Badlands

National Park Service
U.S. Department of the Interior

Badlands National Park

Fire Management Plan
Environmental Assessment
Fire Monitoring Plan
2004

Finding of No Significant Impact

Fire Management Plan

Badlands National Park
Jackson County, South Dakota

September 15, 2004

FINDING OF NO SIGNIFICANT IMPACT

Fire Management Plan, Badlands National Park

Badlands National Park was originally authorized in 1929, and established in 1939 by Presidential Proclamation as a national monument, "to preserve the scenic and scientific values of a portion of the White River Badlands and to make them accessible for public enjoyment and inspiration." The original monument encompassed approximately 140,000 acres. In 1968 100,000 acres of land on the Pine Ridge Indian Reservation were added (to be managed under an agreement with the Oglala Sioux Tribe), and in 1976 approximately 64,000 acres within the monument were legally designated as wilderness. In 1978 Congress elevated the monument to national park status. In order to preserve many of the values for which this area was set aside, an active fire management program is needed to maintain a pre-European settlement (pre-Columbian) fire-dependent ecosystem. The Fire Management Plan (FMP) is a working document that details how the park will control and/or use fire to maintain park resources for future generations. The FMP is an implementation plan subordinate to, and derived from, the park General Management Plan, the Strategic Plan, and the Resource Management Plan.

Badlands National Park consists of large expanses of mixed grass prairie, highly eroded, sparsely vegetated badlands topography, and numerous shrub and tree filled "woody draws". It is a classic grassland fire regime characterized by large tracts of continuous fine fuels, frequent periods of hot, dry weather, and recurrent lightning. Fire is a fundamental ecological process that influences plant and animal diversity and distribution as well as abiotic processes such as erosion, nutrient cycling, and soil genesis.

Both natural and human-caused ignitions have historically influenced the landscape at Badlands National Park. The National Park Service has used prescribed fire as a management tool since the early 1980's at Badlands. The park's existing Fire Management Plan has been in place since 1996 and emphasizes fire suppression and the use of prescribed fire for fuel reduction only along the park boundary. Furthermore, it does not address "wildland fire use"--- the management of naturally ignited wildland fires to accomplish specific pre-stated resource management objectives in pre-defined geographic areas. The National Park Service's Fire Management Policy (*Director's Order #18: Wildland Fire Management*) was revised in 2002, with specific guidance (*Reference Manual #18: Wildland Fire Management*) implemented in 1999. Consequently, the park's existing Fire Management Plan is inconsistent with the new policy.

A new Fire Management Plan was drafted to address the need for an integrated fire management program consistent with the new management policies. An Environmental Assessment (EA) was developed in conjunction with the plan to describe the two basic alternatives and the environmental consequences of each.

Alternative A: No Action. The park's current Fire Management Plan would remain in effect with an emphasis on fire suppression and prescribed fire only for fuel reduction along park boundaries. No natural ignitions would be allowed to burn under any circumstances.

Alternative B: Integrated Fire Management. The park would incorporate wildland fire use as a management tool to preserve and restore the native prairie ecosystem. Prescribed fire would be used for fuel reduction along park boundaries and developed areas, as well as to achieve resource management goals. Wildland fire would be allowed burn in interior portions of the park under specific conditions (wildland fire use). Wildland fires burning in undesired conditions would be suppressed. This is the preferred alternative and its implementation is more fully described in the **Fire Management Plan**.

Alternatives considered but rejected include the use of mechanical treatment for fuel reduction and the exclusion of wildland fire use.

PREFERRED ALTERNATIVE

Alternative B: Comprehensive Fire Management Program. Under this alternative, the draft Fire Management Plan would be adopted. As described, the park would be divided into two Fire Management Units (FMU): A suppression unit, termed the "Boundary FMU"; and a wildland fire use unit, termed the "Natural FMU". These units would be delineated along administrative and natural barriers representing locations suitable for defensive fire tactics. These FMUs would be used to drive fire management actions in various areas of the park. The Natural FMU would be managed with a combination of prescribed fire, wildland fire use, and wildland fire suppression, while the Boundary FMU would only utilize suppression and prescribed fire. Appropriate firefighting strategies and tactics would be employed for all unwanted wildland fires occurring as the result of human ignitions. Prescribed fires would be implemented in both FMUs when it has been determined through development of a prescribed fire plan for a specific fire unit that clearly articulated resource objectives identified in the plan can be accomplished for that fire unit.

The Boundary FMU covers approximately 191,000 acres, primarily adjacent to the park boundary and in developed areas. The entirety of the South Unit is also classified as a Boundary FMU because this area is tribal land located within Pine Ridge Indian Reservation and the tribe has grazing interests and other activities that may be negatively affected by wildland fire use. In this zone wildland fires would be suppressed by hand tools and/or mechanical equipment to prevent fire spread. Prescribed fire would by incorporated in the South Unit only upon agreement with the Oglala Sioux Tribe. Prescribed fire would be used in the North Unit only at this time, as a tool for resource management, monitoring, and research to simulate a natural ecological process.

In addition, prescribed fire would be used in the Boundary FMU to reduce fuel load and thereby reduce the potential for wildland fire damage of park resources, tribal interests, and adjacent lands. The Boundary FMU contains 23 prescribed fire units. The prescribed fire accomplishments within the Boundary FMU would be nearly 4000 acres per year averaged over fifteen years, with each unit burning at least once every fifteen years to replicate the historic fire frequency of 5-20 years. Each of the prescribed fire units has been placed in a burning cycle based on past burns, as well as on park needs and objectives. Boundaries for the prescribed fire units are based on physical barriers (badlands/roads) to minimize the need for fire line construction. The prescribed fire unit map can be found in the Fire Management Plan.

The Natural FMU covers approximately 53,400 acres and is located in the interior of the Badlands Wilderness Area. In this zone, wildland fires would be allowed to interact with the fire dependent communities to maintain the natural variability of the ecosystem. Monitoring of current and expected weather and associated fire dangers would be

immediately implemented. Availability of sufficient wildland firefighting resources would be ensured should the weather change or the criteria are not being met (more details of fire management within the Natural FMU are provided in the Fire Management Plan). The Natural FMU has four identified fire use/prescribed fire units that may be treated as prescribed fire units. The appropriate management response would be determined and utilized for all wildland fires occurring in the Natural FMU, provided the annual burn acreage accomplishment within the Natural FMU would not exceed 10,000 contiguous acres for all wildland fire types (suppression, prescribed fire and wildland fire use acres combined). This acreage limitation is directly tied to ungulate populations and is intended to ensure adequate forage during the winter season.

Each prescribed fire conducted in the park will require preparation of a detailed prescribed fire plan that will identify appropriate prescription parameters (wind speed, relative humidity, fuel moisture) and resources needed. These plans are step-down implementation plans that will follow the direction of the Fire Management Plan.

ENVIRONMENTALLY PREFERRED ALTERNATIVE

The "prescribed fire" alternative (Alternative B) is the environmentally preferred alternative. The environmentally preferred alternative is the alternative that will promote the national environmental policy as expressed by §101 of the National Environmental Policy Act (NEPA). This includes alternatives that:

1. fulfill the responsibilities of each generation as trustee of the environment for succeeding generations;
2. assure for all generations safe, healthful, productive, and esthetically and culturally pleasing surroundings
3. attain the widest range of beneficial uses of the environment without degradation, risk of health or safety, or other undesirable and unintended consequences;
4. preserve important historic, cultural and natural aspects of our national heritage and maintain, wherever possible, an environment that supports diversity and variety of individual choice
5. achieve a balance between population and resource use that will permit high standards of living and a wide sharing of life's amenities; and
6. enhance the quality of renewable resources and approach the maximum attainable recycling of depletable resources.

Alternative B would provide maximum protection of park resources and values, and employee safety, thus fulfilling the requirements of the goals set out in §101 of NEPA. This alternative best protects the important resources by restoring fire an as ecosystem process. Most prairie species, and/or their habitats are dependent upon fire as a sustaining or restoring force. This alternative bests mimics the natural fire regime in the mixed grass prairie ecosystem, and will result in the return of the most nutrients to the soils that will enhance the native plants.

THE PREFERRED ALTERNATIVE AND SIGNIFICANCE CRITERIA

As defined at 40 CFR §1508.27, from the regulations of the Council on Environmental Quality that implement the provisions of NEPA, significance is determined by examining the following criteria:

Impacts that may be both beneficial and adverse. A significant effect may exist even if the Federal agency believes that on balance the effect will be beneficial.

Burning of the prairie and the subsequent regeneration of the native grass species is a substantial factor in the prairie ecosystem. The EA discusses the fact that periodic burning can enhance the productivity of the native grasses, decrease the spread of some exotic species, and control the expansion of woody species. Because of these factors, the preferred alternative will have a major beneficial impact on the ecosystem, both directly on the vegetation communities and as a force for creating and maintaining habitat for native animal species. However, there may be short term, negligible or minor impacts to some species, particularly threatened and endangered species. These impacts will not be significant.

Fire will also have short term, minor, negative impacts to the wilderness experience of visitors who may be present during fires. However, restoring native ecosystems via fire can be considered long term, positive benefits to wilderness values.

The degree to which the proposed action affects public health or safety.

The purpose of the action is to provide public and worker safety during the annual burning of the pastures. By providing a strip of vegetation that would not burn or would not burn as intensely around the resources to be protected, it allows the annual burns to be better controlled. The preferred alternative provides the best protection since the prescribed fire will leave very little if any vegetation to burn. The other alternatives will leave some vegetation to burn, but in a condition that fire would be easier to control. The prescribed fire will be used in a manner in which the utmost care will be taken to protect the health and safety of the employees conducting the burn. That should result in the greatest amount of safety for the general public.

Unique characteristics of the geographic area such as proximity to historic or cultural resources, park lands, prime farmlands, wetlands, wild and scenic rivers, or ecologically critical areas.

Only ten percent of the North Unit, and one percent of the South Unit have been inventoried for archeological resources. Of nearly 300 identified sites, nearly all are lithic and artifact scatters. None have been included on the National Register of Historic Places. Section 106 compliance has been completed with receipt of a letter from the State Historic Preservation Officer (dated July 30, 2004) stating no concerns with the plan. Fire is considered to have a transient, minor impact to these sites. Vehicle travel (ATVs, engines) is considered to be more of a risk, and one that can be minimized. Old homestead sites can be found within the park, but they are mostly wooden remnants. Only the Ben Reifel Visitor Center has been identified as eligible for the National Register. There are no prime farmlands or wild and scenic rivers affected. Wetlands consist of stock ponds and springs. Other ecologically critical areas include woody draws found in parts of the park. These are not likely to be negatively impacted by fire.

Legally designated wilderness may be considered a unique characteristic of the park. In all fire management activities in the Badlands Wilderness Area, minimum impact analysis will be completed prior to any action. Only the minimum tools, as identified in the analysis, will be used in fire activities.

The degree to which the effects on the quality of the human environment are likely to be highly controversial.

There were no controversial impacts identified during the analysis done for the EA, and no controversial issues were raised during the public review of the EA.

Degree to which the possible effects on the quality of the human environment are highly uncertain or involve unique or unknown risks.

There are no identified risks associated with the preferred alternative that are unique or unknown, and there are no effects associated with the preferred alternative that are highly uncertain identified during the analysis for the EA or during the public review of the EA.

The degree to which the action may establish a precedent for future actions with significant effects or represents a decision in principle about a future consideration.

The preferred alternative does not establish a precedent for any future actions that may have significant effects, nor does it represent decisions about future considerations.

Whether the action is related to other actions with individually insignificant but cumulatively significant impacts.

Cumulative impacts are described in regulations developed by the Council on Environmental Quality (CEQ), 40 CFR 1508.7. 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 who 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 project alternatives 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 the surrounding region. The projects identified include:

Badlands National Park General Management Plan

Badlands National Park has begun preparation of a General Management Plan (GMP) for the park. The GMP will provide overall guidance of the park for the next twenty years. The plan will look at alternative ways of managing the park, and is expected to be completed in 2002. The GMP will have an accompanying environmental impact statement prepared evaluating its potential impacts. Because the GMP is incomplete at this time, and the nature of the effects on resources is unknown, it is difficult to predict what cumulative impacts may be posed by the implementation of both the General Management Plan and the Fire Management Plan's Preferred Alternative.

It is likely that the General Management Plan will anticipate and accommodate increased visitation. This increased visitation may result in increased emissions from vehicles, thus an impact on air quality. The cumulative effects of increased emissions from visitor vehicles and emissions from fire events could be adverse, although it is difficult to predict the magnitude of emissions. Smoke from prescribed fire events would generally occur in spring and fall when visitation is generally moderate. During the peak visitor season of mid-summer, smoke would generally be from wildland fires that could occur in absence of this Fire Management Plan. Adoption of the preferred alternative of the Fire Management Plan would implement a fire prevention strategy that would decrease emissions caused

by wildland fires overall. Increased visitation may result in a small amount of increased use of the Badlands Wilderness Area, although use is currently very low and additional visitor use can be easily accommodated without having a negative effect on the wilderness experience.

Other impacts associated with the General Management Plan may be the construction of new visitor facilities. In most cases, new construction would occur in existing developed areas, for example adding restroom facilities to an overlook that already includes a parking lot and paths. As a result of locating new construction in developed areas, the potential to impact vegetation or wildlife would be minimized. As a standard policy, all ground disturbing activities, such as would be associated with new construction, are reviewed by the park Paleontologist and Cultural Resource Specialist. As needed, excavations are monitored by paleo and/or archaeological monitors to protect those resources. Due to the limited extent of new construction likely to be proposed by the GMP and the monitoring protocols already in place, significant cumulative impacts to vegetation, wildlife, paleontological resources, and cultural resources are not anticipated.

Energy Development Proposals

There are several proposals for energy development that may impact Badlands National Park, primarily from the aspect of air quality. These proposals include coalbed methane development in the Powder River Basin of Wyoming and Montana (two EIS's have been developed by the Bureau of Land Management), the WYGEN II power generating plant (Wyoming state permit), and the Dakota, Minnesota and Eastern (DM&E) Railroad being developed to haul coal from Wyoming to generating plants in Wisconsin.

The DM&E is seeking a permit from the Surface Transportation Board (STB) to reroute and upgrade a railroad from Wyoming to Minnesota. The primary purpose of this railroad is to transport coal to the east (Wisconsin, Illinois) to supply power plants. The preferred alternative places the railway corridor within two miles of the western boundary of Badlands National Park. The National Park Service reviewed the Draft Environmental Impact Statement (DEIS) prepared on the proposed railroad expansion. NPS comments were submitted as part of the Department of the Interior's response on the DEIS. Based on review of the DEIS, the NPS is concerned that the project would result in impacts to air quality, would increase noise in the Badlands Wilderness Area, provide a corridor for the expansion of exotic plants, and has the potential to cause wildland fires. STB has pushed for permitting the railroad expansion over the NPS concerns. The Final Environmental Impact Statement (FEIS) did not fully address NPS concerns.

The cumulative effects of the DM&E railroad project and other energy development efforts, and the implementation of the preferred alternative of the Fire Management Plan would have adverse effects on air quality. However, the emissions from the trains, generating plants and gas wells would be more long-term and persistent than the short duration of smoke generated by very infrequent fire events. In addition, DM&E would have negative cumulative impacts to wildlife, particularly mammals; however, the disturbance to wildlife posed by the trains would be more long-term and persistent than the rather short duration of impacts caused by fire events. These two projects would have the cumulative effect of causing a change in plant species. Implementation of the Fire Management Plan would restore a fundamental natural process to the grasslands, thus having the beneficial effect of increasing vigor of native species, increasing species diversity, and increasing the diversity of plant communities due to the mosaic pattern caused by burning. The DM&E railroad project would have adverse impacts on plant

communities by increasing the spread of non-native species, particularly tamarisk and Canada thistle.

The degree to which the action may adversely affect districts, sites, highways, structures, or objects listed on National Register of Historic Places or may cause loss or destruction of significant scientific, cultural, or historical resources.

Three roads (Badlands Loop Road, Sage Creek Rim Road, Sheep Mountain Road) and two structures (Tyree Gravesite and Homestead Well) on the park List of Classified Structures. The Ben Reifel Visitor Center has been determined eligible for the National Register. None of these are likely to be adversely impacted by the preferred alternative. A study completed in 2001 found that prescribed fire had only minor impacts on archeological and paleontological resources.

The degree to which the action may adversely affect an endangered or threatened species or its habitat that has been determined to be critical under the Endangered Species Act of 1973.

The EA determined that the implementation of the preferred alternative will not adversely affect threatened and endangered species. The U.S. Fish and Wildlife Service concurred with the determination of no effect on threatened or endangered species on June 10, 2004. Documentation is on file at Badlands National Park, file code Y1421(BADL).

Whether the action threatens a violation of Federal, state, or local law or requirements imposed for the protection of the environment.

This action violates no federal, state, or local environmental protection laws.

IMPAIRMENT

In addition to reviewing the list of significance criteria, the National Park Service has determined that implementation of the proposal will not constitute an impairment to the critical resources and values of Badlands National Park. This conclusion is based on a thorough analysis of the environmental impacts described in the Fire Management Plan and its EA, (lack of) public comment, relevant scientific studies, and the professional judgment of the decision-maker guided by the direction in NPS *Management Policies 2001* (December 27, 2000). The plan under the preferred alternative will result in potential negligible to minor adverse impacts to paleontological resources, wilderness, and public safety. Moderate negative impacts may occur to air quality (short term visibility impacts) and cultural resources. Overall, the plan results in long term benefits to park resources and values, and opportunities for their enjoyment, and it does not result in their impairment.

PUBLIC INVOLVEMENT

The environmental assessment was made available for public review and comment during a 30-day period ending April 30, 2004. A legal notice announcing its availability and the dates and times of public meetings was published in the local papers the week of March 22, 2004. Notice of the availability was also posted on the park's website the same week. No one from the general public requested copies of the document and no comments from the general public were received. Two public meetings were held, one in the town of Wall, SD, and the other at park headquarters near the town of Interior, SD. No one attended either meeting. Two letters were received from other agencies (one from the State Historic Preservation Officer and one from the U.S. Fish and Wildlife Service). There were no

substantive issues raised upon review of the EA. The lack of comment on the part of the general public and other agencies resulted in no changes to the text of the environmental assessment. Documentation of the public comment period will be kept on file at Badlands National Park.

The preferred alternative does not constitute an action that normally requires preparation of an environmental impact statement (EIS). The preferred alternative will not have a significant effect on the human environment. Negative environmental impacts that could occur are generally negligible or minor in intensity. There are no significant impacts on public health, public safety, threatened or endangered species, cultural resources, or other unique characteristics of the region. No highly uncertain or controversial impacts, unique or unknown risks, significant cumulative effects, or elements of precedence were identified. Implementation of the action will not violate any federal, state, or local environmental protection law.

CHANGES TO THE PLAN

Based on internal NPS discussion, Goal 5 of the draft plan, *Limit impacts from fire suppression activities to less 5% of the estimated monetary value of the impacted resource*, was determined to be unmeasurable. Therefore, this goal will be changed to state: *Limit impacts from fire suppression activities to minimize impacts to resources in accordance with their monetary value or relative importance to the park purpose.*

Other changes in the plan will be limited to corrections of minor formatting, clarification, or spelling errors.

Based on the foregoing, it has been determined that an EIS is not required for this project and thus will not be prepared.

Recommended: _____ 9/15/04
Superintendent Date

Approved: _____ 9/30/04
Midwest Regional Director Date

BADLANDS NATIONAL PARK
FIRE MANAGEMENT PLAN
Environmental Assessment
Fire Monitoring Plan
2004

United States Department of the Interior
National Park Service
Badlands National Park
Interior, South Dakota

Submitted by: _____ Date 9/15/04
Chief, Resource Management, Badlands National Park

Reviewed by: _____ Date 9/27/04
Northern Great Plains Fire Management Officer

Concurred By: _____ Date 9/27/04
Regional Fire Management Officer

Approved By: _____ Date 9/15/04
Superintendent, Badlands National Park

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I. INTRODUCTION

The Badlands National Park Fire Management Plan (FMP) is a part of the park Resource Management Plan. An environmental assessment (EA) was prepared and made available for public review as part of this plan (see *Appendix D*). This FMP and the accompanying EA meet requirements of the National Environmental Policy Act (NEPA, 42 U.S.C. §4321 *et seq.*) and the National Historic Preservation Act (NHPA, 16 U.S.C. §470 *et seq*.). It will serve as a detailed program of action, providing specific guidance and procedures for accomplishing wildland fire management objectives.

This document is mandated by and complies with National Park Service (NPS) *Director's Order #18: Wildland Fire Management* (*DO-18*, USDI 2002), which outlines NPS fire management policy and requires that "every park area with burnable vegetation must have a fire management plan approved by the Superintendent". More specific guidance is found in *Reference Manual 18* (*RM-18*, USDI 1999). This plan also complies with the Service's policy guidance, the *Management Policies* (USDI 2001). The Organic Act of the National Park Service (16 U.S.C §1 *et seq.*) provides the primary authority for implementation of this plan.

This plan will implement fire management policies and help achieve resource management and fire management goals as defined in: (1) the *2001 Federal Wildland Fire Management Policy & Program Review* (USDA/USDI 2001); (2) *Managing Impacts of Wildfires on Communities and the Environment,* and *Protecting People and Sustaining Resources in Fire Adapted Ecosystems-A Cohesive Strategy* (USDI/USDA); and (3) *A Collaborative Approach for Reducing Wildland Fire Risks to Communities and the Environment: 10-Year Comprehensive Strategy Implementation Plan.*

As NPS management planning becomes more science-based and proactive, fire management assumes a role of greater importance. This Fire Management Plan has been prepared to serve as a detailed program of action, which provides specific guidance and procedures for accomplishing park fire management objectives. The implementation of this plan will define levels of protection necessary to ensure safety, protection of facilities and resources; will minimize undesirable environmental impacts of fire management, and will define levels of fire use to restore and perpetuate natural processes given current understanding of the complex relationships in natural ecosystems.

Cooperation and collaboration are important in land management, and particularly in fire management. This plan tiers off the park General Management Plan (in draft) planning process, which involves input from a wide variety of park neighbors, other agencies and Native American tribes. Development of this plan has involved the collaborative efforts of the NPS Northern Great Plains Fire Management Office, the Midwest Region Fire Management Office, fire ecologists from other parks and agencies, and park staff. Implementation of the plan will be dependent upon collaboration with the Northern Great Plains Fire Management Office, the US Forest Service, the Northern Plains Interagency Dispatch Center, local area volunteer fire departments, the Bureau of Indian Affairs, the South Dakota State Fire Management Coordinator, other area national park units, and all park divisions. Native American tribes will be consulted prior to approval of the plan.

ENABLING LEGISLATION

Authority for establishment and management of Badlands National Park is found in the following acts:

1. An act to establish the Badlands National Monument, March 4, 1929 (45 Stat. 1553);
2. An act to extend the boundaries of Badlands National Monument, June 26, 1936 (49 Stat. 1979);
3. A Presidential Proclamation (#2320) extending the boundaries of Badlands National Monument, January 26, 1939 (53 Stat. 2521);
4. An act to adjust the boundary of Badlands National Monument, May 7, 1952 (66 Stat. 65);
5. An act to revise the boundaries of Badlands National Monument and to authorize the exchange of land with the Oglala Sioux Tribe, Aug. 8, 1968 (82 Stat. 663);
6. An act to designate lands within the National Park System as wilderness and to revise the boundaries of certain of those units, Oct. 20, 1976 (90 Stat. 2693);
7. An act to change the name of Badlands National Monument to Badlands National Park, Nov. 10, 1978 (92 Stat. 3467).

OTHER AUTHORITIES

The authority for NPS Fire Program (FIREPRO) funding (Normal Fire Year Programming) and all emergency fire accounts is found in the following authorities:

- Section 102 of the General Provisions of the Department of Interior's (DOI) annual Appropriations Bill - provides the authority under which appropriated monies can be expended or transferred to fund expenditures arising from the emergency prevention and suppression of wildland fire.
- Public Law 101-121, DOI and Related Agencies Appropriation Act of 1990 - established the funding mechanism for normal year expenditures of funds for fire management purposes.
- 31 U.S.C. §665 (E) (1) (B) - provides the authority to exceed appropriations due to wildland fire management activities involving the safety of human life and protection of property.

Authorities for procurement and administrative activities necessary to support wildland fire suppression missions are contained in the Interagency Incident Management Handbook. Authorities to enter into agreements with other Federal bureaus and agencies; with state, county, and municipal governments; and with private companies, groups, corporations, and individuals are cited in *Director's Order #20: Agreements* (*DO-20,* USDI 1999).

Authority for interagency agreements is found in "Interagency Agreement between the Bureau of Land Management (BLM), Bureau of Indian Affairs (BIA), National Park Service (NPS), U.S. Fish and Wildlife Service (USFWS) of the United States Department of the Interior (USDI) and the Forest Service (USFS) of the United States Department of Agriculture (USDA)" (1982). Authority for rendering emergency fire or rescue assistance outside the National Park System is

the Act of August 8, 1953 (16 U.S.C. §1b(1)) and Department of the Interior Manual (910 DM). Existing agreements pertaining to implementation of the fire management program are cited or included in *Appendix E*(3). As a general rule, these agreements give guidance on mutual aid zones for wildland fire suppression activities and specify procedures for billing and payment between agencies for wildland fire management activities.

INTERAGENCY FIRE POLICY

Federal wildland fire policy is established in the *Federal Wildland Fire Management Policy & Program Review of 1995* (USDA/USDI 1995). This policy was reviewed following 2000 fire season (USDA/USDI 2001). The 2001 Working Group found that the policy is generally sound, but recommended changes:

> In summary, the Working Group finds and recommends that federal fire management activities and programs are to provide for firefighter and public safety, protect and enhance land management objectives and human welfare, integrate programs and disciplines, require interagency collaboration, emphasize the natural ecological role of fire, and contribute to ecosystem sustainability.

Recognizing the ecological role of fire and the goal of ecosystem sustainability in federal policy reflects a fundamental change in our society's perception of fire and its role in land management. Principal conclusions of the Working Group included:

- As a result of fire exclusion, the condition of fire-adapted ecosystems continues to deteriorate; the fire hazard situation in these areas is worse than previously understood.
- Changes and additions to the 1995 Federal Fire Policy are needed to address important issues of ecosystem sustainability, science, education, communication, and to provide for adequate program evaluation.

In addition, the review stated, "The 2001 Federal Fire Policy and its implementation are founded on the following guiding principles:"

1. Firefighter and public safety is the first priority in every fire management activity.
2. The role of wildland fire as an essential ecological process and natural change agent will be incorporated into the planning process.
3. Fire management plans, programs, and activities support land and resource management plans and their implementation.
4. Sound risk management is a foundation for all fire management activities.
5. Fire management programs and activities are economically viable, based upon values to be protected, costs, and land and resource management objectives.
6. Fire management plans and activities are based upon the best available science.
7. Fire management plans and activities incorporate public health and environmental quality considerations.
8. Federal, State, tribal, local, interagency, and international coordination and cooperation are essential.
9. Standardization of policies and procedures among federal agencies is an ongoing objective.

This plan is intended to follow these principles and incorporate them into all aspects of the Badlands National Park Fire Management Program.

Department of the Interior policy, as specified in *Wildland and Prescribed Fire Management Policy: Implementation Procedures Reference Guide* (1998), states that all fires in wildland fuels will be classified as either "wildland fire" or "prescribed fire".

Wildland fire is defined as any non-structure fire, other than prescribed fire, that occurs in the

wildland. These fires can, but do not always, achieve burning intensities capable of causing loss of life, detrimental impacts upon natural resources, and damage to, or destruction of, man-made developments. With the implementation of this plan, managers will have a wide range of appropriate management responses to naturally ignited wildland fires, while all human-caused fires will be suppressed. The management of naturally ignited wildland fires to accomplish specific pre-stated resource management objectives in pre-defined geographic areas outlined herein is defined as wildland fire use.

Prescribed fire is defined as any fire ignited by management actions to meet specific objectives. These fires are conducted under prescription, and on a predetermined area that will produce the intensity of heat and rate of spread required to accomplish specific management objectives. Overall, fire use (the combination of wildland fire use and prescribed fire application) objectives are to employ fire scientifically to realize maximum net benefits at minimum impact and acceptable cost.

Within the framework of management objectives and plans, overall negative wildland fire impacts will be held to the minimum possible giving full consideration to:

1. firefighter and public safety,
2. an aggressive fire prevention program,
3. the least expenditure of public funds for effective suppression,
4. the methods of suppression least damaging to resources and the environment, and
5. integration of cooperative suppression actions by agencies of the DOI among themselves or with other qualified suppression organizations.

NATIONAL PARK SERVICE FIRE POLICY

National Park Service management policy directs each park to prepare a wildland fire management plan appropriate for that park's purpose and resources. As stated previously, fire management at Badlands National Park is based upon this policy and the guidance found in *Director's Order #18* and the supporting *Reference Manual 18*. These guidelines identify fire as the most aggressive natural resources management tool employed by the National Park Service.

DO-18 identifies the goals of the NPS wildland fire management program. These goals are:

1. Conduct a vigorous and safe wildland fire management program with the highest professional and technological standards.
2. Identify the type of wildland fire that is most appropriate to specific situations and areas.
3. Efficiently accomplish resource management objectives through the application and management of prescribed and wildland fires.
4. Continually evaluate the wildland fire program operations and accomplishments to better meet program goals by refining treatment and monitoring methods, and by integrating applicable technical and scientific advancements.

II. RELATIONSHIP TO LAND MANAGEMENT PLANNING AND FIRE POLICY

NPS MANAGEMENT POLICIES

Badlands National Park was originally established by presidential proclamation as a national monument "to preserve the scenic and scientific values of a portion of the White River Badlands and to make them accessible for public enjoyment and inspiration." In order to preserve these values, an active fire management program is required to maintain the fire-dependent ecosystem. The Fire Management Plan is a working document that details how the park will control and/or use fire to preserve park resources for future generations. The primary values to be protected include scenic values, geologic values of "badlands" formations, scientifically significant fossilized remains of over 250 faunal species, large expanses of remnant native mixed-grass prairie and associated native wildlife species, and the human occupation story for the past 11,000 years.

NPS *Management Policies* (USDI 2001, sec. 4.5) provide the guidance for integration of fire into overall park management and resource management objectives:

> Naturally ignited fire is a process that is part of many of the natural systems that are being sustained in parks. Human-ignited fires often cause the unnatural destruction of park natural resources. Wildland fire may contribute to our hinder the achievement of park management objectives. Therefore, park fire management programs will be designed to meet park resource management objectives while ensuring that firefighter and public safety are not compromised.
>
> Each park with vegetation capable of burning will prepare a fire management plan and will address the need for adequate funding and staffing to support its fire management program. The plan will be designed to guide a program that responds to the park's natural and cultural resource objectives; provides for safety considerations for park visitors, employees, neighbors, and developed facilities; and addresses potential impacts to public and private property adjacent to the park. An environmental assessment developed in support of the plan will consider the effects on air quality, water quality, health and safety, and natural and cultural resource management objectives. Preparation of the plan and environmental assessment will include collaboration with adjacent communities, interest groups, state and federal agencies, and tribal governments.

GENERAL MANAGEMENT OBJECTIVES

The Badlands National Park Master Plan (1982) recognizes fire as "a natural part of the ecosystem." The plan further states that "a fire management plan will establish guidelines for managing natural fires to perpetuate natural ecosystems while recognizing the interest of adjacent landowners." The Statement for Management (1992) also expresses the need for prescribed fire, stating that the park should "recognize fire as a natural factor in park ecosystems, control natural fire as necessary, and use prescribed burns when needed." Revision of the park's General Management plan began in the year 2000, and as of the writing of this plan, is in draft and has not yet been approved for public review and comment. Through the GMP planning process, fire management objectives may be further refined. However, the approved GMP will certainly recognize the importance of fire as a primary factor in maintaining and restoring the native prairie the park is mandated to preserve. The desired future conditions

identified in the GMP will include a native prairie in which fire, as a natural process and a management tool, acts to maintain native plant communities and native animal populations, prevent and/or reduce invasive non-native plant species, and enhance biodiversity.

RESOURCE MANAGEMENT OBJECTIVES

This Fire Management Plan prescribes actions necessary to implement servicewide fire management policies (*DO-18*, 2002) and to achieve park resource management objectives. The current park Resource Management Plan (1999) states "without the occurrence of fire, the vegetation of the park has been allowed to progress to an unknown condition in relation to a fire-influenced regime." This plan further states that the park Fire Management Program should restore fire as "one of the vital and dynamic processes in the Badlands environment to reduce risk to adjacent lands, while at the same time reintroducing fire into areas that normally could not burn due to concern for public safety and public and private property values."

More specifically, the Badlands National Park resource management objectives related to the Fire Management Program are:

1) Alter vegetation composition in natural areas, from exotic plant species (Japanese brome, smooth brome, Kentucky bluegrass, crested wheatgrass, and Canada thistle) to native plant species.
2) Promote hardwood regeneration in woody draw areas of the park. Most, if not all, of these areas are decadent or remain dormant. As a result, nutritional quality and productivity have declined. Without the rejuvenating effects of fire, these communities may continue to deteriorate and the value to native wildlife may also decline**.**
3) Restore or gain the mosaic pattern of different plant communities associated with post-fire stages.
4) Rehabilitate areas that have been planted or established with non-native grasses (roadsides, pullouts, and other disturbed sites).
5) Manage grasslands to increase suitable habitat for butterfly species listed on the SD Natural Heritage List (Regal Fritillary and Tawny Crescent).
6) Improve the nutritional quality and palatability of native grasses, shrubs, and trees for use by ungulate species in the park.
7) Maintain distribution of wildlife/range use throughout the park by burning large enough areas so that bison, sheep, and deer do not concentrate in one small area of the park.
8) Restore fire as a critical component of the ecosystem.
9) To the extent practical, use fire as a tool to restore the ecosystem to the condition existing prior to settlement by Europeans. The primary factors here are: (1) fire suppression, which began in the late 1800's; and (2) agriculture, which not only directly replaced native vegetation, but also served as fire breaks, inhibiting the natural spread of fire across landscapes.

WILDERNESS POLICIES

Badlands National Park includes 64,000 acres of legally designated wilderness (PL 94-567, 1976), known as the Badlands Wilderness Area (BWA). Fire management activities within the

BWA must conform to policy guidance under the 1964 Wilderness Act (16 U.S.C. §1131).

National Park Service *Management Policies* (2001) provides overall guidance for fire management within wilderness:

> Fire management activities conducted in wilderness areas will conform to the basic purposes of wilderness. The park's fire management and wilderness management plans must identify and reconcile the natural and historic roles of fire in the wilderness, and will provide a prescription for response, if any, to natural and human-caused wildfires. If a prescribed fire program is implemented, these plans will also include the prescriptions and procedures under which the program will be conducted within wilderness.
>
> Action taken to suppress wildfires will use the minimum requirement concept, and will be conducted in such a way as to protect natural and cultural resources and to minimize the lasting impacts of the suppression actions. Information on developing a fire management program in wilderness is contained in Director's Order #18: Wildland Fire Management. (Chapter 6, 6.3.9)

Motorized equipment will not normally be used to suppress fires in the Badlands Wilderness Area. However, due to rapid spread rates and the emergency nature of fires near the boundary, light motorized equipment, such as all-terrain vehicles, may be authorized by the Superintendent to control fires on an emergency basis.

