600 and require 688 days to treat 10,000 acres of weeds one time. These dollar figures are for comparison purposes only. Realistically, the park's budget for weed control would vary over time based on availability of base funds and project funds.

Actual acres treated with herbicide each year is very dependent upon weather conditions and staffing levels. Rain, wind, and extreme heat all limit the use of herbicides. Based on label recommendations and restrictions, most spraying activities take place in late May through June and again in September, a total of about eight weeks per year. Currently, average staffing level is six seasonal biological technicians each working four, 10-hour days staggered throughout the week to minimize weather-related shut downs. Assuming that only 60% of the time can be spent spraying due to weather conditions, each person would spray approximately 20 days each season. One person spraying one 10 hour workday is a "sprayday". For a six person crew, that's 120 spraydays per season. On average, 60 of those days would likely be spent using ATV spray units at 32 acres per day, 50 of those days would be spent using horse-mounted spray units at 10 acres/day, and 10 of those days would be spent using backpack sprayers (including application of granulars) at 0.3 acres per day. Based on those estimates, there would be 1920 acres treated with ATV, 500 acres treated with horse-mounted sprayers per year, and 3 acres treated with backpack sprayers. In addition to the ground-based herbicide application effort, this alternative would also allow for aerial application by a contractor. Actual acres treated with aerial application of herbicide would be widely variable based on funding availability, but would generally cover about 500 acres per year. Under this alternative, herbicide would be used on approximately 2923 acres per year.

Three herbicides would be proposed for four year approvals. Picloram would be used in most areas and is the primary chemical used for fall treatment. Glyphosate labeled for use in aquatic areas would be used near water and clopyralid would be used near trees. This mix of chemicals is the most effective combination for thistles and knapweeds (Redente 1993, Wrage 2001). Clopyralid and picloram are both selective herbicides that affect many broadleaf weeds and woody plants, but generally not grasses. Picloram has a restricted use label because it can persist in the root zone of soil for up to thirteen months after application and is also prone to leaching. It's persistence makes it the most effective herbicide for hard to control perennial weeds such as Canada thistle. Clopyralid does not have a restricted use label because it has limited persistence and is generally not prone to leaching. However, the limited persistence also limits its effectiveness for fall application and makes it less effective on hard to control perennial weeds. The limited persistence also requires more frequent application. Rodeo is a nonselective

herbicide in a formulation that is deemed safe to aquatic environments (Rodeo 1998). Rodeo affects grasses, broadleaf weeds, and woody plants. Rodeo has no persistence, becoming inert upon contact with the soil, thus it is the least effective on hard to control perennial weeds. Personnel with Commercial Pesticide Applicators Certifications would apply all herbicides with calibrated equipment. All applications would be consistent with their labels and reported on a pesticide use log. All pesticide use would be compiled and reported according to agency and state requirements at the end of each calendar year. Other herbicides would be considered for experimental or localized use, and those chemicals would be proposed through the annual pesticide use proposal process required by the NPS to evaluate pesticide use in parks.

Counties would continue to be responsible for weed treatments within their road rights-of-way inside of park boundaries. Currently they all use a combination of picloram and 2-4,D applied with truck mounted boom sprayers. County-applied herbicides would continue to be proposed, evaluated, and approved through the NPS annual pesticide use proposal process.

Table 6: Biological control species in Badlands National Park

Weed species	Insect species	Dates released
Canada thistle	*Urophora cardui, Hadroplontus litura, Larinus planus*	1996, 1999, 2000, 2001, 2002
Musk thistle	*Rhynocyllus conicus*	Colonized from surrounding lands in 1970's
Musk thistle	*Trichosirocalus horridus*	Potential for future release
Knapweeds	*Urophora quadrifasciata/affinis, Metzneria paucipunctella, Larinus minutus, Agapeta zoegana, Cyphocleonus achates*	Potential for future release
Common mullein	*Gymnetron tetrum*	Potential for future release
Dalmation toadflax (not in park currently)	*Brachypterolus pulicarius, Gymnetron antirrhini, Calophasia lunula*	Potential for future release
Leafy spurge (not in park currently)	*Aphthona* spp*, Oberea erythrocephala, Spurgia esulae*	Potential for future release

Biological control would be used for any species for which they are available in order of priority: quadrant 1, 2, 4 and 3. Generally, new populations of biological controls would be established in areas that are inaccessible or poorly accessible for other control methods, such as the interior of the Badlands Wilderness Area. Furthermore, biological controls would only be used on established weed populations that meet the habitat requirements of the insects. Biological controls for Canada thistle have been released in the park since 1996 (Table 5) and those populations would continue to be monitored, augmented, and redistributed. Potential exists for additional biological control species to be released for control of Canada thistle and other weeds. Only those species approved by the USDA Animal and Plant Health Inspection Service would be considered for release in the park and only those species that show no affinity for native plant species would be released. Release of biological control agents would be documented and entered in the park's biological control database. Release sites would be monitored

annually by the most practical and reliable means available. Currently, Canada thistle biological control sites are monitored annually by photopoints to provide a qualitative measure of success. This method would be continued, although other non-destructive monitoring methods could be used as appropriate. Biological control sites would be accessed on foot or horseback.

Mechanical control would be used as a single control measure or integrated with chemical control for optimal effectiveness. Species in all four quadrants would be considered for mechanical treatment as appropriate; although, it is most practical for biennial forb species that occur in localized dense patches, namely common mullein and spotted knapweed. Cutting the seedhead off the plant before the seed capsules desiccate and disperse their seed effectively treats mullein. Spotted knapweed is treated by herbicide application followed by hand pulling (with gloves to protect personnel from potentially dangerous plant extracts). In both cases, control sites would be accessed on foot, horseback, or ATV, depending on the location of the stand. Mechanical treatment is also effective in setting up plants for chemical treatment. Mowing during bud stage could prevent seeding of thistle species and force plants to form new rosettes for fall herbicide application. Control of saltcedar requires mechanical treatment (saw the tree off) followed by a cut-stump chemical treatment. Access for saltcedar control would be on foot, horseback, or ATV depending on the location of the stand.

Fire would be used as described in preferred alternative of the park's Draft Fire Management Plan (NPS 2001*c*). This action includes the use of prescribed fire for fuel reduction, removal of weeds, and rejuvenation of native prairie with an average of 4000 acres per year planned for implementation over a 15 year period. This action also includes suppression of unplanned ignitions except for those designated as fire use. Fire use would be allowed within an area of approximately 53,400 acres located in the interior of the Badlands Wilderness Area. In this fire use zone, naturally ignited wildland fires would be allowed to burn and interact with the fire dependent communities to maintain the natural variability of the ecosystem. Not more than 10,000 contiguous acres of suppression, prescribed fire and wildland fire use acres combined would be allowed in a given growing season in order to assure adequate forage during the winter season for the park's bison herd. Prescribed fire for weed control would primarily target cool season exotic grasses, namely smooth brome, Kentucky bluegrass, and crested wheatgrass. All three of these species occur in moderate to high densities and can be effectively treated with consecutive spring burns followed by planting of native species (Blankenspoor 1987, FEIS 1996, Kay 1960, Lodge 1960, Nagal 1983, Willson and Stubbendieck 2000). In situations where these species occur as a dense, hardy stand, fire may be followed with a herbicide application to further reduce stand vigor and thus reduce the number of years necessary to control the species through burning (Willson and Stubbendieck 2000). Generally, Japanese brome and downy brome do not occur in the park in densities high enough to be effectively treated with fire, although this method would be applied opportunistically through the burn planning. The literature indicates that Yellow sweetclover may be controlled in a limited geographic area through the use of consecutive year spring fire (FEIS 1996, Heitlinger 1975). However, this plant currently occupies more than 100,000 acres of parkland, thus fire would only be practical to control isolated populations and other methods would be needed for long-term control of this species. Fire may also be used to set up thistle for herbicide application, with burns reducing thatch and making thistle rosettes more receptive to chemical application during the next growing season. Prescribed burns conducted in late summer and early

fall can also be used to rejuvenate native prairie, thus making the native prairie more resistant to weed invasions. Use of fire to control weed species would be fully integrated with the park's prescribed fire program and would meet all requirements of the National Fire Plan and related guidance.

Research sponsored by the park would focus on species in quadrants 1 and 4. A primary purpose of this research would be to advance understanding of the ecology of the weed species in order to develop new control strategies. The highest priority for weed ecology research would be yellow sweetclover, as it is a quadrant 1 species for which there are currently no effective control strategies available. Measuring the effectiveness of new treatments would also be the subject of park-sponsored research and would focus on species in quadrant 4, as these species currently have a limited distribution but are known to be hard to control. Non-park sponsored research could be conducted on any weed species. All research projects would be subject to NPS Research and Collecting permit requirements, reviews, conditions, and reports.

IV. A. 4. Comparison of Alternatives

Common to all alternatives:

- All alternatives include chemical, mechanical, biological, and cultural (fire) controls, but the frequency and purpose of treatments varies between alternatives
- All alternatives use ATV's only in non-Wilderness areas
- All alternatives use backpack and/or horsepack sprayers in Wilderness areas
- All alternatives use backpack and/or horsepack sprayers in high visibility areas near visitor centers and campgrounds
- All alternatives require access to biocontrol sites, research sites, and other weed related locations in Wilderness on foot or horseback
- All alternatives include implementation of the park's preferred alternative in the Draft Fire Management Plan. This action would include prescribed fire, fire suppression, and Fire use.

Alternative 1: No Action is difficult to quantify and compare with the other alternatives. Because this alternative would only treat county and state listed weed species, the targeted species and therefore targeted acres of weeds would be different than Alternative 2 or 3 and would potentially change every time the County or state changed their weed list. Also, this alternative limits the scope and effect of weed management efforts unless further environmental analysis is undertaken. Under this alternative, there would be no effort made to contain or control *all* weed populations. There would also be no comprehensive effort made at prevention or early detection and eradication. Prescribed fire would be used to reduce cool-season exotic grasses incidental to other management objectives, such as fuel reduction.

Alternatives 2 and 3 are similar to each other except that Alternative 3 allows for use of aerial application for weed populations that meet specific criteria. The proposed aerial application sites are in Wilderness or other remote areas that would otherwise be treated with horse-mounted sprayers, so aerial treatment acres are in lieu of horse-mounted treatment acres. The use of aerial application is not required under alternative 3, but would be available at management discretion if specific criteria were met.

Alternatives 2 and 3 both include considerable efforts directed at prevention, early detection and eradication. Both alternatives also include the use of fire with an increased emphasis on treatment of cool-season exotic grasses through consecutive year prescribed burns.

These comparisons between the three alternatives are summarized in Table 7.

Table 7: Summary of actions proposed in each alternative

Action	Alt. 1: No Action	Alt. 2: Proactive Management without aerial	Alt. 3: Proactive Management with aerial
Selection of targeted species and priorities	State and county listed species only	Alien Plant Ranking System	Alien Plant Ranking System
Environmental analysis	Categorical Exclusion	Environmental Assessment	Environmental Assessment
Prevention	Not included	Included	Same as Alt. 2
Early detection and eradication	Not included	Included	Same as Alt. 2
Chemical selection	Glyphosate, picloram, clopyralid	Same as Alt. 1	Same as Alt. 1
ATV herbicide application: acres, days, cost	Limited use without further environmental analysis	7200 acres of weeds in 225 days at $345,600	Same as Alt. 2
Aerial application	Not included	Not included	1500 weed acres in 10 days at $75,000
Horse-mounted herbicide application: acres, days, cost	Limited use without more environmental analysis	2700 acres of weeds in 270 days at $151,200	1200 weed acres in 120 days at $67,200
Backpack herbicide application: acres, days, cost	Limited use without further environmental analysis	100 acres of weeds in 333 days at $37,800	Same as Alt. 2
Chemical control totals: acres, days, costs for treating each existing weed population one time	Indefinite because not all weeds could be treated under this alternative without further environmental analysis	10,000 acres in 828 days at $534,600; approximately 2423 acres per year	10,000 acres in 688 days at $525,600; approximately 2923 acres per year
Biological controls	3 species in use and managed. New insects species would require environmental analysis	3 species in use and managed, new insects species would be released as appropriate	Same as Alt. 2
Mechanical controls	Included	Included. Also used to set up plants for chemical treatment	Same as Alt. 2
Fire	Included but with less emphasis on weed control	Included, but with more emphasis on weed control and may be used with chemical control	Same as Alt. 2
Research	Included but only as researchers approach the park	Included and researchers encouraged to investigate weed ecology and control for specific species	Same as Alt. 2

IV. B. Alternatives Considered but Rejected

IV. B. 1. No weed management effort

This alternative is inconsistent with Executive Order #13112 on Invasive Species, the Federal Noxious Weed Control Act, National Park Service Policy, and South Dakota law. Furthermore, this alternative would defy the purpose and significance of the park to preserve and restore native prairie ecosystems.

IV. B. 2. Biological only, chemical only, or mechanical only

This alternative is inconsistent with National Park Service Policy, which directs parks to use integrated pest management.

IV. C. Environmental Consequences

The National Environmental Policy Act (NEPA) requires that environmental documents disclose the environmental impacts of the proposed federal action, reasonable alternatives to that action, and any adverse environmental affects that cannot be avoided should the proposed action be implemented. This section analyzes the environmental impacts of three alternatives for a weed management program at Badlands National Park. This analysis provides the basis for comparing the effects of the alternatives. In considering the impacts, the intensity, duration and direction of the impacts are discussed, mitigation measures are proposed, and cumulative impacts are discussed.

The NPS based this impact analysis and conclusions on the review of existing literature and park studies, information provided by experts within the National Park Service and other agencies, and professional judgement of park specialists.

For the purpose of this analysis, intensity or severity of the impact is defined as follows:

- Negligible: Impact to the resource or discipline is barely perceptible and not measurable, generally confined to a small area or a point in time.
- Minor: Impact to the resource or discipline is perceptible and may be measurable, generally impact is confined to specific areas within the park.
- Moderate: Impact is clearly detectable and could have appreciable effect on the resource or discipline throughout the park.
- Major: Impact would have a substantial, highly noticeable influence on the resource or discipline throughout the park and surrounding lands.

The duration of the impacts in this analysis are defined as follows:

- Short-term: Impacts are those that occur during implementation of the alternative.
- Long-term: Impacts would extend beyond implementation of the alternative and would likely have permanent effects on the resource or discipline.

The direction of the impacts in this analysis are defined as follows:

- Positive: Impacts would promote the preservation of the resource.

- Negative: Impacts would be destructive to the resource.

IV.C.1. Impact Topics Considered

Vegetation
The use of chemical, biological, and mechanical treatments to reduce weeds would have a direct impact on the composition (what plants are growing) and distribution (where plants are growing) of plant species. Furthermore, use of ATV's would also have a direct impact on individual plants. Specific impacts to grassland, shrubland, and woody draw communities will be addressed. Direct vegetation impacts are therefore analyzed in this EA.

Wildlife
The use of chemical, biological, and mechanical treatments would alter habitat characteristics and therefore would have an indirect impact on populations of small mammals, ungulates, birds, reptiles and amphibians, and invertebrates. Indirect wildlife impacts are therefore analyzed in this EA.

Threatened and Endangered Species
The Endangered Species Act of 1973 requires disclosure of impacts of federal actions on all federally protected threatened and endangered species. NPS management policies (2001) require assessment of impacts to certain state-listed rare, candidate, declining and sensitive species. Within the state of South Dakota there are a total of thirty-five threatened, endangered, and candidate species of invertebrates, fishes, reptiles, amphibians, birds, mammals, and plants. From this list there are a total of three avian and four mammalian species documented as known, or potential to be, resident or migrant species within the local area of Badlands National Park. Listed bird species that are migrant and seasonally resident in the area are the bald eagle (*Haliaeetus leucocephalus*), peregrine falcon (*Falco peregrinus*), and whooping crane (*Grus americana*). The park includes large black-tailed prairie dog colonies (*Cynomys ludovicianus*), provides habitat for the reintroduced federally-listed endangered black-footed ferret (*Mustela nigripes*) and potentially the state-listed threatened swift fox (*Vulpes velox*). The presence of mountain lion (*Felis concolor*) in the local area is supported by sporadic sightings of individuals using rough drainages as travel corridors. Furthermore, the black-tailed prairie dog is considered a candidate species for federal listing as threatened. Prairie dog communities occur throughout the park and weeds occurring within dog towns would be treated. Dog towns may also be crossed on ATV's, horseback, or on foot in route to other weed populations. Five state-listed rare plants are known to occur in and around the park: Dakota buckwheat (*Eriogonum visheri*), Barr's milkvetch (*Astragalus barrii*), and Secund bladderpod (*Lesquerella arenosa var. argillosa*) are endemic to the region, Easter daisy (*Townsendia exscapa*) and Large-flower Townsend-daisy (*Townsendia grandiflora*) occur in the park at the edge of their range. None of the species is known to occur in association with targeted weed species. However, they may be impacted by ATV, horse, or foot travel in route to weed populations. Therefore, direct impacts to these five plant species are analyzed.

Paleontological Resources
Badlands National Park is world renowned for it's paleontological resources. A report that accompanied the 1929 Act creating the park described the Badlands as containing

"vast beds of vertebrate remains." The spectacular vertebrate fossils preserved within the White River Badlands have been studied extensively since 1846 and are apart of museum collections throughout the world. Fossils are not generally found on the surface in vegetated areas where targeted weeds would occur, however, fossil resources may be indirectly impacted by ATV, horse, or foot travel in route to weed populations. Therefore, direct impacts to fossil resources will be analyzed in this EA.

Water Resources

National Park Service policies require protection of water resources consistent with the Clean Water Act. Potential for run-off from areas treated with herbicide could impact surface or subsurface water resources. Both the White River and the Cheyenne River are listed in the National Rivers Inventory, a register of rivers that may be eligible for inclusion in the National Wild and Scenic River System. These rivers were included on the NRI based on the degree to which they are free-flowing, the degree to which the rivers and their corridors are undeveloped, and the outstanding natural and cultural characteristics of the rivers and their immediate environments. Section 5(d) of the National Wild and Scenic Rivers Act requires that, "In all planning for the use and development of water and related land resources, consideration shall be given by all federal agencies involved to potential national wild, scenic and recreational river areas." Therefore, direct impacts to water resources will be analyzed in this EA.

Wilderness

The Wilderness Act of 1964 (16 USC 1132) and the NPS Wilderness Management Guidelines and Policies require consideration of impacts on Wilderness resources. Public Law 94-567 established the 64,250-acre Badlands Wilderness Area in Badlands National Park. The intent of the designation is to preserve wilderness values, that is, wilderness visitor experience and physical wilderness character. Weeds occur in Wilderness and would be subjected to treatment. Direct impacts to these wilderness values are therefore analyzed in this EA.

Cultural Resources: Archaeology

The National Historic Preservation Act, as amended in 2000 (16 USC 470 et. seq.), and the NPS Cultural Resource Management Guidelines and Policies require consideration of impacts on cultural resources listed on or eligible for listing on the National Register of Historic Places. Although one archaeological site is considered eligible to be placed on the National Register, the proposed actions in this plan would not impact this specific site. Potentially eligible archaeological resources may be affected by ATV travel in route to treat weeds. Direct impacts to archaeological resources are therefore analyzed in this EA.

Cultural Resources: Landscapes

According to NPS Management Policies (2001), many cultural landscapes are significant due to their historic land use and practices. When land use is a primary reason for the significance of a landscape, the objective of treatment would be to balance perpetuation of use with retention of the tangible evidence that represents its history. The variety and arrangement of cultural and natural features in a landscape often have sacred or other continuing importance in the ethnic histories and cultural vigor of associated groups. The National Park Service has adopted a comprehensive approach to people and resources that considers parks in rural and urban areas and traditionally associated and other groups as interrelated members of an ecosystem. The beliefs, attitudes, practices,

traditions, and values of traditionally associated groups would be considered in any treatment decisions. These features and their present-day uses have been identified in an Ethnographic Overview (White 2001). Biological and mechanical treatments would not impact plant communities in a manner that would alter traditional uses and will not be analyzed in this EA. The use of chemical treatments would directly affect the types of plants in areas and will, therefore, be analyzed in this EA. Activities in this EA will not impact any potential historic structures. Impacts to this type of resource will not be analyzed in this EA.

IV.C.2. Issues and Impact Topics considered but not further addressed in this EA

Air Quality
The Badlands Wilderness Area is a Class I airshed as designated by the federal 1963 Clean Air Act (42 U.S.C. 7401 et. seq. as amended). This designation stipulates that federal land managers have an affirmative responsibility to protect a park's air quality from adverse air pollution impacts. Implementation of a comprehensive weed management strategy would create a negligible, short-term, localized increase in dust and exhaust associated with ATV travel, but otherwise would not affect air quality. Therefore, this impact topic is not included for further analysis in this EA.

Geologic Resources
National Park Service policies require protection of geologic resources and processes. Implementation of a comprehensive weed management strategy would not have any affect on geologic resources. Therefore, this impact topic is not included for further analysis in this EA.

Socio-economics
National Environmental Protection Act (NEPA) requires an analysis of impacts to the human environment that includes economic, social, and demographic elements in the affected area. The area surrounding the park is primarily ranch land with a few small communities. A comprehensive weed management program would increase the need for additional seasonal personnel in the park. Purchase of equipment and supplies to support a comprehensive weed management program would put federal dollars into the local and regional economy. The reduction of weeds in the park would reduce the spread of weeds onto private lands adjacent to the park and reduce the landowners weed control costs. These socioeconomic impacts are indirectly related to the project and would have no appreciable affect on the communities' overall population, income, or employment base. Therefore, this impact topic is not included for further analysis in this EA.

Environmental Justice
Executive Orders 12250, 12898 and 12948 require agencies to consider the impact of their actions on disadvantaged human populations. The Pine Ridge Indian Reservation is an economically depressed area. Implementation of a comprehensive weed management strategy would have no affect on the quality of life of the Oglala Lakota people. Therefore, this impact topic is not included for further analysis in this EA.

Visitor Use

NPS *Management Policies* (2001) require parks to provide for visitor use. Chemical weed treatment may require visitor use closures for visitor protection while the herbicide dries. The displacement of visitors would be rare, temporary and localized due to the wide distribution of weeds. Generally, similar visitor experiences would be available in other areas of the park. The park's personal and non-personal interpretive services would help visitors understand the need for weed control as part of a prairie restoration effort. Therefore, this impact topic is not included for further analysis in this EA.

Human Health and Safety

NPS Management Policies (2001) advocate a safe work environment for employees and a safe experience for park visitors. The equipment proposed for use (ATV's and horses) is all standard equipment with established safety protocols, including annual training. The herbicides proposed for use have very low acute toxicity to humans and personal protective equipment is used during application to reduce chronic exposure of employees. Treated areas are marked until dry, to advise visitors against entering treated areas and thus exposing themselves to the chemicals. Because of these safety precautions, no actions proposed would likely affect human health or safety for park employees or visitors. Therefore, this impact topic is not included for further analysis in this EA.

Park Operations

Implementation of a comprehensive weed management program (alternatives 2 or 3) would not substantially affect park operations. Funding for its implementation would come from new sources or continuation of existing funding used for weed management. There would likely be a negligible increase in administrative support for personnel and procurement as well as increased storage space needs and fuel use. However, the park already provides those services and can absorb the small increases associated with an increase in the weed program. Improved weed control would improve relations with park neighbors as well as state and local officials who have expressed concern about weeds spreading from the park onto neighboring lands. Because these impacts are either negligible (ie. administrative support) or unquantifiable (ie. community relations), this impact topic is not included for further analysis in this EA.

IV.C.3. Impact analysis by impact topic

Vegetation

- Impacts to Vegetation common to all three alternatives

All three alternatives include the use of chemical control, mechanical control, biological control, and fire towards weed species in the park.

All three alternatives call for the use of fire to manage weeds. Fire Researchers are in agreement that fire provides an overall benefit to the continued growth, health, and maintenance of the mixed grass prairie ecosystem (Vogl 1979, Wright and Bailey 1980). And although there appears to be some conflict in research findings relative to whether fire benefits or harms particular species during specific stages of growth and the degree of benefit or harm resulting to affected species, there is essential agreement that for the mixed grass prairie fire plays an integral role in maintaining the ecosystem. Given the rapid growth characteristics and the chemical composition of most mixed-grassland species, decomposition occurs slowly in the absence of fire in this ecosystem. Thus, fires have the direct effect of removing stagnant, dead plant accumulations while converting that mass to ash and charcoal. The blackened, burned areas protect underlying soils by joining remaining unburned vegetation and charcoal bits and help to raise the soil temperature by several degrees, particularly in the spring. The ash/charcoal material returns a number of minerals and salts to the soil, thus recycling them for new plant growth. Indirectly, the higher temperatures increase fungal, bacterial, and algal activity, which in turn increases available nitrogen. The increased microorganism activity also helps to increase soil temperatures while aiding in nutrient recycling. Fire generally improves mixed-grassland soils. In addition to increasing nitrification of the soils and increasing minerals and salt amounts in the soil, the ash and charcoal residue resulting from incomplete combustion aids in soil buildup and soil enrichment by being added as organic matter to the soil profile. The added material works in combination with dead and dying root systems to make the soil more porous, better able to retain water, and less compact while increasing needed sites and surface areas for essential microorganisms, mycorrhiza, and roots. In general, fires tend to stimulate plant growth, resulting in larger, more vigorous plants, greater seed production, and increased protein and carbohydrate contents. Fires tend to increase species diversity, and reduce woody species relative to grass and forb species (Vogl 1979, Wright and Bailey 1980).

Research conducted at Badlands National Park indicates that western wheatgrass, threadleaf sedge, blue grama, chokecherry, and green ash are beneficially affected by fire, although responses vary somewhat depending on seasonality, frequency, and soil moisture conditions. Needle-and-thread is relatively intolerant of fire and may be decreased. (Whisenant 1987a, Hull-Seig 1998) Research conducted outside the park support these general findings (Whisenant 1987b, FEIS 1996). Cool-season, non-native grasses are usually decreased by fire, although responses vary somewhat depending on seasonality, frequency, residence time, and soil moisture conditions. Research conducted at Badlands National Park indicates that Japanese brome is reduced by spring fire (Whisenant 1987a). Research conducted outside the park indicates that

Kentucky bluegrass, crested wheatgrass, smooth brome, and downy brome are also decreased by fire, particularly by repeated spring fires (Whisenant 1987b, FEIS 1996).

All three alternatives provide for the use of prescribed fire for resource benefits. That is, prescribed fire may be used to stimulate the growth of native species or reduce the growth of non-native species, either directly or indirectly. This may be the primary goal of a prescribed fire, or a product of prescribed fire for fuel reduction. In many cases, a prescribed fire unit identified for fuel reduction would be burned during a specific season and with a specific ignition pattern based on the species composition, thus realizing both resource benefits and fuel reduction. Fire monitoring would continue to be used to assess the effects of fire on specific species, following a standard protocol. The direct and indirect effects of prescribed fires are generally beneficial to the native vegetation species, although individual plants of some species may be destroyed by fire. Indirectly, areas disturbed by fire may be prone to invasion by non-native species such as common mullein and Canada thistle. All prescribed burn units would be assessed before the burn and fire may be excluded from sensitive resources or non-native species populations that increase with fire. A post-burn survey would be conducted as part of the park's on-going weed management program, and non-native species would be treated with appropriate integrated pest management techniques.

All three alternatives provide for suppression of unwanted wildland fires that would have a direct negative effect on vegetation. The impact of suppression activities would be reduced by the use of minimum-impact suppression strategies. That is, suppression would generally favor wet-line or scratch-line over fire breaks made by heavy equipment. The use of minimum impact suppression strategies would reduce the impact on vegetation resources. However, suppression activities would likely result in trampling or removal of vegetation and compaction of soil along routes of travel and fire lines, thus providing disturbed areas that may be invaded by non-native species such as Canada thistle, knapweeds, and field bindweed.

All three alternatives provide for fire use, which is natural ignitions that are allowed to burn under specified conditions within the Badlands Wilderness Area. It is impossible to predict the impact on the park's vegetation resources from any given natural ignition due to the variable responses to fire seasonality and intensity. However, due to the fire dependent nature of most of the park's vegetation communities, it is anticipated that fire use fire would be beneficial to vegetation resources. Furthermore, the use of fire use fire would most closely simulate the natural fire mosaic that characterized the native Northern Great Plains.

The chemical control component of all three alternatives includes the use of picloram, glyphosate, and clopyralid to control weeds. Picloram and clopyralid are broadleaf herbicides and spray drift onto non-target species would cause damage to broadleaf species. Drift is the movement, generally caused by wind, of spray droplets suspended in air onto areas not targeted for spraying. Glyphosate acts on both broadleaf and grass species and spray drift onto non-target species would cause damage to virtually any component of the vegetation community. The most abundant targeted weed species for chemical control is Canada thistle (*Cirsium arvense*). Without treatment, this species tends to grow in dense patches, occasionally interspersed with yellow sweetclover (another high priority weed species) and some grass species. Chemical treatment with picloram or clopyralid at this "dense" stage would primarily affect Canada thistle and

yellow sweetclover. Chemical treatment with glyphosate at this stage would primarily affect Canada thistle, yellow sweetclover, and grasses, both native and non-native. After initial treatment the Canada thistle patches tend to thin as the stunted thistle plants compete less successfully with other species. At this stage, the most commonly intermingled species are the non-native annual bromes, namely Japanese brome (*Bromus japonicus*) and downy brome (*Bromus tectorum*). Treatment at this "sparse" stage would primarily be affecting Canada thistle with any of the three herbicides, and glyphosate would also affect the grasses. With follow-up treatment, native prairie species tend to recolonize the treated areas and Canada thistle occurs as isolated plants. Broad chemical treatment during this "occasional" stage would affect a host of native species as well as the targeted Canada thistle. Use of a targeted application system, ie. handwand, would minimize non-target mortality of native species during this "occasional" stage. During all applications, control of droplet size can greatly decrease the risk of drift to non-target species outside the immediate treatment area. Droplet size is the volume of individual droplets of herbicide mixed with water and is usually controlled by nozzle settings. Non-target plants subjected to herbicide drift could experience no effect, reduced vigor, or death depending on the sensitivity of the plant species to the specific herbicide and the dose the plant was subjected to. Overall, use of chemical controls would have infrequent negative, short-term, minor impacts on individual plants due to drift or non-target treatment during the course of spraying targeted species. Infrequent impacts to individual plants generally do not impact plant populations, plant communities, or ecological processes.

All three alternatives identify the use of biological control on targeted weeds. Any species released in the park is approved by the USDA Animal and Plant Inspection Service with no demonstrated affinity for native plant species. Because biological controls are specific to only weed species, there would be no impacts to non-target plant species.

All three alternatives identify the use of mechanical control such as cutting, mowing, and hand pulling on targeted weeds. These methods would be highly selective for individual plants, consequently there would be no impacts to non-target species through the use of mechanical control.

Intrusion into park lands by personnel conducting the weed control program would cause short-term, direct impacts to vegetation from foot, horse, and ATV traffic in route to weed populations. Individual plants would be trampled resulting in no affect, reduced vigor, or death depending on the stature and structure of the plant and the amount and duration of pressure applied by wheels, hooves, or feet. These impacts would be negative, short-term and negligible to individual plants. Infrequent impacts to individual plants generally do not impact plant populations, plant communities, or ecological processes.

By controlling exotic weeds and promoting healthy native prairies under all three alternatives, the native prairie ecosystem would be restored thus benefiting all native plant species and the habitat they provide. The minor short-term negative impacts would be outweighed by the long-term benefits to habitat preservation.

- Vegetation impacts of Alternative 1

Under this alternative, efforts would continue to focus on assessment and treatment of noxious weeds, namely field bindweed, Canada thistle, perennial sow thistle, hoary cress, Russian knapweed, spotted knapweed, and puncturevine. Political concerns rather than biological concerns would govern priorities for treatment, so weeds adjacent to a complaining neighboring landowner would be treated before more ecologically destructive weeds. Using the Alien Plant Ranking System, only Canada thistle rated in Quadrant 1 as high impact and hard to control, while field bindweed, Russian knapweed, perennial sow thistle, and hoary cress were rated in Quadrant 4 as low impact and hard to control, and puncturevine rated in Quadrant 3 as low impact and easy to control. While this alternative would still be effective at treating several weed species with potential to cause biological impacts on the prairie ecosystem, many other species would go unassessed and untreated.

Prevention of new weed infestations, early detection and eradication, and research would not be incorporated into park operations. Some elements of these programs would likely be implemented independently, but there would no consistent and comprehensive effort. Those independent actions would likely be directed toward noxious species, emphasizing political concerns rather than biological concerns. The lack of a prevention and early detection system could allow the invasion of biologically destructive species to go unchecked until they became such a problem that they attract the attention of state and county weed boards and become listed as noxious weeds. By that time, native prairie may have already been invaded and the control or eradication would be difficult with a higher potential for damage to non-target species and other resources.

In the short-term, intensive treatment would result in negligible, negative impacts to individual plants due to trampling and potential non-target exposure to herbicide. Based on the limited focus of this alternative to remove or reduce noxious weed species, it is anticipated that it would result in long-term, moderate, positive impacts to the park's vegetation by shifting overall species composition and distribution towards native rather than non-native plant species.

- Vegetation impacts of Alternative 2

Under this alternative, the park would implement a comprehensive and proactive weed management program that would not include aerial spraying. The program would include prevention, early detection and eradication, treatment of existing populations, and research. Weed management priorities would be based on the Alien Plant Ranking System as discussed in Section III of this document. Under this alternative, a considerable amount of time and attention would be given to prevention, early detection, and eradication of new populations. Compared to traditional weed treatment approaches, this preventative approach has been documented to be more effective overall in maintaining and/or restoring native plant communities and the habitat they provide (Reichard 1997). Control efforts would be directed toward the species with the most likelihood for successful control and the most potential ecological impact if they go untreated. Because chemical treatment would be limited to ground based equipment, there would be more short-term negative impact to individual native plants from trampling but less potential for non-target exposure to herbicide than Alternative 3. It is

anticipated that implementation of this comprehensive approach would result in a highly effective weed management program.

In the short-term, intensive treatment would result in negligible, negative impacts to individual plants due to trampling and potential non-target exposure to herbicide. Based on a comprehensive approach to remove or reduce noxious weed species, it is anticipated that it would result in long-term, major, positive impacts to the park's vegetation by shifting overall species composition and distribution towards native rather than non-native plant species.

- Vegetation impacts of Alternative 3

Under this alternative, the park would implement a comprehensive and proactive weed management program that could include aerial spraying. The program would include prevention, early detection and eradication, treatment of existing populations, and research. Weed management priorities would be based on the Alien Plant Ranking System as discussed in Section III of this document. Under this alternative, a considerable amount of time and attention would be given to prevention, early detection, and eradication of new populations. Compared to traditional weed treatment approaches, this preventative approach has been documented to be more effective overall in maintaining and/or restoring native plant communities and the habitat they provide (Reichard 1997). Control efforts would be directed toward the species with the most likelihood for successful control and the most potential ecological impact if they go untreated. Because chemical treatment could include aerial application, there would be less short-term negative impact to individual native plants from trampling but more potential for non-target exposure to herbicide than in Alternative 3. It is anticipated that implementation of this comprehensive approach would result in a highly effective weed management program.

In the short-term, intensive treatment would result in negligible, negative impacts to individual plants due to trampling and potential non-target exposure to herbicide, particularly from aerial application. Based on a comprehensive approach to remove or reduce noxious weed species, it is anticipated that it would result in long-term, major, positive impacts to the park's vegetation by shifting overall species composition and distribution towards native rather than non-native plant species.

<u>Wildlife</u>

- Impacts to wildlife species common to all three alternatives

All three alternatives include the use of fire, chemical control, mechanical control, and biological control. towards weed species in the park.

Many researchers have documented that fire provides an overall benefit to the density, diversity, health, and maintenance of native prairie wildlife species. Fire can have direct mortality on small mammals, some invertebrates, reptiles and amphibians and other non-mobile species of wildlife. Mobile species may be impacted indirectly by fire through reductions in the amount of potential nesting, resting and foraging habitat and by increased predation. These impacts are usually short-lived. Conversely, fire can also provide excellent foraging areas for small mammals and many ungulates after the burn.

In general, most researchers believe that fire plays an important role in maintaining the native prairie ecosystem and healthy diverse wildlife populations. Most divergence in philosophy between the positive and negative benefits of fire is found in differences of opinion on the intensity, duration and frequency of fire applied to a particular landscape or wildlife species; large, unplanned and uncontrolled fires can devastate small remnant native species populations. Smaller, managed prescribed fires create the vegetation mosaics beneficial in the long-term to nearly all native species. Possible direct and indirect effects on some of the common small mammals, ungulates, birds, reptiles and amphibians found within Badlands National Park are discussed below.

Wildland and prescribed fire may have some direct mortality on small mammal species, as individual animals may perish due to exposure to smoke, flames, or equipment. Indirectly, fire may impact the population as a result of reducing the amount of available cover and increasing the amount of predation by raptors and other animals. Rodent populations in grasslands usually show an initial drop after fire due to high amounts of raptor predation (Cook 1959).

Fires that create a mosaic of burned and unburned areas are probably the most beneficial to small mammal species because small mammal species densities have been found to increase in areas where mosaics have been created following a burn. Several studies indicate that many small mammal populations increase rapidly subsequent to burning because of the resulting increase in the quality and quantity of food. As fire stimulates post-burn grass production, a corresponding increase in small mammal populations is evident.

One larger mammal species in the mesocarnivore category prevalent throughout Badlands National Park is the coyote (*Canis latrans*). Since coyotes prey upon many species in the small mammal category, fire may improve coyote foraging habitat and amount of prey available by maintaining prey habitat and make hunting easier by opening up the habitat.

Fire probably does not have direct mortality on most healthy ungulates because they are able to move away from the flaming front and out of harms way. The fire may kill sick, diseased, or immobile individuals. However, there have been documented cases of mule deer being trapped and killed by fast-moving fires (Davis 1976). Indirectly, fire may cause ungulates to concentrate in specific areas immediately after the burn to search for food or protective areas.

Effects of fire on mule deer and white-tailed deer habitat are widely varied and well documented in the literature. In general, fires that create mosaics of forage and cover are beneficial. Deer prefer foraging in burned areas compared to unburned areas, although preference may vary seasonally (Davis 1976,1975; Williams et al. 1980). This preference may indicate an increase in plant nutrients, which usually occurs following fire. Burning in grassland communities reduces litter that otherwise inhibits new growth of grasses. Fire rejuvenates and improves these grasslands, which are important winter range in some areas, and can increase nutrient content and palatability of forage (Dasmann 1963).