Additional constraints applicable to Wilderness Areas include:

- Use of helicopters for aerial ignition, water drops, and transport of personnel, supplies or equipment will be evaluated for each fire situation. Improvement of landing sites shall be kept to a minimum and requires approval of the Superintendent. Helibases will be located outside the Wilderness boundaries. Landing sites within Wilderness will be rehabilitated to pre-fire conditions, to the extent reasonably possible.
- When handline construction is required, construction standards will be issued requiring the handline to be built with minimum impact to wilderness characteristics. The Superintendent may authorize use of power chain saws, although such use should be kept to a minimum. Handlines constructed by exposing mineral soil will be rehabilitated and erosion control methods used on slopes exceeding 10%.
- Incident Command Posts and camps will be located outside designated Wilderness, unless there is a compelling reason for a low-impact spike camp to support wildland fire use operations within the Natural FMU.

Minimum impact suppression is defined as the aggressive application of those strategies and tactics that effectively meet suppression and rehabilitation objectives with the least cultural and environmental impact. All fire management activities in the Badlands Wilderness Area will comply with *Director's Order #41: Wilderness Preservation Management* and *RM-41*, and will use "Minimum Requirement Analysis" process as specified for the park. The following constraints applicable to all suppression actions include:

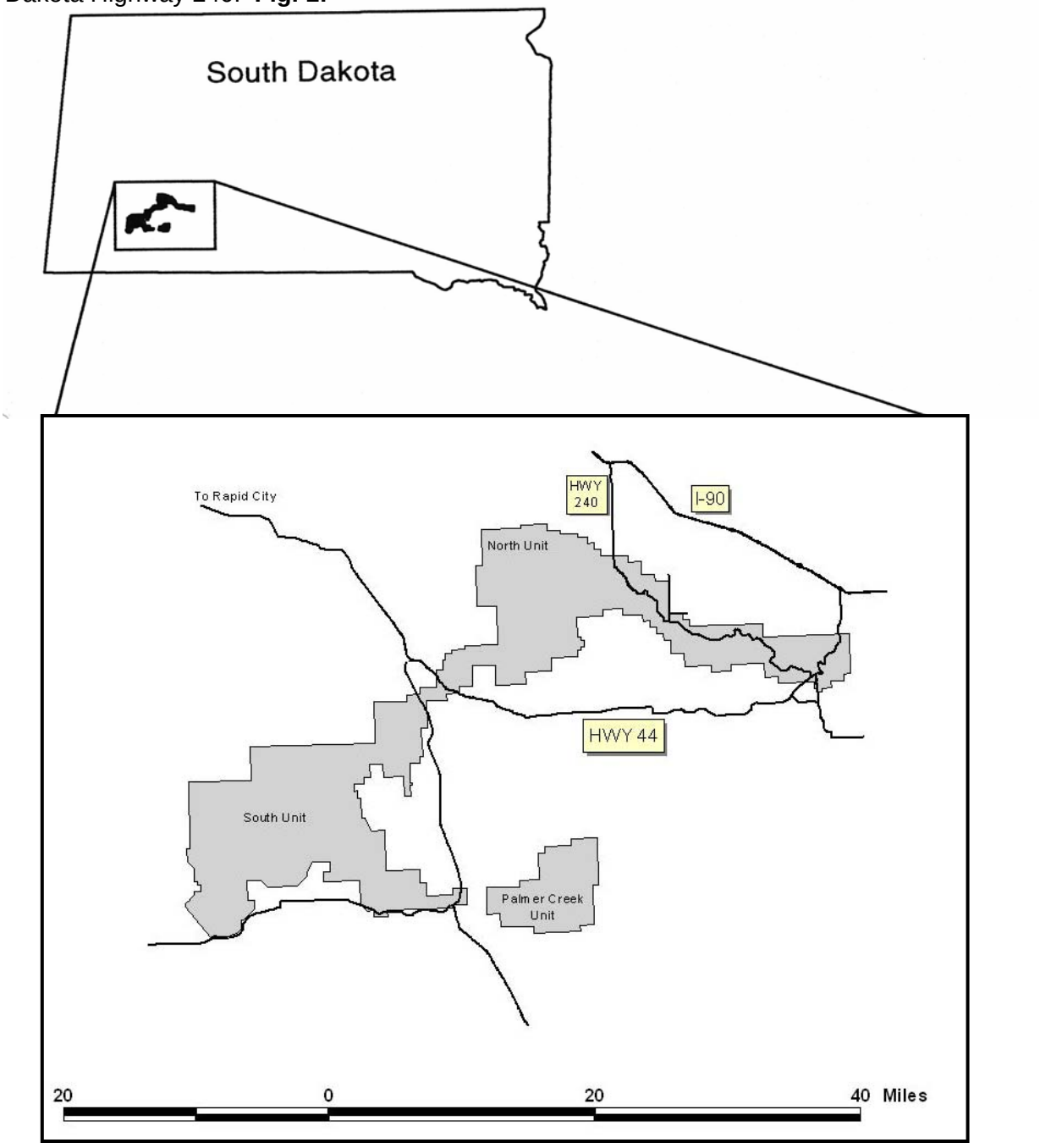
- Whenever consistent with safe, effective suppression techniques, the use of natural barriers, such as unvegetated badlands, should be used as extensively as possible. The use of backfire techniques, burnout lines improvement, and wetting agents (ground and airborne) is authorized. Fire retardant agent used must be on the approved list of retardant for utilization by the Forest Service and Bureau of Land Management.
- All extended attack and project fire operations should have a park employee designated and available to assist suppression forces in the capacity of Resource Advisor.
- Stream crossings should be limited to established locations.

- Except for spot maintenance to remove obstructions, no improvements should be made to roadways, trails, water sources, or clearings. All sites where improvements are made or obstructions removed should be rehabilitated to pre-fire conditions, to the extent reasonably possible.
- Earth moving equipment such as tractors, graders, bulldozers or other tracked vehicles should not be used for fire suppression. If special circumstances warrant extreme measures to ensure protection, the Superintendent can authorize the use of heavy equipment.
- Fireline construction, which is generally avoided in Badlands fire activities, shall be outside of highly erosive areas, steep slopes, and other sensitive areas. Following fire suppression activities, any firelines should be recontoured and have water-bars installed.

III. THE PARK SETTING AND RESOURCES

LOCATION

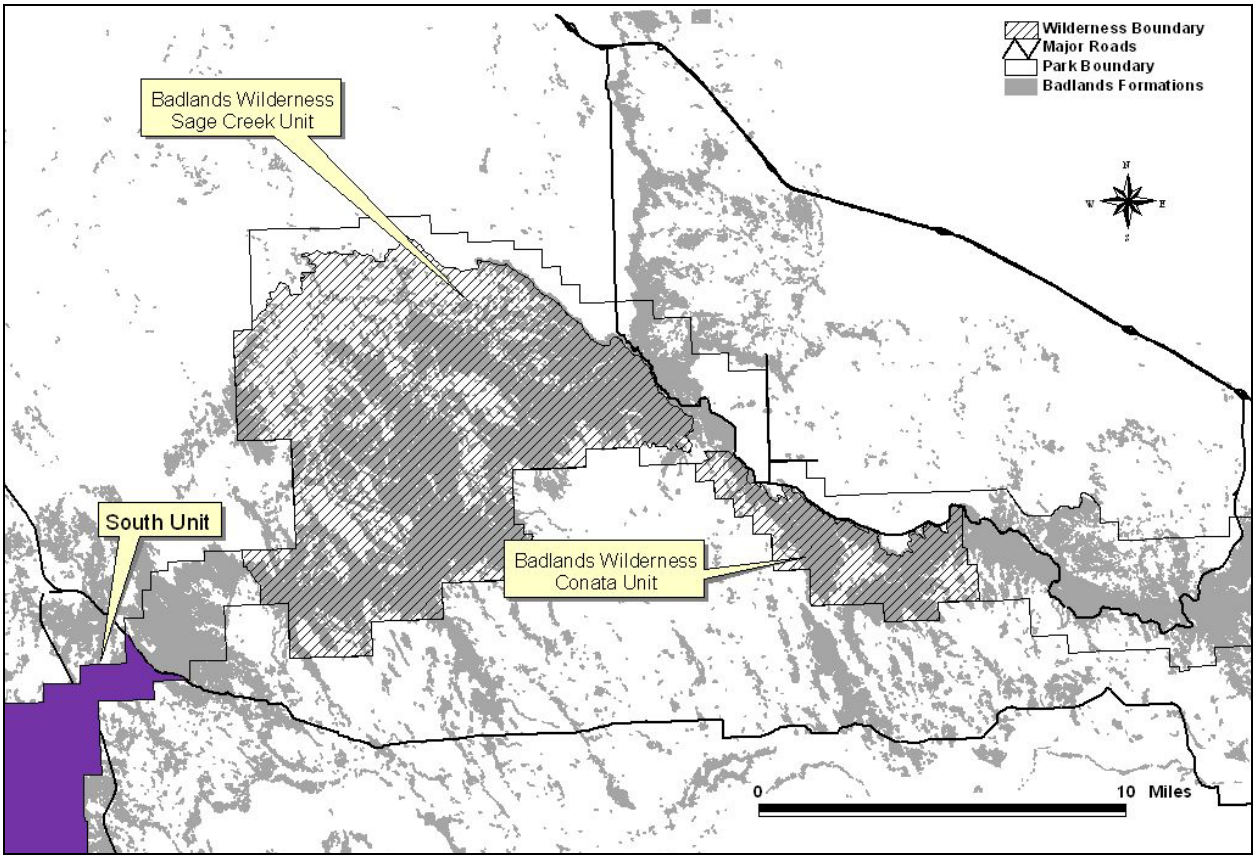
Badlands National Park is located in southwestern South Dakota, in Jackson, Pennington, and Shannon Counties. Access can be obtained from Interstate 90, South Dakota Highway 44, and South Dakota Highway 240. **Fig. 1:**



The park is administratively divided into two units (*see* **Fig. 1** *above)*. The North Unit is owned by the federal government in fee simple and, like most of the early "traditional" parks, the National Park Service has sole management authority. The South Unit is located on the Pine Ridge Indian Reservation and is "trust" land, intended to be managed cooperatively by the National Park Service and Oglala Sioux Tribe. The park is further segmented administratively. The North Unit is split into the Cedar Pass District on the east side, and the Pinnacles District on the west. The South Unit is split into the Stronghold District and the Palmer Creek District, which is not coterminous to the rest of the park.

Badlands National Park has 64,144 acres of designated wilderness, in two separate units, The Sage Creek Unit and the Conata Unit:

Fig. 2: Badlands Wilderness Area



The park is characterized by barren canyons, peaks, and ridges intermixed with large areas of mixed-grass prairie providing habitat for large numbers of wildlife and plant species.

The park boundary was established along jurisdictional lines rather than geographic features. In certain areas (primarily the Cedar Pass District), the park is extremely narrow (less than 2 miles) causing concern for the spread of fire to adjacent lands.

Approximately 730 acres of visitor services, residential, and administrative facilities exist at Cedar Pass, Stronghold, Pinnacles, and the bison corrals. The park has 10 permanent resident employees and their families, 29 seasonal employees, and an annual total visitation of about 1.1 million.

The Stronghold District is located entirely on the Pine Ridge Indian Reservation. It is open to grazing in accordance with Tribal/Bureau of Indian Affairs regulations. Land ownership

adjacent to the Stronghold District is a combination of tribally owned lands and lands held by individual Indians and non-Indians.

The Palmer Creek District is also located entirely on the Pine Ridge Indian Reservation. It is a separate unit located east of the Stronghold District. Currently the NPS has no right of access to this area. It is surrounded by tribally-owned lands and lands held by individual Indians and non-Indians.

The Pinnacles and Cedar Pass Districts of the park are bordered primarily by the Buffalo Gap National Grasslands under the administration of the United States Forest Service (USFS). Privately owned lands are intermixed with federal lands along the park boundary.

CLIMATE

Badlands National Park has a continental climate characterized by cold winters and hot summers with high variations from day to day. Frequent, brief, and intense electrical storms occur during the summer months. Thunderstorm activity continues into September, with generally less precipitation and more dry lightning. The annual precipitation for the 30-year period between 1961 and 1990 averaged 16 inches per year, with 70% falling between May and June. Between 1991 and 2000, a period of above average precipitation, the average annual precipitation was over 22 inches. This increased the annual average to approximately 17.5 inches per year over the full 40-year period. A comparison of 2001 and 2002 totals provides an indication of annual variance: 19 and 12 inches respectively. Winter precipitation is mostly snow, but because of gusty winds, large areas are blown free of snow and sizable drifts may accumulate in road cuts and protected gullies. Average maximum daytime temperatures reach their highest level during July-August and range from 34^{o} to 91^{o} F throughout the year (*see* **Table 1** *below*). Average minimum temperatures range from 11^{o} to 62^{o} F. Extremes of over 100^{o} can occur during the summer months while sub-zero temperatures can occur during the winter months. Normal average wind speeds range from 8 to 12 mph, with slightly higher averages March through May. However, during thunderstorms or winter storms, locally strong wind events are common.

Table 1: AVERAGE TEMPERATURE, PRECIPITATION, AND VEGETATION STAGE

Month	Average High (*F)	Average Low (*F)	Ave. Precipitation (inches)	Vegetation Stage
January	34	11	0.36	C
February	40	16	0.47	C
March	48	24	0.93	T
April	62	35	1.76	G
May	73	46	3.08	G
June	83	56	3.11	G
July	91	62	2.16	T
August	91	61	1.66	T
September	80	50	1.22	C
October	67	38	1.23	C
November	49	25	0.45	C
December	38	17	0.33	C

Annual Average Precipitation **16.76**

Vegetation Stages: C= Cured T= Transition G= Green-up

Weather information from National Weather Service Data 1949-1998

TOPOGRAPHY, GEOLOGY, AND SOILS

The entire park lies within the unglaciated Missouri Plateau section of the Great Plains physiographic province. It is an area characterized by flat to gently sloping grasslands cut by wide, shallow, terraced valleys of the White, Cheyenne, and Bad Rivers and their principal

tributaries. Over time, the retreat of the White River banks has resulted in a unique landscape characterized by barren badlands, including an erosional structure called a "wall." This geologic feature is a distinctive break between the upper and lower grasslands, with an average elevation difference of 200 feet. Elevations within the park range from approximately 2400 feet to 3300 feet. Badlands National Park is a part of the White River or Big Badlands of southwestern South Dakota, an area of steep slopes, numerous small valleys, and sparse vegetation. Badlands topography flanks the White River from south of Kadoka westward to the area south of Red Shirt Table, a distance of 70 miles. Local rock formations are largely soft, fine-grained alluvial clay sediments, comprised of deposition from parent Black Hills material and from volcanic eruptions, which are easily eroded. The rugged topography and variegated rocks produce spectacular visual effects. Badlands National Park was established, in part, for its impressive landforms and spectacular vertebrate fossils.

VEGETATION

There are no Federal threatened and endangered (T&E) species listed plant species known in the park. A more detailed discussion of all species and their habitats found throughout the park may be found in *Appendix E(4)*. The park is considered to represent potential range and habitat for all species indigenous to semiarid mixed prairie grassland ecosystems. With that in mind, park policy is to continue observing for signs of any T&E species and to continue studying methods of managing park lands that will protect and enhance the habitat for all native species. However it should be noted, there are a number of exotic species in abundance in the park. These include yellow sweetclover (*Melilotus officinalis),* brome grasses (*Bromus* sp*.),* Canada thistle (*Circium arvense),* Kentucky bluegrass (*Poa pratensis)*, crested wheatgrass (*Agropyron cristatum*), and knapweeds (*Centaurea* sp.)

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 total suppression fire management policies. With the elimination of livestock grazing, managed cultivation, and concentrated resource management efforts, the current vegetation composition is beginning to reflect what is believed to have naturally existed prior to the influx of the European settlers in the park locale.

The following is a discussion of major landscape areas and corresponding cover types.

Grassland areas: Upland plateaus with moderate to gentle rolling slopes describe the upland grassland topography. Primary native grasses found in these areas include western wheatgrass (*Agropyron smithii);* and green needlegrass (*Stipa viridula*) on clayey sites. Needle and thread (*Stipa comata);* blue grama (*Bouteloua gracilis)*; sideoats grama (*Bouteloua curtipendula*); sand dropseed (*Sporobolus cryptandrus*); and buffalograss (*Buchloe dactyloides*) are more common on upland sites. Other plant species relatively common on both sites are upland sedges, such as threadleaf sedge (*Carex filifolia);* western snowberry (*Symphoricarpos occidentalis);* fringed sage (*Artemisia frigida*) and prairie rose (*Rosa arkansana).*

Woody Draws/Riparian areas: Woody draws are found in the canyons of the badlands wall, especially those located on northwest to northeast facing slopes of 35% to 70%, and along springs and streams. They are typified by green ash (*Fraxinus pennsylvanica)*, American elm (*Ulmus americana*), Rocky Mountain juniper (*Juniperus scopulorum)*, boxelder (*Acer negundo*), chokecherry (*Prunus virginiana)*, sagebrush (*Artemisia* sp.), plains cottonwood (*Populus deltoides)*, and a variety of shrubs. Woody draws are generally less than 40 acres in size and provide valuable habitat for wildlife. They comprise approximately 7% of the vegetated areas of the park and are declining region-wide. Prolonged protection from wildland fire has been

postulated as one reason for the decline of woody stands and may account for the lack of bur oak (*Quercus macrocarpa*) in the park. Site-specific research on Badlands National Park woody draws was initiated in 1989. Three study sites were treated with prescribed burns in the fall of 1990, with post-treatment sampling to take place for three years. The study was conducted by the USFS Rocky Mountain Forest and Range Experiment Station, though no findings have been reported to date. The Park Fire Management Team recognizes the need to prevent unwanted wildland fire from impacting large amounts of woody draw vegetation in one event. Depending on the results of site-specific research, prescribed fires may be used to restore deciduous woody draw vegetation.

Badlands Sparse Vegetation: Approximately 109,715 acres of the park are 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 habitats although the steep badlands formations are completely barren of vegetation. Sparse vegetation can also be found within areas of established prairie dog towns, which cover approximately 2% of the park. (Von Loh et al. 1999).

FAUNA

Wildlife commonly seen in the park include mule deer (*Odocoileus hemionus)*, white-tailed deer (*O. virginianus)*, pronghorn (*Antilocapra americana)*, bison (*Bison bison)*, black-tailed prairie dog (*Cynomys ludovicianus)*, coyote (*Canis latrans*), bobcat (*Lynx rufus*), least chipmunk (*Eutamius minimus)*, and numerous other smaller rodents. More than 200 species of birds have been sighted, and about 25 kinds of reptiles and amphibians are listed on park records. There is currently a reintroduction program in the park for the black-footed ferret (*Mustela nigripes*), which is currently on the list of Federal endangered species. This species is known to have historically inhabited the park, and feeds upon, as its primary prey, the prairie dog. In 2000 the U.S. Fish and Wildlife Service determined that listing of the black tailed prairie dog was warranted, but precluded from listing consideration at this time. A state prairie dog conservation plan is currently under development for South Dakota. Examples of less restrictive prairie dog control measures outside the park include the current ban on hunting and poisoning of prairie dogs on neighboring lands administered by the U.S. Forest Service (Buffalo Gap National Grasslands). A complete listing of Threatened and Endangered terrestrial species known to inhabit the park may be found in *Appendix C*.

Bison were restored to the area in 1963 and now number approximately 500 to 800 head. Bison management requires that a portion of the park be fenced. Limited water resources require that the herd be limited to around 650 animals. Surplus bison are rounded up and transferred to Tribal governments and other agencies. A band of Rocky Mountain bighorn sheep (*Ovis canadensis*) was introduced in 1964 to fill the ecological niche formerly occupied by the extinct Audubon bighorn. In the late 1980's a family of swift fox (*Vulpes velox*) was reintroduced in the park, but persisted only a few years. Beginning in 2003, the NPS initiated reintroduction of swift fox into the park, with a three-year plan of releasing 30 wild born fox from Colorado per year. This experimental program is intended to re-establish a self-sustaining swift fox population in and around the park.

CULTURAL RESOURCES

Fire management activities within the park will be implemented in accordance with the regulations and directions governing the protection of historic and cultural resources as outlined in the Department of Interior Manual Part 519 (519DM), Code of Federal Regulations (36 CFR 800), and DO-28: Cultural Resource Management (USDI 1998). National Historic Preservation

Act of 1966 (16 U.S.C. §470 et seq.) section 106 clearance will be followed for any fire management activity that may affect historic structures or cultural/archeological resources. Other related policies that will be followed as required include the Archeology and Historic Preservation Act of 1974 (16 U.S.C. §469-469c-2) and the Archeological Resources Protection Act of 1979 (16 U.S.C. §470aa-470mm).

Archeological Resources: Research has been conducted on the impacts of fire on archaeological resources. In 2002, Brent Buenger, a Phd. Candidate at Colorado State University in the Department of Anthropology, submitted *Fire Effects on Archaeological Resources During Prescribed and Wildlife Fire in a Prairie Ecosystem (Badlands National Park, Wind Cave National Park, Rocky Mountain National Park)* and determined:

> Prescribed burning in grassland fuels produced relatively low temperatures and residence times. Surface temperatures recorded during a May, 2001 burn ranged from 418.8C to 61.6C. The maximum subsurface temperature was 34.6C. The investigator's findings indicate that thermal alteration of the artifacts placed within the test plots was not significant. The majority of discoloration was due to residence deposits, the byproduct of organic combustion, present on all of the artifacts. No significant damage in the form of cracking, spalling, or deformation occurred. Even the wooden objects showed only minor effects of the fire. Based on these observations, it is suggested that prescribed burning in mixed grass fuels presents only a minimal risk to surface artifacts and little or no risk to subsurface artifacts.

Cultural Landscapes: A Cultural Landscape Report and Environmental Assessment of Cedar Pass Headquarters area was started in 2002. A project entitled Cultural Landscapes Important to the Oglala Lakota was funded in 2002 but deferred to 2004 until issues relating to management of the South Unit are resolved. The park is scheduled for a parkwide Cultural Landscape Inventory in 2004 and 2005, according to the Midwest Region Cultural Landscape Inventory Program.

Ethnographic Resources: A draft Ethnographic Overview was received in 2001. The plant species identified as important to the Lakota people, such as sagebrush, sumac, chokecherry, yucca, and cacti have root structures that have adapted to survive prairie fire. The substructures of these plants are not consumed by fire but instead thrive through exposure to fire. Additionally, the native wildlife populations are also positively impacted by fire as it creates opportunities for new plant shoots to appear for grazers and browsers. Fire was historically used as a tool to draw native prairie animals out for hunting purposes. The ethnographic overview states that scholars have long believed that the Great Plains ecosystem was fundamentally maintained by fire. Many scholars believe most fire was of human origin, while others think natural fires were at least as important. The overview lists the following historic and prehistoric uses for fire by the Plains Indians: to drive game, to improve forage, to concentrate wildlife in unburned areas, and for use as a weapon. Accidental fires likely also occurred. It goes on to state: “More important than the causes of fire is the matter of fire suppression; this practice, beginning with White land management regimes, is what threatens the long-term viability of grassland ecosystems.” Consultation with Tribes affiliated with Badlands National Park has been initiated. Ethographic resources include traditionally associated peoples. Definitions of these classes of resources are:

Ethnographic resources = objects and places, including sites, structures, landscapes, and natural resources, with traditional cultural meaning and value to associated peoples. Research and consultation with associated people identifies and explains the places and things they find culturally meaningful. Ethnographic resources eligible for the National Register of Historic Places are called traditional cultural properties (NPS Management Policies, 2001, p. 129). Traditionally associated peoples = may include park neighbors, traditional residents, and former

residents who remain attached to a park area despite having relocated. For purposes of these *Management Policies*, social/cultural entities such as tribes, communities, and kinship units are "traditionally associated" with a particular park when (1) the entity regards park resources as essential to its development and continued identity as a culturally distinct people; (2) the association has endured for at least two generations (40 years); and (3) the association began prior to establishment of the park (NPS Management Policies, 2001, p. 130).

Museum Collections: Specimens and artifacts in the park museum collections will be not impacted by the fire. These items have been collected for research purposes and provide relationships to the significant history of the science of paleontology, the human history of settlement in the White River Badlands, and document the history of the development of Badlands National Park. These resources will not be impacted and are therefore dismissed as an impact topic.

Cultural Resource Surveys: 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 Inventory and the Cultural Component of the Resource Management Plan should be consulted by the fire management team when planning prescribed burns, preparedness, or suppression activities. The potential for adverse impacts to cultural resources will be evaluated prior to prescribed burning and in the selection of fire suppression strategies during wildland fires. Protective black-line or other mitigation may be used around sensitive sites.

Cultural Resource Mapping: To facilitate the decision making process during any proposed or occurring fire event, a detailed set of digital cultural resource maps needs to be developed and incorporated into the park's geographic information system (GIS). The data set should include location, site number, site type, and site evaluation. This information could then be readily available for prescribed fire planning and to incident commanders for wildland fire management. These digital maps should also include information that will identify preferred fire management activities in regard to specific sites and site types. Actions that could be identified include site avoidance (buffer area), use of physical or applied barriers, mechanical reduction of fuel loads, collection of certain artifact classes prior to burn, follow-up survey, and collection post-burn.

PALEONTOLOGICAL RESOURCES

The spectacular vertebrate fossils preserved within the White River Badlands have been studied extensively since 1846 and can be found 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, 1997; Martin and DiBenedetto, 1997, 1998). A pre-construction survey was completed along the Badlands Loop Road in 1996, 1997 and 1998 (Benton, et al. 1998). A three-year baseline survey of fossil bone beds in the Scenic Member of the Brule Formation was conducted from 2000 to 2003. A baseline survey of the Poleslide Member began in 2003. Data from these projects are being entered into the park spatial database.

AIR QUALITY

Historically, the Park and surrounding area have enjoyed excellent air quality, with only occasional, short-term air pollution from transient wildland fire smoke and blowing dust. National Park Service fire management activities which result in the discharge of pollutants

(smoke, carbon monoxide, particulates, and other pollutants from fires) are subject to and must comply with all applicable federal, state, interstate, and local air pollution control requirements as specified by Section 118 of the Clean Air Act, as amended (42 U.S.C. §7418). The Badlands Wilderness is designated as a Class I area under the Clean Air Act, prohibiting significant deterioration of air quality. The remainder of the Park is managed as a Class II area, allowing some deterioration of air quality.

The State of South Dakota requires that the park inform the State Department of Air Quality prior to performing prescribed burns. Burning permits are not required. The park will also notify local Federal Aviation Association offices so that pilots may be made aware of possible temporary visibility impairments. Smoke drift affecting neighbors and public roads is also a concern. Smoke dispersal will be a consideration in determining whether or not a prescribed burn is within prescription, as described in respective Prescribed Fire Plans. Generally, the fine fuels in the park generate low volumes of smoke for short duration and are not usually a smoke management problem.

It is likely that pre-settlement visibility was lower than current levels due to frequent fires in summer months. A permanently mounted 35mm camera was used between 1985 and1987 to monitor visibility near the northeast entrance. Transmissometer data from 1988 to the present has also been used to monitor visibility. The park has 5 years of ozone monitoring data and is currently adding to 11.5 years of Interagency Monitoring of Protected Visual Environments (IMPROVE) data (1988-present). During the ozone monitoring period, Badlands had some of the lowest average ozone concentrations in the NPS monitoring network (USDI 1998). The ozone levels measured are well below those found to damage sensitive plants. Similarly, wet deposition data does not indicate significant acidic deposition, at the present. More recent data may indicate an increase in the presence of atmospheric nitrates. Nitrate and sulfate emissions from regional-scale sources such as industrial and electric utility facilities and energy development projects in eastern Wyoming and western South Dakota are of significant concern to the Badlands airshed, and these emissions are on the rise.

WATER RESOURCES

Water quality of streams and the White River are unknown and not currently monitored. All streams within the park are intermittent, and most originate within the park with the exceptions of the White River and tributaries of Sage Creek, Battle Creek, Cottonwood Creek, and Cedar Creek. Water tables are said to be lower than in historic times, and appear to have contributed to reduced spring and stream flows. Development of naturally occurring water sources has been used to mitigate this water loss, and provide water to the wildlife. The park maintains water impoundments in the Badlands Wilderness Area and elsewhere in the park for the bison population, which, due to fencing, is no longer able to travel outside the park to the historic water sources of the Cheyenne and White Rivers.

Underground water sources are very limited in and near the park. This shortage is severe enough, that future planned developments may be limited. Local communities and park management have recently become part of the West River/Lyman Jones and Mni Wiconi Water Projects, bringing water from the Missouri River to rural areas of western South Dakota. Cedar Pass has received a new water storage reservoir to store water piped into the park from this source. Water quality monitoring is done only on the well for developments at Cedar Pass. Pinnacles and White River are currently served by a rural water line.

HUMAN USES

Peak visitor season for the park is Memorial Day Weekend through Labor Day Weekend, with the greatest number of visitors staying only a few hours. Most visitors drive through the Park, stopping infrequently for short walks on Park trails and overlooks. Fewer visitors hike longer distances over the maintained trail system. The Pinnacles and Cedar Pass districts are 110,042 acres in size and include the 64,000 acre Badlands Wilderness Area. There are no maintained trails and limited hiking/backpacking use of the Wilderness. Most use in the Wilderness is by horseback, and generally confined to day trips originating from the Sage Creek Campground, located on the northwest edge of the Wilderness. The Stronghold District, on the Pine Ridge Indian Reservation, is open to grazing in accordance with Tribal/Bureau of Indian Affairs regulations. In addition, the Tribe retains mineral rights on tribal lands in the Stronghold District, and the Bureau of Indian Affairs administers livestock stocking levels. Grazing pressure influences fine-fuel loadings and will affect fire behavior in certain areas. Additionally, wildland fire in grazing lease areas could impact leaseholders through temporary but significant forage loss. Land ownership adjacent to the Stronghold District is a combination of tribally owned lands and lands held by individual Indians and non-Indians.

The Pinnacles and Cedar Pass Districts are bordered primarily by Buffalo Gap National Grasslands and private ranch land. The main land use on the National Grasslands is cattle grazing. Privately owned lands are intermixed with federal lands along the park boundary. There are approximately 53.5 miles of boundary with the U.S. Forest Service and 41.5 miles of boundary with private land in these two districts. The Stronghold District is entirely within the Pine Ridge Indian Reservation and includes grazing allotments administered through the Bureau of Indian Affairs (BIA).

IV. WILDLAND FIRE MANAGEMENT STRATEGIES

FIRE MANAGEMENT GOALS

The following Badlands National Park fire management goals support the park's resource management objectives:

Goal 1: Reduce both the incidence and extent of human-caused fires by 20% within 15 years of approval of the park Fire Management Plan.

- Prevent unplanned human-caused ignitions through a cooperative fire prevention program aimed at the park visitor, staff and neighbors.
- Minimize the occurrence of unwanted (human-caused) fires through reduction of hazard fuels by prescribed fire and/or mechanical treatment (limited mowing around buildings) in and around developed areas and along park boundaries.

Goal 2: Restore fire to 80% of the vegetated landscape within 15 years of approval of the park Fire Management Plan.

- Perpetuate, restore, replace or replicate natural processes to the greatest extent practicable.
- Allow wildland fire use within the constraints of policy (*DO-18*) and the Environmental Assessment for the Fire Management Program of Badlands National Park.

Goal 3: Restore fuel and vegetation mosaics to pre-European contact conditions on 25% of the landscape within 15 years of approval of the park Fire Management Plan.

- Create and/or maintain defensible wildland fire use boundaries.
- Reduce dead fuel loadings (litter/duff) of 1.5 - 2 tons per acre by 60% or more in each fire use event. This is one of many fire effects which will be measured and tracked through the NPS fire monitoring protocol.
- Where applicable, restore fuel loads and plant community structure and composition to ranges of natural variability comparable to pre-European settlement using prescribed fire and wildland fire use. Prescribed fire is an integral tool for managing prairie ecosystems. Implemented with a "patchwork" approach to planning burn areas, the prescribed fire program will replicate historic fire occurrences in areas outside the wildland fire use treatment area, as well as within if a need is identified. The intention of the park is to reintroduce fire into all areas of contiguous-mixed grass prairie (where feasible) in an effort to replicate that ecosystem's historical fire return interval of 5-25 years (Wright and Bailey, 1980). A prescribed fire sequence has been developed that is intended to mimic this natural fire cycle. Approximately 4,000 acres of grasslands will be burned in the park each year through prescribed fire projects varying in size from 190 to nearly 5000 acres (*Appendix H(1))*. Repeating this burn cycle will yield a 15-year fire return interval.
- Minimize the occurrence of unnaturally intense fires through reduction of hazard fuels by prescribed burning. Mechanical treatment is unlikely to play a major role in this predominately grassland ecosystem, although some minimal mechanical treatment *may* be necessary to retain woody draws and juniper slumps.

- Train park staff to conduct safe, objective-oriented prescribed fires and wildland fire use consistent with *DO-18* requirements.
- Provide opportunities for public understanding of fire ecology principles, smoke management, and wildland fire program objectives.
- Monitor and evaluate the effectiveness of the prescribed fire program.
- Encourage research to advance understanding of fire behavior, effects, ecology, and management.
- Establish a database on the long-term effects of wildland fire on vegetation and other resources in the park. Utilize the results from the fire effects monitoring program to refine/adjust burning prescriptions to better meet the objectives of the hazard fuel reduction and prescribed fire programs.
- To control exotic grasses, the park will need to adjust its current burning strategies. Prairie restoration may require increased frequency of prescribed fire. Some areas may even require burning in three consecutive years. To control cool season, exotic grasses (bromes and bluegrasses) the park will need to burn in early spring instead of late spring. It is recognized that this "out of season" burning will be necessary to prepare some areas for "in season" burning, promote native species, and allow for wildland fire use in other areas.
- Control areas will be established in representative examples of park vegetation types where wildland and prescribed fire may be excluded if possible. Location and methodology for these control plots will be added to this plan as an appendix at a later date. These areas will be long term study areas for comparison to fire effects.

Goal 4: Incur zero fatalities and an injury rate no higher than the national NPS average in association with wildland fire management activities.