Pronghorn antelope are primarily a forb-eating species with strong requirements for open cover. Pronghorn are favorably influenced by the increase in herbaceous species

and reduction of shrubs after fire. Nutritional benefits of fire on forage may last up to 4 years after the fire with an increase in primary productivity for a longer period depending upon plant species (Higgins et al. 1989).

Bighorn sheep primarily graze grasses and forbs, but eat other vegetation depending on availability (Chapman 1984). Bighorn sheep prefer green forage and move up or downslope or to different aspects for more palatable forage. Forage areas that provide a variety of aspects are preferable to sheep because they provide green forage for longer periods (Van Dyke et al. 1983). Fire generally stimulates the growth of grasses and forbs, thus providing a green food. No information is available regarding the direct effects of fire on bighorn sheep. In the Badlands sheep can easily reach escape terrain to avoid fire.

Fire exclusion, which has allowed non-native and tree species to establish on grasslands, has decreased both the forage and security values on many bighorn sheep ranges. Burning may regenerate rangelands and enhance the production, availability, and palatability of important bighorn sheep forage species. Burning can increase visibility for bighorn sheep. Research has shown that on many burned sites, bighorn sheep use areas more distant to escape terrain than on adjacent unburned sites. Fire can negatively affect bighorn sheep habitat: when range condition is poor and forage species cannot recover; when non-sprouting species that provide important forage for bighorn sheep are eliminated; or, when too much area is burned and forage is inadequate until the next growing season. Another potentially negative effect is when other species, such as deer, bison or antelope are attracted to prescribed burns intended to benefit bighorn sheep. Early spring fires, particularly on south and southwest aspects, may provide more spring forage than would otherwise be available for bighorn sheep if burning did not occur.

The bighorn sheep herd condition at Badlands National Park is currently in jeopardy with the Pinnacles sub-population in danger of extirpation. Consequently, fires have the potential to significantly impact this small population.

Bison are also impacted directly and indirectly by fire. Fires commonly occur on bison ranges without causing appreciable bison mortality. Fire is important in creating and maintaining bison habitat by regenerating grasslands and enhancing production, availability, and palatability of many forage species. During pre-settlement times bison habitats were to a large extent created and maintained by lightning-caused fires or fires set by Native Americans. Several studies have shown that bison prefer to forage on recently burned areas at the expense of other plant species. During the first post-fire years following a fall prescribed fire in grassland habitat at Wind Cave National Park, bulls were found less often than cow-calf herds on burned sites. Both cow-calf herds and bull groups tended to use the burn more in June of the first post-fire season than at any other time. However, only cow-calf herds consistently grazed the burn during the rest of the summer (Coppock et al. 1986).

Direct mortality from fire probably does not usually occur in most bird species because they are able to move out of harms way. Fire occurring during the nesting season may kill ground nesting bird species such as the sharp-tailed grouse and ferruginous hawk. Indirectly, fire may cause birds to nest in other areas immediately after the burn if specific nesting areas are burned up. And fire may cause some nesting bird species to

die from asphyxiation if they remain on their nest during a burn. However, this is not usually the case, and fire is believed by most ornithologists to be an important factor in creating and maintaining ground nesting bird habitat. Fires that reduce tall cover enhance lek viability and quality for the sharp-tailed grouse also, because these birds need open habitat with good horizontal visibility for lek sites. Much of the prairie habitat in which sharp-tailed grouse occur was largely maintained by fire in pre-settlement times (Grange 1948). On native northern mixed prairie grassland in South Dakota, sharp-tailed grouse were absent in an unburned control area, which contained dense grass. They were present on a less dense burned area within a few months following the fire (Huber et al. 1984).

Fire-related mortality of burrowing owl, another fairly common bird found throughout Badlands National Park, has not been documented in the literature. Burrowing mammals that stay in their burrows during fire are usually unharmed; burrowing owls in their burrows during fire probably are probably unharmed as well. Some burrowing mammals have asphyxiated in their burrows during fire and this may also happen to burrowing owls. When caught outside their burrows during fire, adult burrowing owls probably escape fire easily; some young that cannot yet fly may be injured or killed. Fire affects burrowing owl in two ways: by altering vegetation and by altering their prey base. Wright and Bailey (1982) identified three major fire-dependent plant associations (grassland, semi-desert grass-shrub, and sagebrush-grass) in which burrowing owl occur. They found that frequent fire can maintain or improve burrowing owl habitats by reducing plant height and cover around burrows and by controlling woody plant invasion. Periodic fire in grasslands probably increases prey diversity for raptors including burrowing owl, and may increase overall prey density. After a 1- to 3-year reduction in prey, rodent numbers usually match or exceed pre-fire levels.

Very little information is available in the literature on the direct effects of fire on snakes, lizards and turtles but in general, there may be some direct mortality. Small microhabitat areas near and in woody draws and cedar slumps that do not support frequent fires build up high fuel loads. These areas support a more homogeneous, hotter fire, that may have a detrimental effect on turtles because brush fires can be lethal to turtles because they move so slowly (Gibson et al. 1990). Fragments of tortoise shells have been found in burned areas (Woodbury et al. 1948). Indirectly fire may impact the snake, lizard, and turtle populations as a result of lowering the amount of foraging cover, thereby increasing predation by raptors and other animals. Very little information is available in the literature on the direct effects of fire on frogs and newts. The fact that there are no reports of high mortality for any herptile species may indicate that many amphibians are not highly vulnerable to fire (Means et al. 1981). Indirectly fire may impact amphibian population as a result of lowering cover and increasing predation by raptors and other animals.

The direct and indirect effects of fire on invertebrates are variable. There may be some direct mortality of larvae and adults insects from fire. Generally, however, insect populations in grassland habitats recover quickly from fire. Most grasshopper species increase after spring fire due to increased nutritional quality of new grasses. On native tallgrass prairie in Kansas, grasshopper numbers were highest after early spring prescribed burning, followed by mid-spring burning. Grasshopper numbers were lowest on late-spring burned sites. In a review of fire effects on insects, Warren and others reported that grasshoppers and crickets (Orthoptera) generally increase after fire in any

season; however, "hot" grass fires that occur before Orthoptera have developed wings may reduce their numbers.

The chemical control component of all three alternatives identify the use of picloram, glyphosate, and clopyralid to control weeds. Picloram and clopyralid are broadleaf specific herbicides whereas glyphosate effects both grasses and broadleaf species. Picloram and clopyralid can travel (seep or leach) through soil under certain conditions and contaminate ground water. Glyphosate has a strong affinity to soil particles that prevents leaching into ground water. Excessive exposure to animals at very high concentrations (>400 ppm) during periods of four hours or greater causes slight eye and skin irritation, liver damage (picloram), ear lining damage and kidney damage (clopyralid), and birth defects (clopyralid) under greatly exaggerated doses. When these chemicals are used under recommended concentrations they are labeled as “non-toxic” or “no more than slightly toxic” to humans, animals, and birds, and “slightly toxic” to aquatic organisms (Rodeo 1998, Tordon 1998, Transline 1999). It is unlikely that any of the wildlife species within the park would receive any direct exposure to these chemicals during application to weeds, and it is highly unlikely that they would be overexposed if the chemicals were used under label specification. The wildlife species would most likely flee the area or escape to a below ground burrow/den upon the arrival of personnel conducting weed control. Under excessive exposure and high concentrations, these chemicals could adversely effect many wildlife species in the park.

All three alternatives identify the use of biological control on targeted weeds. These insect species are approved by the USDA Animal and Plant Inspection Service and show no affinity for native plant species. The additional biomass created by these potential insect populations would benefit many mammal and bird species that may prey on them.

All three alternatives identify the use of mechanical control such as cutting mowing and hand pulling on targeted weeds. These methods would be highly selective for individual plants with little concern of damage to non-target species. There would be some escape flight response from wildlife species during these activities, but this would produce negligible short-term negative impacts in the form of unnecessary energy expenditures. Intrusion into park lands by personnel conducting the weed control program would cause negligible harassment to wildlife species that they may come in contact with, but only in the short term.

By controlling exotic weeds under all three alternatives, the native prairie ecosystem in which wildlife species are apart of would be restored and ultimately increase the potential for survival and persistence of all native species. Short-term negative impacts would be outweighed by the long-term benefits to habitat preservation.

- Impacts of Alternative 1 to wildlife resources

No action would continue the weed management operations that are currently being implemented. Because this alternative considers efforts that continue to focus on assessment and treatment of noxious weeds, namely field bindweed, Canada thistle, perennial sow thistle, hoary cress, Russian knapweed, spotted knapweed, and puncturevine and the priorities for treatment would are governed by political concerns rather than biological concerns, weed management activities could impact and

potentially disturb many wildlife species on the in and out of the park's boundaries. Prairie habitats and forage would not be rejuvenated in large portions of the park in a pre-settlement timeframe, thus negatively impacting many native wildlife species. Alternative 1 would have a greater long term impact on the wildlife resource than Alternative 2 or 3.

Based on the potential benefits of habitat improvements in parts of the park and continued degradation in others due to weed management activities, long-term, moderate, positive impact to wildlife resources would likely occur.

- Impacts of Alternative 2 to wildlife resources

Similar to the impacts in Alternative, this proactive alternative would provide a greater degree of knowledge about invasive plant populations and their locations through early detection, prevention, and research that would benefit the rare plant species by reducing, but not eliminating, non-target control, application, and compaction of individual plants. Operation of equipment and exposure to herbicide could cause negligible, negative impacts to individual animals. Weed control efforts in the long-term would result in moderate positive impacts to wildlife habitat and thereby wildlife.
Under this alternative, the park would implement a comprehensive and proactive weed management program that would not include aerial spraying. The program would include prevention, early detection and eradication, treatment of existing populations, and research. Weed management priorities would be based on the Alien Plant Ranking System as discussed in Section III of this document. Under this alternative, a considerable amount of time and attention would be given to prevention, early detection, and eradication of new populations. Compared to traditional weed treatment approaches, this preventative approach has been documented to be more effective overall in maintaining and/or restoring native plant communities and the habitat they provide (Reichard 1997). Control efforts would be directed toward the species with the most likelihood for successful control and the most potential ecological impact if they go untreated. Because chemical treatment would be limited to ground based equipment, there would be more short-term negative impact to wildlife species and less potential for exposure to herbicide to wildlife species than Alternative 3.

Based on the potential benefits of habitat improvements gained by reducing the number of alien plant species on the landscape a long-term major impact to wildlife resources would occur. In the short-term, intensive treatment would result in negligible, negative impacts to individual wildlife species due to trampling and potential non-target exposure to herbicide. Based on a comprehensive approach to remove or reduce noxious weed species, it is anticipated that it would result in long-term, major, positive impacts to the park's wildlife resource by shifting overall species composition of the habitat to native habitat.

- Impacts of Alternative 3 to wildlife resources

Similar to the impacts in Alternative 2, this proactive alternative would include the use of aerial chemical application. Operation of aircraft during the breeding season could disturb wildlife species in the process of nurturing young of the year causing decreased reproduction and/or higher juvenile mortality rates. The use of an aircraft within the park would cause additional harassment to wildlife species as a result of noise and intrusion

into home range habitat. There could be potential major negative impacts in the form of injuries and/or mortality to avian species from mid air collisions. Aerial spraying would benefit prairie dogs by increasing area controlled for thistle near prairie dog towns that are currently being reduced by thistle encroachment. By reducing thistle encroachment of prairie dog towns and thus allowing for town expansion, several associated wildlife species could benefit. In the short-term, operation of equipment and exposure to herbicide could cause minor, negative impacts to individual animals. Weed control efforts in the long-term would result in major positive impacts to wildlife habitat and thereby wildlife. The program would include prevention, early detection and eradication, treatment of existing populations, and research. Weed management priorities would be based on the Alien Plant Ranking System as discussed in Section III of this document. Under this alternative, a considerable amount of time and attention would be given to prevention, early detection, and eradication of new populations. Compared to traditional weed treatment approaches, this preventative approach has been documented to be more effective overall in maintaining and/or restoring native plant communities and the habitat they provide (Reichard 1997). Control efforts would be directed toward the species with the most likelihood for successful control and the most potential ecological impact if they go untreated. Because chemical treatment could include aerial application, there would be less short-term negative impact to individual wildlife species from trampling but more potential for exposure to herbicide to wildlife species than in Alternative 3. It is anticipated that implementation of this comprehensive approach would result in a highly effective weed management program.

Based on the potential benefits of habitat improvements gained by reducing the number of alien plant species on the landscape a long-term major impact to wildlife resources would occur. In the short-term, intensive treatment would result in negligible, negative impacts to individual wildlife species due to trampling and potential non-target exposure to herbicide. Based on a comprehensive approach to remove or reduce noxious weed species, it is anticipated that it would result in long-term, major, positive impacts to the park's wildlife resource by shifting overall species composition of the habitat to native habitat.

Threatened and Endangered Species

- Impacts to threatened and endangered species common to all three alternatives

All three alternatives include the use of chemical control, mechanical control, biological control, and fire on weed species in the park.

The chemical control component of all three alternatives note the use of picloram, Glyphosate, and clopyralid to control weeds. Picloram and clopyralid are broadleaf specific herbicides whereas glyphosate effects both grasses and broadleaf species. Picloram and clopyralid can travel (seep or leach) through soil under certain conditions and contaminate ground water. Glyphosate has a strong affinity to soil particles that prevents leaching into ground water. Excessive exposure to animals at very high concentrations (>400 ppm) during periods of four hours or greater causes slight eye and skin irritation, liver damage (picloram), ear lining damage and kidney damage (clopyralid), and birth defects (clopyralid) under greatly exaggerated doses. When these chemicals are used under recommended concentrations they are labeled as "non-toxic" or "no more than slightly toxic" to humans, animals, and birds, and "slightly toxic" to

aquatic organisms (Rodeo 1998, Tordon 1998, Transline 1999). It is unlikely that any of the threatened or endangered species within the park would receive any direct exposure to these chemicals during application to weeds, and it is highly unlikely that they would be overexposed if the chemicals were used under label specification. The threatened and endangered species would most likely flee the area or escape to a below ground burrow/den upon the arrival of personnel conducting weed control. Under excessive exposure and high concentrations these chemicals could adversely effect threatened and endangered animal species in the park. Rare plant species would be adversely effected by these chemical applications if they received exposure. The rare plant species of concern do not generally occur in the same locales of targeted weed species (McGregor and Barkley 1986, Johnson and Larson 1999), but individual rare plants may be found nearby. If spraying equipment were calibrated, through pressure and nozzle adjustments for proper droplet size, there would be a decrease in chemical drift and non-target species application to rare plants.

All three alternatives identify the use of biological control on targeted weeds. These insect species are approved by the USDA Animal and Plant Inspection Service and show no affinity for native plant species. The additional biomass created by these potential insect populations would benefit mammal and bird species that may prey on them.

All three alternatives identify the use of mechanical control such as cutting, mowing, and hand pulling on targeted weeds. These methods would be highly selective for individual plants with little concern of damage to non-target species. There would be some escape flight response from threatened and endangered animal species during these activities. This would produce negligible short-term negative impacts in the form of unnecessary energy expenditures.

Intrusion into park lands by personnel conducting the weed control program would cause negligible harassment to threatened and endangered animal species that they may come in contact with, but only in the short term. The rare plants could receive direct impacts from foot, horse, and ATV traffic in route to weed populations. Trampling and compaction of these plants could harm and/or eradicate individuals of the population. To reduce the potential for impact, field personnel would be trained to recognize and avoid rare plants in their travel routes. These impacts would be negative, short-term and minor to individual plants and not likely to adversely affect rare species populations.

By controlling exotic weeds under all three alternatives, the native prairie ecosystem in which threatened and endangered species are apart of would be restored and ultimately increase the potential for survival and persistence of all species. The minor short-term negative impacts would be outweighed by the long-term benefits to habitat preservation.

All three alternatives identify the use of fire in weed control within Badlands National Park. In prairie systems, fire regenerates grasslands and enhances production, availability, and palatability of forage species for herbivores and prairie dogs (Coppock and Detling 1986). This benefits a variety of endemic species throughout the system and food chain. Subsequently, after burns many small mammal populations increase rapidly in response to an increase in food availability (Nichols and Menke 1984). Bird species richness and diversity also increase following fire (Lawrence 1966). These increases in prey densities generally benefit predators because on the vulnerability of prey species

due to the reduction in cover and increase in visibility immediately following a burn (Lawrence 1966). Fires can be detrimental to bird nests and to nesting grounds (Murphy 1991, Olsen and Derrickson 1980, Nichols and Menke 1984) with possible mortalities to chicks and breeding pairs, and a loss of eggs. Since bald eagles, peregrine falcons, and whooping cranes are not known to nest in the area, there would be no effect on these species. During some grass fires with heavy fuel loads and high heat intensities, isolated trees may perish and become standing snags. These snags would benefit raptors in the form of perching sites. Due to the rapid mobility of avian species, they would escape from the direct dangers of fire. Prairie dogs, ferrets, and swift fox are also very mobile and would utilize underground burrows as escape cover from fire and not be effected by burning. Topography and other physical barriers such as drainages and vegetation generally limit the size and extent of prairie dog colonies. The boundary edges of towns generally contain higher vegetation that provides terrestrial predators the ability to approach prairie dogs undetected. The burning of this vegetation would increase prairie dog ability to detect these predators and possibly reduce predation. Prairie dogs have historically colonized areas of grassland disturbance associated with bison and cattle overgrazing (Hoogland 1995). Areas burned by fire would be a benefit to prairie dogs in the form of a disturbed area that provides nutritious re-growth, high levels of predator detection, and a direction for colony expansion/colonization. The short-term immediate loss of cured forage caused from the burn would be offset by the benefits of the green re-growth. Black-footed ferrets, being obligates of the prairie dog, would also benefit by the potential increase of habitat in the long term and the increased prey base in the short term. Swift fox commonly inhabit areas with a high proportion of edge. Fire that creates a mosaic of burned and unburned areas is probably the most beneficial. The potential decrease in the amount of prairie dogs as prey for swift fox after a burn, associated with less cover for foxes and increased predator avoidance by the prairie dogs, would be offset by the increase detection by foxes of other small mammals and birds as prey.

Both alternatives include wildfire suppression activities. Fire suppression in grasslands is detrimental to populations of small bird and mammal herbivores due to organic matter accumulation and reduced plant vigor (Wagle 1981).The techniques of grass fire suppression generally entail the use of direct attack with water and flappers, or indirect with fire lines and back-burns. Due to the rough landscape of the area, suppression activities are conducted by handcrews or wildland brush trucks, and create minimal damage to the landscape. The short term disturbances to threatened and endangered species, and their habitats, by these human activities would be minimal in comparison to the flame and smoke associated with the wildfire. Any bald eagles, peregrine falcons, or whopping cranes would have fled the area during the fire, and most likely would not be effected by suppression activities. Prairie dogs, black-footed ferrets, and swift fox would have fled the area or gone below ground during the fire, and most likely would not be effected by suppression activities.

- Impacts of Alternative 1 on threatened and endangered species

No action would continue the weed management operations that are currently being implemented. The above listed impacts of chemical control, mechanical control, and biological control would have negligible minor negative impacts to threatened and endangered animal species in the form of harassment and potential chemical exposure. The rare plant species would suffer from minor negative impacts in the short term from

non-target chemical application and compaction of individual plants. The preservation of native habitat would produce long-term moderate positive impacts.

Based on the potential short-term minor negative impacts to individuals and the long-term moderate positive impacts to habitat, implementation of this alternative may affect, but not likely to adversely affect threatened and endangered species.

- Impacts of Alternative 2 on threatened and endangered species

Similar to the impacts in Alternative 1, this proactive alternative would provide a greater degree of knowledge about invasive plant populations and their locations through early detection, prevention, and research that would benefit the rare plant species by reducing, but not eliminating, non-target control, application, and compaction of individual plants.

Based on the potential short-term minor negative impacts to individuals and the long-term moderate positive impacts to habitat, implementation of this alternative may affect, but not likely to adversely affect, threatened and endangered species.

- Impacts of Alternative 3 on threatened and endangered species

Similar to the impacts in Alternative 2, this proactive alternative would include the use of aerial chemical application. The use of an aircraft within the park would cause additional negligible harassment to threatened and endangered species as a result of noise and intrusion into home range habitat. There could be potential major negative impacts in the form of injuries and/or mortalities to avian species from mid air collisions. However, aerial treatments would cause a greater and faster decrease of thistle in areas where thick populations are causing reductions in prairie dog town acreages, thus encouraging prairie dog town expansion. This would have minor indirect benefit for the black-footed ferret, which may be able to establish in the larger prairie dog towns.

Based on the potential short-term minor negative impacts to individuals and the long-term moderate positive impacts to habitat, implementation of this alternative may affect, but not likely to adversely affect, threatened and endangered species, except for the black-footed ferret, which may experience minor, long-term positive impacts.

Paleontological Resources

- Impacts to paleontological resources common to all three alternatives

All three alternatives include the use of chemical control, mechanical control, biological control, and fire towards weed species in the park

Any foot or vehicle traffic from the three alternatives that occur on bedrock could have a potential impact on paleontological resources. All foot and vehicle traffic should be limited to vegetated and soil covered areas whenever possible. Soil and vegetative cover protect vulnerable fossil resources from potential damage from vehicle and foot traffic. Any bedrock areas that are under consideration for development to accommodate greater vehicle or foot traffic would need to be surveyed and monitored before and

during construction. Pre-burn surveys for paleontological resources and paleontological salvage collections also need to be completed before a prescribed fire is completed in the park. Fire in fossil rich areas that also contain some fuel materials could potentially cause damage to fossils.

- Paleontological impacts of Alternative 1

No action would continue the weed management operations that are currently being implemented. The above listed impacts of chemical control, mechanical control, and biological control would have minor negative impacts to paleontological resources as long as foot and vehicle traffic is limited to soil covered and vegetated areas. Any foot or vehicle traffic on bedrock could damage fossils in a measurable fashion in specific areas within the park. A measurable fashion would include one fossil specimen damaged in a specific area.

Based on the potential short-term minor negative impacts and the long-term minor negative impacts to paleontological resources, implementation of this alternative may adversely affect paleontological resources at a minor level.

- Paleontological impacts of Alternative 2

Similar to the impacts in Alternative 1, Alternative 2 would have minor negative impacts to paleontological resources as long as foot and vehicle traffic is limited to soil covered and vegetated areas. Any foot or vehicle traffic on bedrock could damage fossils in a measurable fashion in specific areas within the park. A measurable fashion would include one fossil specimen damaged in a specific area.

Based on the potential short-term minor negative impacts and the long-term minor negative impacts to paleontological resources, implementation of this alternative may adversely affect paleontological resources at a minor level.

- Paleontological impacts of Alternative 3

Similar to the impacts in Alternative 2, Alternative 3 would include the use of aerial chemical application. Aerial chemical application would have no adverse affect on paleontological resources. Alternative 3 could reduce the negative impact from minor to negligible if it reduced the amount of foot and vehicle traffic on exposed bedrock.

Based on the reduction of short-term and long-term negative impacts to paleontological resources, implementation of this alternative would have a negligible adverse impact on paleontological resources.

<u>Water Resources</u>

- Impacts on water resources common to all three alternatives

Under all three alternatives, ATV's and stock would cross numerous intermittent drainages to access weed populations. These crossings could have negative, negligible short-term impact on wetland and/or floodplain values associated with some of these

drainages. Stream crossings could potentially increase localized sedimentation in standing or shallow flowing water at the crossing, although most drainages are dry during the summer months when most weed control efforts occur. Badlands hydrology is characterized by a large amount of suspended sediment, so this localized, temporary increase in sedimentation would not be detectable or cause harm to the aquatic organisms.

Use of glyphosate herbicide with an aquatic label would not pose a risk to aquatic communities or wetland values of stock ponds or other standing water environments. No other herbicides are proposed for use in or near standing water, but may pose a risk from leaching. Clopyralid is moderately prone to leaching, but is less mobile and less persistent than Picloram. Therefore, this impact analysis focuses on picloram because it poses the greatest risk due to its persistence and mobility. A hydrologic analysis for use of picloram to control Canada thistle at Badlands (Fontaine and Tinant 2001) used models to predict the threat posed to surface and ground water resources from application in the Burns Basin area of the park. Burns Basin is typical of much of the park in terms of vegetation, soil, topography, depth to ground water, and the infrequent presence of surface water. The study found that picloram applications would not constitute a threat to surface or ground water resources in the treatment areas. It does recognize that picloram could mobilize following subsequent rainfall events and the herbicide could migrate downslope. Eventually it would decay to weak concentrations in water stored along channel alluvium or continue moving downstream in the White, Bad, or Cheyenne Rivers. Because many townships and ranches get their domestic water supply from shallow wells drilled in water-bearing river alluvium, a more thorough literature search was conducted to see if the park's use of picloram could pose a risk to water quality in these major rivers or their alluvial wells. The results of this search follow in the next paragraph.

Because weed populations occur in a variety of soils, slopes, and proximity to drainage channels, this discussion generally characterizes the potential of picloram to affect water quality. Actual response would vary from site to site throughout the park's 244,000 acres. Picloram persists longer in clay soils than in lighter textured soils (Scifres et al. 1971, Marley 1980). Because of it's affinity for clay soils, there is a low probability that picloram would be transported off the application site unless high intensity rainfall occurs immediately after application (Scifres et al. 1971). Because most of the soils in the park have a high clay content and the badlands are semi-arid, most of the picloram would stay in the soil profile where it was applied. However, Badlands does experience intense thunderstorms during summer, particularly in June when much of the picloram would be applied. In the event a thunderstorm occurred shortly after application of picloram, the picloram is water soluble and could be transported in runoff water. The passage of the runoff water over thick sod would intercept much of the runoff and herbicide thus reducing the amount of herbicide being transported into drainage channels (Trichell et al. 1968, Baur et al. 1972). A stock pond would likely intercept picloram that did reach a drainage channel before it reached a river. Picloram in water is rapidly decomposed by exposure to direct sunlight (Mayeaux 1984, Baur 1972) and elevations such as those at Badlands even further accelerate the decomposition by sunlight in only a few days (Mayeaux 1984). If picloram did reach a river channel without being intercepted by clay soils or sod, or being decomposed by sunlight in a pond or channel, the dilution of the large volume of water found in these major rivers would make the minute amount of picloram below detection (Baur 1972, Scifres 1971). Because of these factors, the

transport of picloram in surface or near-surface waters is not considered a likely impact to water quality.

In most of the park, groundwater aquifers are greater than 1000 feet deep and thus picloram does not pose a risk to these deep ground water resources.

In compliance with the Oglala Sioux Tribe's Groundwater Protection Plan (Oglala Sioux Tribe 1997), herbicide use proposed in this Integrated Weed Management Plan and Environmental Assessment has been evaluated for potential impacts to groundwater resources on Pine Ridge Reservation. Geographic Information System (GIS) was used to analyze risk to groundwater and surface waters. Vulnerability of a water resource to contamination by herbicide use is based upon geology, soils, and proximity to surface water. Sensitivity of a water resource to contamination by herbicide use is based upon proximity to community and individual wells and pesticide properties. Details of this analysis and recommended best management practices are found in Appendix C.

Both the White River and the Cheyenne River are listed in the National Rivers Inventory, a register of rivers that may be eligible for inclusion in the National Wild and Scenic River System. These rivers were included on the NRI based on the degree to which they are free-flowing, the degree to which the rivers and their corridors are undeveloped, and the outstanding natural and cultural characteristics of the rivers and their immediate environments. None of the actions proposed under any of the three alternatives would affect the values for which the White River and Cheyenne River are listed on the National Rivers Inventory.

- Water impacts of Alternative 1

Under this alternative, herbicide would still be used in the park. It's continued use would be subject to annual approvals and thus may change year to year. On an annual basis under Alternative 1, less herbicide would be applied in the park than under Alternatives 2 or 3. Due to the lack of prevention, early detection and eradication, and research efforts, more herbicides may actually be applied in the park long term.

Implementation of this alternative could result in long-term, minor, negative impacts to water quality. The actual impact would be for a brief time between herbicide application and plant uptake if the herbicides were transported off-site by precipitation. However, under this alternative, this impact to water quality would continue year after year due to the continuing need for intensive herbicide treatments every year without a comprehensive weed management strategy in place.

- Water impacts of Alternative 2

Under this alternative, herbicide use would likely increase in the next five years but would decline long-term due to the effectiveness of a comprehensive, proactive weed management program.

Implementation of this alternative could result in short-term, minor, negative impacts to water quality. The impact would be for a brief time between herbicide application and plant uptake if the herbicides were transported off-site by precipitation.

- Water impacts of Alternative 3

Under this alternative, herbicide use would likely increase in the next five years. Compared to Alternatives 1 or 2, there would be a higher probability of impacting surface waters due to the higher potential for drift associated with aerial application. Similar to Alternative 2, there would likely be a decline in herbicide use long-term due to the effectiveness of a comprehensive, proactive, weed management program.

Implementation of this alternative could result in short-term, moderate, negative impacts to water quality. The impact would be for a brief time between herbicide application and plant uptake if the herbicides were transported off-site by precipitation.

Wilderness

- Impacts to Wilderness common to all three alternatives

All three alternatives include the use of chemical control, mechanical control, biological control, and fire towards weed species in the park.

As the mixed-grass prairie is a fire-dependent community, the presence of fire and its effects on the environment would contribute to the naturalness of the Wilderness. However, some aspects of fire management may be intrusive on the Wilderness experience. Most notably would be the presence of mechanized equipment overhead during fire reconnaissance and suppression activities. This would be a short-term impact. Except under extreme threat to life and property, on-the-ground mechanized equipment is prohibited in the Wilderness. These fire related impacts on Wilderness are common to all three alternatives.

All three alternatives could have the potential impact on visitor solitude and self-discovery while in the Wilderness by park personnel and equipment. The impact would be short term and any Wilderness visitor complaints can be reported to the Resource Management Specialist and the Wilderness Program Manager.

Mechanical control, as identified in all three alternatives, included cutting, mowing, and hand pulling of targeted weeds. All three alternatives also call for chemical control by using ATV, horse and backpack mounted herbicide sprayers. As stated in the Wilderness Act of 1964, (c), '…there shall be no use of motor vehicles, motorized equipment…' therefore the use of motorized equipment, such as ATV's and gas powered cutting tools is prohibited within the Wilderness. Reference the completed Minimum Requirement Analysis in Appendix A.

All three alternatives contain, at some degree, the reduction or elimination of weeds. These actions would ultimately restore the native species naturalness sought by visitors in the Wilderness.

- Wilderness impacts of Alternative 1

No action would continue the weed management operations that are currently being implemented. The above listed impacts of chemical control, mechanical control, and biological control would have minor, negative impacts to Wilderness.

Implementation of this alternative would have potential short-term, minor, negative impacts to Wilderness users and long-term, moderate, positive impacts to Wilderness naturalness.

- Wilderness impacts of Alternative 2

This alternative implements a comprehensive and proactive weed management program that does not include aerial spraying. This preventative approach has been documented to increase the effectiveness of maintaining and/or restoring native plant communities and the habitat they provide (Reichard 1997). Alternative 2 would have moderate, positive impacts to Wilderness.

Implementation of this alternative would have potential short-term, minor, negative impacts to Wilderness users and long-term, moderate, positive impacts to Wilderness naturalness.

- Wilderness impacts of Alternative 3

Similar to the impacts in Alternative 2, this proactive alternative would include the use of aerial chemical application. Aerial chemical application could have an adverse affect on the Wilderness experience due to temporary closures during application and the intrusion from the aerial equipment. Alternative 3 would have a moderate, negative impact on the Wilderness because it adversely interferes with the soundscape and solitude Wilderness users seek.

Implementation of this alternative would have potential short-term, moderate, negative impacts to Wilderness users and long-term, moderate, positive impacts to Wilderness naturalness.

Cultural Resources

- Impacts to Cultural Resources common to all three alternatives

All three alternatives include the use of chemical control, mechanical control, biological control, and fire towards weed species in the park

All three alternatives include the use of fire to control weeds. During 2001 and 2002, a research project investigating fire effects on archaeological resources was conducted during implementation of prescribed burns at Badlands National Park. The research was conducted using a variety of artifact materials, under several different fire intensities and in a variety of fuel conditions (Buenger 2002). Findings indicate that the temperatures archaeological artifacts typical within the White River Badlands are exposed to during prescribed fire in a mixed grass prairie ecosystem are not sufficient enough to cause

catastrophic failure. Buenger exposed sample objects in ten trials over two years during prescribed fire operations at Badlands National Park to derive these results. The impacts - black or light brown residue - do not impact the scientific value of the objects. Although fire temperatures can reach nearly 400 °C, residence times impacting artifacts are generally short - ranging between 1-3 minutes. Subsurface temperatures, even at –1cm, are negligible generally producing a maximum increase of only 20 °C over baseline values. The relatively low surface temperatures and short residence times associated with grassland fuels generate low to moderate impacts on experimental artifacts deposited at the soil surface. The impact of burning on artifacts is limited to the deposition of carbonaceous residue and carbonaceous blackening of the upper surfaces of artifacts. No catastrophic damage to artifacts has been observed during the series of experiments performed at the park during 2001 and 2002.

- Cultural resource impacts of Alternative 1

Under the no action alternative, ATV's would continue to be used to access areas for spraying purposes and would potentially impact unknown archaeological resources in unsurveyed areas. Erosion and vandalism may cause secondary impacts. The severity of fire related effects can be controlled and diminished to some degree by controlling the fireline intensity at the time of the burn. Fire would destroy historic archaeological resources that include wooden structures. None of the tentatively identified cultural landscapes would be negatively impacted by existing levels of exotic plant control. The current weed management activities do not impact areas where American Indians gather plants or practice religious activities.

Implementation of this alternative might have long-term, negligible, negative impacts to archaeological resources due to ATV use and fire. It would likely have long-term, negligible, positive impacts on cultural landscapes and ethnographic resources due to removal of non-native species.

- Cultural resource impacts of Alternative 2

Use of ATV's would continue to be used to access areas for spraying purposes and would potentially impact unknown archaeological resources in unsurveyed areas. Use of ATV's would increase under this alternative, increasing the potential impacts. Of the tentatively identified cultural landscapes, only the homestead sites could be negatively impacted by reduction of exotic plants because many of these introduced plant species were intentionally planted by settlers. Some plants were deliberately planted to provide "beauty" while others, such as yellow sweetclover, were sown for grazing animals. The remaining four potential cultural landscapes would be restored to their pre-European appearance through the activities of this plan. None of the high impact weeds are gathered for traditional uses by the Oglala Lakota people. Although a few of the low impact weeds do have ethnobotanical value, they are common enough off park property that there is no known gathering of these plants within park boundaries. Therefore, this alternative would not have an adverse impact on ethnographic resources.

Implementation of this alternative might have long-term, minor, negative impacts to archaeological resources due to ATV use and fire. It would likely have long-term, minor, positive impacts on cultural landscapes and ethnographic resources due to removal of non-native species.

- Cultural resource impacts of Alternative 3

The impacts are the same as under Alternative 2: Use of ATV's would continue to be used to access areas for spraying purposes and would potentially impact unknown archaeological resources in unsurveyed areas. Use of ATV's would increase under this alternative compared to Alternative 1, but would less than alternative 2. Of the tentatively identified cultural landscapes, only the homestead sites could be negatively impacted by reduction of exotic plants because many of these introduced plant species were actually intentionally planted by settlers. Some plants were deliberately planted to provide "beauty" while others, such as yellow sweetclover, were sown for grazing animals. The remaining four potential cultural landscapes would be restored to their pre-European appearance through the activities of this plan. None of the high impact weed species are gathered for traditional uses by the Oglala Lakota people. Although a few of the low impact weed species do have ethnobotanical value, they are common enough off park property that there is no known gathering of these plants within park boundaries. Therefore, this alternative would not have an adverse impact on ethnographic resources.

Implementation of Alternative 2 might have long-term, minor, negative impacts to archaeological resources due to ATV use and fire. It would likely have long-term, minor, positive impacts on cultural landscapes and ethnographic resources due to removal of non-native species.

IV.C.4. Impact Matrix

Table 8. Summary Matrix of Impacts of Alternatives

Impact Topic	Alternative 1: No Action	Alternative 2: Proactive	Alternative 3: Proactive w/aerial
Vegetation Resources	Short-term, negligible, negative; Long-term, moderate, positive	Short-term, negligible, negative; Long-term, major, positive	Short-term, negligible, negative; Long-term, major, positive
Wildlife Resources	Short-term, negligible, negative; Long-term, moderate, positive	Short-term, negligible, negative; Long-term, major, positive	Short-term, negligible, negative; Long-term, major, positive
Threatened & Endangered Species	Short-term, minor, negative; Long-term, moderate, positive	Short-term, minor, negative; Long-term, moderate, positive	Short-term, minor, negative Long-term, moderate, positive
Paleontological Resources	Short-term, minor, negative, Long-term, minor, negative	Short-term, minor, negative, Long-term, minor, negative	Short-term negligible negative, Long-term negligible negative
Water Resources	Long-term, minor, negative	Short-term, minor, negative;	Short-term, moderate, negative;
Wilderness	Short-term, minor, negative on Wilderness users; Long-term, moderate, positive on Wilderness naturalness	Short-term, minor, negative on Wilderness users; Long-term, moderate, positive on Wilderness naturalness	Short-term, moderate, negative on Wilderness users; Long-term, moderate, positive on Wilderness naturalness
Cultural Resources	Long-term, negligible, negative on archaeology; Long-term, negligible, positive on ethnographic resources and cultural landscapes	Long-term, minor, negative on archaeology; Long-term, minor, positive on ethnographic resources and cultural landscapes	Long-term, minor, negative on archaeology; Long-term, minor, positive on ethnographic resources and cultural landscapes

IV.C.5. Environmentally Preferred Alternative

National Park Service policy (NPS 2001*a*) requires that an Environmental Assessment identify the environmentally preferred alternative. Simply put, “this means the alternative that causes the least damage to the biological and physical environment; it also means the alternative which best protects, preserves, and enhances historic, cultural and natural resources “ (NPS 2001*b*). Based on the impact analysis above, Alternative 2: Proactive Management and Alternative 3: Proactive Management with limited Aerial Application are equal in terms of their negative, short-term impacts. Alternative 2 has more impact on archaeological and paleontological resources due to ground disturbance associated with all-terrain vehicle in non-Wilderness areas and horse travel in the Badlands Wilderness Area. Alternative 3 has less impact on archaeological and

paleontological resources due to reduced ground-based travel and the use of aerial application; however, that aerial application has more potential for impact to non-target vegetation and disturbance of wildlife. Because vegetation and wildlife are more resilient than archaeological and paleontological resources, impacts to vegetation and wildlife are considered to be shorter-lived than impacts to archaeological and paleontological resources. Specifically regarding Wilderness values, Alternative 3 would require 10 days of aerial application to treat the 1500 acres of weeds that meet aerial application criteria and 120 days to treat the 1200 acres of other weeds that do not meet aerial application criteria. Alternative 2 would require 270 days to treat the same 2700 acres, thus more than doubling the frequency of human presence in the Wilderness area and prolonging human manipulation of the Wilderness area compared to Alternative 3. Regarding long-term impacts, Alternative 1 realizes the least amount of positive impacts because it provides the least effective control of weeds and requires an indefinite treatment period, Alternative 3 realizes the most positive impacts because it provides the most rapid control of weeds, and Alternative 2 is in between. Alternative 3 is the environmentally preferred because it provides the most long-term benefits to the environment. Alternative 3 is also the park's preferred alternative.