- Provide for the safety of park visitors, neighbors, and employees during all phases of wildland fire management operations.
- Suppress all unwanted wildland fires in the park and in the interagency mutual aid zone. All suppression efforts will be directed toward safeguarding life and property while protecting park resources from harm. All fires will be evaluated to determine the appropriate management strategy.
- Cooperate extensively with adjacent landowners through Memoranda of Understanding to facilitate safe and prompt suppression of unwanted wildland fire. Promote an interagency approach to managing fires on an ecosystem basis.
- Manage all wildland fire with minimum cost, environmental and cultural resource impacts.
- Provide opportunities for public understanding of the wildland-urban interface problem.

***Goal 5: Limit impacts from fire suppression activities to less than 5% of the estimated monetary value of the impacted resource*.**

- Suppress unwanted fires commensurate with values at risk.
- Use minimum impact fire suppression techniques and rehabilitate disturbed areas to protect natural, cultural, wilderness and scenic resources from adverse impacts attributable to fire suppression activities.
- Engender understanding among park staff and firefighters about the impacts of fire

suppression on sensitive park resources.

- Ensure that a resource advisor is present on all major suppression actions.

More specific objectives related to individual vegetation types may be found in the Badlands Fire Monitoring Plan (*Appendix F*).

WILDLAND FIRE MANAGEMENT OPTIONS

At Badlands National Park, with it's predominately grassland vegetation communities, fires are generally fast-moving, short in duration, and intensive fuel reduction is not necessary. Also, with the extensive, sparsely-vegetated badlands formations coursing through the park, natural firebreaks make fire management considerably less difficult than in the open prairie found throughout much of the rest of western South Dakota.

In general, wildland fire management options available and suitable include suppression of human-caused fire (usually along park roads from catalytic converters or discarded cigarettes), use of prescribed fire for areas of continuous prairie across the park boundary, and wildland fire use (lightning-caused) where badlands can provide suitable firebreaks to prevent fires from getting too large or crossing the boundary.

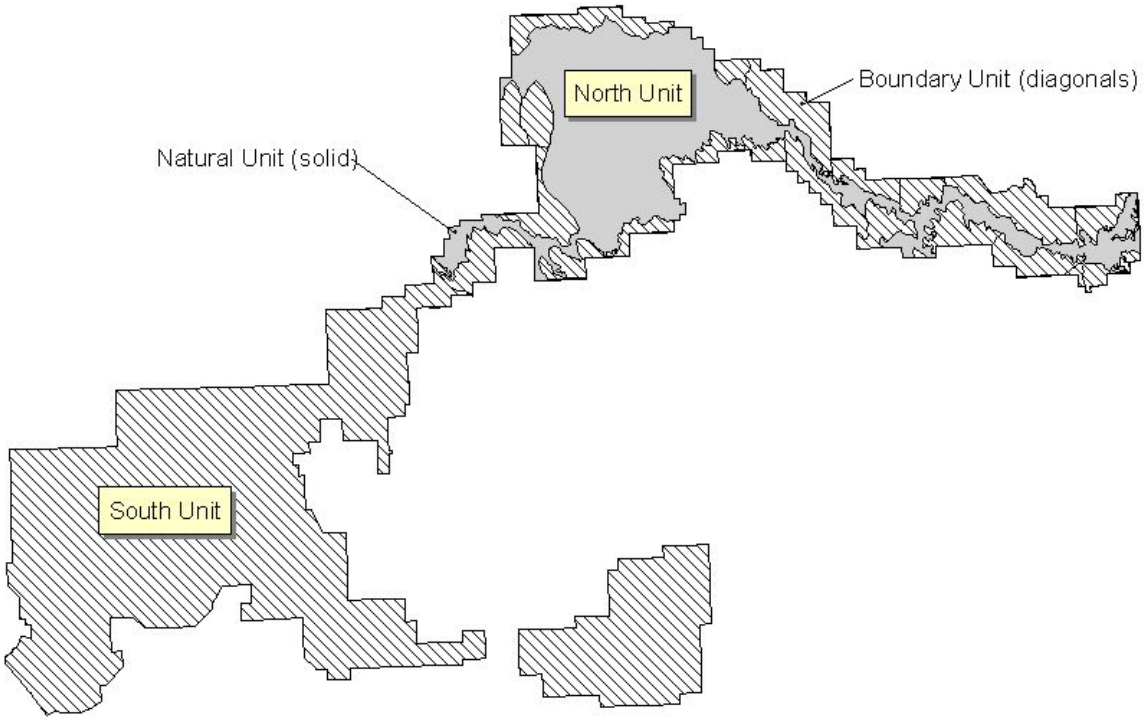
In general, fuel reduction beyond prescribed fires for resource management objectives is not viable in the park. Grassland fuels regenerate quickly after a fire and do not build significantly after two to three years post-fire. Manual fuel reduction along the boundary, via mowing, is also not a viable option because of rough terrain, the need to repeat nearly annually, potential to aid non-native plant invasions, and aesthetic impacts on the native prairie.

PARK FIRE MANAGEMENT UNITS

Under the 1996 Badlands Fire Management Plan, the park was divided into three "Fire Management Units" (FMU), each with different management objectives. Only FMU 1, all non-Wilderness in the North Unit, provided for prescribed fire, and none of the FMUs allowed wildland fire use.

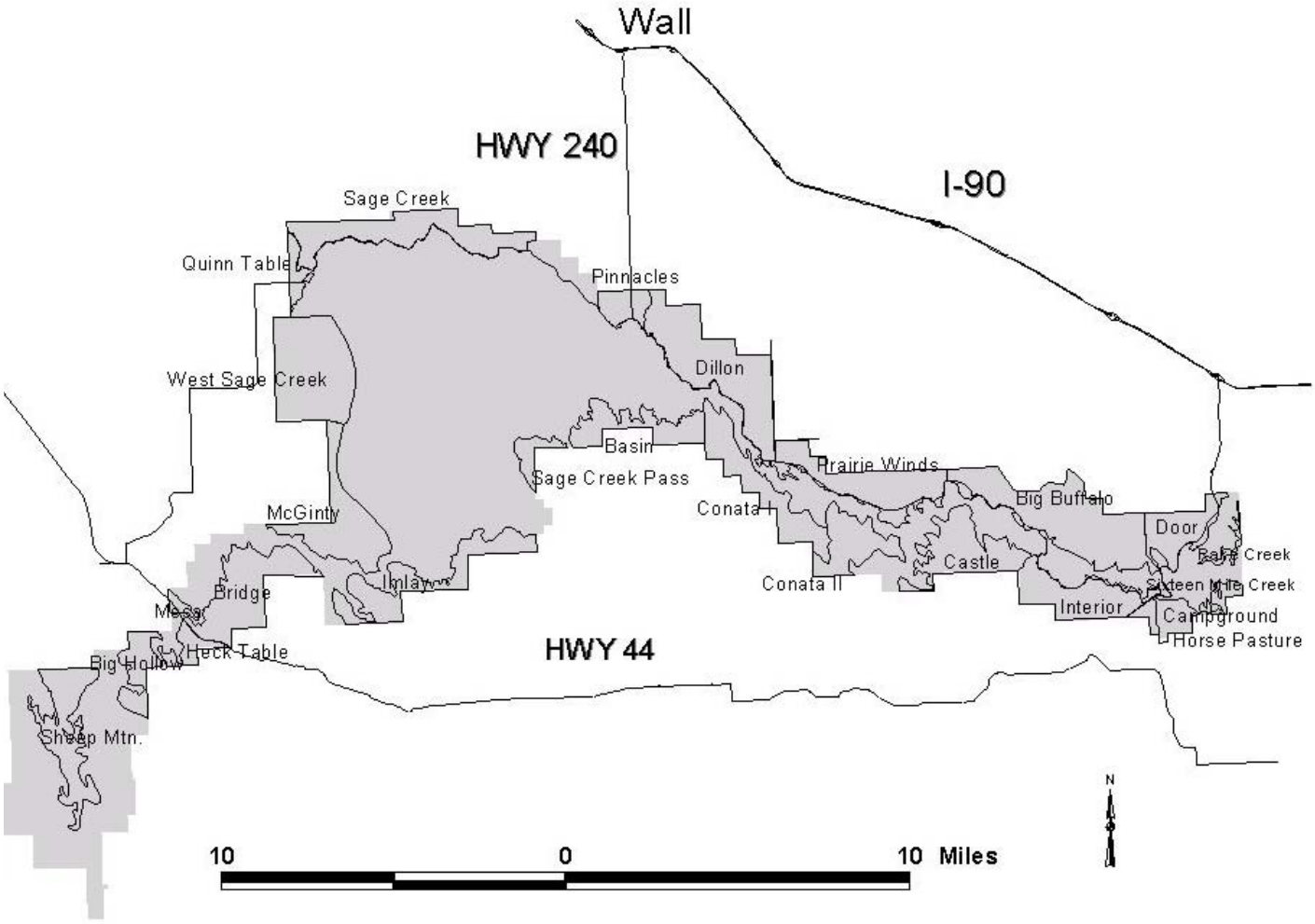
For the purposes of this Fire Management Plan, in order to bring the park into compliance with NPS policy, the park is divided into two Fire Management Units, a "Boundary Unit" and a "Natural Unit" (*see* **Fig. 3** *below*). These units are delineated along administrative and natural barriers representing locations suitable for defensive fire tactics. A FMU is defined as any land management area definable by objectives or features that set it apart from the management characteristics of an adjacent FMU. FMUs may also have pre-selected strategies assigned to accomplish land management objectives. Within each FMU, prescribed fire units are delineated (*see* **Fig. 4** *below*). In Badlands National Park the Natural FMU has four identified prescribed fire units with the remainder in the Boundary FMU. Prescribed fire units simply delineate the geographical extent of each planned prescribed fire treatment. The two Badlands National Park FMUs will be used to drive fire management actions in various areas of the park. The Natural FMU will be managed with a combination of wildland fire suppression, prescribed fire, and wildland fire use, while the Boundary FMU will only utilize suppression and prescribed fire. Aggressive firefighting strategies and tactics will be employed for all wildland fire occurring as the result of human ignitions. The appropriate management response will be determined and utilized for all wildland fires occurring in the Natural FMU. Prescribed fires will be implemented in both FMUs when it has been determined that they can successfully accomplish the desired resource objective.

Fig. 3: Badlands National Park Fire Management Units



Within the two Fire Management Units of the park, the Boundary Unit and portions of the Natural Unit have been divided into twenty-seven Prescribed Fire Units as illustrated in **Fig. 4.** The annual burn acreage accomplishment within the Natural FMU will not exceed 10,000 contiguous acres for all wildland fire types (suppression, prescribed fire and wildland fire use acres combined). This acreage limitation is directly tied to ungulate populations and ensures adequate forage during the winter season. This acreage limitation does not include suppression and prescribed fire acres burned within the Boundary FMU. The prescribed fire accomplishments within the Boundary FMU will be nearly 4000 acres per year averaged over fifteen years. Each of the prescribed fire units has been placed in a burning cycle based on past burns, as well as on park needs and objectives. Boundaries for the prescribed fire units were decided upon by using aerial photography and GIS vegetation maps to determine physical barriers (badlands/roads). Further refinements in prescribed fire units may be made in development of individual Prescribed Fire Plans for individual units.

Fig. 4: Badlands Prescribed Fire Units



Due to current fire hazards, the relatively small size of park, the fuel types, associated rates of fire spread, historic fire duration, park staffing, and budget limitations, this plan utilizes a combination of appropriate suppression responses, wildland fire use, and prescribed fire for resource objectives as fire management tools.

Badlands National Park may take immediate, initial attack suppression action on fires within one mile of the park boundary, depending on the wind direction and local agreements. It is the intent of Badlands National Park fire management to allow natural ignitions occurring within areas where fire poses minimal threat to life, property and resources to play out their revitalizing role within the grassland ecosystem and, ultimately, reestablish a natural fire regime.

HISTORIC ROLE OF FIRE

- ***Fire Ecology***

With large tracts of continuous, fine fuels, frequent periods of hot, dry weather, and recurrent lightning, the mixed grass prairie in and around the park represents a classic grassland fire regime. Historically, frequent, low-intensity surface fires with a return interval of 1 to 25 years typify this ecosystem (Pyne, et. al. 1996). The effect of this is exemplified in the composition of

plant and animal species. The extent of species diversity can be directly related to the fire return interval. The randomness of the fire mosaic often determines species location and dispersal. The earliest notations of fire in this ecosystem are detailed in the accounts of explorers, trappers and settlers. These records indicate a high occurrence of both natural and anthropogenic ignited fire (Pyne 1982). The importance of disturbance in this ecosystem is paramount. Fire, drought, flooding, erosion and animal grazing all should be present to offer the greatest potential for disturbance in the system.

The effect of fire in prairie grasslands is complex; thus ecologists hesitate to generalize. Fires can increase the number of species, especially annuals, or they may create monotypes, or permit invasion by short-lived perennials, weeds, or aggressive exotics. Seed production, germination, and seedling establishment of both annuals and perennials are commonly encouraged by fire. Since perennials, such as most exotic species, are capable of vegetative reproduction, they often survive fires. There is no doubt that fire restricts shrub and tree growth. In the Badlands, trees and shrubs most often survive in rocky breaks and draws, where fire would not penetrate. Frequency, intensity, and especially timing of burning are thus extremely important.

- ***Fire History***

Examining the fire history of the region gives us insight as to the processes that have determined the past and current vegetative patterns. Ultimately, it is this view of fire over time that should guide fire use in the park. Development of prescribed fire prescriptions necessary for the restoration and maintenance of vegetation cover types to preparedness conditions can be guided by this standpoint.

Fire represents an ecological factor of significant importance in the development and structure of nearly every terrestrial ecosystem in North America. It has been present in natural ecosystems since the origin of climate on earth (Wright and Bailey 1982). It has been well established that the plains ecosystem has historically experienced frequent, fast running, short duration fires. From the recorded accounts of early European explorers and settlers, fires were a common occurrence on the plains (Higgins 1986). Fires were often ignited by lightning activity during the late spring to early autumn season. The writings note that the plains were often on fire as a result of Indian activities, e.g., to signal others, to herd game, to alter vegetation composition, and to clear campsites. Following the influx of European settlers in the mid-to-late 1800's, most human-caused prairie fires resulted from the carelessness of cowboys and cooks, rather than Indians (Wright and Bailey 1982).

The historical prevalence of fire on grasslands cannot be denied. Fidler, who observed fires in the fescue grassland of southwestern Alberta in 1793, wrote in his diary:

> These large plains either in one place or another is [sic] constantly on fire and when the grass happens to be long and the wind high, the sight is grand and awful, and it drives along with amazing swiftness. The lightning in the spring and fall frequently lights the grass, and in winter it is done by the Indians ... these fires among the long grass is very dangerous. (Pyne 1982)

In the early 1800's, Lewis and Clark and later Charles Fremont wrote of fire on the Great Plains, which one explorer referred to as "these conflagrated prairies" (Pyne 1982). Early ecologists variously perceived of grasslands as climatic climax or fire climax situations. Wright and Bailey (1980) felt that climate is the dominant inluencing factor of North American grasslands, though fire, ungulate grazing, insects, and rodents do also. Pyne (1982) builds a strong case that anthropogenic fire has maintained grasslands as a cover type, from the Great Plains to the African Savannah, he states that "fire and grass are genetically associated." The adaptations of grass to fire and drought are much the same, indicating an intrinsic link between climate and

fire occurrence.

There are few reliable records of fire frequencies in the Great Plains grassland due to the lack of trees to carry fire scars and from which to collect tree-ring data. We know that fire frequency was high because explorers and settlers were concerned about the danger of prairie fires. Pyne (1982) also states that fires came with summer thunderstorms in a natural fire regime. After anthropogenic fire became dominant, the summer lightning cycle was superseded by a pattern of spring and fall burning.

Fires have always been common on the prairies during drought years. Fires on the prairie were often measured in terms of millions of acres or square miles; however, today they are broken up due to land ownership and fire suppression. A variety of sources indicate that fire frequency in pine forests varies from 1-25 years (Pyne 1996). From these sources we can extrapolate fire frequency data from forests that have grassland understories. Wright and Bailey (1980) believed that fire frequency in prairie grasslands is on the order of 5-10 years.

On the upper and lower prairie of Badlands National Park, it is difficult to determine how much fire has historically been anthropogenic or natural, but fires would likely have been large and fast moving. In the late 1800's when all the prairie between the Cheyenne and Missouri Rivers was on fire, cattlemen brought their herds into the Sage Creek area of the badlands because natural barriers, the wall, and extensive prairie dog towns limit the size of fires in that area.

Ignition of grassland fires has been caused by early and modern man, lightning, spontaneous combustion, sparks from falling rock, and volcanic eruptions. Pyne (1982) argues strongly that fire was anthropogenic across the prairies, used for centuries by Indians. The fire techniques adopted from the Plains tribes were suitable for trappers, hunters, explorers, and military expeditions. As European settlers supplanted the Native American users of the Great Plains, fire and the native prairie grasses were largely eliminated in favor of livestock grazing and domestic cereals. This situation typifies much of the grassland, which today lies within Badlands National Park. On the upper and lower prairie, it will be nearly impossible to determine how much fire was anthropogenic or natural.

The main source of natural ignitions in the park is lightning. Lightning ignition is produced when cloud-to-ground discharges occur without precipitation, when lightning precedes precipitation, or when it produces fires beyond the range of the usually local thunderstorm showers. Lightning fires often persist despite rains, and grasslands thoroughly soaked by rain can often burn after just a few hours of drying winds and/or sun.

With the exception of prescribed fires, Badlands National Park has had an average of three fires per year, with a total of 97 fires recorded from 1974 through 2003 (*Appendix E(5)*). Of those fires, lightning caused 60% of all ignitions. Generally, lightning fires, if not suppressed by humans, are extinguished by rain at less than 2 acres or pushed to 100-acre size by gusty winds associated with thunderstorm activity. Several times during a summer, dry lightning storms, high winds, and dry fuels combine to produce multiple ignitions, stretching initial attack forces to the limit. Two lightning-caused fires in the Badlands Wilderness in late April of 1988 (White Butte and South Fork Fires) required use of a Type II Incident Management Team. Together, the two fires totaled 170 acres in size. Generally, fires do not exceed one burning period due to the effect of evening moisture recovery on fine fuels. Human-caused and unknown ignitions accounted for the remainder of all documented fires and were recorded from all months.

WILDLAND FIRE MANAGEMENT SITUATION

- ***Historical Fire Weather Analysis***

Fuel moistures are at their maximum for live woody and herbaceous plants during the spring when plants are actively growing *(see* graph, *Appendix E(4)*). Dead fuel moistures in large size classes reach minimum values during the late summer and fall months (*see* graph, *Appendix E(4)*). Indicators of fire danger as computed through the National Fire Danger Rating System (NFDRS) show that fire danger is highest when fuel moistures are lowest and when plants are not actively growing (*see* graphs, *Appendix E(4)*). On-site weather observations are made at two remote automated weather stations within the park. The Cedar Pass Station (#394184) adjacent to park headquarters has the most historical data, but was removed in 2000. Originating as a manual station, the earliest fire weather records are from 1982. Other, more recently installed stations, include Pinnacles (#392602) installed in 1995 and White River (#395201) installed in 1996. Both are adjacent to the respective Ranger Stations.

- ***Fire Season***

The fire season at Badlands National Park is April through October. Over 95% of all wildland fire starts recorded at Badlands between 1974 and 1998 occurred during this period (*Appendix E(5)).* April through October represents the time from before spring green-up until after curing has occurred, and when climatic conditions favor ignition. Green-up is signified by the accumulation of new grass growth that significantly retards fire spread. This occurs when the live-to-dead ratio of new grass to thatch exceeds 1:1, usually in mid-May. The bulk of the rainfall occurs in May and June, but severe thunderstorms from June through August are responsible for most lightning-caused fires. Anthropogenic fires were recorded virtually year-round between 1974 and 1998. The abundance of cured, light flashy fuels on the prairie dictates that a minimum state of readiness be maintained year-round (*see* **Table 1***,* pg.11).

- ***Fuel Characteristics***

Badlands National Park is mostly mixed-grass prairie. The wildland fuels are best characterized by the National Fire Danger Rating System (NFDRS) fuel model L. This system has been altered historically by grazing and the influx of non-native grasses such as Japanese brome, wild oats, and cheatgrass. Predominant natives include Western wheatgrass, several bluestems and gramas, and needle-and-thread grass. Woody plant communities occur among the canyons of the Badlands wall, and along springs, streams, stock ponds, and geologic slumps. The woody draws, which provide valuable shelter and browse for wildlife species, are typified by green ash, American elm, juniper, sagebrush, cottonwoods, and a variety of shrubs. These woody draws are best characterized by NFDRS fuel model T.

Numerous intermittent creeks, badlands features, and the dominating badlands "wall" create many natural barriers to fire spread. Agricultural use and grazing on adjacent lands create firebreaks to fire spread during portions of the year. The north and west boundaries of the park are dominated by areas of continuous stands of grasslands which have the potential to carry fire and escape park boundaries. The rugged, remote nature of the topography requires specific "local" knowledge of access routes for fire suppression activities throughout the park and adjacent lands.

Grassland fuels burn rapidly. Most grassland plants are surface deciduous, with the aboveground portions dying back at least once a year. As a result, grasslands are particularly vulnerable to fires as standing plants dry and cure to ground level. Most grassland species are

xerophytic, often with stiff, scabrous leaves and rigid stems whose structure may be aided by high silica content. Shoots produced after a fire have also been found to be stiffer and more erect than shoots emerging in areas not recently burned. Their rigid and erect nature and behavioral adaptations not only help to keep stem and leaves upright even after growth terminates, but also expose the grassland understory and soils to sun and wind. This results in ideal combustion conditions and finely divided fuels with numerous air spaces that permit further drying, as well as abundant oxygen for burning. Compaction of grassland fuels is nearly always conducive to fire propagation, yet seldom reaches the degree attained by heavier fuels, even after heavy snows, rains, or inundation.

Because of these characteristics, conditions are not usually conducive to the rapid decomposition of plant materials by bacteria, fungi, and soil invertebrates in prairies. Therefore grassland plant debris often accumulates faster than it decomposes, with variations in decomposition rates being largely determined by temperatures, amount of rainfall, and the moisture present in the litter. Accumulation not only results from slow breakdown of plant materials, but from the rapid and prodigious growth characteristic of many grassland plants, with entire plant tops being added to the litter layer at the end of each growing season.

The rapid growth, accumulation, the slow decomposition rates, the chemical and physical composition of grassland plants, and the highly flammable nature of the plant debris point to a vegetation type that can readily burn. Grasslands that can be readily and repeatedly burned have apparently evolved with fire, becoming dependent upon it as the primary decomposition agent and key nutrient recycling path. At the same time, the grassland plants create conditions that make fires almost inevitable.

The physical nature of grassland fires is simple in comparison to fires in more stratified vegetation types. Rapidly moving head fires consume most of the vegetation and often develop broad fronts because of the continuity of the fuels and the level to rolling terrain usually associated with grasslands. These fire fronts tend to become irregular in outline as topography, fuel loads, winds, natural barriers, and developing convective columns speed up or retard movements. Head fires in dense fuels and tall grasslands often generate large flames, but produce little spotting as most grassland fuels are consumed too quickly and thoroughly. Further affecting fire behavior, is the greenness stage of the current year fuel load. Green-up of cool- and warm-season grasses is dependent on precipitation and soil moisture. Drought years often produce no green-up for the entire year. Year-to-year variations in the timing of green-up and curing of grasses affect fire danger throughout the growing season (*see* **Table 1,** pg. 11**)**. Fire behavior is significantly reduced immediately after green-up. Rates of spread increase dramatically, as the vegetation cures. Due to the normally high rate of spread and short residence time after grasses cure, long-lasting effects to soils (e.g. hardness, composition, and hydrophobicity) are few. Key nutrients supplied by the fire's potash are quickly recycled into grassland communities, since soil properties are unchanged.

The woody draws found mostly on north and east slopes and slump areas found on a variety of slopes and aspects are generally less than 40 acres. They can change a fire's spotting potential, rate of spread, and fire intensity. Monitoring and experimental burning are needed to better understand fire behavior in these pockets of woody vegetation.

- ***Control Problems***

Control problems can be expected on fires burning in the peak fire season. When continuous fuels and warm, dry, windy environmental conditions are encountered, high fire intensities and rapid spread rates can be achieved within a short time. In these situations, firefighter safety may dictate use of indirect attack suppression methods.

Many areas within the park present hazardous conditions, such as steep slopes with unstable footing, densely wooded draws, and continuous fuels. Suppression activities in such areas must be carefully planned and executed.

V. WILDLAND FIRE MANAGEMENT PROGRAM COMPONENTS

GENERAL MANAGEMENT CONSIDERATIONS

- ***Endangered Species***

The park hosts both State and Federal listed threatened and endangered species that will be considered before any fire management activity takes place (*Appendix C*). Most notable of these is the black-footed ferret. A reintroduction project for the ferret has been ongoing in the park since 1994. Additionally, the ferret's only prey, the prairie dog, was recently considered for Federal listing. It was rejected largely due to a lack of resources for enforcement. A statewide management plan for the prairie dog is expected in the near future, which may impact wildland fire planning in the park. Anecdotal evidence indicates prairie dog towns often increase in size after a fire burns adjacent to the town. The prairie dog towns themselves are highly resistant to direct impacts from fire, due to the lack of vegetation. The fire management program will be within the constraints of the Endangered Species Act of 1973, as amended. A review of the list of threatened and endangered species indicates that no significant impact will result from transient fire.

- ***Locally Rare Plant Communities***

Badlands National Park is dominated by a few vegetation communities, all of which are fire dependent. However, the vegetation mapping completed in 1999 revealed a number of communities that occupy less than 1% of the park (Von Loh, et al, 1999) and should be given careful consideration in any burn plan or suppression activity.

- ***Cultural Resources***

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). The Archaeology of Badlands National Park, South Dakota (Hannus, et.al. 2003) notes:

> No archaeological cultures, phases, or complexes have yet been delineated that call the Badlands "home". The White River Badlands, although centrally located within the "Plains Region," are generally understood as peripheral to many culture areas. This view implies a transitory or seasonal use of the region rather than year-round settlement.

Currently 10% 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 5-year study being conducted jointly by Augustana College and the NPS Midwest Regional Archeological Center (MWAC). A draft this report has been reviewed and the final is expected during summer, 2003. Prior to this survey, less than one percent of the total land area within the park had been surveyed for archeological resources. Less than 1% 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. Two hundred eighty-three sites have been identified as of January, 2001. Site types are primarily lithic and artifact scatters. There are two identified historic farmsteads and two structures with wooden remnants. However, 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 47 are considered poorly documented.

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. To date, only one site has been evaluated for nomination to the National Register; however, it is ineligible due to impacts from the Badlands natural erosion which destroyed the integrity of the site. The research conducted by Brent Buenger in 2000 and 2001 determined that the short, superficial duration of prescribed fire presents only a minimal risk to archaeological sites. The primary impacts will result from off-road vehicle travel to support fire activities.

Research has been conducted on the impacts of fire on archaeological resources. In 2002, Brent Buenger, a Phd. Candidate at Colorado State University in the Department of Anthropology, submitted *Fire Effects on Archaeological Resources During Prescribed and Wildlife Fire in a Prairie Ecosystem (Badlands National Park, Wind Cave National Park, Rocky Mountain National Park)* and determined:

> Prescribed burning in grassland fuels produced relatively low temperatures and residence times. Surface temperatures recorded during a May, 2001 burn ranged from 418.8C to 61.6C. The maximum subsurface temperature was 34.6C. The investigator's findings indicate that thermal alteration of the artifacts placed within the test plots was not significant. The majority of discoloration was due to residence deposits, the byproduct of organic combustion, present on all of the artifacts. No significant damage in the form of cracking, spalling, or deformation occurred. Even the wooden objects showed only minor effects of the fire. Based on these observations, it is suggested that prescribed burning in mixed grass fuels.

Secondary impacts are created by erosion and vandalism. 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 suppression and prescribed fire activities involve construction of black-line and scratch-line, use of swatters, and direct attack with water, all primarily in fine fuels. Ground disturbance is minimal and not likely to adversely affect archaeological resources.

Cultural Landscapes:

The park has not yet been inventoried for cultural landscapes. Identified potential cultural landscapes are:

- Historic fossil collecting camps. The location of these camps is approximated from journals and field reports but have not been pinpointed.
- Fort Pierre to Fort Laramie Road. Documented in a masters thesis in 1975.
- Route of Bigfoot's Band through the White River Badlands to Wounded Knee. Location approximated from oral histories.

- Stronghold Table. Ghost dances held here in 1890 contributed to the events of Wounded Knee and are the last known such ceremonies of the 19th century.
- Cedar Pass Headquarters Area. Currently under evaluation through a Cultural Landscape Report and Environmental Assessment due to be completed in 2004.

Historic Structures and Sites:

In 2002, the Ben Reifel Visitor Center was determined to be eligible for the National Register of Historic Places as a part of the plans to rehabilitate the Center. Consultation with the State Historic Preservation Office resulted in an approved construction plan with mitigation measures specified.

In 1975, the State Historic Preservation Office determined that the Cedar Pass Lodge was ineligible for the National Register of Historic Places due to extensive alteration to the structural integrity and external appearance of the cabins and lodge buildings.

The List of Classified Structures for Badlands National Park was last updated in 1992 and requires updating. It lists three roads (Badlands Loop Road, Sage Creek Rim Road, and Sheep Mountain Table Road) and two structures (Tyree Gravesite and Homestead Well). Both structures are located within the boundaries of the Badlands Wilderness Area.

Ethnographic Resources:

American Indians use many areas within the park as spiritual sites. Activity at these sites usually consists of small offerings (often small packets of tobacco) tied to a tree or bush. Park staff is aware of the general areas where such activities take place. The park may have potential ethnographic landscapes as yet unevaluated.

- ***Paleontological Resources***

To prevent the potential crushing of fossil remains, no vehicle traffic will be allowed in badlands areas associated with a burn. Areas recommended for hand lining, trenching, and heavy equipment operation must first be reviewed by the Park Paleontologist and approved by the Park Superintendent.

Due to the extreme surface temperatures associated with grassland fires (Lata, 1997), paleontological resources exposed at the surface may undergo splitting and cracking when exposed to fire. Due to the buffer created by overlying bedrock, fossils in the subsurface are probably not impacted by fire. Most of the research on fossils and temperature changes have been completed in museum and not field settings (Collins,1995; Johnson, E.V. and J.C. Morgan, 1979; Thomson, G. 1986; Brunton, C.H.C. et al. 1985; Howie, F.M.P., 1978, 1979; Stolow, N., 1966; Ashley-Smith, J., 1987). It appears that temperature changes relate directly to moisture content within the fossil specimen. When moisture within the specimens increase in temperature, the specimen will begin to expand and crack. Field studies involving surface temperature changes and exposed fossils will be implemented during the spring and fall burn seasons of 2000. Temperature probes and/or thermal sensitive paints will be installed in Badlands Areas partially covered with vegetation directly adjacent to burn areas. Photos will be taken of fossil bone before and after the burn event to record any fire-related damage.

As a regular practice, because of the potential impact on exposed fossil resources, pre-burn surveys and potential removal of fossils will be implemented before a prescribed fire is begun. Careful considerations will need to be made on the scientific significance of specimens found and the type of fire that will come in contact with the specimens. If a significant site is found, the site will be protected from fire encroachment or excavated.

- ***Wildlife***

Generally, the direct impacts of fire on wildlife include dislocation and mortality of individuals or groups of individuals. The park's larger mammalian vertebrates (deer, bison, bighorn sheep, pronghorn, coyote) will generally move away from fire. However, the availability of adjacent suitable habitat is important for local populations and is a critical factor in Badlands National Park for the fenced bison populations. A large wildland fire in the Sage Creek Basin during drought conditions or late in the growing season could significantly reduce the forage base needed for the bison herd. Potential for bison escape could increase, overuse of existing range could occur, and the park may be forced to conduct emergency round-up operations to adjust herd size.

Deer, pronghorn, and bison appear to favor areas that have been burned and where green-up has occurred. Observations indicate that the new vegetation sprouting from burned areas is the attraction. Some problems, such as overgrazing, soil compaction, and concentrations of wildlife near roadways, may arise from this behavior if small plots are burned.

Fire in the mixed-grass prairie has been shown to favor bighorn sheep, bison, deer, and other mammals (Coppock and Detling, 1983). A survey of the Badlands National Park bighorn sheep herd conducted by McCutcheon in 1980 concluded that prescribed fire would release stored nutrients for grass production presently tied up in decadent grass stands and litter within bighorn range. Research concerning the effects of fire on wildlife can be reviewed in the *Annotated Bibliography: The Effects of Fire on Mixed Grass Prairie*, prepared by Wisenant, and the park's general annotated bibliography.

Coppock and Detling (1986) found that bison grazing pressure decreased in prairie dog towns with increased use of nearby burned areas, suggesting that prescribed burns could be effective in mitigating bison impacts on colonies. There is anecdotal evidence that burning in or around prairie dog colonies may increase their size, benefiting not only prairie dogs, but possibly their natural predators, as well, like the black-footed ferret. More research is needed to determine if burning may benefit these two species of special interest.

Park resource managers realize the Badlands National Park ecosystems are altered through human activities. Uncontrolled wildland fire has potential for negative impacts at the landscape level. Conversely, fire under the correct prescriptions can be used as a tool to improve habitat. For a more thorough discussion of Badlands National Park flora, fauna, their habitats and the effects of fire see *Appendix D,* the Environmental Assessment*,* and *Appendix E(4),* which discusses park fire ecology.

- ***Water Availability***

Water supplies for fighting fires are basically limited to park water systems and the park water tender. There are a few wildlife impoundments throughout the park, with the majority concentrated in the Badlands Wilderness Area. These reservoirs, in general, are not large enough to be of any assistance in a wildland fire situation and are critical to wildlife. Cedar Pass' water supply is the West River/Lyman Jones pipeline from Kadoka, which will eventually be supplied by the Missouri River. Pinnacles is currently connected to the water system utilized by the town of Wall, SD. At the ranger station, there is a 20,000-gallon sealed reservoir with a 2,000-gallon residual. The White River Visitor Center is connected to the Mni Wiconi rural water pipeline.

- ***Equipment***

As of 2004, the park has two Type 6 wildland engines and one Type 2 structural engine in

operation. One Type 6 and the Type 2 engine are generally stationed at Cedar Pass and the other Type 6 is at Pinnacles. The park has sufficient supplies to equip a crew of ten firefighters. There are also four chainsaws, two Mark III pumps, and a floto-pump. A 6,000-gallon water tender is located at the Cedar Pass Maintenance area. In 2002 the park and FIREPRO split the cost of a used 1998 Kenworth semi-tractor trailer to pull the tender. In 2003 FIREPRO funded a ¾ ton diesel crew cab pickup for fire crew use, and an ATV. The park's Resource Management (RM) Division and Resource Protection (RP) Division also have ATV's available for use on fire. RM has two ATV-mounted sprayers available for use.