IV.C.6. Impairment

National Park Service policy (NPS 2001*a*) requires that management decisions, such as those outlined in this Integrated Weed Management Plan and Environmental Assessment, not impair park resources. The impairment that is prohibited is "an impact that, in the professional judgement of the responsible NPS manager, would harm the integrity of park resources or values, including the opportunities that otherwise would be present for the enjoyment of those resources or values." The negative impacts discussed in the impact analysis section are the unavoidable result of implementing a weed management program that is necessary to preserve or restore the integrity of the park's prairie resources and the habitat value it provides. The negative impacts are mostly short-term, localized, and moderate or less in intensity. No resources would experience irreparable harm such that their function would be diminished. Consequently, it is determined that implementation of any of the alternatives considered in this Integrated Weed Management Plan and Environmental Assessment would <u>not</u> constitute an impairment to vegetation, wildlife, threatened and endangered species, paleontological resources, water resources, Wilderness, or cultural resources.

IV.C.7. Cumulative Impacts

The National Environmental Policy Act requires that agencies consider the cumulative or additive impacts of proposed actions. A cumulative impact is described in regulations developed by the Council on Environmental Quality (CEQ), 40 CFR 1508.7, as follows: a "*Cumulative impact" is the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.*

Cumulative impacts were determined by combining the impact of the action alternatives (alternatives 2 and 3) with potential impacts of other past, present and reasonably foreseeable future actions. Therefore it was necessary to identify, other ongoing or foreseeable future projects within Badlands National Park and the surrounding region. Because the scope and affect of this Integrated Weed Management Plan is park-wide, and primarily affecting vegetation resources and wildlife habitat, only those projects that are likely to have large-scale effects were considered. Those smaller projects, such as rehabilitation of the park's Loop Road or localized construction such as the upcoming rehabilitation of the Sage Creek Campground were determined to be of such as scale that they are not reasonably cumulative when considered with the larger scale projects. The projects identified are: a) implementation of the park's Fire Management Plan (currently in draft); b) preparation of the park's General Management Plan (currently in preparation); and c) implementation of the U.S. Forest Service's Land and Resource Management Plan for Nebraska National Forest and Associated Units, 2001 revision, including Buffalo Gap National Grasslands adjacent to Badlands National Park. Descriptions of these three projects and their cumulative impacts are presented below.

Fire Management Plan (in draft)

The park has prepared a new Fire Management Plan (NPS 2001*c*) that prescribes the management of fire as a fundamental natural process to grassland communities. This plan is currently in draft and would likely be on public review sometime in 2003. The plan is accompanied by an Environmental Assessment. The preferred Alternative allows for the use of management ignited prescribed fire in about 10,000 acres per year, allows for naturally-ignited fires to burn in the park's interior under specific conditions, and provides for suppression of unwanted fires using minimum impact suppression tactics.

Use of fire to invigorate native prairie is an important supplement to the goals described in this Integrated Weed Management Plan because a healthy prairie is less likely to be invaded by weeds. Furthermore, use of prescribed fire to control cool-season exotic grasses is an important part of the park's overall weed management effort. The Integrated Weed Management Plan would also reduce the invasion of weed species that may alter the natural fire regime. So the Fire Management Plan is a very important compliment to this Integrated Weed Management Plan and amplifies the positive impacts of both.

Use of motorized equipment (all-terrain vehicles and engines) and increased foot traffic during prescribed fire activities and suppression efforts would have similar negative impacts to paleontological and archaeological resources as those described in the Integrated Weed Management Plan. Human intrusion into wildlife habitat, particularly with mechanized equipment, during prescribed fire activities and suppression efforts would have similar negative impacts to wildlife and threatened and endangered species as those described in the Integrated Weed Management Plan. Consequently, these impacts would be added to the negative impacts associated with implementation of this Integrated Weed Management Plan, although most would be localized and short-term.

Cumulatively, implementation of the Fire Management Plan and the Integrated Weed Management Plan are expected to have a positive impact on park resources by

enhancing native prairie and the habitat it provides, with potential for some localized negative impacts to paleontological and archaeological resources.

General Management Plan (in preparation)

The park is currently preparing a General Management Plan (GMP) that would guide overall park management for the next ten to fifteen years. The GMP would ensure that the park has a clearly defined direction for resource preservation and visitor use. An Environmental Impact Statement is also being prepared to accompany the GMP.

Overall park purpose and significance has been described in the GMP process. Implementation of this Integrated Weed Management Plan contributes directly to the GMP's park purpose to "preserve the flora, fauna, and natural processes of the mixed-grass prairie ecosystem," and the parks significance in that it "includes a substantial remnant of native prairie and contains the largest mixed-grass prairie protected by the National Park Service."

Alternatives for the GMP have been developed and an impact analysis is being conducted. While it is not possible to accurately describe a preferred alternative and it's impacts, it can be reasonably expected that the preferred alternative would provide for protection of park resources and identify expansion of developed areas or creation of new developed areas to provide for visitor enjoyment. Construction and increased foot or stock traffic would likely result in some localized impacts to all of the resource topics considered above. These impacts would be added to the negative impacts associated with implementation of this Integrated Weed Management Plan, although most negative impacts are short-term.

Cumulatively, implementation of the General Management Plan and the Integrated Weed Management Plan are expected to have a positive impact on the protection of park resources with some temporary, localized negative impacts.

US Forest Service Land and Resource Management Plan for Nebraska National Forest and Associated Units, including Buffalo Gap National Grasslands adjacent to Badlands National Park

In late 2001, the US Forest Service released it's final plan accompanied by a Final Environmental Impact Statement (US Forest Service 2001). This plan provides long-term guidance for management of Buffalo Gap National Grasslands.

Generally, the plan calls for increased protection of grassland resources and more recreational use of the Grasslands in the area surrounding the park through the use of new management zones and prescriptions. The vast majority of Grasslands acres remain classified as "Rangeland with Broad Resource Emphasis," allowing for livestock grazing through permit. Depending on seasonality and duration of grazing pressure, livestock grazing tends to increase certain unpalatable weeds such as thistles, but may reduce other palatable weeds such as yellow sweetclover. This classification also allows for the widest array of weed treatment techniques and the easiest access. New to Buffalo Gap National Grasslands is the 40,450 acres "Recommended for Wilderness" in

the Indian Creek area near the center of Badlands National Park and the 13,860 acres "Backcountry Recreation Non-Motorized" in the Rake Creek area that shares a boundary with the eastern edge of the park. Elimination and/or restriction on vehicular travel within these areas would likely reduce new weed invasions, but may make weed control more difficult. It would also reduce the impacts of vehicular travel on the paleontological and archaeological resources in those areas, many of which share a context with and contribute to understanding of park paleontological and archaeological resources.

Two relevant goals of the US Forest Service's plan are "Goal1.c: Increase the amount of forest and grasslands restored to or maintained in a healthy condition with reduced risk and damage from fires, insects and diseases, and invasive species" and "Goal 2.b: Improve the capability of wilderness and protected areas to sustain a desired range of benefits and values." Implementation of any of the alternatives considered in the park's Integrated Weed Management Plan would contribute to these goals through reduction of weeds in the adjacent park lands, although "Alternative 3 Proactive Management with Aerial Application" would make the most contribution.

Cumulatively, the US Forest Service's implementation of their new Land and Resource Management Plan and the park's implementation of this Integrated Weed Management Plan are expected to have positive impacts on the prairie and the habitat it provides throughout the region.

IV. D. Coordination and Consultation

IV.D.1. Summary of Public Involvement

In September of 1999, a press release announced the initiation of several park planning projects, including a weed management plan. Interested parties were encouraged to submit comment via phone, mail, or email on the upcoming projects. Development of this plan has been a discussion topic at numerous meetings of the Badlands Weed Management Area, two quarterly meetings of the Pennington County Weed Board, two annual District weed meetings, and one annual State Weed Supervisors meeting. Many informal comments and suggestions were received from attendees at these various meetings and many were incorporated into the alternatives. Additional opportunities for comment will be afforded to the general public as well as many weed-oriented and regulatory organizations during the public review period in March 2003. The release of the public review document will be announced widely through press releases and a public open house will be held in the park to discuss the plan with interested members of the public. The document will undergo a 30-day public review period and all substantive comments will be addressed. If no substantive comments or new information are received during the public review period, a finding of no significant impact will be issued and the plan will be implemented as written.

IV.D.2. Oglala Sioux Tribe

The appropriate level of Tribal government has been consulted during development of this plan and environmental assessment. Irving Provost, the Tribe's Pesticide Enforcement Officer was consulted and provided input regarding proposed alternatives, Tribal regulations, and groundwater protection analysis. Furthermore, he evaluated the Appendix C of the internal draft plan and found it to be in compliance with the Tribe's Groundwater Protection Plan and Pesticide Ordnance. Additional opportunities for comment will be afforded to the Oglala Sioux Tribe during the public review period.

IV.D.3. US Forest Service, Buffalo Gap National Grasslands

During development of this plan Jack Isaacs, the former Wall District Range Conservationist, was consulted as a member of the Badlands Weed Management Area. He provided input on alternatives. He also provided a copy of the "Environmental Analysis, Management of Undesirable Plant Species in Nebraska National Forest, May 1993" which prescribes weed management efforts in Buffalo Gap National Grasslands. The proposed actions of this Integrated Weed Management Plan for Badlands National Park have been evaluated and found to be consistent with the US Forest Service plans outlined in "Management of Undesirable Plant Species" as well as the "US Forest Service Land and Resource Management Plan for Nebraska National Forest and Associated Units." Additional opportunities for comment will be afforded to Buffalo Gap National Grasslands during the public review period.

IV.D.4. US Fish and Wildlife Service

In accordance with the Endangered Species Act of 1973, Section 7 consultation with the U.S. Fish and Wildlife Service concerning impacts to threatened and endangered species was initiated during the initial drafting of this Integrated Weed Management Plan and Environmental Assessment (Larson 2001). Additional opportunities for comment and formal documentation will be completed by US Fish and Wildlife Service during public review, according to their agency policies.

IV.D.5. Bureau of Indian Affairs, Pine Ridge Agency

During development of this plan Ed Schuh, the Pine Ridge Agency Weed and Pest Supervisor, was consulted as a member of the Badlands Weed Management Area. He provided input on alternatives. Additional opportunities for comment will be afforded to the Pine Ridge Agency during the public review period.

IV.D.6. State Historic Preservation Office

With several park planning projects underway, recent consultation with South Dakota State Historic Preservation Office has already identified all known National Register properties within the park. A letter has been submitted to the State Historic Preservation Office to notify them that the Integrated Weed Management Plan and Environmental Assessment will be submitted for their review and comment during the public review period.

IV.D.7. South Dakota Game, Fish, and Parks

The South Dakota Natural Heritage Database, managed by South Dakota Game, Fish and Parks, was consulted for information used in this Integrated Weed Management Plan and Environmental Assessment. Opportunities for comment will be afforded to South Dakota Game, Fish, and Parks during the public review period

IV.D.8. South Dakota Department of Agriculture

During development of this plan Ron Moehring, the State's Weed and Pest Supervisor, was consulted. He provided specific information regarding State laws and noxious weed list as well as provided input on the alternatives. Leon Wrage and Darrell Deneke of the South Dakota State University Extension Service were consulted regarding chemical selection and application rates. Additional opportunities for comment will be afforded to South Dakota Department of Agriculture during public review.

IV.D.9. Pennington County

During development of this plan Scott Guffey, the Pennington County Weed and Pest Supervisor, was consulted. He provided specific information regarding county listed

noxious weeds as well as provided input on the alternatives. Development of this plan was discussed at two Pennington County Weed Board meetings and board members provided input on the alternatives. Additional opportunities for comment will be afforded to Pennington County during public review.

IV.D.10. Jackson County

During development of this plan Kelly Fortune, Jackson County Weed and Pest Supervisor, was consulted as a member of the Badlands Weed Management Area. He provided input on the alternatives. Additional opportunities for comment will be afforded to Jackson County during public review.

IV.D.11. Shannon County

During development of this plan, Shannon County Extension Service personnel have been consulted as members of the Badlands Weed Management Area. Additional opportunities for comment will be afforded to Shannon County during public review.

IV.D.12. Badlands Weed Management Area

Since it's inception in 1999, the Badlands Weed Management Area has provided a forum for interagency discussion regarding weed management in and around the park. This is a diverse group of private landowners, county, state, federal, and Tribal interests that meet several times a year to discuss weed management in the Badlands vicinity. This group has provided substantial input into identification of issues and the development of the alternatives. Additional opportunities for comment will be afforded to the members of the Badlands Weed Management Area during public review.

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Minimum Requirement Analysis

Proposed Project/Activity: Implement Alternative 3: Proactive management with limited aerial application (preferred), Integrated Weed Management Plan and Environmental Assessment
Project Coordinator: Sandee Dingman, Resource Specialist **Date:** March 8, 2002

Guiding Questions

Use the available space or additional sheets as necessary.

Is this an emergency? (i.e. does the action involve the loss of life or the threat of life or property.)

If **Yes**, then:
Document rationale for line officer approval using the minimum tool form and proceed with action.

If **No**, then:
⇓
go to next question

Answer:	**YES:** ☐	**NO:** ☒

Explain: The weeds present in Wilderness do not present an immediate threat to human life or park resources. However, if they continue untreated they would continue to degrade the park's prairie resources, habitat value, and the naturalness of the Wilderness.

Will project or action impair wilderness resources (physical, societal, and/or experiential)?

If **Yes**, then:
Do not proceed with the proposed project or activity.

If **No**, then:
⇓
go to next question

Answer:	**YES:** ☐	**NO:** ☒

Explain: Implementation of a comprehensive weed management program with limited aerial application would only temporarily disrupt the wilderness character. There may be some short-term negative impacts to wilderness users during weed control efforts such as aerial or horse-mounted herbicide application. The resource benefit of returning the wilderness to its original wild character improves wilderness values.

Does the project or action conflict with the preservation of wilderness or the requirements of legislation, planned wilderness goals, objectives or future desired conditions?

If **Yes**, then:
Do not proceed with the proposed project or activity.

If **No**, then:
⇓
go to next question

Answer:	**YES:** ☐	**NO:** ☒

Explain: Long-term, implementation of a comprehensive weed management plan would restore more natural conditions to the Wilderness by removing non-native species.

Minimum Requirement Analysis (page 2)

Are there other less intrusive actions that should be tried first? (i.e. signing, visitor education, or information.)	**Answer:**	**YES:** ☐	**NO:** ☒
	Explain: Less intrusive actions have already been used such as education and prevention as well as early detection and eradication to prevent the invasion of new weed species. Horse-mounted herbicide application and biological control which have previously been used in Wilderness areas and would continue to be used with this alternative.		

If **Yes**, then:
Implement other actions using the appropriate process.

If **No**, then:
⇓
go to next question

Can this project be accomplished outside of wilderness and still achieve its objectives?	**Answer:**	**YES:** ☐	**NO:** ☒
	Explain: Weeds that exist within the Wilderness must be treated in the Wilderness.		

If **Yes**, then:

If **No**, then:

Does a CE, EA/FONSI, or an EIS/ROD cover the proposed project or action?	**Answer:**	**YES:** ☒	**NO:** ☐
	Explain: This is the preferred alternative identified in the Integrated Weed Management Plan and Environmental Assessment.		

If **Yes**, then:
The proposed project or activity can be considered. *Go to Minimum Tool, as needed.*

If **No**, then:
⇓
Defer project until compliance is completed.

Minimum Requirement Analysis (page 3)

Option 1: An option utilizing motorized equipment or mechanical transport.	Option 2: An option using non-motorized equipment and non-mechanical transport.	Option 3: Variations of methods 1 and 2, as appropriate.	
Common to all alternatives: Prevention, early detection, and eradication are presumed on all three alternatives. Impacts of biological, mechanical, and cultural (fire) treatments are fully assessed in the Environmental Assessment. This analysis is limited to chemical treatment application method. There is approximately 2,700 acres of weeds in Wilderness that need chemical treatment. Of this 2,700 acres, 1,500 acres meet the criteria for aerial application and 1,200 acres can effectively be treated with horse-mounted sprayers.			
Option #1: Horse-mounted sprayers would be used to treat 1,200 acres of weeds in boundary areas. The remaining 1,500 acres could be treated with either ATV or aerial application. ATV application would leave persistent tracks in the Wilderness that would detract from its natural appearance. ATV's would also require multiple entries into the Wilderness (ie. Forty-seven entries to treat 1,500 acres of weeds), thus repeatedly disrupting the Wilderness experience for users. Aerial application would not leave tracks and would require fewer entries over time (ie. 10 entries to treat 1,500 acres of weeds).	Option #2: Horse-mounted sprayers would be used to treat all 2,700 acres. However, they are inefficient for large infestations located more than one mile from the nearest horse trailer access point. This inefficiency would allow weeds to continue to spread untreated and deteriorate both habitat and Wilderness values in new areas. It would take 270 entries to treat 2,700 acres of Wilderness weeds with horse-sprayers. Because there is a narrow phenological window in which to treat the targeted species, this option would take many years to treat all 2,700 acres of weeds.	Option #3: Horse-mounted sprayers would be used to treat 1,200 acres of weeds in boundary areas. The remaining 1,500 acres would be treated with aerial application. This would require 120 entries with horse-mounted sprayer to treat the 1,200 acres of weeds and 10 entries with aerial application equipment to treat the 1,500 acres of weeds.	
Which alternative would have the least overall impact on wilderness resources, character and visitor experience?			
Option 2 would have the least overall impact on wilderness. However, Option 3 is consistent with the preferred alternative identified in the Integrated Weed Management Plan and Environmental Assessment. Option 3 would have only localized, short-term adverse impacts to wilderness resources users and would have long-term major positive impacts on Wilderness naturalness.			

Approvals	Signature	Name	Position	Date
Prepared by:		Sandra Dingman	Project Coordinator	
Recommended by:		Melanie Berg	Wilderness Program Manager	
Recommended by:		Brian Kenner	Division Chief	
Approved by:		William R. Supernaugh	Superintendent	

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Alien Plant Ranking System: Background Information

Discussion of the Alien Plant Ranking System (APRS Implementation Team 2000) program, species analyzed, analysis methods, and rankings by impact, pest, and difficulty to control are presented in Section VIII of the Integrated Weed Management Plan and Environmental Assessment. This appendix provides additional background information, including the graphical representation of the species analyzed, the questions and weights used in the analysis, and the answers for each species. Complete datasheets and graphs for each species are on file at Badlands National Park.

Figure B1: Graphical representation of weed species as analyzed by the Alien Plant Ranking System. Numbers correspond to species listed in Table B1.

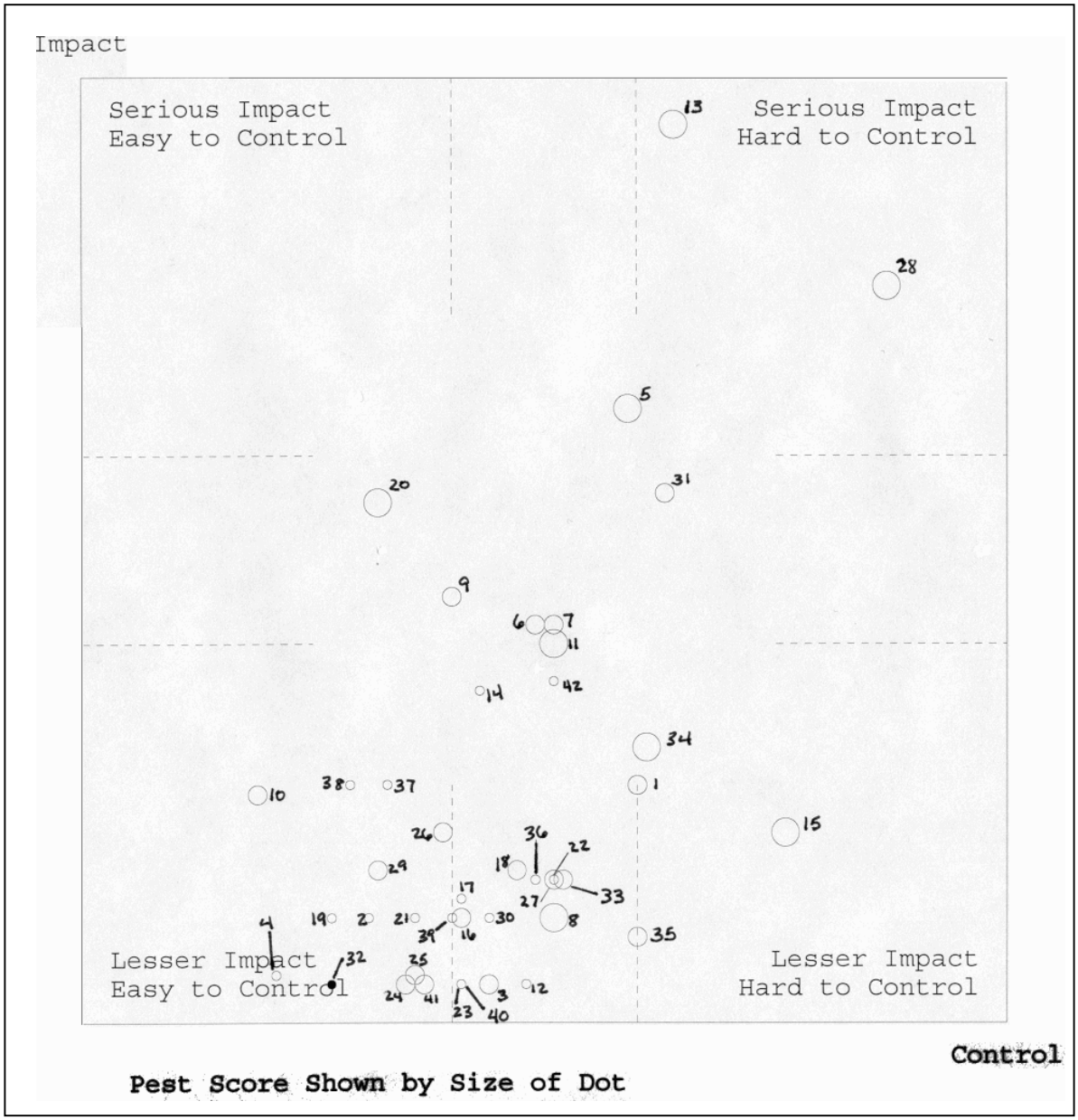

Table B1: List of species analyzed by the Alien Plant Ranking System. Species number corresponds to graph in Figure B1. Score is calculated using answers presented in Figure B3 to the questions presented in Figure B2.

#	Species	Impact	Pest	Control
1	Agropyron cristatum (crested wheatgrass)	57	25	60
2	Agropyron intermedium (intermediate wheatgrass)	30	11	31
3	Arctium lappa (burdock)	40	4	44
4	Asparagus officinalis (asparagus)	19	5	21
5	Bromus inermis (smooth brome)	76	65	59
6	Bromus japonicus (Japanese brome)	44	42	49
7	Bromus tectorum (downy brome)	60	42	51
8	Cardaria draba (hoary cress)	70	11	51
9	Carduus nutans (musk thistle)	40	45	40
10	Centaurea maculosa (spotted knapweed)	41	24	19
11	Centaurea repens (Russian knapweed)	68	40	51
12	Cerastium vulgatum (mouseear chickweed)	37	4	48
13	Cirsium arvense (Canada thistle)	79	95	64
14	Cirsium vulgare (bull thistle)	37	35	43
15	Convolvulus arvensis (field bindweed)	62	20	76
16	Cynoglossum officinale (houndstongue)	41	11	41
17	Dactylis glomerata (orchardgrass)	21	13	41
18	Elaeagnus angustifolia (Russian olive)	44	16	47
19	Elytrigia repens (quackgrass)	35	11	27
20	Euphorbia esula (leafy spurge)	86	55	32
21	Festuca pratensis (meadow fescue)	25	11	36
22	Halogeton glomeratus (halogeton)	25	15	51
23	Hesperis matronalis (dame's rocket)	24	4	41
24	Hyoscyamus niger (black henbane)	40	4	35
25	Linaria dalmatica (Dalmation toadflax)	43	5	36
26	Medicago sativa (alfalfa)	44	20	39
27	Melilotus alba (white sweetclover)	56	15	51
28	Melilotus officinalis (yellow sweetclover)	76	78	87
29	Nepeta cataria (catnip)	41	16	32
30	Phleum pratense (timothy grass)	29	11	44
31	Poa pratensis (Kentucky bluegrass)	60	56	63
32	Rumex stenophyllus (curly dock)	33	4	27
33	Sonchus arvensis (perennial sow thistle)	52	15	52
34	Tamarix parviflora (saltcedar)	70	29	61
35	Taraxacum officinale (dandelion)	43	9	60
36	Tragopogon dubius (western salsify)	29	15	49
37	Tragopogon porrifolius (common salsify)	24	25	33
38	Tragopogon pratensis (meadow salsify)	24	25	29
39	Tribulus terrestris (puncturevine)	38	11	40
40	Trifolium hybridum (Alsike clover)	33	4	41
41	Trifolium pratense (red clover)	41	4	37
42	Verbascum thapsus (common mullein)	35	36	51

Figure B2: Alien Plant Ranking System questions and weights used to conduct the analysis. Answers by species are presented in Figure B3.

Impact Weight	Pest Weight	Control Weight	**I. Significance of Threat or Impact (Site Characteristics)**
			1. Distribution relative to disturbance regime
[0]	[0]	[0]	A. found only within sites disturbed within the last 3 years or sites regularly disturbed
[1]	[0]	[0]	B. found in sites disturbed within the last 10 years
[2]	[0]	[0]	C. found in midsuccessional sites disturbed 11 to 50 years before present
[5]	[0]	[0]	D. found in late-successional sites disturbed 51 to 100 years before present
[10]	[0]	[0]	E. found in high quality natural areas with no known major disturbance for 100 years
			2. Aerial extent of populations (answer in per cent or hectares)
[0]	[0]	[0]	A. not in site, but in adjacent areas
[1]	[0]	[1]	B. found in less than 5% of site
[2]	[0]	[2]	C. found in between 5% and 10% of site
[3]	[0]	[5]	D. found in between 10% and 25% of site
[5]	[0]	[10]	E. found in more than 25% of site
			3. Numerical dominance of species within a community
[0]	[0]	[0]	A. not found on site
[1]	[0]	[1]	B. usually observed as a single individual (or < 5/5 sq. meters)
[2]	[0]	[3]	C. usually observed in numbers less than the 2 or 3 most common native species in the community (but >5/5 sq. meters)
[3]	[0]	[5]	D. usually observed in numbers approximately equivalent to the most common native species in the community
[5]	[0]	[10]	E. usually observed in numbers greater than the most common native species in the community
			4. Association with native community
[0]	[0]	[0]	A. associated with weedy (early successional) species
[3]	[0]	[0]	B. associated with midsuccessional species
[6]	[0]	[0]	C. associated with dominant (late-successional) species
[10]	[0]	[0]	D. displaces native plant community
			5. Hybridization with native species
[0]	[0]	[0]	A. not known to hybridize with native species
[5]	[0]	[0]	B. known to hybridize with native species
			6. Degree if threat and impact
[0]	[0]	[0]	A. little or no increase in numbers of individuals and populations and no invasion of native communities
[1]	[0]	[0]	B. present in native communities, but static or decreasing
[2]	[0]	[0]	C. moderate rate of increase in numbers of individuals and populations; little or no invasion of native communities
[5]	[0]	[0]	D. moderate rate of increase in numbers of individuals and populations; invading native plant communities
[10]	[0]	[0]	E. high rate of increase of numbers of individuals and populations; invading, replacing or modifying native plant communities
			7. Effects on management goals
[0]	[0]	[0]	A. no effect
[3]	[0]	[0]	B. little impact on site management goals
[5]	[0]	[0]	C. moderate impact on site management goals
[10]	[0]	[0]	D. large impact on site management goals

Figure B2, page 2

Impact Weight	Pest Weight	Control Weight	**II. Innate Ability to be a Pest (Species Characteristics)**
			8. Mode of Reproduction
[0]	[0]	[0]	A. rarely, if ever, reproduces in area
[0]	[1]	[0]	B. reproduces almost entirely by vegetative means
[0]	[2]	[0]	C. reproduces only by seeds
[0]	[4]	[0]	D. reproduces vegetatively and by seeds
			9. Vegetative reproduction
[0]	[0]	[0]	A. no vegetative reproduction
[0]	[1]	[0]	B. vegetative reproduction rate maintains population
[0]	[2]	[0]	C. vegetative reproduction rate results in moderate increase in population size
[0]	[4]	[0]	D. vegetative reproduction rate results in rapid increase in population size
			10. Frequency of sexual reproduction for mature plant
[0]	[0]	[0]	A. almost never reproduces sexually in area
[0]	[1]	[0]	B. once every five or more years
[0]	[3]	[0]	C. every other year
[0]	[5]	[0]	D. one or more times a year
[0]	[3]	[0]	E. bursts of sexual reproduction in response to environmental stimulus
			11. Number of seeds per plant
[0]	[0]	[0]	A. rarely, if ever, produces seeds in area
[0]	[1]	[0]	B. few (0-10)
[0]	[3]	[0]	C. moderate (11-1000)
[0]	[5]	[0]	D. many (>1000)
			12. Dispersal ability
[0]	[0]	[0]	A. little potential for long-distance dispersal
[0]	[5]	[0]	B. great potential for long-distance dispersal
			13. Germination requirements
[0]	[0]	[0]	A. requires open soil and disturbance to germinate
[0]	[2]	[0]	B. can germinate in vegetated areas but in a narrow range or in special conditions
[0]	[4]	[0]	C. can germinate in existing vegetation in a wide range of conditions
			14. Seed banks
[0]	[0]	[0]	A. seeds remain viable in the soil for less than 1 year
[0]	[3]	[3]	B. seeds remain viable in the soil for 1 to 5 years
[0]	[5]	[5]	C. seeds remain viable in the soil for more than 5 years
			15. Competitive ability
[0]	[0]	[0]	A. poor competitor
[0]	[2]	[0]	B. moderately successful competitor
[0]	[4]	[0]	C. highly successful competitor
			16. Ecological effects (select all that apply)
[0]	[3]	[0]	A. produces persistent litter or shade that affects germination or growth of native species
[0]	[3]	[0]	B. produces allelochemicals
[0]	[3]	[0]	C. affects availability of soil nutrients, e.g., a nitrogen fixer
[0]	[4]	[0]	D. affects water availability to native plants
[0]	[4]	[0]	E. changes natural fire regime
[0]	[0]	[0]	F. none of the above

Figure B2, page 3

			17. Known level of impact in natural areas
[0]	[0]	[0]	A. not known to cause impacts in any other natural area
[0]	[1]	[0]	B. known to cause impacts in natural areas, but with different habitats and climate zones
[0]	[3]	[0]	C. known to cause low impact in natural areas with similar habitats and climate zones
[0]	[5]	[0]	D. known to cause moderate impact in natural areas with similar habitats and climate zones
[0]	[10]	[0]	E. known to cause high impact in natural areas with similar habitats and climate zones and/or on state list
Impact Weight	Pest Weight	Control Weight	**III. Difficulty of Control** 18. Likelihood of successful control
[0]	[0]	[0]	A. this species has been eradicated in a natural area
[0]	[0]	[3]	B. control (populations declining) of this species has been achieved in a natural area
[0]	[0]	[6]	C. limited control (species is no longer spreading, but persists near pre-control levels) of this species has been achieved
[0]	[0]	[10]	D. control of this species has never been achieved in a natural area
			19. Saturation in surrounding region
[0]	[0]	[0]	A. not present in areas surrounding the site
[0]	[0]	[1]	B. present in few areas surrounding the site
[0]	[0]	[3]	C. present in several areas but not entirely surrounding the site
[0]	[0]	[5]	D. present in most areas surrounding the site
			20. Effectivness of community management
[0]	[0]	[0]	A. protection from disturbance effectively controls target species
[0]	[0]	[2]	B. cultural techniques (burning, flooding) can be used to control target species
[0]	[0]	[5]	C. restoration or preservation practices effectively control target species
[0]	[0]	[10]	D. the above options are not effective
			21. Vegetative regeneration
[0]	[0]	[0]	A. no resprouting following removal of aboveground growth
[0]	[0]	[5]	B. sprouts from roots or stumps
[0]	[0]	[10]	C. any plant part is a viable propagule
			22. Biological control
[0]	[0]	[0]	A. biological control feasible
[0]	[0]	[5]	B. potential may exist for biological control
[0]	[0]	[10]	C. biological control not feasible (not practical, possible, or probable)
			23. Side effects of control measures
[0]	[0]	[0]	A. control measures have little potential to affect native communities
[0]	[0]	[3]	B. control measures are likely to cause moderate impacts on community
[0]	[0]	[5]	C. control measures are likely to cause major impacts on community
[0]	[0]	[5]	D. side effects of control unknown

Figure B3: Alien Plant Ranking System data by species. Numbers and letters correspond with questions presented in Figure B2.

1. Agropyron cristatum				(crested wheatgrass)							
#1:C	#2:B	#3:C	#4:B	#5:A	#6:B	#7:C	#8:D	#9:B	#10:D	#11:C	#12:A
#13:B	#14:C	#15:B	#16:D	#17:E	#18:C	#19:D	#20:D	#21:B	#22:C	#23:A	
2. Agropyron intermedium				(intermediate wheatgrass)							
#1:B	#2:B	#3:B	#4:A	#5:A	#6:A	#7:B	#8:D	#9:B	#10:D	#11:C	#12:A
#13:A	#14:B	#15:A	#16:F	#17:C	#18:A	#19:C	#20:A	#21:A	#22:C	#23:D	
3. Arctium lappa				(burdock)							
#1:A	#2:B	#3:B	#4:A	#5:A	#6:A	#7:A	#8:C	#9:A	#10:C	#11:D	#12:B
#13:B	#14:C	#15:A	#16:F	#17:C	#18:B	#19:C	#20:C	#21:B	#22:C	#23:A	
4. Asparagus officinalis				(asparagus)							
#1:B	#2:B	#3:B	#4:A	#5:A	#6:A	#7:A	#8:A	#9:A	#10:D	#11:C	#12:A
#13:A	#14:B	#15:A	#16:F	#17:B	#18:A	#19:B	#20:A	#21:A	#22:C	#23:A	
5. Bromus inermis				(smooth brome)							
#1:D	#2:B	#3:E	#4:D	#5:A	#6:D	#7:D	#8:D	#9:D	#10:D	#11:D	#12:B
#13:B	#14:C	#15:B	#16:AC	#17:E	#18:C	#19:D	#20:B	#21:B	#22:C	#23:A	
6. Bromus japonicus				(Japanese brome)							
#1:E	#2:B	#3:C	#4:A	#5:A	#6:D	#7:C	#8:C	#9:A	#10:D	#11:C	#12:A
#13:B	#14:B	#15:A	#16:A	#17:E	#18:D	#19:D	#20:B	#21:A	#22:C	#23:B	
7. Bromus tectorum				(downy brome)							
#1:E	#2:B	#3:C	#4:A	#5:A	#6:D	#7:C	#8:C	#9:A	#10:D	#11:D	#12:B
#13:B	#14:B	#15:B	#16:E	#17:E	#18:C	#19:D	#20:B	#21:B	#22:C	#23:B	
8. Cardaria draba				(hoary cress)							
#1:B	#2:A	#3:A	#4:A	#5:A	#6:D	#7:A	#8:D	#9:C	#10:D	#11:D	#12:A
#13:C	#14:B	#15:C	#16:AD	#17:E	#18:C	#19:B	#20:D	#21:B	#22:C	#23:B	
9. Carduus nutans				(musk thistle)							
#1:E	#2:B	#3:B	#4:C	#5:A	#6:C	#7:C	#8:C	#9:A	#10:C	#11:D	#12:B
#13:B	#14:C	#15:A	#16:F	#17:C	#18:B	#19:D	#20:D	#21:A	#22:B	#23:A	
10. Centaurea maculosa				(spotted knapweed)							
#1:B	#2:B	#3:C	#4:B	#5:A	#6:B	#7:C	#8:C	#9:A	#10:C	#11:D	#12:B
#13:B	#14:B	#15:B	#16:B	#17:B	#18:C	#19:B	#20:A	#21:A	#22:A	#23:A	
11. Centaurea repens				(Russian knapweed)							
#1:C	#2:B	#3:D	#4:D	#5:A	#6:B	#7:C	#8:D	#9:C	#10:D	#11:D	#12:B
#13:C	#14:B	#15:B	#16:B	#17:E	#18:B	#19:C	#20:D	#21:C	#22:A	#23:B	
12. Cerastium vulgatum				(mouseear chickweed)							
#1:A	#2:B	#3:B	#4:A	#5:A	#6:A	#7:A	#8:D	#9:B	#10:D	#11:C	#12:A
#13:B	#14:C	#15:A	#16:F	#17:C	#18:C	#19:C	#20:C	#21:B	#22:C	#23:A	