- ***Facilities***

In 2003 the park utilized FIREPRO and Fee Program funds to construct a new fire station at Cedar Pass. This building has a 3-bay heated garage to house the structural engine and at least one wildland engine. In the bays there is also a workshop and tool/equipment storage. There are also a search-and-rescue cache room, a fire cache storage room and a weight room/storage room. There is also an office for the Fire Coordinator, a work area for fire planning and dispatch, and a training/meeting room. This facility is a great advancement for the park fire program.

- ***Personnel***

The park currently has 50+ firefighters meeting minimum NWCG qualifications, including a three-person seasonal FIREPRO-funded fire crew and a permanent fulltime engine supervisor (Fire Coordinator position). Availability of qualified personnel is one area that can be a problem. Engine bosses (ENGB) and incident commanders (ICT4) for pre-suppression activities during preparedness levels 4 and 5 are a particular issue. The park has a commitment to have 4-5 qualified wildland fire personnel able to respond to fires, but that number is not always available at any one time and varies from year to year. The remoteness of some areas of the park can be an obstacle in getting personnel to a fire. This can create a delay in response time. See pages 56-57 of this plan for targeted staffing levels in support of fire management at Badlands National Park.

BADLANDS FIRE MANAGEMENT PROGRAM

There are three basic components to the Badlands Fire Management Program: Wildland Fire Suppression, Wildland Fire Use, and Prescribed Fire.

Wildland Fire Suppression

- ***Wildland Fire Prevention Program***

A major goal of the park fire management program is to reduce the threat and occurrence of human caused wildland fires. The Fire Prevention Plan (*Appendix I*) seeks to accomplish this goal through an analysis of the risk of human caused ignitions within an area; hazards within that area; and values of resources found within that area. Prevention activities developed for specific areas include education aimed at park visitors, employees, and adjacent landowners; engineering (or the use of appropriate equipment, methods, and projects); and enforcement of regulations aimed at preventing human caused fires.

The Superintendent is responsible for overall fire prevention within the park and shall initiate prevention action as indicated within the park's Fire Prevention Plan. General activities identified through the analysis are summarized below. Detailed information can be found in *Appendix I.*

Educational activities will focus on educating park visitors and adjacent landowners about fire prevention regulations, appropriate prevention activities, and current fire danger ratings using media, signs, and verbal contact. Educating park employees about integrating fire prevention activities into their jobs is a continuing responsibility of the fire program staff, as is the development of appropriate fire prevention messages for park neighbors.

The Park Fire Coordinator or their designee will provide and maintain fire prevention devices (e.g., spark arrestor) on appropriate field equipment, inspect power lines or other potential sources of ignition on a yearly basis, and evaluate park structures for flammable construction materials and the need for hazard fuel reduction work.

Resource Protection Rangers will conduct routine patrols and enforce regulations regarding campfires, smoking, and other components of the Fire Prevention Plan, as appropriate.

- ***Wildland Fire Preparedness***

Preparedness includes activities conducted before a fire occurrence to ensure the ability of the park's fire management organization to initiate effective action. This action may include the evaluation of the situation and selection of appropriate management response. Preparedness activities include recruitment, training, planning, and organization, fire equipment maintenance and procurement of equipment and supplies. The objective of preparedness is to have a well-trained and equipped fire management organization in place to manage all fire situations that confront Badlands National Park managers.

Annual training: All training and qualifications of wildland fire personnel are based on the standards developed by National Wildland Fire Coordinating Group (NWCG) and may be found in the *Wildland and Prescribed Fire Qualification System Guide PMS 310-1*. Employee qualifications are tracked and archived through the National Park Service Wildland Fire Management Qualification System found on the Shared Applications Computer System (SACS).

The park goal is to have fitness testing and physicals (when needed) for permanent employees completed prior to February 28th of each year and by June 15th for all others. Annual firefighter refreshers are held at Badlands (usually in April for permanent employees and in June for seasonals) as well as each of the Northern Great Plains parks.

Advanced training (series 200 and above courses) are coordinated through the Northern Great Plains Area Fire Management Office (NGPAFMO). Whenever possible, trainee assignments will be made to further develop skills.

Prior to and during the fire season, the Northern Great Plains Area Fire Management Office along with Badlands personnel will take the following measures to ensure adequate fire preparedness:

January 1 - April 30: Update and maintain accurate employee training and qualification records. Review Cooperative Agreements with surrounding fire management agencies. Prepare plans for any prescribed burn projects for hazard fuel reduction and resource management projects. Order fire cache supplies and replacement equipment as needed. Perform annual maintenance on fire weather station. Provide updates or changes to cooperators for local and regional mobilization plans. By March 15, the fire caches are ready for use and all engines will be in service. A formal inspection will be held on or around March 15. Suppression personnel will be fitness tested and protective gear will be available --- and both wildland engines are operational and properly stocked. Fire tools should also be in a state of readiness by being sharpened and available for use.

May 1 - June 15: Inventory fire supplies and equipment and update list. Inspect fire cache to ensure equipment is ready. Check operation of all slip-on and portable pumps. Outfit field vehicles, all initial attack personnel, and interagency crew participants. Review fire weather station observation, recording, and weather station equipment maintenance procedures. Review established procedures for utilizing suppression and emergency preparedness accounts. Evaluate the need for basic firefighter training and conduct if necessary.

June 16 - September 30: Maintain state of readiness as identified in the Step-Up Plan (*see* **Table 2** *below*). Test all slip-on units and portable pumps at least weekly.

October 1 - December 31: Critique fire season. Evaluate individual performance ratings of fire personnel and correct deficiencies and recommend training as needed. Review and revise Fire Management Plan as needed.

- ***Wildland Fire Emergency Preparedness***

Emergency preparedness describes actions to provide extra capability during times of extreme or unusual fire danger caused by meteorological influences on the park's natural fuel complexes. Unusual occurrences will be addressed by planned use of emergency preparedness funds linked to the National Fire Danger Rating System (NFDRS) burning index and described in the Step-up Plan (*see* **Table 2** *below*). The park's authority to expend emergency preparedness funds is detailed in *RM-18*. Appropriate actions for use of emergency preparedness funds include: hiring of temporary emergency firefighters; placing existing staff on extended tours of duty; increasing or initiating special detection operations; pre-positioning additional wildland fire resources in the park; and hiring fixed wing or rotary aircraft to accomplish necessary preparation. These are planned to ensure the capability of prompt response with adequate forces to whatever specific fire situation develops. Expenditures of these funds will be coordinated with the NGPA Fire Management Officer.

This Plan uses the Burning Index (BI), derived from the National Fire Danger Rating System (NFDRS) (Deeming et al. 1977), for basing determinations regarding the scope and extent of fire management activities. Depending on the BI derived from the daily NFDRS/WIMS data, predicted fire danger is classified as low, moderate, high, very high, or extreme. A set of staffing classes which have a corresponding set of actions that the park will initiate to meet potential fire danger has been developed and is presented in **Table 2** below as the Step-up Plan.

The 90th percentile Burning Index for Badlands National Park is based on fuel model L. The Park is a National Fire Danger Rating System (NFDRS) climate class two area (sub-humid with rainfall deficient during the summer) and averages a 107-day annual fire season from June 1 through September 15. Burning indexes utilized in development of Badlands National Park's staffing classes were taken from an historical analysis of fire weather observations archived for the Cedar Pass weather station (Station Number 394184). For these observations, the low fire danger rating equates with BI's ranging from 0 to 10; moderate equates with BI's ranging from 11 to 20; high ranging from 21-42; very high ranging from 43 to 51; and extreme with BI's of 52 and greater.

Actions taken under staffing classes I - III are funded through the normal park budget. Additional actions detailed under staffing classes IV - V can be supplemented by emergency preparedness funding coordinated through the Northern Great Plains Area FMO. Burning index, associated staffing classes, and designated prevention, detection, and preparedness actions to be taken with each level are discussed in the Step-up Plan below.

Table 2: STEP-UP PLAN FOR BADLANDS NATIONAL PARK

Staffing class	Burning Index	Actions
I (Low)	0 – 10	♦ Prevention – Fire Prevention activities can be grouped into three categories: in-Park activities, out-of-Park activities, and coordination with other agencies. During low fire danger situations, in-Park activities will represent the majority of the prevention activities. Visitors, upon entering the Park, will be instructed to restrict vehicle travel to constructed Park roads only; to make no open fires except in designated campgrounds and picnic areas and only in existing, constructed fire places; and to totally refrain from the use of any fireworks or explosives. ♦ Detection – Park personnel will carry out normally assigned duties. ♦ Get Away Standard (the goal for the length of time required to staff an engine)– None ♦ Preparedness – A minimum of one engine will be prepared for operation. Park personnel will carry out normally assigned duties.
II. (Moderate)	11 – 20	*All Staffing Class-1 actions apply with further considerations noted below* ♦ Prevention - The in-Park and out-of-Park actions described above will be sufficient. ♦ Detection – Personnel to carry out normally assigned duties. ♦ Get Away Standard – 10 Minutes ♦ Preparedness - Two engines will be prepared for operation. Fire suppression tools will be added to Park vehicles involved in field operations.
III (High)	21 - 42	*All Staffing Class-1 and 2 actions apply with further considerations noted below* ♦ Prevention - Restrictions will be implemented against any smoking in the Park's backcountry. Out-of-Park activities may include notification to local media services of increasing fire danger. ♦ Detection – Personnel to carry out normally assigned field duties with special emphasis on fire detection. At the discretion of the Chief of Resource Protection, one or more individuals may be assigned road patrol at set times during the day. ♦ Get Away Standard – 5 Minutes ♦ Preparedness - Fire suppression tools will be added to designated Park vehicles. A minimum of two engines will be operable. The Fire Management Officer has the authority to increase the Staffing Class by one level if warranted by current and/or forecasted burning conditions.
IV (Very High)	43 – 51	*All Staffing Classes-1, 2, and 3 actions apply with further consideration noted below.* ♦ Prevention - Out-of-Park activities will be stepped-up to include notification of local and regional media services. Coordination with other agencies will increase in terms of both short and long range planning, public notification, coordinated prevention activities, and increased cooperation. ♦ Detection – Park personnel will carry on normally assigned detection duties. FMO or Chief of Resource Protection may designate one or more personnel to part or fulltime road patrol. Patrols may be increased at the discretion of the FMO or Chief of Resource Protection. ♦ Get Away Standard – 5 Minutes ♦ Preparedness – Preparedness overtime may be authorized by NGPA FMO, Fire Program Manager, or Fire Program Coordinator if necessary to conduct these activities. An initial attack crew of at least 2 personnel, will be identified and available to staff an engine. An ICT IV will be available. All available engines and the water tender will be made fire-suppression ready. All Park personnel qualified and assigned fire suppression duties will be notified about the fire danger. Dispatch may be staffed for extended hours. Automatic dispatch of the interagency helicopter to fires, if the helicopter is on contract, will be implemented. Notice will be forwarded to the cooperator offices of the very high fire danger condition. Daily availability of additional local and regional resources will be monitored. Temporary closures may be imposed upon areas in the park or for certain activities in conjunction with similar impositions by adjacent land managing agencies. *Table continued on next page*

Staffing class	Burning Index	Actions
V (Extreme)	52 +	*All Staffing Classes-1,2,3,4 actions apply with further consideration noted below .* ♦ Prevention - Visitors to the Park will be verbally warned of the fire danger, all smoking on trails and in moving vehicles will be expressly prohibited, and no open fires or stove fires will be permitted anywhere in the Park. Cooperators will be advised in regard to conditions and opportunities for bans on open burning. ♦ Detection - Fire patrols will be increased. ♦ Get Away Standard – 2 Minutes ♦ Preparedness –Consideration will be given to prepositioning additional local or regional suppression resources in the park to supplement suppression capabilities.

- ***Wildland Fire Detection***

Badlands National Park relies on ground-based fire detection using confirmation of visitor reports with park personnel. When in Staffing Class IV or V during the approach and passage of thunderstorms, lookouts will be pre-positioned at strategic locations to watch for lightning strikes and smoke. Personal knowledge of the area is required for this duty, as these locations vary depending on the direction of any storm. Experience indicates that a minimum of three lookouts are required for "cloud watch," one for each district.

All smoke and fire reports will be made to the park's communication center. If a dispatcher cannot be reached, then a report will be made to the park fire office. The park fire office will notify the NGPA Fire Management Office of all fire or smoke reports as soon as possible. To enhance communication with cooperators and the public, the fire office may notify cooperators, fire management offices, and the local radio station.

Visitors and employees will report most fires. Any park employee to whom a fire is reported shall obtain complete information regarding the following: location; fire behavior and smoke dispersal; approximate size; and name, address, and phone number of reporting party. These personnel are instructed to take fire reports from visitors and relay the pertinent information to the park dispatch office or Fire Management Office. If possible, they should remain in contact until the fire is confirmed and located. Further investigation may be necessary if park staff in the field cannot verify a reported fire. Park Rangers on road patrol and backcountry rangers and crews will look for new fire starts as part of their routine duties.

- ***Appropriate Management Response***

Consideration of human safety, availability of equipment, management objectives, and constraints will govern all wildland fire response. Current Badlands National Park objectives include aggressive initial attack and/or appropriate management response by NPS personnel of all fires occurring within the park. In general, these can be met most effectively and cost-efficiently by:

1. Quickly evaluating each fire occurrence within the park for geographic location, spread potential, and amount and type of force(s) needed for effective suppression.
2. Providing rapid, aggressive initial attack for those fires to be suppressed.
3. Using appropriate management response methods and tactics designed to efficiently and effectively suppress fires while accomplishing resource management objectives so that park personnel can return to their normal duties as soon as possible.

Whenever fire is reported within park boundaries, the following steps will be taken:

1. Report of the fire to the Badlands National Park dispatch office or Fire Management Office. The park does not have a full-time dispatcher. The Fire Program Manager or Fire Program Coordinator will begin dispatch duties and radio operation.
2. Determine the location, legal description, and land ownership at the occurrence site.
3. At least two or more Badlands National Park personnel will be dispatched to the location of the fire. Personnel dispatched will be qualified and equipped to undertake initial attack action.
4. Division Chiefs will be notified of the need to put their available personnel on standby (during normal duty hours). All personnel placed on standby will assemble at the appropriate staging area.
5. Immediately upon arrival at the fire location, a Stage I Wildland Fire Implementation Plan (WFIP) will be completed. Information found in the Stage I WFIP includes a report of the fire size, behavior, environmental conditions, fuels, terrain features, existence of special hazards or threats to persons or improvements, and any other factors observed which could affect fire behavior and suppression efforts. This information will be reported to the Badlands National Park Chief of Resource Protection. These fire size-up observations will be immediately forwarded to the Northern Great Plains Fire Management Office (NGPAFMO).
6. Upon determination of actual fire location and based on the information reported following the initial fire size-up, the Northern Great Plains FMO, Chief of Resource Protection, or his/her designee will develop the appropriate suppression response, giving consideration to applicable resource management objectives and constraints, together with considerations of personnel safety and economics. Data gathered in the size-up will be utilized to determine an appropriate strategy for managing the fire.

The Northern Great Plains Fire Management Office will monitor the Burning Index (BI) daily from each of the three park weather stations. Whenever a fire is reported on Badlands National park-administered lands, forces and equipment dispatched for initial attack will be based on daily Burning Index from the nearest park weather station, fire location, existing and predicted environmental conditions and any other factors pertinent to making sound fire management decisions.

All unwanted wildland fire will receive an immediate and aggressive initial attack response. The first qualified Incident Commander on-scene will determine the appropriate suppression strategy to be utilized. The Chief of Resource Protection or his/her designee will keep the Superintendent updated of the fire situation. The goal in initial attack actions is to limit damage to threatened values, while minimizing the area burned and preventing escape of the fire. An Incident Commander Type IV (ICT4) will be responsible for all actions taken on the fire. The ICT4 will inform the Area Fire Management Officer of the fire situation as soon as possible after arrival on the scene. If the fire behavior and complexity continue to increase, the ICT4 may be replaced by an ICT3 along with additional support personnel and equipment. The Area Fire Management Officer, Chief of Resource Management, or their designee is responsible for the selection of a replacement Incident Commander.

If the fire threatens to exceed all initial attack capabilities, the fire will become an extended attack action. Extended attack actions occur when fires have not been contained or controlled by initial attack forces. Extended attack continues until either the transition to a higher level

incident management team is completed or the fire has been contained or controlled. The Wildland Fire Situation Analysis (WFSA) must be completed by park staff when a fire escapes initial attack, and if the action escalates to incident management team levels, the incoming team will be briefed by the Superintendent (Agency Administrator's Briefing) and current Incident Commander. The team will be given a written delegation of authority and will have an Agency Administrator's Representative assigned as a staff member to the incoming Incident Commander. The delegation of authority will provide the Agency Administrator's priorities, constraints, and other guidelines prerequisite to effective suppression of the fire.

When the team has accomplished its assigned tasks, the fire will be transferred back to the park. A local Incident Commander will be assigned, and the departing team will hold a debriefing to provide for an orderly transition of command. The Superintendent will conduct a closeout session that will include a performance evaluation of the departing team. The transition Incident Commander will assume command at the agreed upon time. The departing team will then be demobilized.

Occasions in which two or more fires are ignited can be generally associated with days when high to extreme fire intensity condition exists. Suppression actions taken on multiple fires can quickly deplete Badlands National Park's fire suppression resources. At least two individuals will be dispatched to each fire reported on days experiencing multiple starts. However, if sufficient personnel are not immediately available, the priority order will govern which fires in which units will receive the first available personnel resources. Priority of initial attack on days of multiple fire starts will be:

1. Fires threatening life or property within park boundaries;
2. Fires starting within the park which are within one mile of park boundaries and which are likely to burn across the boundary and onto non-park lands;
3. Fires starting outside the park which are within one mile of park boundaries and which are on lands administered by the USDA Forest Service, Buffalo Gap National Grassland or on the Pine Ridge Indian Reservation. Initial attack on fires starting on such lands is allowed pending approval of a Cooperative Fire Control Protection Agreement executed by and between the U.S. Forest Service, Bureau of Indian Affairs, and the National Park Service;
4. All other park lands.

Safety in fighting fire is extremely important. Firefighting is hazardous work, sometimes performed in unfamiliar surroundings and under emergency conditions. Special hazards are almost always present and danger from fatigue conditions can give only subtle warnings. It is the responsibility of every incident commander to ensure that safety instructions are given and followed during all suppression actions. It is the responsibility of every employee to perform only jobs that they are qualified for, to wear personal protective equipment at all times, and to ensure that adequate water, food, and rest are provided to firefighters so that high standards of safety can be maintained. Ultimately, each firefighter is responsible for his/her own safety.

- ***Wildland Fire Monitoring***

Wildland fires will be monitored at levels 1 and 2 with observations entered into the park's monitoring database. In the event that long-term fire effects plots are burned in a wildland fire they will then be read, by the NGPA Fire Effects crew, according to the schedule of plot rereads following a burn treatment. Level 1 and 2 monitoring observations will be filed with the final fire

package and a copy placed with the records for the Fire Management Unit that was burned.

- ***Wildland Fire Documentation, Reports, and Records***

Individual Fire Reports (DI-1202) - Procedures are outlined in *RM-18*. Fire reports will be completed by the Incident Commander, submitted to the Fire Program Coordinator, and then forwarded to the NGPA Fire Management Office for approval and input to the National Park Service Shared Applications Computer System (SACS). Individual fire reports will be completed for Badlands National Park wildland fires, cooperative agreement fires, and all other fire responses, including all out-of-park fire assignments. Each wildland fire suppression documentation package will include the following:

- Individual Fire Report Form (DI-1202)
- Fire Weather Observations
- Situation Reports and fire updates
- Incident Maps
- Wildland Fire Situation Analysis (if appropriate)
- Narrative Summary (if appropriate)

Also, all fires of suspicious or unknown origin will be investigated by a Wildland Fire Investigator to determine the cause. Legal action, if appropriate, will be pursued. In such cases, a fire investigation report will be included in the fire documentation.

Table 3 below shows the reports and records necessary for implementation of the park's fire management program:

Table 3: Reports and Records Required to Implement the Badlands Fire Program

RECORD/REPORT	FREQUENCY	RESPONSIBLE PARTY	DISTRIBUTION
DI-1202 Fire Report	Per Incident, w/I 5 days	IC	FPC, FMO
DI-1202 Computer Entry	Within 10 days	FMO	SACS
Fire Weather Records	Daily	FMO	Park
Fire Atlas	As Needed	FPM	Park
FMP revision and EA	5 years	FPM, FMO	Park, FMO, MWRO
Situation Report	As Needed	FMO	Park, FMO, MWRO
Fire Danger/Staffing Class	Daily During Fire Season	FMO	FPM, FPC, Park
Wildland Fire Situation Analysis (WFSA)	Per Extended Attack Fire	IC, Supt	FMO, Supt, FPC
Rx Fire Plan	Per Rx Fire	Rx Fire Burn Boss, FMO	Supt, FMO, MWRO
Red Cards	Annual	FMO	FPC, Park
Hazard Fuel/RM Project Accomplishment Reports	Per Project	FMO	Park, SACS

Table continued on next page

RECORD/REPORT	FREQUENCY	RESPONSIBLE PARTY	DISTRIBUTION
Supplemental FIREPRO Budget Requests	Annual	FPM, FMO	FPM, FMO, MWRO
Fire Reviews	As Needed	FMO	Park, FMO, MWRO
Fire Critique	As Needed	FMO, FMT	Park

Abbreviations: FMO = Northern Great Plains Area Fire Management Office
MWRO = Midwest Regional Office
Supt = Badlands Park Superintendent
FPM = Badlands Fire Program Manager (currently Chief, Resource Management)
FMT = Badlands Interdivisional Fire Management Team
FPC = Badlands Fire Program Coordinator
IC = Incident Commander
SACS = Shared Access Computer System (interagency fire database)
FIREPRO = Federal fire program

Wildland Fire Use

Only naturally ignited wildland fires can be managed to accomplish resource management objectives once an appropriate management response is chosen based upon the Wildland Fire Implementation Plan Stage I: Initial Fire Assessment. All human-caused wildland fires will receive a suppression response commensurate with values-to-be-protected, firefighter and public safety, and cost efficiency. Human-caused wildland fires will also include an investigation phase for possible legal recourse.

- ***Rational for Wildland Fire to Accomplish Resource Objectives***

Badlands National Park has identified a Natural Management Unit, which allows wildland fire use, which will be managed and maintained to retain its primitive character, allowing natural processes to occur. Although moderate in size it represents 22% of the total park acreage (53,406 acres) and based upon geography and geology represents an opportunity to permit fire to play its role in these fire dependent communities. The area also provides opportunities for public understanding of fire ecology in the area along the Badlands Loop Road and Sage Creek Road, both of which provide access for visitors to the area. Strategies to provide for firefighter and public safety and protect property will be proactive.

- ***Wildland Fire Use Objective***

The primary objective for wildland fire use will be to permit wildland fire use in the fire-dependent communities to maintain the natural variability of the ecosystem. Wildland fire use combined with prescribed fire will not exceed 10,000 acres per year parkwide.

- ***General Plan of Implementing Wildland Fire Use***

A workshop will be conducted prior to the start of fire season to review the fire management plan and Wildland and Prescribed Fire Management Policy Implementation Procedures Reference Guide and go through a mock fire use scenario to refresh staff roles and responsibilities. Every other year the regional prescribed fire specialist or fire management officer will be involved in this workshop to critique and assure compliance with policy.

- ***Decision Responsibilities***

It is the responsibility of the Fire Program Manager or their designee to prepare the Decision Criteria Checklist to present the checklist to the Park Superintendent for evaluation and signature. The Decision Criteria Checklist will include an evaluation of visitor use in the park at the time of the fire start.

- ***Personnel Qualifications***

An Incident Commander of the appropriate complexity rating must be assigned to all wildland fire use actions and remain in the immediate area for the duration of the fire. A Long Term Fire Analyst or Fire Behavior Analyst will be resource ordered to arrive within 24 hours of the decision to "GO' with an appropriate management response. Should a prescribed fire behavior analyst not be available within 36 hours actions will be taken to suppress the fire. When a wildland fire is designated to be managed under a wildland fire use strategy, a Resource Advisor will be assigned to that incident.

- ***Monitoring Required***

Level 2 Fire Monitoring as described in the *Fire Monitoring Handbook* (2001) will be completed daily on the fire. During periods of forecast growth greater than 100 acres per day, on-site observations of dry bulb, relative humidity, wind speed, wind direction and cloud cover will be made one hour before activity begins to two hours after activity ceases or minimally from one hour before sunrise to two hours after sunset. Fire characteristics as described in the *Fire Monitoring Handbook* will be collected on site hourly when conditions and monitor safety permit. Smoke characteristics will be monitored hourly any time a forecast wind direction places the smoke plume towards a community and/or highway.

- ***Fire Use Planning***

Wildland fire use implementation will not be considered when the park is in or forecasted to be in staffing class V (Extreme) at the time of the ignition. **Fig. 4** (pg. 22) identifies Prescribed Fire Units within the Natural Unit. These boundaries should be utilized to assist in rapid development of a final Maximum Manageable Area (MMA) for Stage II implementation of a wildland fire use strategy. The fast-moving nature of grass fires prohibit lengthily planning exercises after ignition to develop an MMA. Trigger points for various management holding actions may be developed, after the MMA is finalized. PFUs may be combined or altered, bearing in mind the 10,000 total acreage burned limitation within the Sage Creek Unit of the Badlands Wilderness Area. These PFUs vary in size from the smallest, Sheep Table Mountain (FMA J) at 1387 burnable acres, to 5147 burnable acres (FMA F). If natural ignitions do not occur within the Natural Unit, and it is determined that the fire frequency therein is significantly outside of the historic range of variability, then the FMA boundaries may be utilized as prescribed fire boundaries to simulate natural ignitions. FMAs are only developed for larger, contiguous areas of wildland fuel within the Natural Unit. Any ignition occurring in an isolated pocket of wildland fuel bounded by badlands may be managed for resource benefit using a wildland fire use strategy. Portions of the Boundary FMU may be combined with the Natural FMU in developing the Maximum Manageable Area (MMA) for a fire with the focus then being on the maximum permissible acres allowable because of wildlife forage.

- ***Fire Use Implementation Procedures***

All wildland fire use applications will follow the Wildland and Prescribed Fire Management Policy Implementation Procedures Reference Guide (1998). A Wildland Fire Implementation Plan (WFIP) Stage I will be completed on every wildland fire, including a GO/NO GO decision to

manage the fire as a wildland fire use incident. A Stage II WFIP: Short Term Implementation Actions will be completed within 2 hours of the "GO" decision from Stage I. The Stage II WFIP will include the delineation of a maximum manageable area (MMA). The need assessment chart for Stage III will always be completed with the Stage II activity. Finally, if the event is expected to have a long duration, a Stage III WFIP: Long Term Implementation Actions will be completed.

- ***Documentation and Project Records***

Each wildland fire use documentation package will include the following:

  - Individual Fire Report Form (DI-1202)
  - Fire Weather Forecasts for every day
  - Monitoring reports including summary of findings, monitoring schedule, and field observations
  - WIMS forecasts (NFDRS indices and components)
  - Situation Reports and fire updates
  - Incident Maps
  - Wildland Fire Implementation Plan including revalidation and certification documents, Stages I, II and III as appropriate to complexity and duration. This document will also identify resource objectives being met through wildland fire use.
  - Wildland Fire Situation Analysis (if appropriate)
  - Narrative Summary
  - Photographs and videos will be held in the park fire management files for one year and then stored with the park archives and library collection.

- ***Information and Interpretation Actions***

The park's wildland fire use program will include an information and interpretation program, which provides for the timely and accurate communication of:

- The specific fire management objectives of NPS and the park.
- Information on fire location, behavior, growth.
- Information on the effects of fire.
- Fire management actions taken on a fire.
- Fire impacts, on and off the park, on public and private facilities and services.
- Restrictions and closures within the park.

During wildland fire use activities, as with prescribed fires, the park will emphasize the positive elements of fire's past and present role in the park ecosystem through an aggressive interpretive program. Adequate and accurate public information on the goals and program rationale for fire management at Badlands National Park is critical to program success. The local communities of Interior, Scenic, Wall, Kadoka, Philip, and the Pine Ridge Indian Reservation may be affected by the park's programs to some degree depending on the size of the project. Smoke generated from wildland fire is of special concern, since public health and safety are affected. One vehicle for dissemination of information is through park interpretive media. Public education programs on fire management themes are most effective when the smoke is present. Interpretive tours and on-site talks during wildland fire will be planned on a case by case basis. Signs will be designed and built that will convey short informative messages to the public on park trails and roads.

The three actions described in **Chapter X** (Public Information and Education) of this plan will provide management guidance for this program. In addition, message-specific signs that describe a wildland fire in progress will be posted at appropriate trailheads and along trail(s) through or near the fire.

- ***Potential Impacts with Mitigation***

Paleontological impacts should be low, as most sites containing significant fossil resources are located in unvegetated rock outcrops. If any fossil resources are discovered during fire management activities, ground disturbance and travel will be rerouted around the area. The exact location of the paleontological site will be reported to the Park Paleontologist and a follow-up determination will be made as to the significance of the resource. Any significant paleontological site should be protected from wildland fire as deemed necessary by the investigating paleontologist and recorded in the park's files. The greatest potential for impact to exposed fossils is from vehicle travel.

Vegetation could have some long and short-term impacts associated with spread of non-native species into fire disturbed sites. Resource Management will monitor each burn site one year post-burn to map infestation levels and treat as appropriate with Integrated Pest Management (IPM) techniques for control. Project funds may be used for the post-burn survey.

Park wildlife staff will be consulted prior to any planned fire management activities. Disturbances such as temporary displacement, loss of habit, or interference with reproductive activities (e.g. bighorn sheep lambing, nesting) will be considered in all aspects of fire management planning. Any fire management activities planned in park areas known to support species listed as threatened or endangered (*Appendix C*) may require further consultation with the US Fish & Wildlife Service, and mitigation. Details of wildlife mitigation measures will be detailed in fire management project plans. Wildlife are not expected to experience adverse impacts if these prescriptive elements are followed.

Aquatic species may experience an immediate post-burn short-term impact from increased soil erosion runoff, possible water temperature increases, and removal of riparian vegetation. No actions are required, as natural vegetation processes will replace the disturbed communities.

Air Quality/Smoke Management will have immediate short-term impacts, typically of an episodic nature, which will require mitigation when critical sites are impacted. This mitigation will include limiting fire acreage growth when winds are forecast such that the smoke plume will impact nearby communities. When smoke is forecast or observed to be impacting Interstate 90 or Highway 44 the South Dakota Highway Patrol and Department of Transportation will be notified to restrict traffic speeds commensurate with visibility and associated driving conditions.

Visual and Noise Quality will experience immediate short-term impacts associated with wildland fire management activities and some long-term impacts resulting from drastic changes in the visual appearance of the affected area. The long-term impacts are related to the viewer's perception and must be addressed in media and visitor contacts to promote the understanding of fire's role in the ecosystem.

Archeological resources, historical sites and structures may experience long and short-term impacts with the worst case scenario of previously unrecorded resources being consumed or altered by the fire. Mitigation will be through coordination with the Midwest Archeological Center (MWAC), South Dakota State Historic Preservation Officer (SHPO), and protection of known sites. Any sites discovered during wildland fire management activities will have ground disturbance and travel rerouted around the area, its exact location will be reported to the Chief of Resource Education and a follow-up determination will be made by a representative of

MWAC as to the significance of the resource.

Economic impact will be short-term associated with visitors wanting to leave the fire area because of perceived or real threat to health and safety. This can be mitigated through public awareness, information dissemination, and cooperation with the local communities for a complete understanding of the management actions that are being taken on each wildland fire. Additionally, when wildland fire use or a prescribed fire is in progress, an interpretive sign or personnel will be stationed in a high-volume visitor use area (e.g. parking area, trailhead) to discuss the benefits of fire.

Visitors will experience immediate short-term impacts from possible temporary trail closures, perceived scenic degradation by blackened prairie, travel restrictions, and visibility impairments. Mitigation is to minimize the impacts but retain the focus of public safety. This is also the opportunity to deal with visitor concerns by increasing the number of visitor contacts through additional staffing and coordination with all cooperators to assure the information is reaching the impacted groups.

Concession Operations may experience a short-term impact from a temporary closure, travel restriction, and/or visibility impairment. Mitigation will be by information sharing and public contacts with affected user groups as to the duration and magnitude of the impact.

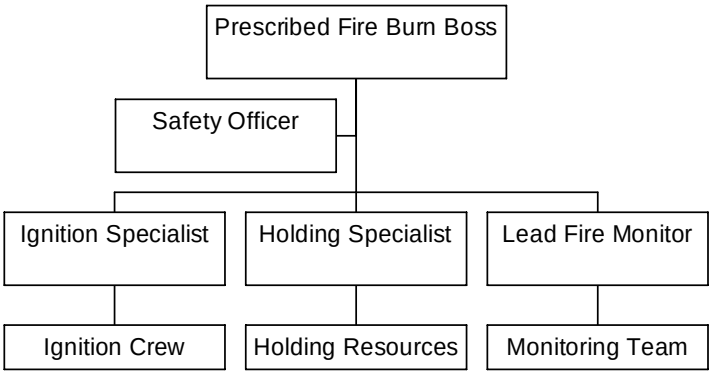
Prescribed Fire Program

Prescribed fires are utilized as a tool to achieve management objectives. Prescribed fire will reflect and support resource management objectives to restore some vegetative conditions, maintain others, and simulate natural fire where ignitions have not occurred or management action was required. Treatment of landscape-scale areas, with prescribed burning, strives to restore fuel loading and vegetative composition to the natural conditions existing prior to the fire exclusion policy and practices followed in the park through recent years. Research burning may also take place when it is determined necessary to support research projects under permit with the NPS.

Prescribed fire, like wildland fire use, is authorized in the Badlands Wilderness Area. These fires may be used where it has been determined by resource management and fire management personnel that prescribed fires are a necessary substitute for naturally occurring fires.

Actions included in the prescribed fire program include: selection and prioritization of projects to be carried out during the year, Prescribed Fire Plans, prescription preparation, documentation and reporting, and burn critiques. Measures to ensure successful implementation of prescribed fires will include Prescribed Fire Plans prepared by a qualified Prescribed Fire Manager (RXM1 or RXM2) or a Prescribed Fire Burn Boss (RXB1 or RXB2). A qualified Prescribed Fire Burn Boss will conduct prescribed fires with qualified support personnel present to accomplish objectives. Support personnel will monitor fire behavior and fire effects, control hot spots and fires outside control lines, support ignition needs, and complete initial attack on escaped fires. The complexity of Badlands National Park prescribed fires requires a normal organization structure (**Fig. 5** *on next page*) consisting of Type II Burn Boss (RXB2), Type II Ignition Specialist (IGN2), Holding Specialist (specific mnemonic depends on number and type of holding resources), and Prescribed Fire Monitor (FEMO). This organizational structure may be modified for specific requirements.

Fig. 5: Typical Prescribed Fire Organization



The park will continue with a training program designed to maintain a minimum of two personnel qualified in each of the prescribed fire overhead positions. This program ensures continuity during the normal turnover of permanent staff.

All Prescribed Fire Plans will be approved and signed by the Park Superintendent. Outside support in the form of NPS prescribed fire management teams or interagency incident management teams may be requested for support in planning, implementation, or supplemental management stages.

- ***Annual Prescribed Fire Planning***

Prescribed burning may be used throughout Badlands National Park to accomplish resource management objectives as outlined in this plan. The Northern Great Plains Prescribed Fire Specialist will prepare the annual Prescribed Fire Plan with assistance from the Northern Great Plain Area FMO at Wind Cave National Park, the Midwest Regional FMO in Omaha, Nebraska, the Badlands National Park Fire Coordinator, and the Badlands National Park Resource Management Specialist. The program will detail all burn projects proposed, including Prescribed Fire Plans, for the coming year and will specify objectives of each burn. The program plan will be reviewed by the Chief of Resource Protection and Chief of Resource Management. The plan will then be submitted to the Superintendent for approval.

The Area Fire Management Officer will recommend a Prescribed Fire Burn Boss for each specific planned burn. The Burn Boss will conduct a field reconnaissance of proposed burn locations with park staff to discuss objectives and special concerns and to gather all necessary information to develop the Prescribed Fire Plan.

The ten-year burn schedule is included in *Appendix H*. Additional prescribed fire projects may be added to either a) conduct specific exotic species control, particularly adjacent to roadsides, and b) to simulate natural processes within the designated wildland fire use area, should none occur naturally.

- ***Prescribed Fire Plan***

The Prescribed Fire Plan is a site specific action plan which describes the purpose, objectives, prescription, operational procedures, go-no go check list, organization chart, weather forecasts, contingency actions, monitoring actions, and safety concerns involved in burn preparation and implementation. The treatment area, objectives, constraints, and alternatives will be clearly outlined, and no burn will be ignited unless all prescriptions of the plan are met. The factors considered in all Prescribed Fire Plans are described in *RM-18*. Prescribed Fire Plans will be

approved by a qualified burn boss, with technical assistance provided by the Black Hills Area Parks Fire Management Office. All plans will be reviewed by the Area FMO and approved by the park's Superintendent.

- ***Prescribed Fire Operations***

Prescribed burns shall be conducted under the direction and control of a Prescribed Fire Burn Boss designated by the Northern Great Plains Area FMO. The project Burn Boss will be certified for that position according to standards currently utilized by the National Wildfire Coordination Group. All positions required to conduct the burn will be filled with qualified personnel. All personnel listed in the plan must be available for the duration of the burn or it will be postponed.

Operational guidelines, allowable ranges of fire behavior and allowable ranges in weather conditions shall be specified in the Prescribed Fire Plan drafted for each prescribed burn project. Each prescribed burn project shall include monitoring and evaluation as part of the project. This monitoring and evaluation must be a continuous activity during the actual burn operation. Its purpose is to ensure that the ongoing fire behavior and weather conditions remain within the Prescribed Fire Plan parameters. The individual responsible for the ongoing fire monitoring/evaluation shall keep the project Burn Boss informed of any and all changes, which might result in the fire exceeding the Prescribed Fire Plan parameters.

Weather, fuel loading, and fuel moisture conditions must be monitored closely in planned burn units to determine when the prescription criteria are met. Weather data will be gathered for a period of 30 days prior to burn implementation to enable calculations of fuel moistures, energy release component, ignition component, and burning index. Fuel moisture samples of dead fine fuels, fine dead woody fuels (if appropriate), or live fuels may be collected, weighed, oven dried, and percent moisture contents calculated to assist in determining when conditions are consistent with the prepared prescription.

When all prescription criteria are within the desired ranges, the Prescribed Fire Burn Boss will select an ignition date/dates based on current and predicted weather forecasts and available resources. The Resource Management Specialist will identify the windows of opportunity and work with the Prescribed Fire Burn Boss to assure the burn is accomplished the year it is scheduled. All personnel and equipment will be assembled on the day prior to the planned ignition date. A thorough briefing will be conducted stressing personnel assignments, resource placements, contingency actions, and safety concerns and measures to mitigate these concerns. Ignition sequence will be of special concern. Ignition team members must know how and where to ignite, as well as the locations of sensitive areas to be excluded from treatment. A current spot weather forecast will be obtained on the day of ignition, and all prescription elements will be rechecked to determine if all parameters are within the desired ranges. If all prescription criteria meet the planned ranges, a test fire will be ignited to determine on-site fire behavior conditions. If these conditions appear satisfactory and consistent with the plan, the burn will continue. If the test burn indicates the fire behavior to be outside the desired ranges, the test fire will be suppressed and the main burn will be postponed until conditions are more favorable.

The Prescribed Fire Burn Boss will, at a minimum, be a qualified Incident Commander Type IV (ICT4). An Incident Commander Type III will be available within a one-hour response time of the project. In the event a prescribed fire escapes the assigned holding resources, ignition of the prescribed fire in progress will cease. The on-scene ICT3 or ICT4 will then assume control of the escaped fire and take appropriate suppression actions as discussed in the pre-burn briefing, while the Prescribed Fire Burn Boss continues management of the prescribed fire. The

Chief of Resource Protection and NGP Fire Management Office will be notified immediately of the current escape and prescribed fire status. Once a wildland fire declaration has been made, the project cannot return to a prescribed fire designation. For all escaped prescribed fires converted to wildland fire status, a Wildland Fire Situation Analysis will be prepared and appropriate resource orders will be placed.

- ***Prescribed Fire Monitoring***

Prescribed fire can be successfully used to reintroduce fire as an ecosystem process and to alter plant communities toward more desirable compositions. Prescribed burning will be used at Badlands National Park to meet the resource management objectives listed in **Chapter II** of this fire management plan. Monitoring is used to establish quantifiable objectives and then observe and measure the key indicators to evaluate whether these objectives were met. For example, the park is going to restore fuel loads and plant community structure and composition. To determine if a prescribed fire has accomplished these objectives, the changes in fuel loadings and the relative abundance of species must be measured.

Fire monitoring is called for in the 1999 Resource Management Plan. Fire effects monitoring will be identified in future project statements. The park will use the protocols in the National Park Service *Fire Monitoring Handbook* (2001) to examine short and long term fire effects. The Northern Great Plains Fire Monitoring Team based at Wind Cave National Park will be installing, monitoring and rereading monitoring plots for the park. Monitoring type descriptions will be written in cooperation with the Resource Management Specialist and included as part of the Fire Monitoring Plan included as *Appendix F*. Plot installations will be based on burn priorities and will reach a statistically valid sample size within five years for the priority monitoring types. For further information regarding prescribed fire monitoring, please see the Monitoring Plan in *Appendix F.*

An important part of monitoring involves comparing burned areas to non-burned areas. Consequently, control plots of sufficient size and acreage to proposed park prescribed fires may be established at a future data. These control plots will represent similar areas of species composition and diversity as areas to be treated and will be maintained free of prescribed or natural fires, as much as possible. Resource Management staff will assist members of the Northern Great Plains Fire Monitoring Team in monitoring established FMH plots. Team members will, in turn, assist Resource Management staff in monitoring these control plots.

- ***Prescribed Fire Documentation and Reporting***

All prescribed burn documentation will be completed by the Prescribed Fire Burn Boss, the NGPA Prescribed Fire Specialist, or FMO. Fire monitors will collect all predetermined information and complete all necessary forms prior to, during, and after the burn. All records will be archived in the park's fire records and stored in the Fire Management or Resource Management Office for future use and reference.

The Prescribed Fire Burn Boss will prepare a final report on the prescribed fire for Superintendent. Information will include a narrative of the burn operation, a determination of whether or not the objectives were accomplished, weather and fire behavior data, a map of the burn area, photographs of the burn, number of hours worked, and final cost of the project.

Each prescribed fire documentation package will include the following:

- Documentation of all management decisions concerning the project
- Prescribed Fire Plan
- On-site Weather Observations

- Project Maps
- Open Burning Permits
- Spot Weather Forecasts
- Narrative Summary Analyzing Costs, Objectives, and Chronology of Events
- Individual Fire Report Form (DI-1202)

- ***Prescribed Fire Critique***

The Superintendent may convene a review committee for any prescribed fire. A report detailing the actual burn will accompany any recommendations or changes to the program identified. The report will be submitted to the Superintendent, the Area Fire Management Officer, and the Regional Fire Management Officer for review.

- ***Air Quality and Smoke Management***

National Park Service fire management activities which result in the discharge of air pollutants, (e.g., smoke, carbon monoxide, and other pollutants from fires) are subject to, and must comply with, all applicable federal, state, interstate, and local air pollution control requirements. These requirements are specified by Section 118 of the Clean Air Act, as amended (42 U.S.C. §7418). It is not the primary intent of the Clean Air Act to manage the impacts from natural sources of impairment (i.e. naturally ignited wildland fires). Smoke from these fires is an inevitable by-product. Fires are not considered point sources of emissions, but tend to be spatially distributed singular events, and temporary impacts to visibility and visitor enjoyment must be recognized, expected, and managed. This may include temporary closures or warnings during the progress of management approved prescribed fires.

Smoke drift affecting neighbors and public roads is a concern. Pertinent areas that will demand attention include the Interstate Highway travel corridor north of the park, the Badlands Loop Road, and the towns of Interior, Scenic, Wall, Philip, Wanblee, Kadoka, and Rapid City, South Dakota, as well as other towns and communities on the Pine Ridge Indian Reservation south of the park.

Badlands National Park is designated a Class I area under the Clean Air Act due to the presence of the Badlands Wilderness Area. This designation places an affirmative responsibility on the Park Superintendent to maintain or improve air quality.

Ambient air quality and meteorological monitoring are conducted at the park, including gaseous pollutants (sulfur dioxide, and ozone). DI-1202 reports will be made available as needed to the park's air quality technician or contractors in order to reconcile unusual readings related to fire activity. Meteorological parameters monitored include wind speed and direction, temperature, relative humidity, solar radiation, and precipitation.

Badlands National Park will comply with Air Quality-Smoke Management Guidelines listed in *RM-18*. The fire management program will be in compliance with interstate, state, and local air pollution control regulations, as required by the Clean Air Act. The procedures to ensure compliance will include:

- The Northern Great Plains Area Fire Management Office will contact local and state authorities to ascertain all procedures prerequisite to compliance with regulations or permits, will obtain any necessary permits or ensure in writing that regulatory requirements will be met. At this time, the State of South Dakota requires that the park inform the South Dakota Department of Environment and Natural Resources, Air Quality Program, prior to prescribed fires. Burning permits are not required. A copy of the Badlands National Park Fire Management Plan and Prescribed Fire Plans will be

forwarded to the appropriate authorities, if necessary. Personnel from permitting agency will be allowed on-site during prescribed fires and wildland fires used for resource objectives for observational purposes if necessary for their agency needs.

- Prescribed fires will be conducted only on days that are acceptable to the permitting agency. In the case of wildland fire use, local authorities will be contacted and kept informed of current status of fire(s). Any monitoring activities will be coordinated with the permitting agency and information collected will be made available to them as requested. The park will also notify local Federal Aviation Administration offices so that pilots may be made aware of possible temporary visibility impairments.
- All Prescribed Fire Plans will have clear objectives and will monitor impacts of smoke on the human and natural environments. Current and predicted weather forecasts will be utilized along with test fires to determine smoke dispersal. The fine-grass fuels in the park generate low volumes of smoke for short duration and are not usually a smoke management problem. An air dispersion analysis using the Simple Approach Smoke Estimation Model (SASEM), or a similar model, may be used to assess the impact to surrounding areas and detail the atmospheric conditions under which a burn can be successfully completed within the ambient standards.

Prescribed burns ignited in proximity to structures will be ignited only after careful considerations are given to levels of visitation and impacts upon visitation and local residents.

Considerations useful in managing smoke from longer duration fires include:

- Develop contingency plans to limit smoke production if the need arises (may involve suppression on portions of the line).
- Establish and maintain close communication with state and local air regulatory agencies regarding status of such fires.

NON-FIRE FUEL TREATMENT APPLICATIONS

Non-fire fuel treatments to reduce fuels are generally not appropriate for Badlands National Park because the park is primarily comprised of grassland communities, particularly along the park boundary. Fuel treatments are not beneficial because of the short duration of effectiveness (i.e. the grass regrows too quickly and thatch will build up within two to three years. Also, the visual intrusion of mow lines and mower tracks in the native prairie is considered unacceptable to park management.

While not anticipated to be necessary at this time, limited mechanical treatments, including mowing or light thinning with chain saws may also be used as needed, so long as impacts to other park resources are adequately considered. These could be tools used to meet the objectives specified earlier in this plan.

EMERGENCY REHABILITATION AND RESTORATION

Because of the rapid post-burn regrowth of the grassland communities in the park, emergency rehabilitation and restoration is not expected to be needed for any aspect of the fire program.

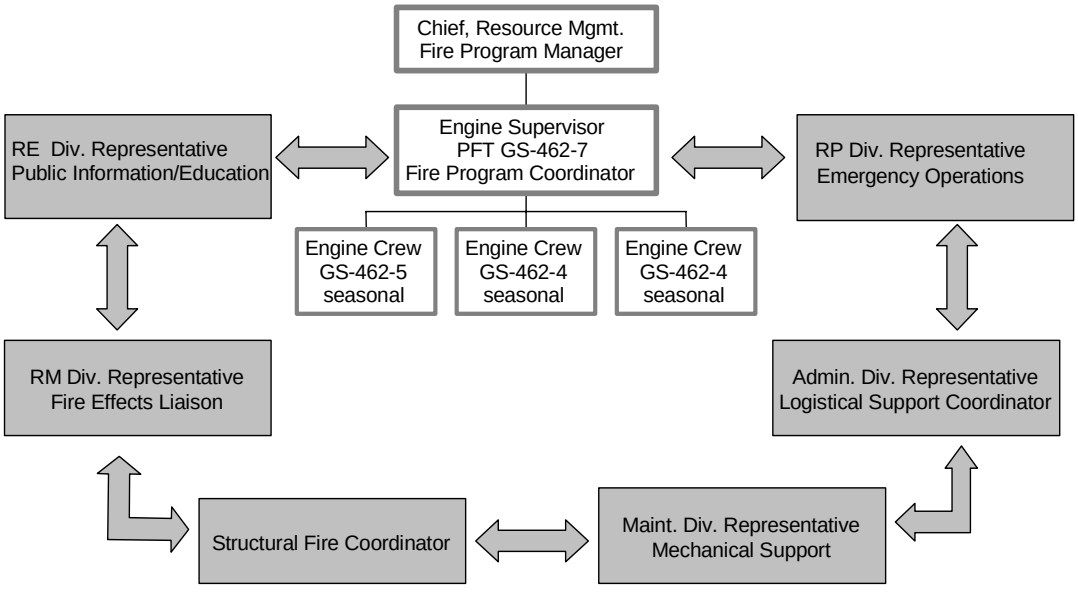
VI. ORGANIZATIONAL AND BUDGETARY PARAMETERS

This chapter describes the key personnel for fire management at Badlands National Park, including the staff at the Northern Great Plains Area Fire Management Office (NGPAFMO). NGPAFMO is a FIREPRO-funded National Park Service program office that provides guidance, technical support and coordination for national park units in the Northern Great Plains. The sections below delineate the chain of command, describe responsibilities, and recommends targeted fire qualifications needed to ensure safe and efficient fire operations. It also describes interagency roles and responsibilities for coordination and cooperation.

FIRE MANAGEMENT RESPONSIBILITIES: BADLANDS NATIONAL PARK

While direct oversight of the Fire Management Program at Badlands is the responsibility of the Chief of Resource Management, participation from all divisions is necessary to ensure all fire management activities are conducted safely and according to legal and policy constraints. The park utilizes a team approach to share responsibility and ensure input from across the park staff. Below is **Fig. 6**, the general organizational structure for the Badlands Fire Program:

Badlands National Park Fire Organization 2004



Gray boxes denote Interdivisional Fire Team for planning, coordination and support of all fire-related activities.

Engine Supervisor/Fire Tech is Fire Team Leader.

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Individual roles and responsibilities for the Badlands Fire Management Program are as follows:

Park Superintendent:

- Responsible for overall operation and management of the park, ensures that Department, Service and park policies are maintained and followed.
- Secures funds and personnel needed to meet the objectives of the park's Fire Management Program.
- Responsible for overall fire prevention within the park.
- Approves decisions to manage wildland fires as either wildland fire use for resource benefit, or as a suppression incident.
- Signs Go/No Go checklist for each prescribed fire.
- Signs verification forms for fuel management activities.
- Ensures that all park divisions support the team effort to maintain a fire management program.
- Approves Wilderness exemptions for fire management actions.
- Approves Fire Management Plan and all burn plans.
- Responsible for implementation of the Fire Management Plan.

Fire Program Manager (Chief of Resource Management):

- Provides oversight for the park Fire Management Program as part of the Resource Management Program.
- Directly supervises the park Fire Program Coordinator.
- In coordination with the NGPAFMO, ensures that the fire management program complements resource management objectives and complies with NPS and interagency fire policy.
- Coordinates the approval process for the Fire Management Plan including public scoping, internal and public review, and other National Environmental Protection Act (NEPA) compliance.
- Obtains input from technical experts for all fire planning.
- Ensures fire suppression activities are integrated with other emergency operations (law enforcement, search and rescue, structural fire protection) in the park.
- Coordinates, with NGP FMO to determine actions (fire use or suppression) for naturally caused fires in Natural Fire Management Unit.
- Ensures training opportunities for park fire personnel across all park divisions based on identified park needs and individuals' interest, and with supervisors' support.
- Provides general oversight for monitoring and research programs designed to evaluate fire effects on resources, and uses feedback from technical experts to incorporate adaptive management.
- Principle responsibility for planning and executing fire use projects, including prescribed fire and wildland fire use for resource benefit.
- Ensures technical staff for natural and cultural resources are trained to function in the Resource Advisor capacity.
- Ensures that appropriate fire management activities are incorporated into the park's GIS database.
- Ensures pre- and post-burn paleontological surveys are conducted in areas of potential impact from planned fire management activities.

Fire Program Coordinator (FIREPRO):

- Responsible for day-to-day fire program operations and implementation under direction from Fire Program Manager.
- Serves as Team Leader for the park Fire Management Team.

- Supervises seasonal FIREPRO funded engine crew.
- Ensures fire preparedness; maintains readiness for two type six engines throughout the year; notifies Maintenance of equipment and vehicle repair needs via work requests; maintains fire cache; manages FIREPRO budget; requisitions fire equipment; utilizes support funding to the benefit of the park.
- Organizes, coordinates and conducts fire training for park staff, including annual refreshers, in cooperation with NGPAFMO.
- Maintains individual park firefighter files; ensures all documentation is complete for each firefighter; ensures files are reconciled with SACS database.
- Administers pack tests, coordinates physical exams, submits documentation to NGPAFMO; ensures firefighters are issued red cards from NGPAFMO correctly and in a timely manner.
- Ensures all documentation for park fires (including DI-1202 reports) is completed and provided to NGPAFMO for input into the national database.
- Ensures GPS data collected for all fires and spatial data is input to the park's relational (GIS) database.
- Coordinates with the NGPAFMO and Badlands staff to plan and implement prescribed fires under the Fire Management Plan; assists NGPAFMO in writing prescribed fire plans.
- Qualified as an Incident Commander Type lV (ICT4) and Prescribed Burn Boss Type 2 (RXB2) within the National Wildfire Coordination Group (NWCG) fire qualification system.
- Coordinates park personnel dispatches for in- and out-of-park fire assignments with NGPAFMO and Northern Great Plains Interagency Dispatch Center.

Fire Management Team:

- This team consists of the Park Superintendent, The Chief of Resource Management (Fire Program Manager), the Fire Program Coordinator, and representatives from each division as identified by each division chief. The Park Superintendent may, at his/her discretion, designate other personnel to serve on the Fire Management Team.
- Meet at least once between fire seasons to review fire operations, identify problems/issues, and make recommendations for changes at the park or Northern Great Plains Area level as needed to improve the program; discuss upcoming FIREPRO budget for the park and make recommendations for use of support funds.
- Review the Fire Management Plan, particularly the prescribed fire schedule, making revisions as deemed necessary.
- May be convened by the Park Superintendent whenever fire and/or weather conditions present a serious threat to park facilities or resources, or neighboring property, to evaluate fire potential, weather and management concerns; determine an appropriate course of action, using the Fire Management and Resource Management Plans as guidelines and any prepared Wildland Fire Situation Analysis for ongoing fires.

Fire Effects Liaison (Resource Management Specialist):

- Primary park contact for the NGPA Fire Ecologist and Fire Monitoring Team.
- Responsible for ensuring ecological aspects of fire are incorporated into all aspects of the park Fire Management Program.
- Coordinates environmental compliance process for all fire-related activities.
- Lead author for NEPA-related documents pertaining to the Fire Management Program. Establishes interdisciplinary teams for completing environmental assessments of impact statements as needed.
- Serves as park liaison with the NGP fire monitors; coordinates monitoring and research

programs designed to evaluate fire effects on resources.
- Coordinates with NGPA Fire Ecologist to ensure fire effects monitoring is integrated with the NPS Northern Great Plains Inventory and Monitoring Program.
- Assists in development of five-year plan for prescribed fire activities.
- Develops information base on fire behavior and effects.

Chief of Resource Protection:
- Ensures traffic control and public use management is conducted when needed and requested by Incident Commander
- Ensures coordination between Wilderness Program and Fire Program.
- Provides a member of division, as well as the Structural Fire Coordinator, for participation on Fire Management Team.
- Supports and encourages fire training and assignments for Resource Protection staff, particularly higher-level skill positions.
- Supports the fire program by making personnel available for park fire operations, out-of-park fire assignments, and fire training to the extent possible.
- Assigns investigative resources to determine fire cause and pursue appropriate enforcement action when necessary for human-caused ignitions.

Chief of Resource Education:
- Incorporates fire management information into interpretive programs, when appropriate.
- Advises of cultural resource concerns; notifies State Historic Preservation Officer of planned fire activities for Section 106 compliance.
- Provides fire information to park staff and visitors.
- Ensures that accurate information is incorporated into park books, brochures, and exhibits.
- Provides for on-site interpretation of fires when appropriate and safe.
- May serve as Fire Information Officer, as appropriate.
- Supports the fire program by making personnel available for park fire operations, out-of-park fire assignments, and fire training to the extent possible.

***Administrative Manager*:**
- Provides overall administrative support for the fire management program to include budget support, personnel services, contracting and purchasing.
- Provides a member of division for participation on Fire Management Team.
- Supports the fire program by making personnel available for park fire operations, out-of-park fire assignments, and fire training to the extent possible.

Facility Manager:
- Responsible for overall maintenance of fire cache building, equipment and vehicles, including wildland engines and water tender.
- Provides a member of division for participation on Fire Management Team.
- Supports the fire program by making personnel available for park fire operations, out-of-park fire assignments, and fire training to the extent possible.

Resource Management Division Clerk:
- Completes travel documents for fire personnel from all park divisions dispatched on assignment; maintains assignment log.
- Completes time recording for firefighters on park fires, and submits to appropriate timekeepers for payroll purposes.
- Serves a dispatch for in-park fire suppression activities.
- Assists Fire Coordinator in maintaining fire personnel files and all park fire records;

tracks training and fire experience.
- Inputs data to SACS program assist NGPAFMO.

All qualified park personnel will be subject to occasional fire duty. The order of preference shall be dependent on availability/response time, level of qualification, and complexity of fire assignment. Division Chiefs are also responsible for making a reasonable effort to provide qualified firefighting personnel from their staffs to assist with wildland and prescribed fire support efforts, both locally and nationally.

FIRE MANAGEMENT RESPONSIBILITIES: NORTHERN GREAT PLAINS AREA FIRE MANAGEMENT OFFICE

The Northern Great Plains Area Fire Management Office (located at Wind Cave National Park) was established to provide guidance and technical support for participating national park units (Wind Cave, Jewel Cave, Mount Rushmore, Devils Tower, Scotts Bluff, Agate Fossil Beds, and Badlands). The following are the key positions associated with this shared office and their responsibilities in the Badlands Fire Management Program.

Fire Management Officer (FMO):
- Responsible for overall safety of the Fire Management Program.
- Coordinates fire management activities within the Northern Great Plains Area (NGPA), providing technical assistance and advice to parks as needed. Reviews and advises the Superintendent on requests for fire emergency assistance, operational activities required for the implementation of this Fire Management Plan, and completeness and correctness of all final fire reports.
- In cooperation with the Superintendent, is responsible for assisting and coordinating the park's fire management program. This responsibility includes coordination and supervision of all prevention, pre-suppression, detection, wildland fire use, prescribed fire, suppression, monitoring, and post-fire activities involving park lands. Submits budget requests and monitors FIREPRO funds allocated to Badlands National Park.
- Nominates personnel to receive fire-related training as appropriate.
- Coordinates the implementation of the Fire Management Plan with other governmental agencies administering adjacent lands and with local landowners. Develops and implements cooperative fire management agreements with other federal, state, and local agencies and with the local landowners.
- Coordinates, prioritizes, and submits all FIREPRO funding requests for fire program activities.Reviews all burn plans and Fire Reports (DI-1202).
- Approves Red cards and Task books (certifies).

Assistant Fire Management Officer (AFMO)/Prescribed Fire Specialist:
- In cooperation with the park Fire Program Coordinator and Fire Program Manager, develops short and long-range plans for prescribed fires. Is responsible to coordinate Prescribed Fire Plans for individual projects.
- Responsible for coordinating development of Prescribed Fire Plans for individual projects.
- Makes entries into NFPORS database for prescribed fire and fuels treatment planning.
- Coordinates preparation and implementation of prescribed fire and fuels treatment projects.
- The NGPA Prescribed Fire Specialist will ensure that all park fire weather station equipment is operable and will perform required cyclic maintenance on the stations.

Assistant Fire Management Officer (AFMO)/Training and Suppression:

- Serves as Safety Officer for the Fire Management Program.
- Ensures all park fire weather equipment is operable and performs required cyclic maintenance on the stations.
- Coordinates annual firefighter refreshers.
- Develop, coordinate and conduct fire training as necessary to meet wildland fire needs of the park according to approved Fire Management Plan and local and national guidelines.
- Coordinates Fire Preparedness Reviews and site reviews.

Fire Ecologist:

- Analyze and interpret fire effects data and report findings to Park Superintendent and fire staff.
- Manage fire effects database (monitoring plot database, spatial data, photographic images).
- Assists with describing monitoring types and developing prescribed fire objectives.
- Coordinates fire-related research.
- Assists with writing various management plans and compliance documents; helps ensure ecological implications of fire are included in all park planning.

Lead Fire Monitor:

- Responsible for implementing the park's Fire Monitoring Plan and descriptions of monitoring types.
- Responsible for all standard (NPS *Fire Monitoring Handbook*, 2001) fire effects monitoring activities in the park; will coordinate with the Fire Program Coordinator and Fire Effects Liaison.

Fire Program Assistant:

- Provides technical and administrative support for the Area Fire Management Officer and all parks within the Northern Great Plains Area. Will assist with dispatching and mobilization activities.
- Collects and records daily fire weather observations and ensures they are entered into the Weather Information Management System (WIMS).
- Maintains records for all personnel involved in suppression and prescribed fire activities, detailing the individuals' qualifications and certifications for such activities.
- Updates all fire qualifications for entry into the DOI Shared Applications Computer System (SACS).

PARK FIRE QUALIFICIATIONS

The park will target the following minimum number of qualified people for the identified fire management positions. Additional wildland qualifications will be developed from park staff as interest, training and physical fitness requirements allow. (*see* **Table 4** *next page*)

Table 4: TARGETED FIRE MANAGEMENT/INCIDENT MANAGEMENT POSITIONS

Organizational Position	Number Targeted for Park	2003 Positions
Firefighter—Type II (FFT2)	20	35
Fire Effects Monitor (FEMO)	3	3/3T
Crew Boss (CRWB)	3	6/ 3T
Squad Boss (FFT1)	6	17/ 7 T
Engine Boss (ENGB)	6	8/ 4T
Ingnition Specialist (RXI2)	3	5/3T
Burn Boss- Type II (RXB2)	2	1
Incident Commander-Type V (ICT5)	4	2/ 1T
Incident Commander-Type IV (ICT4)	6	9/ 1T
Incident Commander- Type III (ICT3)	0	2T
Tender Driver (WTOP)	3	4
Public Information Officer (IOF)	2	1/ 1T
Division Group Supervisor (DIVS)	0	1/ 1T
Helicopter Crew Member (HECM)	4	11/ 3T
Helicopter Manager (HEMG)	0	2T
Resource Advisor (RA)	4	0
Fire Use Manager (FUMA)	1	0
Radio Operator (RADO)	4	1
Personal Time Recorder (PTRC)	3	2/ 1T
Equipment Time Recorder (EQTR)	1	1/ 2T
Claims Recorder (CYMS)	1	1/ 1T
Base Camp Manager (BCMG)	1	2T
ATV Operator (ATVO)	10	18
Faller A (FALA)	5	10
Faller B (FALB)	0	10
EMT Basic (EMTB)	3	7
EMT Paramedic (EMTP)	0	1

Organizational Position	Number Targeted for Park	2003 Positions
Air Base Radio Operator (ABRO)	0	1
Security Type II (SEC2)	0	1
Security Type I (SEC1)	0	2
Engine Operator (ENOP)	0	1
Helispot Manager (HESM)	0	2/1T
GIS Technician (GIST)	0	1
Display Processor (DPRO)	0	1
Field Observer (FOBS)	0	3
Firing Boss (FIRBS)	0	6
Equipment Manager (EQPM)	0	2
Ground Support Unit Leader (GSULT)	0	1T
Dozer Boss (DOZB)	0	2T
Strike Team Leader Engines (STEN)	0	2/ 3T
Strike Team Crew Leader (STRC)	0	2/2T
Task Force Leader (TFLD)	0	2/2T
Helicopter Call When Needed (HCWN)	0	1T
Helicopter Boss (HELB)	0	1T
Helicopter Manager (HETM)	0	1

The park has identified a need for personnel familiar with park-specific natural and cultural resource issues, as well as local terrain, land ownership, and access routes. These personnel would be used as Badlands National Park resource advisors and would advise cooperating agencies on park resource issues, serve as lookouts, advise on access routes, and serve as liaison with landowners. A minimum of three people should be qualified in this capacity.

All personnel, seasonal and permanent, involved in wildland fire suppression, prescribed burning, or fire monitoring will meet national standards as determined by the Interagency Wildland Fire Qualifications System. Park personnel assigned fire management responsibilities and tasks are to meet the minimum training and experience guidelines for the position held. All personnel involved in fire management operations will have their qualifications, training, and experience entered into the NPS Fire Qualifications System (SACS Database).

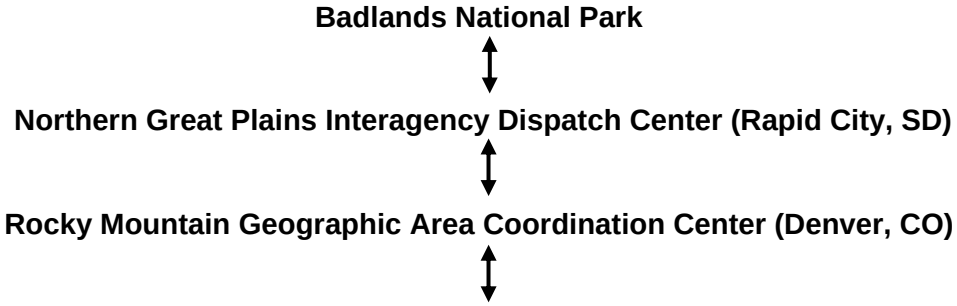
INTERAGENCY COOPERATION AND COORDINATION

A statewide Interagency Cooperative Fire Management Agreement exists among the National Park Service, U.S. Forest Service, South Dakota State Division of Forestry, and 52 local fire departments (including Wall, Interior, and Rapid Valley). The SD Division of Forestry coordinates annual wildland firefighter certification and interagency mobilization of local fire departments. This agreement specifies reimbursement rates and procedures and is reviewed annually. See *Appendix E(3)* for a current listing of interagency agreements.

The National Agreement between the U.S. Departments of the Interior and Agriculture also serves as an umbrella agreement for interagency assistance. Closest forces for initial attack from the Bureau of Indian Affairs Pine Ridge Agency and the US Forest Service, Buffalo Gap National Grasslands, are currently utilized by informal agreement. Badlands National Park maintains close coordination with the Northern Great Plains Fire Management Office in Wind Cave National Park and the Area FMO at that office.

From an interagency standpoint, Badlands National Park is situated in the Rocky Mountain Geographic Area. Coordination for resource orders for in-park needs and out-of-park needs are served through the following logistical support sequence:

Fig. 7: RESOURCE ORDER LOGISTICAL SUPPORT SEQUENCE



The Northern Great Plains Interagency Dispatch Center, located at the Rapid City Airport (former terminal building) provides the primary wildland fire dispatching function for Badlands National Park. The Northern Great Plains Area Fire Management Office compiles weekly availability of Badlands National Park resources during fire season. This availability list is then provided to the Interagency Dispatch Center. Procedures for requesting assistance are found in the Rocky Mountain Interagency Mobilization Guide, published annually, and the Mobilization Guide for the Northern Great Plains Area.

VII. MONITORING AND EVALUATION

FIREPRO funded long-term fire effects monitoring emphasizes vegetative responses to fire. Fire effects monitoring involves systematic collection and recording of fuels, topography, weather, air quality, and fire behavior data during wildland fire use and prescribed fires. Monitoring will follow the protocols outlined in the National Park Service *Fire Monitoring Handbook* (2001). This monitoring will be completed by the Northern Great Plains Area Fire Monitoring Team, duty stationed at Wind Cave National Park, with assistance provided by park Resource Management Specialist (Fire Effects Liaison) and park staff. Monitoring is essential to successful understanding of prescribed fires by evaluating the long-term achievement of the established, measurable resource management objectives described in the individual prescribed fire plan, and identifying any undesirable or unintended effects that may occur. Plots, photo points, and vegetation transects will be included as part of the monitoring program to document burn results and long-term vegetative response. Monitoring data will be archived and reviewed for future refinement of prescriptions and to determine program success.

The Badlands National Park Fire Monitoring Plan, included as *Appendix F* of this plan, details the fire effects monitoring program, including monitoring design, vegetative monitoring type, and data management protocols.

The park would like to institute an intensive ecological fire monitoring program that provides a more comprehensive analysis of the broad range of fire effects across various prairie community components, such as ground-nesting birds, lepidoptera, raptors, small mammals, rare plants, ungulates. However, funding for such comprehensive monitoring is non-existent. The NPS Northern Great Plains Inventory and Monitoring Program (NGP I&M), is part of a servicewide program, and is currently conducting baseline inventories of vascular plants, mammals, fish, herpetofauna, and birds for thirteen park units in the northern plains. The program will soon transition to targeted “vital sign” monitoring for key ecosystem indicators across the parks, and this monitoring will be integrated with the FIREPRO fire effects monitoring, leading to more ecologically-based, long-term monitoring. The Badlands Resource Management Program, the NGP I&M Program, and the NGPA Fire Program (with cooperators and contractors) will work to institute and conduct this monitoring.