Figure B3, page 2

13. Cirsium arvense				(Canada thistle)							
#1:E	#2:C	#3:E	#4:D	#5:B	#6:E	#7:D	#8:D	#9:D	#10:D	#11:D	#12:B
#13:B	#14:C	#15:C	#16:AC	#17:E	#18:B	#19:D	#20:D	#21:C	#22:A	#23:B	
14. Cirsium vulgare				(bull thistle)							
#1:D	#2:B	#3:B	#4:B	#5:B	#6:B	#7:B	#8:C	#9:A	#10:C	#11:D	#12:B
#13:B	#14:B	#15:A	#16:F	#17:C	#18:B	#19:B	#20:D	#21:A	#22:C	#23:B	
15. Convolvulus arvense				(field bindweed)							
#1:B	#2:B	#3:C	#4:B	#5:A	#6:B	#7:B	#8:D	#9:D	#10:D	#11:C	#12:B
#13:C	#14:C	#15:C	#16:F	#17:D	#18:D	#19:D	#20:D	#21:C	#22:C	#23:B	
16. Cynoglossum officinale				(houndstongue)							
#1:A	#2:B	#3:B	#4:A	#5:A	#6:B	#7:B	#8:C	#9:A	#10:C	#11:C	#12:B
#13:A	#14:B	#15:A	#16:AD	#17:C	#18:B	#19:C	#20:D	#21:A	#22:C	#23:A	
17. Dactylis glomerata				(orchardgrass)							
#1:A	#2:B	#3:C	#4:B	#5:A	#6:B	#7:A	#8:D	#9:B	#10:D	#11:C	#12:A
#13:A	#14:A	#15:A	#16:F	#17:A	#18:C	#19:B	#20:C	#21:B	#22:C	#23:A	
18. Eleagnus angustifolia				(Russian olive)							
#1:A	#2:B	#3:B	#4:B	#5:A	#6:B	#7:B	#8:D	#9:B	#10:D	#11:D	#12:B
#13:B	#14:C	#15:A	#16:F	#17:B	#18:A	#19:C	#20:D	#21:B	#22:C	#23:A	
19. Elytrigia repens				(quackgrass)							
#1:A	#2:B	#3:C	#4:A	#5:A	#6:A	#7:B	#8:D	#9:D	#10:D	#11:C	#12:A
#13:A	#14:B	#15:A	#16:F	#17:C	#18:A	#19:C	#20:A	#21:A	#22:C	#23:A	
20. Euphorbia esula				(leafy spurge)							
#1:E	#2:A	#3:A	#4:D	#5:A	#6:E	#7:A	#8:D	#9:D	#10:D	#11:C	#12:B
#13:C	#14:C	#15:C	#16:AC	E #17:	E #18:	B #19:	C #20:	C #21:	B #22:	A #23:B	
21. Festuca pratensis				(meadow fescue)							
#1:A	#2:B	#3:C	#4:A	#5:A	#6:A	#7:B	#8:D	#9:B	#10:D	#11:C	#12:A
#13:A	#14:A	#15:A	#16:F	#17:C	#18:B	#19:C	#20:B	#21:B	#22:C	#23:A	
22. Halogeton glomeratus				(halogeton)							
#1:A	#2:B	#3:C	#4:A	#5:A	#6:C	#7:B	#8:C	#9:A	#10:D	#11:C	#12:A
#13:A	#14:B	#15:A	#16:F	#17:C	#18:C	#19:D	#20:D	#21:A	#22:C	#23:A	
23. Hesperis matronalis				(dame's rocket)							
#1:A	#2:B	#3:B	#4:A	#5:A	#6:A	#7:A	#8:C	#9:A	#10:D	#11:D	#12:A
#13:A	#14:B	#15:A	#16:F	#17:A	#18:B	#19:C	#20:C	#21:A	#22:C	#23:D	
24. Hyoscyamus niger				(black henbane)							
#1:A	#2:B	#3:B	#4:A	#5:A	#6:A	#7:A	#8:C	#9:A	#10:D	#11:D	#12:B
#13:A	#14:C	#15:A	#16:F	#17:C	#18:B	#19:B	#20:A	#21:B	#22:C	#23:A	

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25. Linaria dalmatica				(dalmation toadflax)							
#1:A	#2:A	#3:A	#4:B	#5:A	#6:A	#7:A	#8:D	#9:C	#10:D	#11:C	#12:B
#13:B	#14:B	#15:B	#16:F	#17:B	#18:B	#19:B	#20:D	#21:B	#22:B	#23:A	
26. Medicago sativa				(alfalfa)							
#1:C	#2:B	#3:B	#4:B	#5:A	#6:B	#7:B	#8:C	#9:A	#10:D	#11:D	#12:A
#13:B	#14:C	#15:A	#16:AC	#17:C	#18:A	#19:D	#20:B	#21:B	#22:C	#23:A	
27. Melilotus alba				(white sweetclover)							
#1:C	#2:B	#3:B	#4:A	#5:A	#6:B	#7:B	#8:C	#9:A	#10:D	#11:D	#12:B
#13:B	#14:C	#15:A	#16:AC	#17:D	#18:C	#19:D	#20:B	#21:B	#22:C	#23:B	
28. Melilotus officinalis				(yellow sweetclover)							
#1:E	#2:E	#3:D	#4:D	#5:A	#6:D	#7:D	#8:C	#9:A	#10:D	#11:D	#12:B
#13:C	#14:C	#15:B	#16:AC	D #17:	E #18:	D #19:	D #20:	D #21:	B #22:	C #23:C	
29. Nepeta cataria				(catnip)							
#1:D	#2:B	#3:D	#4:A	#5:A	#6:A	#7:A	#8:D	#9:C	#10:D	#11:D	#12:B
#13:A	#14:C	#15:A	#16:F	#17:A	#18:A	#19:C	#20:A	#21:A	#22:C	#23:A	
30. Phleum pratense				(timothy grass)							
#1:A	#2:B	#3:C	#4:A	#5:A	#6:A	#7:B	#8:C	#9:A	#10:D	#11:D	#12:A
#13:A	#14:C	#15:A	#16:F	#17:B	#18:C	#19:C	#20:C	#21:A	#22:C	#23:A	
31. Poa pratensis				(Kentucky bluegrass)							
#1:D	#2:B	#3:E	#4:D	#5:A	#6:D	#7:C	#8:D	#9:C	#10:D	#11:C	#12:A
#13:C	#14:C	#15:C	#16:AC	#17:D	#18:C	#19:D	#20:B	#21:B	#22:C	#23:B	
32. Rumex stenophyllus				(curly dock)							
#1:A	#2:B	#3:B	#4:A	#5:A	#6:A	#7:A	#8:D	#9:B	#10:D	#11:C	#12:A
#13:B	#14:B	#15:A	#16:F	#17:C	#18:A	#19:D	#20:A	#21:A	#22:C	#23:A	
33. Sonchus arvensis				(perennial sow thistle)							
#1:B	#2:B	#3:C	#4:A	#5:A	#6:B	#7:B	#8:D	#9:D	#10:D	#11:D	#12:B
#13:A	#14:B	#15:A	#16:D	#17:C	#18:B	#19:B	#20:D	#21:B	#22:C	#23:B	
34. Tamarix parviflora				(saltcedar)							
#1:A	#2:B	#3:C	#4:B	#5:A	#6:D	#7:C	#8:D	#9:C	#10:D	#11:D	#12:B
#13:A	#14:C	#15:C	#16:D	#17:E	#18:C	#19:C	#20:D	#21:B	#22:C	#23:B	
35. Taraxacum officinale				(dandelion)							
#1:A	#2:B	#3:B	#4:A	#5:A	#6:A	#7:B	#8:C	#9:A	#10:D	#11:D	#12:B
#13:B	#14:C	#15:A	#16:F	#17:C	#18:B	#19:D	#20:D	#21:B	#22:C	#23:D	
36. Tragopogon dubius				(western salsify)							
#1:C	#2:B	#3:B	#4:B	#5:A	#6:B	#7:A	#8:C	#9:A	#10:C	#11:C	#12:B
#13:B	#14:A	#15:A	#16:F	#17:C	#18:D	#19:D	#20:D	#21:A	#22:C	#23:A	

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37. Tragopogon porrifolium				(common salsify)							
#1:E	#2:B	#3:C	#4:A	#5:A	#6:B	#7:A	#8:C	#9:A	#10:C	#11:C	#12:B
#13:B	#14:A	#15:A	#16:F	#17:A	#18:D	#19:B	#20:A	#21:A	#22:C	#23:A	
38. Tragopogon pratensis				(meadow salsify)							
#1:D	#2:B	#3:B	#4:C	#5:A	#6:B	#7:A	#8:C	#9:A	#10:D	#11:C	#12:B
#13:A	#14:A	#15:A	#16:F	#17:A	#18:D	#19:A	#20:A	#21:A	#22:C	#23:A	
39. Tribulus terrestris				(puncturevine)							
#1:A	#2:B	#3:C	#4:A	#5:A	#6:A	#7:B	#8:C	#9:A	#10:D	#11:D	#12:B
#13:A	#14:B	#15:C	#16:F	#17:A	#18:A	#19:C	#20:D	#21:A	#22:C	#23:A	
40. Trifolium hybridum				(Alsike clover)							
#1:A	#2:B	#3:B	#4:A	#5:A	#6:A	#7:A	#8:C	#9:A	#10:D	#11:C	#12:A
#13:A	#14:C	#15:A	#16:C	#17:C	#18:B	#19:B	#20:A	#21:B	#22:C	#23:D	
41. Trifolium pratense				(red clover)							
#1:A	#2:B	#3:B	#4:A	#5:A	#6:A	#7:A	#8:C	#9:A	#10:D	#11:C	#12:B
#13:B	#14:B	#15:A	#16:C	#17:C	#18:A	#19:C	#20:A	#21:B	#22:C	#23:D	
42. Verbascum thapsus				(common mullein)							
#1:C	#2:C	#3:D	#4:B	#5:A	#6:D	#7:C	#8:C	#9:A	#10:C	#11:D	#12:A
#13:A	#14:C	#15:B	#16:F	#17:D	#18:B	#19:C	#20:D	#21:B	#22:B	#23:A	

Oglala Sioux Tribe Ground Water Protection Plan Analysis

In compliance with the Oglala Sioux Tribe's Groundwater Protection Plan (Oglala Sioux Tribe 1997), herbicide use proposed in this Integrated Weed Management Plan and Environmental Assessment has been evaluated for potential impacts to groundwater resources on Pine Ridge Reservation. Geographic Information System (GIS) was used to analyze risk to groundwater and surface waters. Vulnerability of a water resource to contamination by herbicide use is based upon geology, soils, and proximity to surface water. Sensitivity of a water resource to contamination by herbicide use is based upon proximity to community and individual wells and pesticide properties. This analysis includes only those herbicides proposed for use, namely picloram (restricted use), clopyralid, and glyphosate. Furthermore, this analysis includes only those water resources in or adjacent to park administered lands on Pine Ridge Reservation.

Table C1: Vulnerability Action Matrix. Strikethrough represents those sections that are not applicable to the park's Integrated Weed Management Plan because of the actions proposed or the location. NA indicates sections that were further analyzed and determined to be "not applicable" to actions proposed in the park's Integrated Weed Management Plan.

	~~Arikiree Aquifer~~	**~~Oglala Aquifer~~**	**300' of surface water**	**1000' of surface water**	**Aquifer Recharge Area**	**Vulnerable Soil**
Management Plan Required	~~Site specific plan~~	~~Site specific plan~~	Prohibit use	Prohibit use	Prohibit use	Site specific plan
~~Restricted Label~~	~~Required BMPs~~	~~Required BMPs~~	~~Prohibit use~~	~~Required BMPs~~	~~Prohibit use~~	~~Required BMPs~~
Ground Water Detection – Pine Ridge	~~Required BMPs~~	~~Required BMPs~~	Prohibit use **(NA)**	Required BMPs **(NA)**	Required BMPs **(NA)**	Required BMPs **(NA)**
~~Ground Water Detection – United States~~	~~Required BMPs~~	~~Required BMPs~~	~~Prohibit use~~	~~Required BMPs~~	~~Required BMPs~~	~~Required BMPs~~
Restricted Use Pesticide	~~Voluntary BMPs~~	~~Voluntary BMPs~~	Voluntary BMPs	Voluntary BMPs	Voluntary BMPs	Voluntary BMPs

Note: Best Management Practices (BMPs)

Discussion:

Management Plan Required:

This Integrated Weed Management Plan and Environmental Assessment for Badlands National Park serves as the required management plan and was developed in consultation with the Oglala Sioux Tribe Pesticide Enforcement Program.

Groundwater Detection – Pine Ridge:

> "Contamination of ground water by a pesticide has been detected in the Cuny Table area. This ground water source is the only potential drinking water supply available to people living in the Cuny Table area. A shallow spring system within an aeolian geologic formation relies upon surface water recharge in the immediate areas to recharge ground water. " Page 32, Oglala Sioux Tribe Ground Water Protection Plan

Because the northern edge of Cuny Table forms the southern boundary of the Park, this item is analyzed. The contamination is from atrizine, a cropland herbicide that is not proposed for use in Badlands National Park. Therefore, four action items in the matrix above do not apply and are marked NA.

Restricted use herbicide:

The Integrated Weed Management Plan and Environmental Assessment for Badlands National Park proposes one restricted use herbicide for application within the park. That herbicide is picloram, sold under the trade name of Tordon®. A general analysis of picloram's persistence and mobility is found in the Environmental Consequences, Water Resources, on pages 52-54 of the Plan. That analysis applies park wide. Voluntary Best Management Practices for use of this chemical on park administered lands in Pine Ridge Reservation are proposed below.

Vulnerable Soils:

Following the table on Page 37 of the Oglala Sioux Tribe's Ground Water Protection Plan, the location and distribution of twenty-nine severe vulnerability soils were analyzed due to their association with leaching, run-off, and/or flooding. The park administered lands of Pine Ridge Reservation contain zero acres of severe vulnerability soils with leaching, sixteen acres of severe vulnerability soils due to their association with runoff and 351 acres of severe vulnerability soils due to their association with flooding.

Following the table on Page 38 of the Oglala Sioux Tribe's Ground Water Protection Plan, the location and distribution of fourteen moderate vulnerability soils were analyzed due their association with leaching and/or run-off. The park administered lands of Pine Ridge Reservation contain 9,236 acres of moderate vulnerability soils that were associated with both leaching and run-off.

Surface Waters:

One perennial river, the White River, flows through the southeastern portion of the park near Rocky Ford for three and forty-three hundredths miles. Another perennial river, the Cheyenne River, flows immediately outside the boundary on the northwest corner of the park near Red Shirt Village for eight and eighty-nine hundredths miles. There are twenty-two and nine tenths miles of intermittent streams that are usually dry except for brief periods following rain events. There are sixteen stock dams that hold water.

Aquifer Recharge Area:

There are no large aquifer recharge areas in the park administered lands of Pine Ridge Reservation. There are a few alluvial aquifers along the Cheyenne and White Rivers and other stream courses. The Oglala Sioux Tribe's Groundwater Protection Plan states that these alluvial aquifers are highly susceptible to contamination.

There are springs and seeps associated with the windblown deposits of Cuny Table and to a lesser extent Red Shirt Table where they are often used for individual household water supplies. These springs are associated with woody draws composed of green ash, elm, and chokecherry. By looking for these deciduous trees, the park's vegetation map provides a good approximation of the location of where the water from these springs pools. In some cases springs or seeps may daylight on the steeper slopes above where the water pools and the trees grow. There are approximately sixty acres of springs daylighting in the park administered lands of Pine Ridge Reservation.

Summary:

Over 110,000 acres of the park administered lands of Pine Ridge Reservation do not meet any of the criteria above and would be treated as described in the Integrated Weed Management Plan without any special considerations.

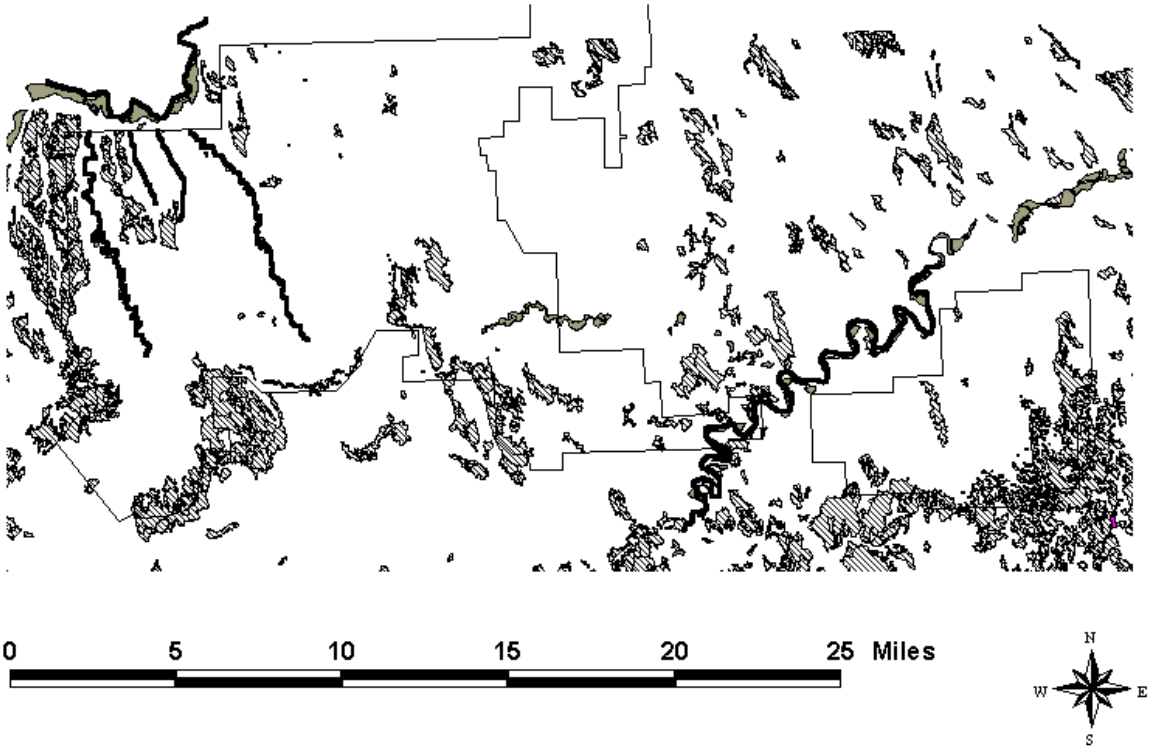
Best Management Practices:

To avoid and minimize the risk posed by herbicide use on the park administered lands of Pine Ridge Reservation, the following practices would be implemented.

1) Only glyphosate with an aquatic label would be used within 300' of surface water and no herbicide would be applied directly to standing water.
2) Only glyphosate or clopyralid would be applied to weeds in areas around seeps and springs with no standing surface water.
3) Only glyphosate would be applied to weeds growing on severe vulnerability soils.
4) Glyphosate or picloram at rates of 1 pint/acre or less may be applied to weeds growing on moderate vulnerability soils.
5) When transporting picloram to unrestricted weed areas, care would be taken to minimize travel within 300' of surface water, through springs or seeps, or across high vulnerability soils.
6) All mixing of chemicals would occur at least 300' from surface water, springs and seeps, high vulnerability soils, and moderate vulnerability soils.
7) The Pesticide Applicators Personal Protective Equipment and Safety Requirements found in Appendix D are hereby incorporated by reference.
8) The Emergency Discharge Response Plan found in Appendix E is hereby incorporated by reference.