Targeted short and long-term plant, animal, and paleontological resource monitoring, key to a particular Prescribed Fire Unit may be stated in the specific Prescribed Fire Plan for that unit. At a minimum, monitoring will comply with NPS monitoring protocol identified in the *Fire Monitoring Handbook* (2001). Data collected from short term monitoring will be attached to the fire report along with any narrative completed by the Fire Monitoring Team. It is the intent of the Badlands Resource Management Program to increase fire effects monitoring to include a wide variety of ecosystem indicators.

VIII. FIRE RESEARCH

Fire research and long-term monitoring needs beyond the fire effects monitoring conducted by the NGPA Fire Monitors are addressed in the Resource Management Plan (1999), and will be more completely addressed when the plan is revised after *Director's Order #2.1: Resource Stewardship Planning* is approved. Additional work is needed to develop fire programs that better approximate natural fire results. Studies are needed to determine the effects of fire on various invasive non-native plant species. Some research has been done on the effects of burns at different times of the year, but further work is needed.

The Badlands National Park Resource Management Plan (1999) includes projects for fire research in the following areas: effects of fire on prairie dog colony size, fire effects on bighorn sheep range, historical fire frequency, effects of fire on exotic grass populations, impacts of fire on paleontological resources, effects of fire and fire seasonality on vegetation diversity and lepidoptera populations. These projects have been migrated to the PMIS project database.

In recent years the park has obtained FIREPRO research funding to study the effects of fire on fossils, and currently has a project under review by USGS Biological Resources Division to study fire impacts on the invasive non-native yellow sweetclover.

Park natural resource staff will continue to work in cooperation with the NGPA Fire Ecologist, research institutions, and other cooperators to develop, fund and conduct fire-related research projects.

IX. SAFETY

PUBLIC SAFETY

Because wildland fires are dynamic and can be hazardous, they must be given very high priority during certain critical conditions. Employees responsible for and involved in any wildland fire management activity must always consider the safety of human life above all other values. Assuring visitor safety takes priority over other activities at all times; being able to provide a consistent and accurate evaluation of fire behavior is the basis for plans, contacts, and briefings that ensure public and personnel safety. The following are Badlands National Park's public and employee safety considerations:

- There are limited opportunities to find safety zones for escaping from a fast moving wildland fire on the park trail and road system. Park visitors will likely not be able to recognize a safe area so emphasis will be to sweep potentially affected areas as quickly as possible.
- Certain areas will be closed to use when the risk to visitors is too high or there are not enough personnel to handle the situation any other way. The authority to close areas is cited in 36 CFR 1.5.
- Information concerning fire danger will be disseminated through entrance station and visitor center contacts, trailhead/bulletin board signing, and backcountry permit issuing.
- Any time human life may be endangered, all necessary means will be taken to warn or evacuate visitors and neighboring landowners and other users.
- Smoke on roadways may create a vehicle visibility hazard, from a fire burning nearby or at night under light wind conditions. It could also occur on roadways outside the park.

The Northern Great Plains Area Fire Management Office will inform the Fire Program Manager and the Superintendent of all potentially hazardous fires in the park. The Fire Program Manager and the Superintendent will then coordinate public and interagency notifications and implement suppression actions to mitigate the fire's impact within and outside the park. The extent of public notice will depend on the specific fire situation. The following actions should be considered:

- When fire affects travel along any roads in Badlands National Park, rangers will be dispatched to stop or control traffic. The State Patrol and Sheriffs office will be informed and assistance requested as needed.
- When evacuation of an area is recommended, the Superintendent and the Chief of Resource Protection will be informed immediately.
- When heavy smoke impacts the campgrounds or Cedar Pass Lodge, park personnel will be sent to inform people of the situation and assure them of the safety of remaining where they are. Notices will be posted in park campgrounds, prior to conducting prescribed fire projects and when wildland fire use incidents are in progress.
- When fire is projected to rapidly spread and threaten backcountry sites or trails where campers or hikers are known or strongly suspected to be, a park employee will be dispatched to the area by best possible means to notify visitors of the danger. Such individuals will be knowledgeable of fire behavior and fire safety principles to be able to

stay with visitors as long as needed to assist them to safety.

- As part of initial and continuing size-up, the incident commander will determine the proximity to the fire of any visitors or other land users, inform them of potential hazards, and aid in evacuation if needed. If life is threatened, and the parties do not cooperate, law enforcement assistance may be requested through dispatch.
- When needed, information on location, behavior, expected dangers, areas to avoid, and other precautions will be posted on park bulletin boards, at the entrance stations, local post offices, and businesses.
- When the risks from a wildland fire are high, precautionary signs will be posted on roads and trails leading into the fire area. Trails, campsites, and day use sites will be closed if deemed necessary by the NGPA FMO, and approved by the Superintendent. The Prescribed Fire Burn Boss will ensure that closure and/or informational signs on prescribed burns are properly posted.

An Incident Status Summary (ICS-209) for all fires burning over 24 hours will be provided to the park information officer. Information on the fire activity will be broadcast on the park radio as part of a morning report. The status summary will be distributed to all park divisions on a daily basis.

Smoke plume trajectories from large fires will be plotted using computer programs, weather information and onsite monitoring. Expected smoke impacts on off-park communities and roadways will be evaluated and information shared with the respective agencies. If needed, vehicular or air patrols will be used to monitor smoke plumes.

The Fire Information Officer will notify and make media releases to local TV and newspapers, and through electronic mail. If needed, a park information "hot line" will be installed, and the Fire Information Officer will update the message whenever new fire information is available. Additional notification will be made to cooperating agencies, as appropriate, about park fires through the Fire Information Officer.

FIREFIGHTER SAFETY

Ensuring and maintaining firefighter safety is of the utmost importance and takes precedence over rapid suppression targets or goals. On all actions on wildland fires in Badlands National Park, the Fire Orders and the Watch Out Situations will be strictly adhered to. Failure to maintain communications and to obtain fire behavior predictions and weather forecasts constitute grounds for suppression forces to withdraw from firelines and re-establish tactics. It will be the responsibility of the Fire Safety Officer or the Park Safety Officer to ensure that all safety measures are implemented and anyone failing to adhere to fireline safety will be removed from the fire.

The Incident Commander or Prescribed Fire Burn Boss will ensure that:

- All firefighters will wear proper personal protective equipment.
- All firefighters will have completed basic wildland fire training S-130/190.
- Communications are possible with all people involved with the fire.
- Fire weather will be taken at minimum every hour during on going fires.
- All firefighters are certified (on their red cards) for the position they are performing.
- Any significant change in fire behavior or weather will be communicated immediately to everyone on the fireline.

X. PUBLIC INFORMATION AND EDUCATION

Good public relations can engender public support and is prerequisite to a successful fire management program. Failure to provide good public information can be responsible for collapse of the program. On the prairie, fires can spread very quickly and visibly, necessitating that timely, accurate wildland fire information be provided to park visitors and adjacent land owners.

The Superintendent's Office will issue all press releases regarding fire danger levels, closures, special precautions, and prescribed fires to newspapers, radio and television stations, unless this task is specifically delegated to the Incident Commander or Incident Management Team. The Chief of Resource Education, or other designated staff member, when necessary, will function as Public Information Officer, and provide for effective communication between park personnel, the public, and the media. The fire management program will be incorporated into the park's overall interpretive program and explained when possible and appropriate. At higher staffing classes and/or during periods of high fire activity, a Public Information Officer may be ordered from outside the park.

Prior to prescribed fires, the Fire Program Coordinator will inform project personnel on details of the burn. Landowners or agencies located near the prescribed burn will be contacted and the Superintendent will initiate a press release. On the day of the burn, all staff should be notified as to the burn's location and any special safety warnings to pass on to visitors, i.e., caution to watch for smoke on the road, or advice not to hike in the area. Key visitor use or access sites where visitors could likely observe or approach the burn area should have temporary signs indicating a management fire is occurring. This provides for public safety and education, and decreases the likelihood that visitors will report or attempt to put out a wildland fire use or prescribed fire accomplishing resource objectives.

Post-season activities will include those tasks necessary to adequately assess how the local public and cooperators received the park’s fire management efforts. This will be accomplished through coordination with neighbors, local groups, and the State Department of Air Quality. The bulk of this coordination will be performed by the NGPA Fire Management Office, though Badlands National Park staff will be involved, depending on interest and need. The purpose of this feedback is to revise plans, procedures, and educational efforts regarding overall fire management at Badlands National Park.

The Fire Program Manager will cooperate with the Chief of Resources Education on the following programs:

- Development of a brief interpretive handout which will discuss the basic objectives of using both Prescribed Fire and Wildland Fire Use.
- Develop an outline and materials for an evening program that contains a prevention message and describes the park’s fire program.
- Maintaining a file of public comments received concerning prescribed burns, and using them to improve communication efforts targeted at increasing support for the fire management program.

XI. PROTECTION OF SENSITIVE RESOURCES

The Fire Management Officer will work closely with the park's Chief of Resource Management and/or Chief of Resource Education to identify all historic, ethnographic, archeological, and paleontological resources; cultural landscapes; habitat for threatened, endangered, and other species of concern; and collections that need special attention to provide protection from fire. Badlands National Park archeological sites are described in the *Cultural Sites Inventory* book maintained in the office of the Chief of Resource Education at Cedar Pass. The Inventory and the Cultural Component of the Resource Management Plan will be consulted when planning prescribed burns, when considering fire use events, or during preparedness activities. Protective measures may be used around sensitive sites. All sensitive sites will be addressed in site specific Prescribed Fire Plans, or as required by the Cultural Resource Specialist.

When making decisions regarding management actions for wildland fire, incident commanders will consider potential impacts to resources including cultural resources prior to implementation. Cultural resource protection actions will be utilized when necessary and or safely possible. A variety of fire management techniques including black lining, foam and or water application, and mechanical fuel removal may be utilized to protect sensitive areas.

As a general rule, vehicle traffic is limited to established roads in the park and is strictly regulated in wilderness areas. Fire suppression and prescribed fire activities involve construction of black-line and scratch line, use of swatters, and direct attack with water, all primarily in fine fuels. Soil disturbance is not encouraged and will not likely occur under most fire management events. Consequently, cultural resources are not likely to be adversely affected. The order of attack, to minimize soil disturbance, is as follows:

(1) Direct attack with water resources (engine use only from established roadways).

(2) Use of swatters.

(3) Burning-out to create a black-line.

(4) Direct attack with water resources (off-road).

(5) Construction of a scratch line.

XII. FIRE CRITIQUES AND ANNUAL PLAN REVIEW

This Fire Management Plan will be reviewed and evaluated annually to determine if the resource objectives are current and being met, and to make necessary revisions. The Northern Great Plains Area Fire Management Office and Badlands Fire Management Team will conduct this evaluation. Any problems associated with the guidelines or standards set for fire management, cost effectiveness and suppression will be addressed through revision or addendum and made a part of this plan. The Superintendent will approve all revisions.

Fire reviews will be conducted in accordance with procedures found in *RM-18*. Each review will be documented and filed with the final fire documentation. The Fire Management Officer will retain a file copy.

The Badlands Fire Management Team and cooperators will critique all suppression actions on fires having extended attack and multi-period activities, if appropriate. If the need exists, the Regional Fire Management Officer can be included in such reviews and a national review by the National Fire Management Program Center can be requested.

All entrapment and fire shelter deployments will be reviewed in accordance with NWCG "Wildland Fire Entrapment/Fatality Initial Report and Entrapment Investigation Element Matrix" (*RM-18*, Chapter 13).

XIII. CONSULTATION AND COORDINATION

Park staff, in cooperation with the Northern Great Plains Area Fire Management Office, carry out the fire management program with emphasis on human safety and prevention of damage to threatened and endangered species, natural resources, private and public buildings and facilities. Careful planning, good public information and a well-trained staff can provide for a safe and effective fire program.

The Northern Great Plains Area Fire Management Officer is responsible for coordination and consultation with cooperators regarding fire management activities. This includes involvement with the Midwest Regional Office; Rocky Mountain Coordinating Group; Northern Great Plains Interagency Dispatch Center; South Dakota Interagency Fire Council; U.S. Forest Service, Buffalo Gap National Grasslands; South Dakota State Forestry Department; Oglala Sioux Tribe; Bureau of Indian Affairs; and local cooperators.

The following staff participated in the planning and preparation of this fire management plan:

Badlands National Park

Bill Supernaugh, Superintendent
Brian Kenner, Chief of Resource Management
Scott Lopez, Chief of Resource Protection
Bruce Bessken, former Chief of Resource Management
Sandee Dingman, Resource Management Specialist
Rachel Benton, Paleontologist
Eddie Childers, Wildlife Biologist
Doug Albertson, Wildlife Biologist
Marianne Mills, Chief of Resource Education

Northern Great Plains Area Fire Management Office

Bill Gabbert, former FMO
Mike Beasley, former AFMO/Prescribed Fire Specialist
Dan Morford, AFMO
Kara Paintner, former Fire Monitoring Team Leader
Doug Alexander, FMO
Cody Wienk, Fire Ecologist
Andy Thorstensen, Fire Monitoring Team Leader

Others Assisting

Ed Delaney, former GIS Specialist, Wind Cave National Park
Richard Bahr, former NPS Midwest Region Prescribed Fire Specialist
Jim DeCoster, NPS Midwest Region Fire Ecologist

XIV. APPENDICES

Appendix A

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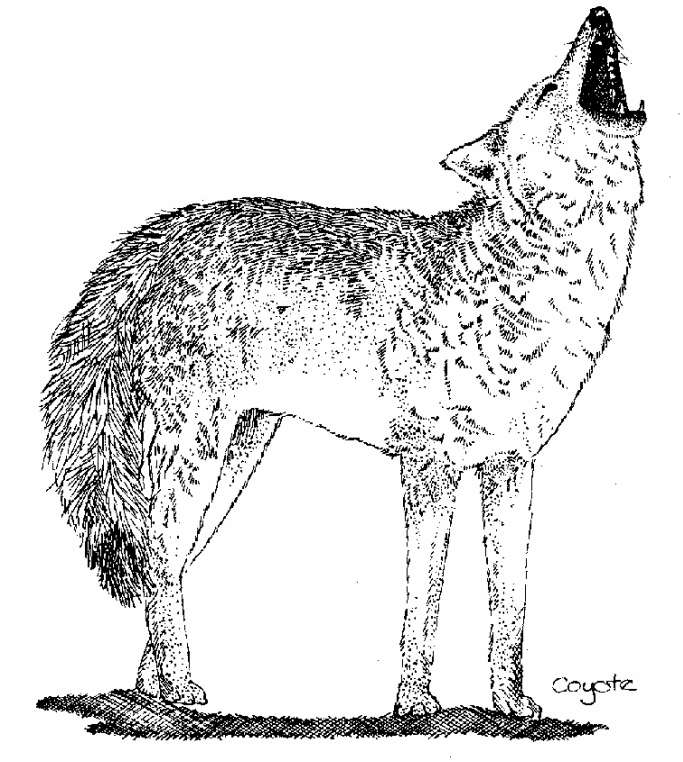

Coyote

Appendix B

DEFINITIONS (from RM-18)

Appropriate Management Response - Specific actions taken in response to a wildland fire to implement protection and fire use objectives. This term is a new term that does not replace any previously used term.

Daily revalidation – A process named the periodic fire assessment, which evaluates the continued capability of the local unit to manage the fire for resource benefits, and to determine if the fire is escalating in complexity and operational needs. This process is completed as frequently as specified by the local unit.

Decision Criteria Checklist (Initial Go/No-Go Decision) – A set of standards evaluation criteria to determine if the current wildland fire meets criteria to be managed for resource benefits. The completion of these criteria will lead to a decision to “Go/Not-Go” with management of the fire for resource benefits.

Expected Weather Conditions - those weather conditions indicated as common, likely, or highly probable based on current and expected trends and their comparison to historical weather records. These are the most probable weather conditions for this location and time. These conditions are used in making fire behavior forecasts for different scenarios (one necessary scenario involves fire behavior prediction under "expected weather conditions").

Experienced Severe Weather Conditions - those weather conditions that occur infrequently, but have been experienced on the fire site area during the period of weather records. For example, rare event weather conditions that significantly influence fires may have occurred only once, but their record can be used to establish a baseline for a worst-case scenario. These are the most severe conditions that can be expected. These conditions are used in making fire behavior forecasts for different scenarios (one necessary scenario involves fire behavior prediction under "experienced severe weather conditions").

Fire Complexity Analysis – A process for assessing wildland fire organizational needs and relative complexity in terms of ICS types (I, II, III etc.).

Fire Management Areas (FMA) - a sub-geographic area within an FMU that represents a pre-defined ultimate acceptable management area for a fire managed for resource benefits. This pre-defined area can constitute a Maximum Manageable Area (MMA) and is useful for those units having light fuel types conducive to very rapid fire spread rates. Pre-definition of these areas removes the time-lag in defining an MMA after ignition and permits pre-planning of the fire area, identification of threats to life, property, resources, and boundaries, and identification of initial actions.

Fire Management Plan (FMP) - A strategic plan that defines a program to manage wildland and prescribed fires and documents the Fire Management Program in the approved land use plan. The plan is supplemented by operational plans such as preparedness plans, preplanned dispatch plans, prescribed fire plans and prevention plans.

Fire Management Unit (FMU) - any land management area definable by objectives, topographic features, access, values-to-be-protected, political boundaries, fuel types, or major fire regimes, etc., that sets it apart from management characteristics of an adjacent unit. FMUs are delineated in Fire Management Plans (FMP). These units may have dominant management objectives and pre-selected strategies assigned to accomplish these objectives.

Holding Actions - planned actions required to achieve wildland and prescribed fire management objectives. These actions have specific implementation timeframes for fire use actions but can have less sensitive implementation demands for suppression actions. For wildland fires managed for resource benefits, an MMA may not be totally naturally defensible. Specific holding actions are developed to preclude fire from exceeding the MMA. For prescribed fires, these actions are developed to restrict the fire inside the planned burn unit. For suppression actions, holding actions may be implemented to prohibit the fire from crossing containment boundaries. These actions may be implemented as firelines are established to limit the spread of fire.

Initial Attack - An aggressive suppression action consistent with firefighter and public safety and values to be protected.

Management Action Points - also called "trigger points." Either geographic points on the ground or specific points in time where an escalation or alteration of management actions is warranted. These points are defined and the management actions to be taken are clearly described in an approved Wildland Fire Implementation Plan (WFIP) or Prescribed Fire Plan. Timely implementation of the actions when the fire reaches the action point is generally critical to successful accomplishment of the objectives.

Maximum Manageable Area (MMA) - MMA defines the firm limits of management capability to accommodate the social, political, and resource impacts of a wildland fire. Once established as part of an approved plan, the general impact area is fixed and not subject to change. MMAs can be developed as part of the FMP and described as a FMA. They can also be developed as part of the planning and implementation of management actions after a fire has ignited. If they are developed after the ignition, their definition will occur during the Wildland Fire Implementation Plan Stage III process. In the event a fire occurs in a pre-planned MMA or FMA and the local unit determines that this MMA is not the best-suited alternative for the present conditions, a new MMA can be developed as part of the Stage III process. Once this occurs, the Stage III MMA becomes the firm limits of the fire and is fixed.

Mitigation Actions - Mitigation actions are considered to be those on-the-ground activities that will serve to increase the defensibility of the MMA; check, direct, or delay the spread of fire; and minimize threats to life, property, and resources. Mitigation actions may include mechanical and physical non-fire tasks, specific fire applications, and limited suppression actions. These actions will be used to construct firelines, reduce excesssive fuel concentrations, reduce vertical fuel continuity, create fuel breaks or barriers around critical or sensitive sites or resources, create "blacklines" through controlled burnouts, and to limit fire spread and behavior.

Normal Fire Year – The normal fire year for suppressed wildland fires is the year with the third highest number of wildland fires in the past ten years of record. The normal wildland fire managed for resource benefits year is the year with the third highest number of acres burned by wildland fire managed for resource benefits in the past ten years of record.

Preparedness - Activities that lead to a safe, efficient and cost effective fire management program in support of land and resource management objectives through appropriate planning and coordination. This term replaces presuppression.

Prescribed Fire - Any fire ignited by management actions to meet specific objectives. A written, approved prescribed fire plan must exist, and NEPA requirements must be met, prior to ignition. This term replaces management ignited prescribed fire.

Prescribed Fire Plan - a plan required for each fire application ignited by managers. It must be prepared by qualified personnel and approved by the appropriate Agency Administrator prior to

implementation. Each plan will follow specific agency direction and must include critical elements described in agency manuals. Formats for plan development vary among agencies, although content is the same.

Prescription - Measurable criteria which define conditions under which a prescribed fire may be ignited, guide selection of appropriate management responses, and indicate other required actions. Prescription criteria may include safety, economic, public health, environmental, geographic, administrative, social or legal considerations.

Trigger points - see Management action points.

Wildfire - An unwanted wildland fire. **This term was only included to give continuing credence to the historic fire prevention products. This is NOT a separate type of fire.**

Wildland and Prescribed Fire Complexity Analysis – The formal process to determine the full complexity rating for wildland and prescribed fires. It utilizes 12 variables having numerically weighted importance combined with user identified complexity values.

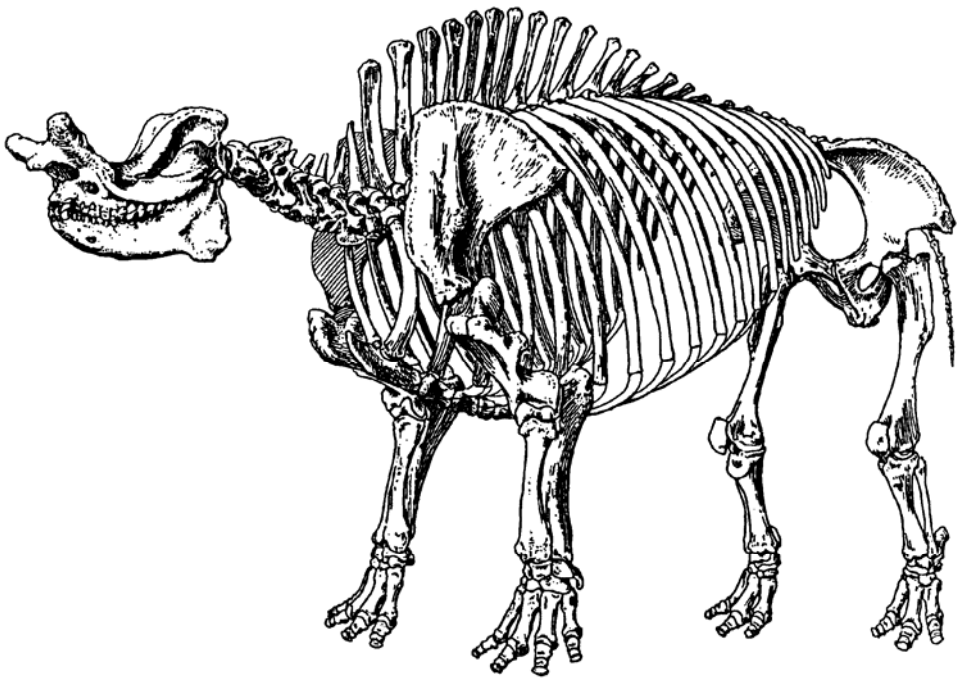
Wildland Fire - Any non-structure fire, other than prescribed fire, that occurs in the wildland. This term encompasses fires previously called both wildfires and prescribed natural fires.

Wildland Fire Implementation Plan (WFIP) - A progressively developed assessment and operational management plan that documents the analysis and selection of strategies and describes the appropriate management response for a wildland fire. A full WFIP consists of three stages. Different levels of completion may occur for differing management strategies (i.e., fires managed for resource benefits will have two - three stages of the WFIP completed while some fires that receive a suppression response may only have a portion of Stage I completed).

Wildland Fire Management Program - The full range of activities and functions necessary for planning, preparedness, emergency suppression operations, and emergency rehabilitation of wildland fires, and prescribed fire operations, including non-activity fuels management to reduce risks to public safety and to restore and sustain ecosystem health.

Wildland Fire Situation Analysis (WFSA) -A decision-making process that evaluates alternative management strategies against selected safety, environmental, social, economic, political, and resource management objectives.

Wildland Fire Suppression - an appropriate management response to wildland fire that results in curtailment of fire spread and eliminates all identified threats from the particular fire. All wildland fire suppression activities provide for firefighter and public safety as the highest consideration, but minimize loss of resource values, economic expenditures, and/or the use of critical firefighting resources.



The Titanothere *Brontops robustus*
(after Scott, 1936)

Appendix C

BADLANDS NATIONAL PARK THREATENED AND ENDANGERED SPECIES (3/2004)

Species	Federal	State
Gray Wolf (*Canis lupis*)	E	-
Bald eagle (*Haliaeetus leucocephalus*)	T	T
Osprey *(Pandion haliaetus)*	-	T
Whooping crane (*Grus americana*)	E	E
Eskimo curlew (*Numenius borealis*)	E	E
Peregrine falcon (*Falco peregrinus*)	-	E
Black-footed ferret (*Mustela nigripes*)	E	E
Swift fox (*Vulpes velox*)	-	T
Black-tailed Prairie Dog (*Cynomys Ludovicianus)*	C	-
Lined snake (*Tropidoclonion lineatum*)	-	E
Eastern hog-nosed snake (*Heterodon platyrhinos*)	-	T
Sturgeon chub *(Macrhybopsis gelida)*	-	T

Key: T = threatened C = candidate
E = endangered

Note: There are no known federal or state listed threatened or endangered plant species known to inhabit Badlands National Park, however there are over 100 plant species in and around Badlands National Park that are tracked by the South Dakota Natural Heritage Program (S. Dakota Dept. of Game, Fish and Parks 1998). Of these two are ranked "G3" which is defined as "either very rare and local throughout its range, or found locally (even abundantly at some of its locations) in a restricted range, or vulnerable to extinction throughout it range because of other factors." These species are Vishers Buckwheat (*Eriogonum Visheri*), also known as Dakota Buckwheat, and Barrs Milkvetch (*Astragalus barrii*).

U.S. DEPARTMENT OF THE INTERIOR
NATIONAL PARK SERVICE

ENVIRONMENTAL ASSESSMENT
for the
FIRE MANAGEMENT PLAN
BADLANDS NATIONAL PARK
Jackson, Pennington, and Shannon Counties, South Dakota

Summary: Badlands National Park is a classic grassland fire regime characterized by large tracts of continuous fine fuels, frequent periods of hot, dry weather, and recurrent lightning. Fire is a fundamental ecological process that influences plant and animal diversity and distribution as well as abiotic processes such as erosion, nutrient cycling, and soil genesis.

Both natural and human-caused ignitions have historically influenced the landscape at Badlands National Park. The National Park Service has used prescribed fire as a management tool since the early 1980's at Badlands. The park's existing Fire Management Plan has been in place since 1996 and emphasizes fire suppression and the use of prescribed fire for fuel reduction only along the park boundary. Furthermore, it does not address "wildland fire use"--- the management of naturally ignited wildland fires to accomplish specific pre-stated resource management objectives in pre-defined geographic areas. The National Park Service's Fire Management Policy (*Director's Order #18: Wildland Fire Management*) was revised in 2002, with specific guidance (*Reference Manual #18: Wildland Fire Management*) implemented in 1999. Consequently, the park's existing Fire Management Plan is inconsistent with the new policy.

A new Fire Management Plan has been drafted to address the need for an integrated fire management program consistent with the new management policies. This Environmental Assessment (EA) describes two alternatives and the environmental consequences of each.

Alternative A: No Action. The park's current Fire Management Plan would remain in effect with an emphasis on fire suppression and prescribed fire only for fuel reduction along park boundaries. No natural ignitions would be allowed to burn under any circumstances.

Alternative B: Integrated Fire Management. The park would incorporate wildland fire use as a management tool to preserve and restore the native prairie ecosystem. Prescribed fire would be used for fuel reduction along park boundaries and developed areas, as well as to achieve resource management goals. Wildland fire would be allowed burn in interior portions of the park under specific conditions (wildland fire use). Wildland fires burning in undesired conditions would be suppressed. This is the preferred alternative and its implementation is more fully described in the **Fire Management Plan**.

Alternatives considered but rejected include the use of mechanical treatment for fuel reduction and the exclusion of wildland fire use.

This environmental assessment is an appendix to Badlands National Park's **Fire Management Plan**, which provides specific guidance and procedures for accomplishing park fire management objectives.

The public comment period on this document will remain open for 30 days. **Comments should be received by April 30, 2004,** and may be addressed to:

Superintendent
Badlands National Park
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Interior, SD 57750
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CONTENTS

INTRODUCTION

Park Purpose, Significance, and Mission

Badlands National Park was originally authorized in 1929, and established in 1939 by Presidential Proclamation as a national monument, "to preserve the scenic and scientific values of a portion of the White River Badlands and to make them accessible for public enjoyment and inspiration." In 1968 lands on the Pine Ridge Indian Reservation were added (to be managed under an agreement with the Oglala Sioux Tribe), and in 1976 approximately 64,000 acres within the monument were legally designated as wilderness. In 1978 Congress elevated the monument to national park status. In order to preserve many of the values for which this area was set aside, an active fire management program is needed to maintain a pre-European settlement (pre-Columbian) fire-dependent ecosystem. The Fire Management Plan (FMP) is a working document that details how the park will control and/or use fire to maintain park resources for future generations. The FMP is an implementation plan subordinate to, and derived from, the park General Management Plan, the Strategic Plan, and the Resource Management Plan.

Based on park legislation and legislative history, the **purpose** of Badlands National Park (as identified in park strategic planning) is to:

- 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.
- Interpret the archeological and contemporary history of use and settlement of lands within the park, with special emphasis on the history of the Sioux Nation and the Lakota People.

The **significance** and unique characteristics of Badlands National Park are as follows:

- The park's geological and paleontological resources of the park provide insight into climatic history, biological diversity, evolution, and geological process particular to the boundary between the Eocene and Oligocene epochs.
- Fossil and geologic records provide a unique opportunity to trace the evolution of the prairie ecosystems of the Great Plains.
- The park contains places of spiritual and historical significance to the Lakota people.
- The harsh climate and extreme geography of the badlands region influenced both aboriginal use and contemporary settlement patterns of the lands now administered by the National Park Service and directly contributed to the establishment of the park.
- The long history of research in the White River Badlands has contributed greatly to the science of vertebrate paleontology in North America.
- The park contains a substantial remnant of native prairie and encloses the largest mixed-grass prairie protected by the National Park Service.
- The park contains large, fully protected prairie dog colonies that provide habitat for the endangered black-footed ferret.

- The park contains spectacular scenery, predominantly highly eroded landforms that comprise a concentrated collection of rutted ravines, serrated towers, pinnacles, and precipitous gulches.

As identified in the park's Strategic Plan, the following is the **mission** of Badlands National Park:

> *Badlands National Park preserves a diversity of significant resources for the education and inspiration of a world audience. These resources are a blend of the best known Oligocene fossil deposits contained within archetypal Big Badlands formations, a rich and varied cultural history spanning from paleo-Indian occupation through the early twentieth century homesteading period, and a fine expanse of a mixed-grass prairie ecosystem. Other qualities, most notably the wilderness character, clean air, quiet, solitude, vastness, and natural processes, provide visitors with a setting for exploration and appreciation through such experiences as hiking, camping, wildlife viewing, scenic drives and vistas, research and educational opportunities, and quiet contemplation.*

Purpose of Action

The purpose of this federal action is to provide a long-range fire management plan and program that restores fire as a fundamental ecological process while protecting people, structures, and adjacent lands from fire. The proposed action is implementation of a long-range fire management plan. As required by the National Environmental Policy Act (NEPA; 42 U.S.C. 4321 *et seq*.), this environmental assessment (EA) analyzes program alternatives and their direct, indirect, and cumulative impacts.

Need for Action

The existing park Fire Management Plan has been in place since 1996 and primarily emphasizes fire suppression and the use of prescribed fire only for fuel reduction along the park boundary. Furthermore, it does not address "wildland fire use", which is the management of naturally ignited wildland fires to accomplish specific pre-stated resource management objectives in pre-defined geographic areas. The National Park Service's (NPS) fire management policy (*Director's Order #18: Wildland Fire Management*) was revised in 2002, with specific guidance (*Reference Manual #18: Wildland Fire Management*) implemented in 1999. Consequently, the park's existing Fire Management Plan is inconsistent with the new policy and requires revision. Because the revisions will be major, an entirely new Fire Management Plan is proposed.

Objectives of Fire Management and Planning

Consistent with NPS policy and the park's resource management objectives, the fire management plan will achieve the following fire management goals (for full discussion, see Fire Management Plan, pages 18-20).

1) *Reduce both the incidence and extent of human-caused fires by 20% within the next 15 years*
2) *Restore fire to 80% of the vegetated landscape within the next 15 years*
3) *Restore fuel and vegetation mosaics to pre-European contact conditions on 25% of the landscape within the next 15 years*
4) *Incur zero fatalities and an injury rate no higher than the national NPS average in association with wildland fire management activities*

5) *Limit impacts from fire suppression activities to less than 5% of the estimated monetary value of the impacted resource*

More specific objectives related to individual vegetation types may be found in the Fire Monitoring Plan (*Appendix F* of the Fire Management Plan). Also, each prescribed fire plan for individual prescribed fires will include specific resource goals and objectives which will be refinements of, and compatible with, these program objectives.

Issues and Impact Topics included in this EA

In September 1999 a press release to area newspapers invited the public to identify issues and concerns related to several park planning efforts, including the proposed Fire Management Plan. Additionally, in fall of 2000, the park conducted scoping for the General Management Plan. These efforts identified the following issues to be addressed by this plan:

- *ISSUE:* Fire events within the park may have an adverse impact on archaeological resources, but the subsequent removal of thatch may also provide an opportunity to conduct a more thorough inventory.
- *ISSUE:* Wildland fires near park boundaries pose a risk to park neighbors.
- *ISSUE:* Fire may generate large volumes of smoke, reducing the air quality of the park and surrounding lands.
- *ISSUE:* Wilderness should be included as a specific resource category in the assessment of environmental impacts.
- *ISSUE:* Natural processes should prevail within Wilderness. Naturally ignited fires should be given priority over prescribed fire within Wilderness.

The following impact topics are included in this Environmental Assessment:

Vegetation Resources: The frequency, duration, and seasonality of fire have direct impacts on the composition and distribution of plant species. The suppression of fire has an indirect impact on the composition and distribution of plant species. Specific impacts to grassland, shrubland, and woody draw communities will be addressed. Direct and indirect vegetation impacts are therefore analyzed in this EA.

Wildlife Resources: The distribution and frequency of fire have direct impacts on populations of small mammals, ungulates, birds, reptiles and amphibians, and invertebrates. Fire may have a marked affect on predator-prey relationships between these populations by reducing the amount and availability of cover, thus increasing animal predation on small mammals. It can also destroy nests and kill young animals. Direct and indirect wildlife impacts are therefore analyzed in this EA.

Fire can also change wildlife habitat and forage quality. Fire's effects on habitat depend on fire characteristics. Soils lose fewer nutrients in low-severity fire than in severe fire. Severe fire volatilizes nutrients and occasionally decreases wettability of the soil surface. Forage is improved when low-severity fire increases herb diversity and stimulates plant growth, particularly among native legumes. Improved nutritional levels in forage species can occur following fire.

Threatened and Endangered Species: The Endangered Species Act of 1973 (16 U.S.C. 1531 *et seq*.) prohibits federal agencies from taking actions that jeopardize the continued existence of listed species or to adversely modify critical habitat. Under Section 7 of the Act, agencies must consult with the US Fish and Wildlife Service before undertaking any action with such potential. 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 35 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 to be, or known potentially to be, resident or migrant species within the local area of Badlands National Park. Bird species that are migrant and seasonally resident in the area are the federally threatened/state endangered bald eagle (*Haliaeetus leucocephalus),* the federal/state endangered whooping crane (*Grus americana*), and the state endangered peregrine falcon (*Falco peregrinus*). Infrequent sightings of the state threatened mountain lion (*Felis concolor*) have been documented within the park. The park includes large colonies of the black-tailed prairie dog (*Cynomys ludovicianus*), a species considered warranted for but precluded from listing by the US Fish and Wildlife Service at this time. These colonies provide a prey base and critical habitat for the reintroduced federal and state endangered black-footed ferret (*Mustela nigripes*) and potentially the state threatened swift fox (*Vulpes velox*). Prairie dog communities occur throughout the park and would be subjected to wildland fire use and possibly to wildland fires. Direct impacts to these communities and the seven species mentioned above are therefore analyzed in this EA. Two state listed rare plants are known to occur in the vicinity of the park: Dakota buckwheat (*Eriogonum visheri*) and Barr's milkvetch (*Astragalus barrii*). However, both occur on sparsely vegetated badlands where it is highly unlikely for fire to occur. Therefore, impacts to these two plant species are not analyzed.

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*.). This designation stipulates that federal land managers have an affirmative responsibility to protect a park's air quality from adverse air pollution impacts. Air quality would be affected to various degrees by fire events inside the park. In addition, smoke generated inside the park could affect sensitive receptors outside of the park. Visibility would be affected by the presence of particulates associated with smoke. However, the short duration of most grassland fire events would make contributions to acid deposition or ozone unlikely. Direct, indirect, and cumulative impacts to visibility are therefore analyzed in this EA.

Paleontological Resources: Badlands National Park is world renowned for its 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 included in museum collections throughout the world. Paleontological resources exposed at the surface may undergo splitting, cracking and discoloration when exposed to fire. Vehicle or foot traffic, which accompanies prescribed burn and fire suppression activity, can potentially crush delicate fossil remains. Direct impacts to fossil resources will be analyzed in this EA.

Wilderness: The Wilderness Act of 1964 (16 U.S.C. 1132) and *RM-41,: Wilderness Preservation and Management* require consideration of impacts on Wilderness resources. The Badlands Wilderness Area within Badlands National Park was designated to preserve wilderness values, including wilderness visitor experience and physical wilderness character, as well as natural resources and processes. The boundaries of the Wilderness area would be subjected to prescribed fires, and the interior of the Wilderness may experience wildland fires and wildland fire use. Therefore, direct, indirect, and cumulative impacts to these wilderness values are analyzed in this EA.

Cultural Resources: The National Historic Preservation Act, as amended in 2000 (16 U.S.C. 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. No parkwide inventories have been initiated to evaluate whether there are National Register-eligible historic structures, cultural landscapes, or any ethnographic

resources. One structure, the Ben Reifel Visitor Center, was determined in 2002 as eligible for the National Register. Potentially eligible archaeological and other cultural resources may be affected by fire events. Consultation with the State Historic Preservation Officer has been consistent and documented on all undertakings shared with the cultural resource manager.

Archaeological Resources: Research has been conducted on the impacts of fire on archaeological resources. In 2002, Brent Buenger, a PhD. candidate at Colorado State University in the Department of Anthropology, submitted *Fire Effects on Archaeological Resources During Prescribed and Wildlife Fire in a Prairie Ecosystem (Badlands National Park, Wind Cave National Park, Rocky Mountain National Park)* and determined:

> Prescribed burning in grassland fuels produced relatively low temperatures and residence times. Surface temperatures recorded during a May, 2001 burn ranged from 418.8C to 61.6C. The maximum subsurface temperature was 34.6C. The investigator's findings indicate that thermal alteration of the artifacts placed within the test plots was not significant. The majority of discoloration was due to residence deposits, the byproduct of organic combustion, present on all of the artifacts. No significant damage in the form of cracking, spalling, or deformation occurred. Even the wooden objects showed only minor effects of the fire. Based on these observations, it is suggested that prescribed burning in mixed grass fuels presents only a minimal risk to surface artifacts and little or no risk to subsurface artifacts.

Therefore, the impacts analyzed in this EA focus on the impacts resulting from fire activities such as driving vehicles across the prairie rather than the impacts of the fire itself.

Cultural Landscapes: A Cultural Landscape Report and Environmental Assessment of Cedar Pass Headquarters area was started in 2002. A project entitled *Cultural Landscapes Important to the Oglala Lakota* was funded in 2002 but deferred to 2004 until issues relating to management of the South Unit are resolved. The park is scheduled for a parkwide Cultural Landscape Inventory in 2004 and 2005, according to the Midwest Region Cultural Landscape Inventory Program.

Ethnographic Resources: A draft Ethnographic Overview was received in 2001. The plant species discussed as important to the Lakota people, such as sagebrush, sumac, chokecherry, yucca, and cacti have root structures that have adapted to survive prairie fire. The substructures of these plants are not consumed by fire but instead thrive through exposure to fire. Additionally, the native wildlife populations are also positively impacted by fire as it creates opportunities for new plant shoots to appear for grazers and browsers. Fire was historically used as a tool to draw native prairie animals out for hunting purposes. The ethnographic overview specifically states, “Scholars have long been inclined to believe that the Great Plains ecosystem was fundamentally maintained by fire. Many have seen this as substantially of human origin, while other think natural fires were as important or more so.” The overview lists the following historic and prehistoric uses for fire by the Plains Indians: to drive game, to improve forage, to concentrate wildlife in unburned areas, and for use as a weapon. Accidental fires or campfires were also likely sources. The overview goes on to state, “More important than the causes of fire is the matter of fire suppression; this practice, beginning with White land management regimes, is what threatens the long-term viability of grassland ecosystems.” Consultation with Tribes affiliated with Badlands National Park has been initiated.

Museum Collections: Specimens and artifacts in the park museum collections will be not impacted by the fire. These items have been collected for research purposes and provide relationships to the significant history of the science of paleontology, the human history of settlement in the White River Badlands, and document the history of the development of Badlands National Park. These resources will not be impacted and are therefore dismissed as an impact topic.

Public Health and Safety: Fire on the landscape poses obvious threats to public health and

safety. Smoke can cause severe respiratory difficulty, particularly in children and the elderly. Visibility on roadways can be severely reduced, leading to vehicular collisions. Uncontrolled fire can threaten lives and property. Effects of fire on public health and safety will be addressed in this EA.

Issues and Impact Topics Considered but not further addressed in this EA

Water Resources: National Park Service policies require protection of water resources consistent with the Clean Water Act (33 U.S.C. 1251 *et seq*.). Burned areas may be subjected to erosion that would result in a temporary increase in sediment loading of surface waters. However, this increase is negligible given the naturally high rates of erosion and sediment loading that characterize the badlands landscape. Sparsely vegetated and highly erodable badlands constitute 44,400 hectares (109,700 acres), or 46 percent of park acreage, and annual acreage burned under any realistic fire management program would be no more than 4,000 hectares (10,000 acres), or 4 percent of the total park acreage. Plus there is generally a short time period between a fire event and vegetative regrowth, which stabilizes the soil and limits the period of post-burn erodability. Therefore, erosion increase from fire is likely to be negligible, and 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. Burned areas may experience increased rates of erosion for short periods of time following burns. However, this increase would be negligible given the short duration of the increase and the naturally high rates of erosion that characterize the badlands landscape. Therefore, this impact topic is not included for further analysis in this EA.

Socioeconomics: NEPA requires an analysis of impacts to the human environment, which includes economic, social, and demographic elements in the affected area. The area surrounding the park is primarily ranch land with a few small communities. Fire events may bring a short-term need for additional personnel in the park, usually provided by the local volunteer fire departments, but would not affect 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. The suppression of wildland fire and the use of prescribed fire would be generally consistent with the Bureau of Indian Affairs fire management program in place on the Reservation. Communities in and near the Reservation would be protected as diligently as other adjacent communities, and there would be the same opportunities for Tribal fire crews to participate in the park's fire management activities. 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. Fire events may require visitor use closures for visitor protection. However, the displacement of visitors would be temporary and localized due to the discontinuity of fuels and the burn unit distribution. Generally, similar visitor experiences would be available in other areas of the park. The park's Media Plan, developed to accompany the Fire Management Plan, would be implemented when needed. Interpretive programs to explain the role of fire in the landscape are generally well received, and many visitors are curious about fire. Thus, fire operations may provide a desirable visitor experience. Therefore, this impact topic is not included for further analysis in this EA.

Park Operations: Fire events may redirect park personnel with fire qualifications from their usual responsibilities. However, the advanced scheduling of prescribed burns and the use of a weekly call-out list for response to unwanted wildland fires would allow managers to anticipate

needs and develop a strategy to continue essential park operations. Therefore, this impact topic is not included for further analysis in this EA.

Adjoining Lands: The park is primarily surrounded by rangeland and ranches. Much of the surrounding land is US Forest Service, Buffalo Gap National Grassland, and Pine Ridge Indian Reservation, which leases much of it's acreage to local ranchers for grazing. Other land is private rangeland or cropland. Small communities, Wall, Scenic, and Interior, are also located near the park and could be affected by the fire program. Direct impacts to be considered are those from smoke and vegetative impacts from fires that start in the park and escape to surrounding lands. Smoke is addressed an Air Quality impact in this EA. Under any fire management scenario, risk to adjoining lands is similar. Badlands will work to prevent any ignition within the park from burning across the boundary, except where we are conducting a cooperative prescribed fire with the US Forest Service. Therefore, impacts to adjoining lands will not be addressed in this fire plan.

Compliance and Authority for Action

National Park Service management policy directs each park to prepare a wildland fire management plan appropriate for that park's purpose and resources. Fire management at Badlands National Park is based upon this policy and the guidance found in *RM-18: Wildland and Prescribed Fire Management Policy* (1999) and *Wildland and Prescribed Fire Management Policy: Implementation Procedures Reference Guide* (1998). These guidelines identify fire as the most aggressive natural resources management tool employed by the National Park Service. NPS policy also directs that all fires burning in natural vegetation be classified as either wildland fires or prescribed fires. Prescribed fires and wildland fire use may be authorized by an approved fire management plan and can be of significant importance in achievement of the park's resource management objectives. More detailed information regarding fire policy can be found in *Section II: Policy Compliance* of the Fire Management Plan. The draft Fire Management Plan for Badlands National Park has been prepared in compliance with these policies.

The National Environmental Policy Act of 1969 (NEPA), as amended, requires all federal agencies to prepare in-depth studies of the impacts of, and alternatives to, proposed major federal actions; use information contained in such studies in deciding whether to proceed with the action; and involve the interested and affected public before any decision affecting the environment is made. Specific policy and procedures by which the NPS will comply with NEPA are set forth in *RM-12: Conservation planning, Environmental Impact Analysis, and Decisionmaking*. This Environmental Assessment for the Fire Management Plan for Badlands National Park has been prepared in compliance with these policies.

ALTERNATIVES

Alternatives are different ways of meeting stated purpose of this project, which is to implement a long-range fire management program to restore fire as a fundamental ecological process while protecting structures and adjacent lands from fire. To this end, two alternatives are fully analyzed and several alternatives are considered but rejected because they do not fulfill the purpose of this project or they are inconsistent with NPS policy.

To better enable the reader to follow the discussion presented, the following terms are defined in *RM-18* and are provided here for easy reference:

- *Control:* This strategy reflects aggressive suppression efforts and would be the strategy of choice whenever the imminent threat to life or property exists or when fire behavior is

potentially extreme.

- *Containment:* The spread of the fire under prevailing and forecasted weather conditions to the fullest extent possible to minimize resource damage, and to restrict an unwanted wildland fire to a defined area. This strategy would be utilized when no significant values are at risk and fire behavior predictions preclude direct attack to assure firefighter safety. Consultation with adjacent landowners may be initiated before this tactic is selected.
- *Confinement:* Confinement entails minimal suppression action intended to limit fire spread to a certain acceptable geographic area. This strategy may be utilized depending on size, irregular boundaries, and the values of resources at risk adjacent to the park.
- *Fire Management Unit (FMU)*: Any land management area definable by objectives, topographic features, access, values-to-be-protected, political boundaries, fuel types, or major fire regimes, etc., that sets it apart from management characteristics of an adjacent unit. FMUs are delineated in Fire Management Plans. These units may have dominant management objectives and pre-selected strategies assigned to accomplish these objectives. Within each FMU, prescribed fire units may be also be delineated.
- *Wildland Fire Use*: The management of naturally ignited wildland fires to accomplish specific pre-stated resource management objectives in pre-defined geographic areas outlined in Fire Management Plans.
- *Prescribed Burn or Fire*: Any fire intentionally ignited by a management agency to meet specific objectives. A prescribed fire plan must be prepared and approved in advance. NEPA requirements must be met, prior to ignition. Prescribed fire units simply delineate the geographical extent of each planned prescribed fire treatment.
- *Wildland Fire Suppression*: An appropriate management response to wildland fire that results in curtailment of fire spread and eliminates all identified threats from the particular fire. All wildland fire suppression activities provide for firefighter and public safety as the highest consideration, but minimize loss of resource values, economic expenditures, and/or the use of critical firefighting resources.

Alternatives Analyzed in this EA

Alternative A - No Action: Status Quo

Under this alternative, the park's fire management program would continue to operate under the existing Fire Management Plan that was adopted in 1996. This plan is inconsistent with the NPS fire policies adopted in years since its approval that prescribe specific analysis and use of templates. However, this alternative is included because NEPA requires analysis of the no action alternative as a baseline by which to compare proposed alternatives.

Under the 1996 plan, all wildland fires in Badlands National Park are suppressed. All suppression efforts are directed toward safeguarding life and property while protecting park resources from harm. All fires are evaluated to determine the appropriate suppression strategy. There is no Fire Management Unit that allows for wildland fire use. Wildland fires are suppressed in such a manner as to reduce threat to human life and facilities while ensuring adequate protection of natural and cultural resources. Prescribed fire is utilized as an appropriate management tool.

Three fire management units are delineated for the park. Where logical the units follow boundaries of the existing park management zones. However due to the complexity of both the topography and the surface ownership that exists at Badlands National Park, fire management units are tied to ownership and natural topographic boundaries. Appropriate fire management strategies are identified for each unit, considering vegetation, terrain, fire behavior/effects,

cultural resources, access, developed areas, political boundaries and protection of life and property.

Fire Management Unit #1: Includes all non-wilderness in the Pinnacles and Cedar Pass Districts. The boundary interface (approx. 1/4 mile wide) throughout the Pinnacles and Cedar Pass Districts boundary is included. Also included are all developed areas in the Pinnacles and Cedar Pass Districts. Total Unit size is approximately 46,500 acres. Unit objectives:

a) When possible suppress fire under a control strategy.
b) Utilize prescribed fire to reduce heavy fuel loadings and reintroduce prescribed fire for prairie restoration into areas that cannot support wildland fire use due to other management concerns.

Fire Management Unit #2: Consists of the designated Wilderness Area (most of which is in the Sage Creek drainage), approximately 64,000 acres. Unit objectives:

a) When possible suppress fires on isolated tables under a confine strategy.
b) When possible suppress all other fires under a "containment" suppression strategy.
c) Prevent fire from spreading northward and westward toward private land and bison corrals.
d) Protect woody draws.
e) Protect forage base utilized by insular wildlife populations.
f) Reintroduce fire for prairie restoration into areas that cannot support wildland fire use due to management concerns.

Fire Management Unit #3: Encompasses the park's Stronghold and Palmer Creek Districts, approximately 133,300 acres. This Unit includes the White River Visitor Center complex. It is also extremely rugged with limited access. Because the South Unit of the park (which includes the Stronghold and Palmer Creek Districts) is managed cooperatively with the Oglala Sioux Tribe and currently has cattle grazing on it, management objectives are different from the other fire management units. Unit objectives:

a) Suppress wildland fires in the vicinity of the White River Visitor Center complex under a control strategy.
b) Suppress wildland fires in the remainder of the Unit under a contain strategy.
c) Explore with the Oglala Sioux Tribe and the Bureau of Indian Affairs the possibility of using management-ignited prescribed fire as a management tool, particularly for bighorn sheep habitat management and revitalization of grazing allotments.

Management-ignited prescribed fire would be used as a management tool for resource management, hazard fuel reduction, monitoring, and research. The intention of the park has been to reintroduce fire into prescribed fire units in an effort to replicate the historical fire frequency (5-20 years). Approximately 4500 acres would be burned annually.

Summary of *Alternative A:*

- 3 Fire Management Units: FMU 1 = boundary interface (46,500 acres); FMU 2 = designated Wilderness (64,000 acres); FMU 3 = South Unit (133,300 acres)
- FMU 1 employs prescribed fire and suppression to reduce fuel along the boundary and restore/preserve native prairie
- FMU 2 employs suppression and containment of wildland fire; some prescribed fire
- FMU 3 employs suppression at this time, but looks to reach agreement with Oglala Sioux Tribe for use of prescribed fire

- No use of wildland fire is allowed
- Approximately 4,500 acres per year burned via prescribed fire

Alternative B (Preferred) - Comprehensive Fire Management Program

Under this alternative, the draft Fire Management Plan would be adopted. As described, the park would be divided into two Fire Management Units: A suppression unit, termed the "Boundary FMU"; and a wildland fire use unit, termed the "Natural FMU". These units would be delineated along administrative and natural barriers representing locations suitable for defensive fire tactics. These FMUs would be used to drive fire management actions in various areas of the park. The Natural FMU would be managed with a combination of prescribed fire, wildland fire use, and wildland fire suppression, while the Boundary FMU would only utilize suppression and prescribed fire. Appropriate firefighting strategies and tactics would be employed for all unwanted wildland fires occurring as the result of human ignitions. Prescribed fires would be implemented in both FMUs when it has been determined through development of a prescribed fire plan for a specific fire unit that clearly articulated resource objectives identified in the plan can be accomplished for that fire unit.

The Boundary FMU covers approximately 191,000 acres, primarily adjacent to the park boundary and in developed areas. The entirety of the South Unit is also classified as a Boundary FMU because this area is tribal land located within Pine Ridge Indian Reservation and the tribe has grazing interests and other activities that may be negatively affected by wildland fire use. In this zone wildland fires would be suppressed by hand tools and/or mechanical equipment to prevent fire spread. Prescribed fire would be used as a tool for resource management, monitoring, and research to simulate a natural ecological process in the North Unit only at this time. In addition, prescribed fire would be used in this zone to reduce fuel load and thereby reduce the potential for wildland fire damage of park resources, tribal interests, and adjacent lands. The Boundary FMU contains 23 prescribed fire units. The prescribed fire accomplishments within the Boundary FMU would be nearly 4000 acres per year averaged over fifteen years, with each unit burning at least once every fifteen years to replicate the historic fire frequency of 5-20 years. Each of the prescribed fire units has been placed in a burning cycle based on past burns, as well as on park needs and objectives. Boundaries for the prescribed fire units are based on physical barriers (badlands/roads) to minimize the need for fire line construction. The prescribed fire unit map is presented below can be found on page 22 of the Fire Management Plan.

The Natural FMU covers approximately 53,400 acres and is located in the interior of the Badlands Wilderness Area. In this zone, wildland fires would be allowed to interact with the fire dependent communities to maintain the natural variability of the ecosystem. Monitoring of current and expected weather and associated fire dangers would be immediately implemented. Availability of sufficient wildland firefighting resources would be ensured should the weather change or the criteria are not being met (more details of fire management within the Natural FMU are provided in Chapter IV of the Fire Management Plan). The Natural FMU has four identified fire use/prescribed fire units that may be treated as prescribed fire units. The appropriate management response would be determined and utilized for all wildland fires occurring in the Natural FMU, provided the annual burn acreage accomplishment within the Natural FMU would not exceed 10,000 contiguous acres for all wildland fire types (suppression, prescribed fire and wildland fire use acres combined). This acreage limitation is directly tied to ungulate populations and is intended to ensure adequate forage during the winter season.

Summary of *Alternative B*:

- 2 Fire Management Units: Natural FMU (53,400 acres) and Boundary FMU (191,000 acres)
- Natural FMU employs wildland fire use, prescribed fire, fire suppression
- Boundary FMU employs prescribed fire and suppression only
- South Unit would be part of the Boundary Unit, with an intent to work with the Oglala Sioux Tribe on an agreement to conduct prescribed fires
- Both units look to use fire to restore/preserve native prairie
- Approximately 4,000 acres per year to be burned via prescribed fire; 10,000 acres total to be burned per year including both prescribed and wildland fire

Alternatives Considered but not further Addressed in the EA

Allow wildland fires to burn without human intervention: This alternative was considered initially to determine its extent of impacts and resource benefits. This alternative would create a significant risk to lives, property and park resources. The preferred alternative allows for wildland fires in the Natural FMU, but only under certain conditions and criteria. Allowing uncontrolled wildland fires would not meet resource objectives and could potentially violate a number of state and federal resource laws; therefore, it was not analyzed further.

Mechanical treatment: Removal of fuel by mechanical means is not useful in the grassland fuels of Badlands National Park. This treatment most often employs chainsaws to remove woody fuels (i.e. trees) to reduce fuel loads. Less than 5% of the land cover at Badlands is composed of widely scattered woodland or shrublands and the remainder is grassland or sparsely vegetated badlands. Therefore, the only mechanical treatment available is mowing, however, the rugged terrain and rapid growth of grasses during the summer months preclude mowing as a viable fuel reduction treatment. Furthermore, widespread or frequent mowing would cause unacceptable visual impacts to the park's prairie resources (long lasting tracks from the mower) and tends to encourage encroachment by non-native plant species. Due to the impracticality of mechanical treatment to achieve fuel reduction and the unacceptable impacts of mowing, this alternative was not further analyzed or incorporated into other alternatives.

No Prescribed Fire: The NPS mission is to protect and preserve the native ecosystems it manages for the enjoyment of future generations. Guided by this mandate, the national fire management program focuses on restoring and maintaining fire as a natural process while protecting human life and property. Furthermore, RM-18 directs parks to scientifically manage wildland fire using best available technology as an essential ecological process to restore, preserve, or maintain ecosystems and use resource information gained through inventory and monitoring to evaluate and improve the program. To help in achieving these long-term goals, the NPS has a comprehensive fire management program including hazardous fuels reduction, prescribed fire, wildland fire for resource benefit, and wildland fire suppression (NPS Appropriations Implementation, 2001). Native species in Badlands National Park evolved with fire, and many are dependent upon fire for their continued survival. Natural fire events are fewer due to the discontinuous fuels associated with urban and agricultural landscapes surrounding the park, making prescribed fire necessary to replicate historic fire frequency. Because the absence of prescribed fire would result in degradation of the native grassland ecosystem at Badlands National Park, this alternative was not further analyzed or incorporated into other alternatives.

Environmentally Preferred Alternative

The Environmentally Preferred Alternative is Alternative B, which is also the agency Preferred Alternative. This alternative has the greatest long-term positive environmental impacts with the least negative impacts. Specifically, the Preferred Alternative has significant long-term positive impacts by restoring a natural process that would support native plant growth and survival, and generally inhibit invasive non-natives. By supporting native plant species and communities, the Preferred Alternative would also have long-term benefits for the native mixed-grass prairie ecosystem as a whole.

Summary Matrix of Alternatives

Elements	Alternative A: No Action	Alternative B: Comprehensive
Acres of Boundary Fire Management Unit	244,400	191,000
Acres of Natural Management Unit	0	53,400
Average number of acres treated by prescribed fire annually	4500	4000

Summary Matrix of Impacts of Alternatives

Impact Topic	Alternative A: No Action	Alternative B: Comprehensive
Vegetation Resources	Long-term, minor positive	Long-term, major positive
Wildlife Resources	Long-term, major negative	Long-term, major positive
Threatened/Endangered Species	Short-term, minor negative	Short-term, minor negative
Air Quality	Short-term, minor negative	Short-term, moderate negative
Paleontological Resources	Long-term, moderate negative	Long-term, minor negative
Cultural Resources	Long-term, moderate negative	Long-term, moderate negative
Wilderness	Long-term, moderate negative	Short-term, minor negative
Public Health and Safety	Short-term, minor negative	Short-term, minor negative

AFFECTED ENVIRONMENT

Vegetation Resources

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, restoration of fire, 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. Such areas are known as juniper slumps and are generally isolated from surrounding fine fuels and thus not subjected to natural fire occurrence except from direct lightning strike.

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*). Many of the deciduous woodland species are fire dependent and sprout vigorously after fire (FEIS 1996).

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. The tree species found in these floodplain and wetland communities are generally not tolerant of fire (FEIS 1996).

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. Most of the native shrub species are fire tolerant and many are fire dependent, experiencing increased germination rates and/or vigorous sprouting after fire (FEIS 1996).

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. Plant species that inhabit sandhills are generally fire tolerant (FEIS 1996).

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. All of the native shrub species in this vegetation type are fire tolerant or fire dependent (FEIS 1996).

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. These shrub species have varied responses to fire that are highly dependent upon season, intensity, and duration of fire exposure (FEIS 1996).

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, some of which are non-native weeds. Fire generally does not carry easily into the sparse vegetation surrounding prairie dog burrows.

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*). Almost all of the native grass and forb species of these grassland communities are fire tolerant and many are fire dependent (FEIS 1996).

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. Non-native annual grasses may be decreased with fire (FEIS 1996, Whisenant 1987). 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*), both of which are fire tolerant species (FEIS 1996).

Unique and predictable grassland associations 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. These grassland communities are fire tolerant (FEIS 1996).

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*).

The lack of fire in the early part of the 1900s allowed these cool-season exotic grasses to become well established and encroach into the surrounding native grassland. 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).

In summary, virtually all of the park's native species are fire tolerant and many are fire dependent to some extent (FEIS 1996). Those species that are not fire tolerant generally occur in areas that are not naturally prone to fire, such as floodplains and isolated juniper slumps.

Wildlife Resources

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 55 documented mammalian species within the park including five species of ungulates, more than 120 species of birds, over 19 species of reptiles and amphibians, 28 known species of lepidoptera along with numerous other arthropod species. (Higgins et al., 2000; Smith, 1998).

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 500 head. Bison management requires that a portion of the park be fenced. Water supplies and other factors require that the herd be limited to around 650 animals. Surplus bison are rounded up and transferred to tribal governments and other agencies. 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 and now number between 58 to 74 animals. The park is currently searching for other animals to translocate to Badlands National Park to boost the population genetically and reproductively.

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 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 CheckSkipper (*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

NPS policy states that national parks must give state-listed species the same consideration as federal-listed species. Several federal and state listed species are known to exist in and around the Badlands National Park area and utilize a variety of habitats within the system. The federally threatened / state endangered bald eagle (*Haliaeetus leucocephalus*) is a migrant or winter resident in mature riparian woodlands, and occasionally uses prairie dog colonies. The federal and state endangered whooping crane (*Grus americana*) makes use of shallow, sparsely vegetated wetlands, wet meadows, and agricultural fields during spring and fall migrations. The state endangered peregrine falcon (*Falco peregrinus*) may nest on shelves or in crevices in the rugged badlands features and forage in open grasslands during its seasonal residency. The federally endangered American burying beetle (*Nicrophorus americanus*) utilizes moist grassy areas. Although this beetle was historically found in the area, its status today in the Badlands is unknown. The state listed "species of management concern" 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 2% of the total park acreage. Black-tailed prairie dogs are currently considered "warranted but precluded from listing" by the US Fish and Wildlife Service while plains states work to develop individual management plans to ensure its survival as a species. The Buffalo Gap National Grassland/Badlands National Park prairie dog population is one of the largest complexes in South Dakota, which makes this area essential habitat for the endangered black-footed ferret (*Mustela nigripes)* a nocturnal member of the weasel family and resident obligate predator of prairie dog towns. Black-footed ferret re-introductions occurred in Badlands National Park from 1994-1999. Current population estimates are 5-15 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.

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 US Fish and Wildlife Service recently reversed an earlier decision that the swift fox warranted listing, and has determined that it should not be considered for federal listing. There are occasional sightings within the park of

the state threatened mountain lion (Felis concolor), but the remnant local population is likely juvenile dispersers expanding out from the Black Hills and/or the Cheyenne River.

Air Quality

Historically, the park and surrounding area have enjoyed excellent air quality, with only occasional, short-term air pollution from transient wildland fire smoke and blowing dust. National Park Service fire management activities which result in the discharge of pollutants (smoke, carbon monoxide, paticulates, and other pollutants from fires) are subject to, and must comply with, all applicable federal, state, interstate, and local air pollution control requirements as specified by Section 118 of the Clean Air Act, as amended (42 USC 7418). As legally designated wilderness, the Badlands Wilderness Area is designated as a Class I area under the Clean Air Act, prohibiting significant deterioration of air quality. Because Badlands was a national monument when the Clean Air Act was enacted, the remainder of the park is a Class II area.

It is likely that pre-Columbian visibility was lower than current levels due to frequent fires in summer months. A permanently mounted 35mm camera was used between 1987and1995 to monitor visibility near the northeast entrance. Transmissometer data from 1988 to the present has also been used to monitor visibility. The park has 5 years of ozone monitoring data and is currently adding to 12 years of Interagency Monitoring of Protected Visual Environments (IMPROVE) data (1988-present). During the ozone-monitoring period, Badlands had some of the lowest average ozone concentrations in the NPS monitoring network (NPS 1998). The ozone levels measured are well below those found to damage sensitive plants. Similarly, wet deposition data does not indicate significant acidic deposition, at the present. More recent data may indicate an increase in the presence of atmospheric nitrates. Nitrate and sulfate emissions from regional-scale sources such as industrial and electric utility facilities in eastern Wyoming and western South Dakota are of significant concern to the Badlands airshed, and these emissions are on the rise.

Paleontological Resources

The White River Badlands region contains 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 80 to 65 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 apart of 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, 1997; Martin and DiBenedetto, 1997,1998). A pre-construction survey was completed along the Badlands Loop Road in 1996, 1997 and 1998 (Benton, et al. 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 GIS system. More paleontological sites will be recorded in GIS once the

GIS program has fully expanded.

Wilderness

Wilderness was legally designated in Badlands National Park in 1976 (PL 94-567). The Badlands Wilderness Area (BWA acres). See Fig. 2 on page 10 of the Fire Management Plan for boundaries of the wilderness units.

The BWA contains extensive badlands features, but also has expanses of rolling prairie. No permits are required for hiking or camping in the BWA, so data for visitor use is lacking. However, mostly due to the high summer temperatures, few access points, limited water sources, and biting insects, visitation is quite low and limited mostly to the Sage Creek Unit. Most visitors only view the Wilderness from viewpoints along the Loop and Sage Creek roads. Few people hike, camp, or ride horses in the BWA. The primitive automobile-access Sage Creek campground off the Sage Creek Road is the primary access point for hikers and horse users venturing into the Wilderness.

There are no trails or facilities in the Wilderness, but because of the great sight distances human intrusions (ranch buildings and lights, telecommunications towers) from outside the park can be seen from several points within the BWA. Vehicles on park roads can also be seen from parts of the Wilderness. Also, both units are fenced along the 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 explosives are used to clear sediments from impoundments identified as wildlife watering sources.

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 in the wilderness character. With ferret re-introduction success the predator exclosures have been removed, as has much of the fencing. There is little remaining evidence of the cattle grazing, haying and homesteading that existed in some of the area in the earlier part of the twentieth century.

For the most part, wilderness attributes, such as opportunities for solitude, natural night sky, and natural soundscapes are well preserved within the Wilderness, particularly the larger and more rugged Sage Creek Unit.

Cultural Resources

Archaeological Resources

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). The Archaeology of Badlands National Park, South Dakota (Hannus, et.al. 2003) notes:

> No archaeological cultures, phases, or complexes have yet been delineated that call the Badlands "home." The White River Badlands, although centrally located within the "Plains Region," are generally understood as peripheral to many culture areas. This view implies a transitory or seasonal use of the region rather than year-round settlement.

Currently 10% 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 5-year study being conducted jointly by Augustana College and the NPS Midwest Regional Archeological Center (MWAC). A draft this report has been reviewed and the final is expected during summer, 2003. Prior to this survey, less than one percent of the total land area within the park had been surveyed for archeological resources. Less than 1% 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. Two hundred eighty-three sites have been identified as of January, 2001. Site types are primarily lithic and artifact scatters. There are two identified historic farmsteads and two structures with wooden remnants. However, 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 47 are considered poorly documented.

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. To date, only one site has been evaluated for nomination to the National Register; however, it is ineligible due to impacts from the Badlands natural erosion which destroyed the integrity of the site. The research conducted by Brent Buenger in 2000 and 2001 determined that the short, superficial duration of prescribed fire presents only a minimal risk to archaeological sites. The primary impacts will result from off-road vehicle travel to support fire activities.

Cultural Landscapes

The park has not yet been inventoried for cultural landscapes. Identified potential cultural landscapes are:

- Historic fossil collecting camps. The locations of these camps is approximated from journals and field reports but have not been pinpointed.
- Fort Pierre to Fort Laramie Road. Documented in a masters thesis in 1975.
- Route of Bigfoot's Band through the White River Badlands to Wounded Knee. Location approximated from oral histories.
- Stronghold Table. Ghost dances held here in 1890 contributed to the events of Wounded Knee and are the last known such ceremonies of the 19th century.
- Cedar Pass Headquarters Area. Currently under evaluation through a Cultural Landscape Report and Environmental Assessment due to be completed in 2004.

Historic Structures

In 2002, the Ben Reifel Visitor Center was determined to be eligible for the National Register of Historic Places as a part of the plans to rehabilitate the Center. Consultation with the State

Historic Preservation Office resulted in an approved construction plan with mitigation measures specified.

In 1975, the State Historic Preservation Office determined that the Cedar Pass Lodge was ineligible for the National Register of Historic Places due to extensive alteration to the structural integrity and external appearance of the cabins and lodge buildings.