Figure C1: Ground Water Protection Analysis

Showing: severe vulnerability soils, moderate vulnerability soils, probable seeps and springs, rivers, stock ponds and intermittent drainages.



Map Legend

- Rivers, Streams and Ponds
- Probable Spring Locations
- Severe Soils Vulnerability
- Moderate Soils Vulnerability

Statistics

Vulnerable Soils:
O acres severe vulnerablity soils with leaching
16 acres of severe vulnerability soils with runoff
351 acres of severe vulnerability soils with flooding
9236 acres moderate vulnerability soils with leaching and runoff
3.43 miles of White River within park boundaries
8.85 miles of Cheyenne River adjacent to park boundary
22.90 miles of intermittent streams within park boundaries
16 stock ponds
60 acres of probable seeps and springs

Pesticide Applicators Personal Protective Equipment and Safety Requirements

Consistent with federal and state laws, as well as agency and Tribal policies, pesticide applicators are required to wear the minimum personal protective equipment identified on the product label. For picloram, clopyralid, and glyphosate, the labels require that applicators wear long-sleeved shirt and long pants, waterproof gloves, shoes plus socks In addition, the park would provide and encourage use of additional protective equipment including respirators with pesticide filters, nitrile gloves, nitrile overboots, and Tyvek coveralls. Face shields would also be available and encouraged for use while mixing herbicides.

Furthermore the following safety recommendations would be followed:

- Pesticide handlers should wash hands before eating, drinking, chewing gum, using tobacco, or using the toilet.
- Pesticide handlers should remove clothing immediately if pesticide gets inside. Then wash thoroughly and put on clean clothing.
- Pesticide handlers should remove personal protective equipment immediately after handling this product. Wash the outside of gloves before removing. As soon as possible, wash thoroughly and change into clean clothing.
- Emergency response kits would be carried on all vehicles or stock transporting or applying herbicide. Response kits would include spill containment materials, emergency eye wash canisters, as well as small tools and parts for field repairs.
- Pesticide notebooks would be carried in each crew vehicle. Notebooks would include: 1) approvals, labels, and material safety data sheets for all chemicals to be applied; 2) application rates and measurements, 3) Emergency Discharge and Response Plan, and 3) operations manuals for all pesticide applicator equipment.

All weed crew members would complete the following training, certifications, and evaluations:

- Evaluation by a medical provider for appropriateness of respirator use including Pulmonary Function Test
- Respirator fit evaluation consistent with respirator manufacturers recommendations
- ATV safety riders course
- Badlands stock use training
- Badlands pesticide use training
- Possess a valid Commercial Pesticide Applicator's Certification issued by the State of South Dakota
- Possess a Pesticide Applicator's Certification issued by the Oglala Sioux Tribe if they would be responsible for herbicide application on park administered lands of Pine Ridge Reservation

A job hazard analysis has been completed for herbicide application and would be updated as required. All herbicide applicators would be provided a copy of the analysis during pesticide use training.

Pesticide Handling and Emergency Discharge Plan
Badlands National Park

Pesticide Use Precautions

-Read and post all Material Safety Sheets (MSDS) for pesticides in the Hazardous Materials Storage Building.

-Read and post all labels for pesticides to be used.

-Copies of MSDS and labels are to be carried to the field on a daily basis for chemicals being used that day.

-Always wear protective clothing when handling pesticides.

-Maintain emergency first aid supplies for pesticide application.

-Post the National Fire Protection Association (NFPA) labels for all pesticides on all storage cabinets and buildings.

-Keep Hazardous Storage Building orderly. Clean all spills immediately and maintain a cache of emergency supplies.

-Never make guesses when dealing with pesticides. Ask questions. Protect yourself and the park.

First Aid

-First aid is chemical specific. Read labels and MSDA and be prepared to act quickly if needed.

-Notify supervisor immediately so Workers Compensation forms can be initiated.

-Emergency care facility is Wall Clinic. If needed, the staff from that office will contact medical specialists.

-In case of medical emergency, no one will be left alone at the job site and no one will travel to medical facilities alone.

Pesticide handling and mixing procedures will include:

-Mixing all pesticide solutions in the field at different locations using portable water tank.

-No mixing near water sources

-Constant supervision of filling backpacks and spray units

-Using an air gap between filler hose and solution tanks

-Transporting pesticides in secured containment tubs outside of any passenger areas

-Use marker dyes in spot spraying equipment

-Mix pesticides according to label directions

Inspection of equipment and repair will include:

-Daily inspection and repair to be conducted by pesticide applicators

-Inspection will include equipment to be used during a given day

-Faulty or damaged equipment will not be used. It will be repaired immediately or tagged to indicate the problem.

-Supply of common repair parts for the backpack sprayers and boom sprayer will be kept on hand

Procedures for rinsing equipment and containers

-When empty, triple rinse in the field and spray rinsate on various approved treatment sites

-All spray equipment will be rinsed before storage if empty and always before repair
*rinse 1….clean water
*rinse 2….detergent solution (capful)
*rinse 3….clean water

-Schedule work to attempt to have empty spray equipment by the end of the spray hours. In the event that this does not happen, tag tanks to indicate contents.

-Triple rinse all pesticide containers immediately. Puncture container so it can not be used and dispose of it according to the label

-Use protective clothing when rinsing. Rinse rubber gloves and boots each day.

-Store used gloves in bucket in RM storage shed. Wash with ammonia and hang to dry.

Procedure for handling a spill

-Wear protective clothing to handle a spill. An adequate supply of protective clothing can be found in the Spray Shed at the maintenance compound

-Prevent spill from spreading. Emergency supplies on hand include:
*Shovel *Empty containers
*Hoses/Hose clamps *Duct tape

*Plastic tarp/sheeting *Heavy plastic bags
*Caulking/sealant *Spare screws/nuts/bolts
*Absorbent material * Dedicated miscellaneous tools

Methods for stopping/containing spills

-Prevent additional spills first

-If in a building or a pickup bed, use absorbent material to soak up the liquid

-If on the ground, use the shovel to scrape earth to form dikes to contain the liquid. Use plastic and absorbent material if it will help.

-Flag the area of the spill to indicate the perimeters

-As soon as spill is contained. Contact the Resource Management Specialist/Chief Resource Manager who will in turn determine whether the spill is minor or major and be handled using readily available equipment and materials. If major, requiring notification of appropriate authorities. If major, the Resource Management Specialist/Chief Resource Manager, or Hazardous Materials Coordinator will contact the following:

-South Dakota Division of Emergency Management ……...…...…605-773-3580
800-932-4027

-South Dakota Department of Environment and Natural Resources…….605-773-6035
800-438-3367

-South Dakota Department of Agriculture……...605-773-4432
800-228-5254

-Oglala Sioux Tribe Pesticide Enforcement Program……605-867-5624
(Only if spill occurs on or adjacent to Pine Ridge Reservation)

Methods for collection of spilled pesticides and materials

-If not in contact with the soil, collect spilled liquids with absorbent material and put into heavy plastic bags or empty containers. Tag containers indicating the contents.

-If in contact with the soil, collect liquids with absorbent material, gather all material including the soil that came into contact with the spilled pesticides, and put them into empty containers. Tag container indicating the contents.

Plan for storage, handling and disposal of spilled pesticides and materials

-All materials will be handled as hazardous materials and stored in the Hazardous Materials Storage Building and will be disposed of according to instructions from the South Dakota Division of Emergency Management.

Emergency numbers

Emergency Medical Information	
Sioux Valley Poison Control Center	1-800-222-1222
South Dakota Division of Emergency Management	1-605-773-3580 1-800-935-4027
South Dakota Department of Agriculture	1-605-773-4432 1-800-228-5254
South Dakota Department of Environment & Natural Resources	1-605-773-6035 1-800-438-3367
Resource Management Specialist, Badlands, Sandee Dingman	w)1-605-433-5262 Radio 510 h)1-605-859-2987
Chief Resource Management, Badlands, Brian Kenner	w)1-605-433-5260 Radio 500 h) 1-605-859-3407
Hazardous Materials Coordinator, Badlands, Mark Gorman	1-605-433-5232 Radio 210
Badlands National Park Dispatch	1-605-433-5361 Radio KAC 745
Pennington County Sheriff	1-605-279-2990
Jackson County Sheriff	1-605-837-2285
Shannon County Sheriff	1-605-867-5528
National Response Center	1-800-424-8802
CHEMTREC	1-800-424-9300

Training

-Training for pesticide handling, safety, and application to be provided by the Lead Weed Technician before beginning pesticide handling tasks.

- All personnel must have a valid Pesticide Applicators Certification from South Dakota. All personnel doing weed control on the South Unit must also have an Oglala Sioux Tribe Pesticide Applicators Certification.

Miscellaneous

-Remember to fill in the pesticide use log each day for each patch treated.

-For boom spraying use twenty-five pounds. Working pressure, four mph, this should give you roughly three acres/tank. Boomless sprayers are self-adjusted for two acres per tank.

-For spot spraying, go right up to the plant, don't try to shoot the chemical a long distance.

-Carry collapsible container of wash-up water, extra gasoline and oil.

-Have the chemical label, MSDS, and pesticide applicator license with you at all times.

-Empty containers should be triple rinsed and have holes punched in them

- Weather limits: For boom spraying, winds should be under eight mph, for spot spraying winds should be less than fifteen mph. For boomless sprayers, winds should be under ten mph. Most of the chemicals will bind in five to six hours. Watch for possible rain within that time frame.

-Tank must be cleaned before switching chemicals. Follow the label directions and clean tank on site. Field apply the rinsate according to the label.

- Personal Protective Equipment (PPE): Check label for minimum PPE for each chemical, when in doubt more protection is better than less. Each person will wear all personal protective equipment required by the label. In addition, coveralls, rubber boots (coverall cuffs should not be tucked into the boots), rubber gloves, respirator, and hardhat will be provided and you are encouraged to use them. Safety sunglasses or goggles would be provided. Carry an extra set of gear in the vehicle in case of spills or rips.

RODEO (glyphosate)
Avoid contact with skin and eyes.

TORDON 22K (picloram)
Eye injury
Harmful if inhaled or absorbed through the skin
Wear face shield or safety glasses when handling
Avoid contact with the skin
Avoid breathing spray mist

TRANSLINE (clopyralid)
Avoid contact with eyes, skin, clothing
Avoid breathing spray mist

Application Rates and Mixing

Glyphosate with aquatic label (Rodeo ®)

ATV Boombuster (24.5 gallons)
- Travel at 5 MPH
- 1.5 to 2.5 gallons glyphosate
- 4.5 pints/acre application rate

ATV trailer Spot Mix (50 gallons)
- 25 PSI pressure
- 3 gallons glyphosate
- 4 pints/acre application rate

Saddle-light spray system (5 gallon canisters) x 4
- 24 ounces per canister
- 3 pints/acre application rate

Backpack Mix (5 gallons)
- 10 ounces glyphosate
- 3 pints/acre application rate

Picloram (Tordon 22K®)

Label direction for spot spraying is 1 oz. per gal.

ATV Boombuster (24.5 gallons)
- 5 MPH
- 48 ounces picloram
- 3 pints/acre application rate

ATV trailer Spot Mix (50 gallons)
- 25 PSI pressure
- 50 ounces picloram
- 1 quart surfactant
- 1.5 pints/acre application rate

Saddle-Light spray system (5 gallon canisters) X 4
- 5 ounces picloram per canister
- 2 pints/acre application rate

Backpack Mix (5 gallons)
- 6.25 ounces picloram
- 3 ounces Surfactant
- 4 pints/acre application rate

Clopyralid (Transline®)

ATV Boombuster (24.5 gallons)
- 5 MPH
- 32 ounces clopyralid
- 1 pint surfactant
- 1 pint/acre application rate

ATV trailer spot mix (50 gallons)
- 25 PSI pressure
- 36 ounces clopyralid
- 1 quart surfactant
- 0.66 pint/acre application rate

Saddle-Light spray system (5 gallon canisters) X 4
- 6 ounces clopyralid per canister
- 6 ounces surfactant per canister
- 0.66 pint/acre application rate

Backpack Mix (5 gallons)
- 1.25 ounces clopyralid
- 3 ounces surfactant
- 0.66 pint/acre application rate

Blue dye
- Tank Mix (50 gallons) - 5 to 8 ounces
- Saddle-Light (5 gallons) - 1 to 2 ounces
- Backpack Mix (5 gallons) - 1 to 2 ounces

Annual work plan for the Preferred Alternative

A. Annual priorities: 2003 – 2006

Note: Geographic descriptions refer only to those areas that NPS has jurisdiction or management responsibility. This does not include private, state, Tribal, or other federal lands that occur within the same geographic description.

2003

- Inventory the South Unit
- Re-treat all targeted non-Wilderness weed populations north of Highway 44
- Re-treat Wilderness weed populations in Burns Basin Colony and Lower Bigfoot Colony
- Treat targeted Wilderness weed populations within one-half mile of western boundary of Burns Basin and northern boundary of Conata Basin
- Treat or re-treat targeted Wilderness weed populations within one-half mile of Sage Creek Campground
- Treat or re-treat all targeted weed populations along BIA 27, BIA 2 and farm roads north of BIA 2.
- Assess and treat areas for potential aerial application using criteria listed under Alternative 3

2004

- Complete inventory of the South Unit
- Begin re-inventory of the North Unit, non-Wilderness Area
- Re-treat all targeted non-Wilderness weed populations north of Highway 44
- Re-treat Wilderness weed populations in Burns Basin Colony and Lower Bigfoot Colony
- Re-treat targeted Wilderness weed populations within one-half mile of western boundary of Burns Basin and northern boundary of Conata Basin
- Treat targeted Wilderness weed populations within one-half mile of eastern boundary of Conata Basin
- Re-treat targeted Wilderness weed populations within one-half mile of Sage Creek Campground
- Treat or re-treat all targeted weed populations along BIA 27, BIA 2 (and farm roads), and BIA 44
- Assess and treat areas for potential aerial application using criteria listed under Alternative 3

2005

- Re-inventory of the North Unit, Wilderness Area, Burns Basin and east of Hay Butte
- Re-treat all targeted non-Wilderness weed populations north of Highway 44
- Re-treat targeted Wilderness weed populations within one-half mile of western boundary of Burns Basin, northern boundary of Conata Basin, and eastern boundary of Conata Basin
- Treat or re-treat targeted Wilderness weed populations within one mile of Sage Creek Campground
- Treat targeted Wilderness weed populations within one-half mile of Sage Creek Rim Road and Sage Creek Road

- Re-treat all targeted weed populations along BIA 27, BIA 2, and BIA 44
- Treat all targeted weed populations accessible from off-road vehicle trails in the South Unit
- Assess and treat areas for potential aerial application using criteria listed under Alternative 3

2006

- Re-inventory of the North Unit, Wilderness Area west of Hay Butte
- Re-treat all targeted non-Wilderness weed populations north of Highway 44
- Re-treat targeted Wilderness weed populations within one-half mile of western boundary of Burns Basin, northern boundary of Conata Basin, and eastern boundary of Conata Basin
- Re-treat targeted Wilderness weed populations within one mile of Sage Creek Campground
- Re-treat targeted Wilderness weed populations within one-half mile of Sage Creek Rim Road and Sage Creek Road
- Re-treat all targeted weed populations along BIA 27, BIA 2, and BIA 44
- Treat all targeted weed populations accessible from off-road vehicle trails in the South Unit
- Assess and treat areas for potential aerial application using criteria listed under Alternative 3

B. Table G1. Monthly priorities

Month	Action	Person responsible
October	Conduct fall burns	All firefighter qualified personnel
	Seed native grass species	Biotech
	Repair and winterize spray equipment	Biotech
	Prepare budgets for coming year	Program Manager
	Enter data into biocontrol database	Biotech
November	Inventory pesticide storage building	Biotech
	Submit pesticide inventory to park's Structural Fire program manager and Safety Committee	Program Manager
	Inventory personal protective equipment	Biotech
	Collect galls for redistribution	Biotech
	Download biocontrol microhabitat dataloggers	Biotech
	Attend district weed meeting	Program Manager and Biotechs
	Prepare annual work plan for Exotic Plant Management Team	Program Manager and Lead Biotech
	Prepare year end summaries	Program Manager
	Total pesticide uses for year	Lead Biotech
December	Submit pesticide use logs to NPS	Program Manager and Lead Biotech
	Submit pesticide logs to Oglala Sioux Tribe	Program Manager and Lead Biotech

	Prepare pesticide use proposals for coming year	Program Manager and Lead Biotech
	Collect galls for redistribution	Biotech
	Research new weed treatments	Program Manager and Lead Biotech
	Submit commercial applicator records to South Dakota Dept of Agriculture	Lead Biotech
January	Attend pesticide applicator re-certification training	All commercial applicators in park
	Research new weed treatments	Program Manager and Lead Biotech
	Finalize pesticide use proposals for coming year; receive regional concurrence	Program Manager and Lead Biotech
	Recruit for seasonal positions	Program Manager and Personnel Clerk
	Collect galls for redistribution	Biotech
February	Prepare and submit request for bid for purchases over $2500 (ie. pesticides, biological control insects, new equipment)	Program Manager and Contracting Officer
	Submit funding proposals for weed related research and new projects	Program Manager
	Attend State Weed Meeting	Program Manager and Lead Biotech
	Research new weed treatments	Program Manager and Lead Biotech
	Prepare press release for National Invasive Weeds Awareness Week	Program Manager and Public Information Officer
	Collect galls for redistribution	Biotech
March	Select and hire seasonal positions, set enter-on-duty dates for April or May	Program Manager and Lead Biotech and Personnel Clerk
	Order personal protective equipment for new seasonal employees	Lead Biotech
	Finalize purchases over $2500 (ie. let contracts or purchase orders)	Program Manager and Contracting Officer
	Update emergency discharge and response plan	Lead Biotech
	Update pesticide mixing instructions and rates	Lead Biotech
	Collect galls for redistribution	Biotech
	Attend Weed Management Area planning meeting	Program Manager and Lead Biotech
April	Update labels and MSDS for notebooks	Lead Biotech
	Conduct spring burns for reduction in non-native grasses	All firefighter qualified personnel

	Check biocontrol microhabitat dataloggers	Biotech
	Redistribute galls collected over winter months	Biotech
May	Biocontrol insect releases	Biotechs
	Apply herbicide to untreated areas of thistle	Biotechs
	Inspect last Falls burn areas and treat weeds	Biotechs
	Weed mapping	Biotechs
	Conduct weed awareness training for park staff and cooperators	Program Manager
June	Biocontrol insect releases	Biotechs
	Apply herbicide	Biotechs
	Weed mapping	
	Assess areas for potential aerial application, develop contracts if needed, prepare pesticide use proposal for aerial application	Program Manager and Contracting Officer
July	Biocontrol site photopoints	Biotechs
	Apply herbicide	Biotechs
	Weed mapping	Biotechs
	Mow to set up for fall spraying	Biotechs
	Inspect this year's spring burn units and treat weeds	Biotechs
August	Biocontrol insect releases	Biotechs
	Weed mapping	Biotechs
	Conduct in-season burns	All firefighter personnel
	Let contract for aerial application	Contracting Officer
September	Apply picloram to thistle populations	Biotechs
	Weed mapping	Biotechs
	Conduct fall-season burns	All firefighter personnel
	Conduct aerial application	Contractor