The List of Classified Structures for Badlands National Park was last updated in 1992 and requires updating. It lists three roads (Badlands Loop Road, Sage Creek Rim Road, and Sheep Mountain Table Road) and two structures (Tyree Gravesite and Homestead Well). Both structures are located within the boundaries of the Badlands Wilderness Area.

Ethnographic resources

American Indians use many areas within the park as spiritual sites. Activity at these sites usually consists of small offerings (often small packets of tobacco) tied to a tree or bush. Park staff is aware of the general areas where such activities take place. The park may have potential ethnographic landscapes as yet unevaluated.

Public Health and Safety

The area around Badlands National Park is very lightly populated, which reduces potential for public health and safety concerns arising from the park's fire program. Two small (less than 100 people each) towns, Scenic and Interior, are right on the park boundary, and the next closest town, Wall (approximately 1000 people) is 10 miles from the park. The rest of the nearby population consists of scattered ranches. Three important travel corridors cross through the park area in general east-west routes. Interstate 90 crosses within 10 miles of the park, and SD State Highway 44 passes through the thin "neck" of the park that joins the North and South Units. Highway 240 traverses through the North Unit of the park. Two other travel routes, BIA 27 (north-south) traverses the east side of the South Unit, and BIA 2 (east-west) traverses the south side of the unit.

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 effects that cannot be avoided should the proposed action be implemented. This analysis provides the basis for comparing the effects of the alternatives. In considering the impacts both the intensity and duration of the impacts, mitigation measures and cumulative impacts were assessed.

Methodology

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 judgements and insights of park staff.

Intensity

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

- *Negligible* - impact to the resource or discipline is barely perceptible and not measurable, and confined to a small area.

- *Minor* - impact to the resource or discipline is perceptible and measurable, and is localized.
- *Moderate* - impact is clearly detectable and could have appreciable effect on the resource or discipline.
- *Major* - impact would have a substantial, highly noticeable influence on the resource or discipline.

Duration

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

- *Short-term impacts* occur during implementation of the alternative, including activities occurring during a fire (suppression or holding actions).
- *Long-term impacts* extend beyond implementation of the alternative and would likely have permanent effects on the resource or discipline.

Direct and Indirect Effects

- *Direct effects* are caused by the action and occur at the same time and place.
- *Indirect effects* are caused by the action, but occur later in time or are further are removed in distance, but must be reasonably foreseeable. Indirect effects may include changes in ecological processes that result in a change to the environment.

Vegetation Resources

Impacts to vegetation resources common to both alternatives:

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). 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 general agreement that fire plays an integral role in maintaining the mixed-grass prairie ecosystem. Collins and Gibson (1990) documented the need for an interaction of four different disturbance types, including fire, to maintain diverse community structure in mixed-grass prairie. In the absence of fire, species richness (the number of species per unit area), evenness (the distribution between dominance among species) and patch structure (the association of species at various spatial scales) may change. The absence of fire tends to increase woody species and reduce species richness and patch structure.

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, mycorrhizae, 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, 1987(a); Hull-Seig, 1998). Research conducted outside the park support these general findings (Whisenant, 1987(b); U.S. Department of Agriculture, 2000).

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, 1987(a)). 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, 1987(b); U.S. Department of Agriculture, 2000). Most native grasses are warm season, and thus are not emerged when these spring fires occur and not affected.

Generally, a grassland without fire (either prescribed or natural) has an increased abundance of cool season non-native grasses, a lack of native forbs, and an increase in woody vegetation. As the National Park Service strives to restore and/or maintain naturalness at Badlands National Park, the altered condition of plant composition and distribution that would result from the suppression of all fires and an absence of prescribed fire would be a negative, long-term impact to vegetation resources.

Both 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 (see Fire Management Plan, *Appendix F*). 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.

Both 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 (water) or scratch-line (hand tools) 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. Furthermore, suppression activities deny the benefits of fire to the vegetation resources.

Impacts of Alternative A on Vegetation Resources: Because this alternative does not allow for wildland fire use, all unplanned (human or natural) ignitions would be suppressed. Consequently, there would be increased suppression activities and increased impacts to vegetation resources than if the wildland fires were allowed to burn.

Conclusion: Due to the direct impacts of fire and equipment on individual plants and the indirect impacts on species composition of the fire dependent plant communities, implementation of this alternative would result in long-term, minor positive impacts to vegetation resources.

Impacts of *Alternative B* on Vegetation Resources: In the Natural Fire Management Unit, wildland fire use would be allowed. As such, natural ignitions may be allowed to burn within specified conditions. It is impossible to predict the impact on the park's vegetation resources from any given wildland fire. However, due to the fire dependent nature of most of the park's vegetation communities, wildland fire use is expected to have significant beneficial impacts to vegetation resources. Furthermore, wildland fire use would most closely simulate the natural fire mosaic that characterized the native Northern Great Plains.

Conclusion: Because more wildland fires would be allowed to burn, the proposed fire regime would more closely simulate pre-Columbian conditions, and potential for impacts from suppression equipment and activities would be less (compared to Alternative A), implementation of this alternative would result in long-term, major positive impacts to vegetation resources.

Wildlife Resources

Impacts to wildlife resources common to both alternatives:

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 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-term. 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 fires create 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.

Small Mammals

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). Effects of fire on prairie dog towns are addressed in the "Threatened and Endangered Species"

section below.

Fires that create a mosaic of burned and unburned areas are probably the most beneficial to small mammal species because their densities have been found to increase in areas where mosaics have been created following a burn (Landers, 1987; Taylor, 1981, Hooven, 1973, Cornely et al 1983). 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.

Ungulates

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 recently burned areas (once regrowth begins) 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. This rejuvenates and improves these communities, 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 essential for nutrition. 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 due to low numbers, low reproduction and disease. 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. 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).

Birds

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. Fire may cause some nesting bird mortality 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-grass prairie 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 owls 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. Also, at Badlands, burrowing owls are general found in prairie dog towns where vegetation is kept cropped and are thus not likely to support fire.

Reptiles and Amphibians

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, which 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.

Invertebrates

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.

Impacts of *Alternative A* to wildlife resources: Because this alternative calls for suppression of all wildland fires, suppression activities involving mechanized equipment could impact and potentially disturb many wildlife species. Also wildland fire suppression is completed under situations when pre-burn surveys are difficult if not impossible to perform. Fuel loads would increase to abnormally high levels under this alternative because of continued suppression, and fire would not be permitted to burn in areas where it historically occurred naturally. Prairie habitats and forage would not be rejuvenated in large portions of the park in a pre-Columbian timeframe, thus negatively impacting many species. Consequently, when fire did occur, it would burn longer and at higher temperatures, causing increased erosion and more resource damage. Alternative A would have a greater negative impact on the wildlife resource and, in many cases, in areas that cannot be monitored easily.

Conclusion: Based on the potential benefits of habitat improvements in parts of the park, continued degradation in others due to fire suppression, and the potential impacts from greater suppression activities, long-term, major negative impacts to wildlife resources would likely occur.

Impacts of *Alternative B* to wildlife resources: Because this alternative allows for wildland fire use in the Natural Fire Management Unit, the greatest impact to wildlife resources would be the wildland fires in areas that would be difficult to effectively monitor and perform pre- and post-burn surveys. Therefore, it is impossible to predict the impact on the park's wildlife resources from any given natural ignition. However, due to the fire dependent nature of most of the park's vegetation communities, it is expected that wildland fire use would be significantly beneficial to native prairie wildlife resources. Furthermore, wildland fire use would most closely simulate the natural fire mosaic that characterized the native Northern Great Plains during pre-European settlement times.

Conclusion: Based on the potential benefits of habitat improvements gained through more extensive fire on the landscape, a long-term, major positive impact to wildlife resources would occur.

Threatened and Endangered Species

Impacts to threatened and endangered species common to both alternatives:

Since bald eagles, peregrine falcons, and whooping cranes are not known to nest in the area, there would be no impact expected 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. The American burying beetle can fly to avoid fire, and its larvae are buried below ground, so fire would likely have no impact. Prairie dogs, ferrets, mountain lions and swift fox are also very mobile and would utilize underground burrows and badlands topography 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 increased detection by foxes of other small mammals and birds as prey.

Both alternatives include some wildland fire suppression. 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, hand crews conduct suppression activities, 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 wildland fire. Any bald eagles, peregrine falcons, or whooping cranes will have fled the area during the fire, and most likely would not be affected by suppression activities. Prairie dogs, black-footed ferrets, mountain lions, and swift fox will have fled the area or gone below ground during the fire, and most likely would not be affected by suppression activities.

Impacts of *Alternative A* to threatened and endangered species: The impacts of fire in the grasslands landscape produce overall benefits to the habitats of the concerned threatened and endangered species at Badlands National Park. Suppression of all wildland fires has the potential to decrease this benefit. Prescribed burning on boundary areas might offset this decrease. A small amount of stress would be placed on individual animals in the form of energy demands during fire avoidance and/or human avoidance during suppression activities,

but poses little risk to populations. Consultation with the U.S. Fish and Wildlife Service (Larson, 2001) concerning these specific impacts produced agreement with the following conclusion.

Conclusion: Based on the benefits of habitat improvements gained through fire on the landscape, and the short-term, minor negative impacts on individuals, implementation of this alternative may affect, but is not likely to adversely affect, threatened and endangered species.

Impacts of *Alternative B* to threatened and endangered species: Similar to the fire effects in Alternative A, this alternative would show a similar response by threatened and endangered species and their habitats with the exception that a possibly greater benefit could be gained utilizing fire as a resource management objective by burning to increase and improve natural habitats. The decrease in the amount of fire suppression in wildland fire use areas would also decrease any negative impacts caused by these human activities. Consultation with the U.S. Fish and Wildlife Service (Larson, 2001) concerning these specific impacts produced agreement with the following conclusion:

Conclusion: Based on the benefits of habitat improvements gained through fire on the landscape, and the short-term, minor negative impacts on individuals, implementation of this alternative may affect, but is not likely to adversely affect, threatened and endangered species.

Air Quality

Impacts to air resources common to both alternatives:

Both alternatives include the use of prescribed fire. The State of South Dakota requires that the park inform the State Department of Air Quality prior to performing prescribed burns. Burning permits are not required. The park would also notify local Federal Aviation Administration offices so pilots may be made aware of possible temporary visibility impairments. Smoke drift affecting neighbors and public roads is also a concern. Smoke dispersal would be a consideration in determining whether or not a prescribed burn is within prescription, as described in the specific prescribed fire plan. For either wildland fires or prescribed fires, the fine-grass fuels in the park generate low volumes of smoke for short duration and are not usually a smoke management problem.

Impacts of *Alternative A* to air resources: Because this alternative calls for suppression of all wildland fires, the duration of smoke generation and resulting impacts to air resources would be less than if there was wildland fire use.

Conclusion: Due to the generation of smoke for short durations during prescribed fires and wildland fires before suppression, implementation of this alternative would result in short-term, minor impacts to air resources.

Impacts of *Alternative B* to air resources: Because this alternative would allow wildland fire use in the Natural Fire Management Unit, the duration of smoke generated during a fire use event would generally exceed the duration of smoke generated by a wildland fire that is immediately suppressed. Fires may be allowed to burn for days under appropriate conditions, while most fires in grassland fuels are suppressed within a day and most prescribed fires last for less than a day.

Conclusion: Due to the generation of smoke for short duration during prescribed fires and wildland fires before suppression, as well as the potential for slightly longer duration of smoke during wildland fire use (fires allowed to burn), implementation of this alternative would result in short-term, moderate negative impacts to air resources.

Paleontological Resources

Impacts to paleontological resources common to both alternatives:

Due to the extreme surface temperatures associated with grassland fires (Lata, 1997), paleontological resources exposed at the surface may undergo splitting, cracking and discoloration when exposed to fire. This is especially the case where bedrock outcrops in heavy fuel areas. However, most surficial fossils are found in poorly vegetated bedrock sites. Due to the buffer created by overlying bedrock, fossils in the subsurface are probably not impacted by fire.

Under both alternatives, prescribed burns around the park perimeter have the greatest impact on fossil resources. Both vehicle and foot traffic can impact delicate fossils exposed on the surface. To prevent the potential crushing of fossil remains, no vehicle traffic would be allowed in badlands areas associated with a burn and foot traffic would be limited. Areas recommended for hand lining, trenching, and heavy equipment operation would be identified in a burn plan and reviewed by the park Paleontologist.

As a regular practice, because of the potential impact on exposed fossil resources, pre-burn surveys and potential removal of fossils would be implemented before a prescribed fire is initiated. Careful consideration would be made on the scientific significance of specimen found and the type of fire that would come in contact with the specimen. If a significant site is found, that site would either be protected from fire encroachment or would be excavated. Long range goals include developing burn areas that do not come in direct contact with badlands and creating barriers to protect badlands areas from fire.

Impacts of *Alternative A* to paleontological resources: Alternative A has the greatest impact on fossil resources through active suppression of wildland fires and associated suppression activities that could destroy exposed fossils.

Conclusion: Based on the likely disturbance of exposed fossils on the surface in this alternative, long-term moderate, negative impacts to paleontological resources would occur.

Impacts of *Alternative B* to paleontological resources: Prescribed fires and wildland fire use may both impact exposed fossils, primarily on the bedrock/prairie interface at the edge of many fires. However, most fires would not reach exposed fossils in the poorly vegetated bedrock where fossils are found. Also, since badlands interface will be used as fire breaks whenever possible, suppression activities in badlands will be minimal and will be avoided.

Conclusion: Based on the potential disturbance of exposed fossils on the surface in this alternative, long-term, minor negative impacts to paleontological resources may occur.

Wilderness

Impacts of *Alternative A* to Wilderness: This alternative would necessitate immediate, full suppression of all wildland fire in the Wilderness. The immediate result would be an impact to the Wilderness from suppression activities, which, depending on determinations of “minimum tools” necessary to suppress fire, could include helicopter use and mechanized equipment. The result would be a short-term negative impact to visitor experience (visual and noise intrusions) for any visitor within the wilderness when suppression activities were conducted, and potential long-term impacts from tracks and other evidence of suppression activities that may

detract from wilderness character for several years.

Conclusion: Due to potential for long lasting impacts from suppression activities, this alternative would have long-term, moderate negative impacts.

Impacts *Alternative B* to Wilderness: This alternative may result in more frequent prescribed fires, but because the burning conditions would be carefully controlled, and natural ignitions within the Wilderness would be allowed to burn unless they threaten property outside the park, fire management and suppression activities would be less impacting than under Alternative A. Mechanized equipment would be avoided within the Wilderness. Fires allowed to burn would have a short-term impact on wilderness users with reduced visibility from smoke. Prescribed burns and wildland fire use may also restrict visitor use at times. There would be no long-term impacts on the wilderness visitor experience because there would be no mechanized equipment used, except in extreme conditions.

Conclusion: Because of the prolonged (by days) impacts of smoke, due to wildland fire use, and possible restrictions to visitor use, this alternative would have short-term, minor negative impacts and long term, major positive impacts on naturalness of wilderness.

Cultural Resources

Archaeological resources

Under both alternatives, prescribed burns around the park perimeter have the greatest impact on archaeological resources. While vehicular traffic can have a damaging impact on fragile surface remnants, foot traffic would not likely cause excessive damage. To prevent the potential crushing or scattering of archaeological resources, vehicle traffic should be kept to a minimum and avoid areas of known historic resources. Areas recommended for hand lining, trenching, and heavy equipment operation must first be reviewed by the park Cultural Resource Specialist and approved by the park Superintendent.

Prescribed burning in grassland fuels produced relatively low temperatures and residence times (Buenger, 2001). Based on these observations, it is our conclusion that prescribed burning in mixed grass fuels presents only a minimal risk to surface artifacts and little or no risk to subsurface artifacts. Because archaeological resources are not consumed by fire, the impacts are considered moderate in nature.

To facilitate the decision making process during any proposed or occurring fire event, a detailed set of digital cultural resource maps needs to be developed and incorporated into the park's geographic information system (GIS). The data set should include location, site number, site type, and site evaluation. This information could then be readily available for prescribed fire planning and to incident commanders for wildland fire management. These digital maps should also include information that would identify preferred fire management activities in regard to specific sites and site types. Actions that could be identified include site avoidance (buffer area), use of physical or applied barriers, mechanical reduction of fuel loads, collection of certain artifact classes prior to burn, follow-up survey, and collection post-burn. However, the impacts to these resources through fire management activities will not consume the resources. Even tests on wooden artifacts indicated minimal impact through the duration and temperature of prairie fire. Although this information will assist in management of cultural resources, they are not critical to making a well reasoned decision relating to fire management.

Cultural Landscapes and Ethnographic Resources

The park has not yet been inventoried for cultural or ethnographic landscapes. Since this type of historic resource can vary dramatically in purpose and in story, it cannot be predicted what impact fire would have on these potential resources. However, since fire was historically a part

of the American Indian heritage on the plains, it is possible that fire could help restore certain landscapes to their historic appearance. Additionally, since the resources are not likely to be consumed, the impacts are considered moderate.

Historic Structures

Specific fire management activities will be managed to avoid any structures or features on the List of Classified Structures or structures eligible to the National Register. As a matter of course, wildland fires are managed to avoid destruction to government property.

Impacts of *Alternative A* to cultural resources: Alternative A has the greatest impact on cultural resources through active suppression of wildland fires. Bulldozers and the construction of fire lines could impact historic and ethnographic resources. Because wildland fire suppression is completed under emergency situations it is difficult to complete the pre-burn surveys and monitoring needed.

Conclusion: Based on the potential disturbance of exposed artifacts, cultural landscapes, and ethnographic resources in this alternative, long-term, moderate negative impacts to archaeological resources would occur. During fire, these resources are not consumed, resulting in a moderate impact.

Impacts of *Alternative B* to cultural resources: The greatest impact to cultural resources under Alternative B would be the initiation of prescribed burns within the remote areas of the wilderness area. These areas are difficult to access. It is a challenge to effectively document sites or recover artifacts during pre-burn surveys without great cost and effort. Use of helicopters should be examined as appropriate under the provisions of wilderness management. Access to sacred sites may be impacted and offerings left behind could be consumed. These activities are typically not performed in the prairie environment; however, because access to sites may be impacted and offerings left behind could be consumed, the park must make every effort to insure that users are aware of proposed fire activities.

Conclusion: Based on the potential disturbance of exposed artifacts, cultural landscapes, and ethnographic resources in this alternative, long-term, moderate negative impacts to archaeological resources would occur. During fire, these resources are not consumed, resulting in a moderate impact. Based on the potential consumption of religious offerings, long-term, moderate negative impacts to ethnographic resources would occur.

Public Health and Safety

Impacts common to both alternatives:

Since both alternatives involve the use of prescribed fire around much of the park boundary, there is approximately equal potential in each alternative for problems associated with smoke and escaped fires burning into towns or ranches. Poorly dispersed smoke from prescribed fires can settle over nearby sites and sustained breathing of smoky air can cause severe respiratory ailments, particularly in children and the elderly. It can also cause visibility hazards on nearby roads. Since the number of acres to be burned via prescribed fire is approximately the same in each alternative, the impacts to public health and safety from prescribed fire is also the same.

Impacts from *Alternative A:* Because this alternative does not allow for wildland fire use, there would be less chance for problems associated with smoke. Wildland fires would be fought aggressively in every case, and thus there would be less potential for fires to reach the size where smoke would be a significant issue. Impacts from this alternative are likely to be short term and minor.

Impacts from *Alternative B:* Because this alternative includes wildland fire use, there is a

greater potential for smoke from naturally-ignited fires allowed to burn in the Wilderness to settle over a town or ranch, or impair visibility on one of the main transportation routes. However, the likelihood of a significant amount of smoke impacting homes, schools or roads for any extended period of time (more than an hour or two) would be slim. Therefore, impacts from this alternative would be expected to be short term and minor.

Mitigation Summary for Preferred Alternative

Mitigation measures to reduce impacts are included in the preceding discussion of environmental consequences specific to each impact topic. In many cases the same mitigation measure may serve to reduce impacts on a number of resources. To reiterate, those actions are presented below by mitigation measure, rather than impact topic. Specific mitigation measures to be utilized for individual fires will be identified in the prescribed fire plan or determined for the specific wildland fire use fire when needed.

Pre-burn Vegetation Surveys:

Prior to completion of the Burn Plan for a Prescribed Burn, the site would be surveyed to:

- Identify locations of fire intolerant, desirable native plant populations. The burn would be planned to exclude fire in those areas as feasible.
- Identify locations of non-native species populations that may increase with fire. The burn would be planned to exclude fire in those areas as feasible.
- Identify long-term research plots that may be adversely affected by fire. The burn would be planned to exclude fire in those areas as feasible.
- Identify and salvage, as appropriate, fossils that would be impacted by fire. If a significant site is located, the site may be excavated or fire may be excluded in that area.
- Identify and salvage, as appropriate, archaeological artifacts that would be impacted by fire. If a significant site is located, either fire would be excluded from that area or it would be subject to a full site assessment including the impact fire would have specifically on the type of resources associated with the site.

Post-burn Vegetation Surveys:

- 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.

Smoke Management:

- All prescribed fire plans will include prescriptions for appropriate smoke dispersal to avoid impacts to park neighbors.

Holding Crews:

- All prescribed fire plans will include identification of needed holding personnel based on formulas developed by the National Wildfire Coordinating Group. The fire will not be conducted without the identified resources in place and ready to prevent escapes.

Designate Routes of Travel:

- In prescribed burns, the information collected in the pre-burn survey would be used to designate routes of travel and/or restrict travel in areas that contain resources that could be crushed.

Use of Minimum Impact Suppression Strategies:

- Favor wet-line or scratch-line (hand tools) over fire breaks made by heavy equipment.
- Areas recommended for hand lining, trenching, and heavy equipment operation must first be reviewed by the park Paleontologist, Cultural Resource Specialist and approved by the Superintendent.
- Suppression activities in Wilderness would be subject to a minimum tool analysis.

Long-range Paleo Protection:

- Long-range goals include developing burn areas that do not come in direct contact with badlands and creating barriers to protect badlands areas from fire, and comprehensive parkwide paleo surveys to identify and document significant fossil locations.

Long-range Development of GIS Data:

- A detailed set of digital cultural resource and paleontological spatial data needs to be developed and incorporated into the park's geographic information system (GIS). These digital data should also include information that would identify preferred fire management activities in regard to specific sites and site types. Actions that could be identified include site avoidance (buffer area), use of physical or applied barriers, mechanical reduction of fuel loads, collection of certain artifact classes prior to burn, follow-up survey, and collection post-burn. Until a comprehensive set of data for the park is created, each prescribed fire plan will ensure information is known for that specific fire.

Cumulative Effects Analysis

Cumulative impacts are described in regulations developed by the Council on Environmental Quality (CEQ), 40 CFR 1508.7. 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 who 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 project alternatives 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 the surrounding region. The projects identified include:

Badlands National Park General Management Plan

Badlands National Park has begun preparation of a General Management Plan (GMP) for the park. The GMP will provide overall guidance of the park for the next twenty years. The plan will look at alternative ways of managing the park, and is expected to be completed in 2002. The GMP will have an accompanying environmental impact statement prepared evaluating its potential impacts. Because the General Management Plan is incomplete at this time, and the nature of the effects on resources is unknown, it is difficult to predict what cumulative impacts may be posed by the implementation of both the General Management Plan and the Fire Management Plan's Preferred Alternative.

It is likely that the General Management Plan will anticipate and accommodate increased visitation. This increased visitation may result in increased emissions from vehicles, thus an impact on air quality. The cumulative effects of increased emissions from visitor vehicles and emissions from fire events could be adverse, although it is difficult to predict the magnitude of emissions. Smoke from prescribed fire events would generally occur in spring and fall when visitation is generally moderate. During the peak visitor season of mid-summer, smoke would generally be from wildland fires that could occur in absence of this Fire Management Plan. Adoption of the preferred alternative of the Fire Management Plan would implement a fire prevention strategy that would decrease emissions caused by wildland fires overall. Increased visitation may result in a small amount of increased use of the Badlands Wilderness Area, although use is currently very low and additional visitor use can be easily accommodated without having a negative effect on the wilderness experience.

Other impacts associated with the General Management Plan may be the construction of new visitor facilities. In most cases, new construction would occur in existing developed areas, for example adding restroom facilities to an overlook that already includes a parking lot and paths. As a result of locating new construction in developed areas, the potential to impact vegetation or wildlife would be minimized. As a standard policy, all ground disturbing activities, such as would be associated with new construction, are reviewed by the park Paleontologist and Cultural Resource Specialist. As needed, excavations are monitored by paleo and/or archaeological monitors to protect those resources. Due to the limited extent of new construction likely to be proposed by the General Management Plan and the monitoring protocols already in place, significant cumulative impacts to vegetation, wildlife, paleontological resources, and cultural resources are not anticipated.

Energy Development Proposals

There are several proposals for energy development that may impact Badlands National Park, primarily from the aspect of air quality. These proposals include coalbed methane development in the Powder River Basin of Wyoming and Montana (2 EISs have been developed by the Bureau of Land Management), the WYGEN II power generating plant (Wyoming state permit), and the Dakota, Minnesota and Eastern (DM&E) Railroad being developed to haul coal from Wyoming to generating plants in Wisconsin.

The DM&E is seeking a permit from the Surface Transportation Board (STB) to reroute and upgrade a railroad from Wyoming to Minnesota. The primary purpose of this railroad is to transport coal to the east (Wisconsin, Illinois) to supply power plants. The preferred alternative places the railway corridor within two miles of the western boundary of Badlands National Park. The National Park Service reviewed the Draft Environmental Impact Statement (DEIS) prepared on the proposed railroad expansion. NPS comments were submitted as part of the Department of the Interior's response on the DEIS. Based on review of the DEIS, the NPS is concerned that the project would result in impacts to air quality, would increase noise in the Badlands Wilderness Area, provide a corridor for the expansion of exotic plants, and has the potential to cause wildland fires. STB has pushed for permitting the railroad expansion over the NPS concerns. The Final EIS did not fully address NPS concerns.

Extensive coalbed methane development has been proposed for southeastern Montana/northeastern Wyoming. Over 50,000 wells are planned. NPS has found the two EIS's for the project do not adequately address air quality concerns in Class I parks (Badlands and Wind Cave). NPS does not feel BLM has been responsive to our concerns.

The cumulative effects of the DM&E railroad project and other energy development efforts, and the implementation of the preferred alternative of the Fire Management Plan would have adverse effects on air quality. However, the emissions from the trains, generating plants and

gas wells would be more long-term and persistent than the short duration of smoke generated by very infrequent fire events. In addition, DM&E would have negative cumulative impacts to wildlife, particularly mammals; however, the disturbance to wildlife posed by the trains would be more long-term and persistent than the rather short duration of impacts caused by fire events. These two projects would have the cumulative effect of causing a change in plant species. Implementation of the Fire Management Plan would restore a fundamental natural process to the grasslands, thus having the beneficial effect of increasing vigor of native species, increasing species diversity, and increasing the diversity of plant communities due to the mosaic pattern caused by burning. The DM&E railroad project would have adverse impacts on plant communities by increasing the spread of non-native species, particularly tamarisk and Canada thistle.

Impairment

Under NPS *Management Policies*, Section 1.4 *et seq.* (2001), park managers must determine if management activities constitute impairment to park resources. To quote, “The impairment of park resources and values may not be allowed by the Service unless directly and specifically provided for by legislation or by the proclamation establishing the park." *Policies* defines impairment as “an impact that, in the professional judgment 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.”

Adoption of the preferred alternative, Alternative B would not constitute an impairment of the resources and values Badlands National Park was established to preserve. In fact, the purpose of the Fire Management Plan is to implement a program that enhances the integrity of park resources and the ecosystem with which they are linked by restoring an essential natural process. In the case of non-renewable resources such as paleontological and archeological resources, actions would be taken in conjunction with adoption of this fire management strategy to mitigate the potential negative impacts to significant resources.

CONSULTATION AND COORDINATION

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 writing of this EA (Larson, 2001). Once the final EA is completed and published, the U.S. Fish and Wildlife Service will have the opportunity to comment and concur with the findings, and thus completing consultation requirements. U.S. Fish and Wildlife Service comments and recommendations will be included with the final Fire Management Plan and EA.

In accordance with Section 106 of the National Historic Preservation Act, consultation with the State Historic Preservation Officer was initiated in January 2001. That office will be provided a copy of the entire Fire Management Plan, including this Environmental Assessment, for review and comment during the public review period. The comments of the State Historic Preservation Officer will be included with the final Fire Management Plan and EA.

The Northern Great Plains Fire Management Office has consulted with Oglala Sioux Tribe authorities during the course of preparation of this plan. Consultation will continue throughout the public involvement process.

Staff of Badlands National Park who contributed to this EA:

- Sandee Dingman, Resource Management Specialist
- Eddie Childers, Wildlife Biologist
- Doug Albertson, Wildlife Biologist
- Rachel Benton, PhD., Paleontologist
- Marianne Mills, Chief, Resource Education and Cultural Resource Specialist
- Brian Kenner, Chief, Resource Management

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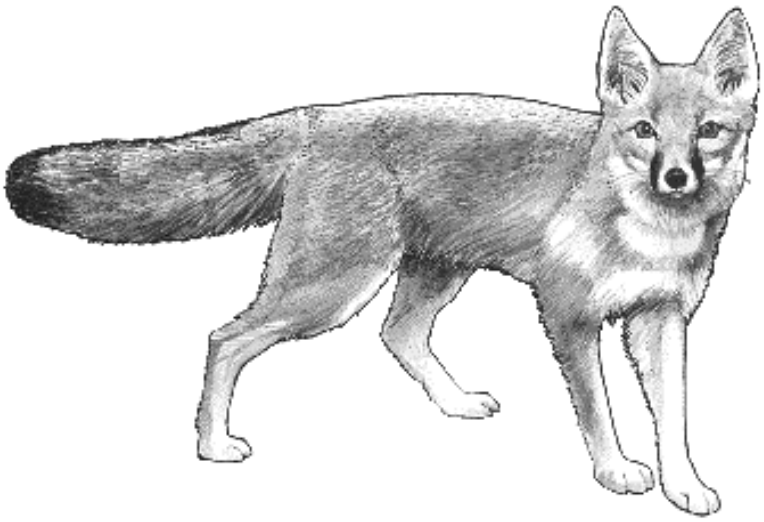


Appendix E(1)

Fire Call-up List for Badlands National Park

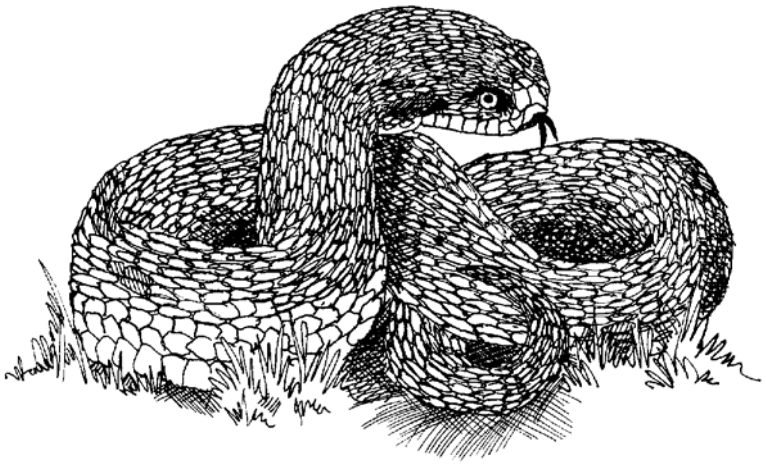
The contact list for securing Badlands firefighters is the following:

Mike Carlbom, Wildland Fire Coordinator	Work	605-433-5279
	Home	605-433-5381
	Cell	605-685-4138
Brian Kenner, Wildland Fire Program Mgr.	Work	605-433-5260
	Home	605-859-3407
	Cell	605-685-4220
Linda Williams, RM Division Clerk	Work	605-433-5265
	Home	605-433-5469
	Cell	605-441-1155

The number of park firefighters, and their qualifications, changes rapidly, even within one fire season. Therefore, we do not provide a current list within the Fire Management Plan. The Division Clerk maintains a current call-out list, which is kept by the Fire Coordinator, the Program Manager and the Clerk at work as well as at home. This call-up list has work, cell and home phone numbers, and current qualifications, for each red carded firefighter. It also includes their supervisors' work, cell and home phone numbers. This enables any one of the three contacts to call up firefighters for assignment and ensure their supervisor approves it.

Other park phone numbers that may be called if one of the above contacts cannot be reached:

Badlands Central Phone Line (Dispatch)	605-433-5361 (8:00-4:30)
Badlands Fire Cache Work Area/Dispatch	605-433-5286
Ben Reifel Visitor Center	605-433-5100 (8:00-5:00)



Appendix E(2)

PREPAREDNESS INVENTORY

Fire Cache Supplies and Equipment

Besides personal protective equipment checked out to permanent employees, equipment and tools kept on the wildland fire engines, and tools and equipment stored at the Pinnacles Ranger Station, the *minimum* stock of supplies and equipment intended to be kept in the Badlands Fire Cache at the beginning of the fire season (April 1) and prior to seasonal employees coming on board is:

Personal Protective Equipment:	
Nomex shirts	20 various sizes
Nomex pants	20 various sizes
Brush coats	20 various sizes
Nomex shrouds	20
Fire shelters	20
Personal web gear	20
Gloves	40 pair, various sizes
Ear plugs	200 pair
Goggles	40 pair
Water bottles	100

Fire Tools:	
Flappers	20
Shovels	10
McLeods	10
Pulaskis	10

Equipment:	
Mark III pumps	1
Floto-pump	1
ATV	1
Chain saws	3

Perishables:	
First Aid Kits	20
MREs	6 cases
Bottled water	10 cases

Overnight gear:	
Gear bags	10
2 week bags	10
Sleeping bags	10
Tents	10
Ground cloths	10
Sleeping pads	10

3/2004

PINNACLES FIRE ENGINE 627 INVENTORY (I264003)

COMPARTMENT 6

SHELF 1

2 – NOMEX COVERALLS
3 – FIRE SHELTERS
1 – CASE FUSEES

SHELF 2

1 – CHAINSAW KIT
- 1 – AXE
- 1 – TOOL KIT
- 1 – 1 PINT 2 CYCLE OIL
- 2 – FELLING WEDGES H8
- 2 – FELLING WEDGES 5 ½ W
- 5 – ROUND FILES
- 2 – T-WRENCHES
- 2 - CHAPS

1 – BOLT CUTTERS
5-GAL. WATER COOLER

COMPARTMENT 5

1 - STHIL 044 CHAIN SAW
1 - DOLMAR
1 - 1 GAL. BAR OIL
1 - 1 QT. SAE 15W-40 OIL
1 – 1 QT. 2 CYCLE OIL
1 – 2 GALLON REGULAR GAS CONTAINER
3 - DRIP TORCHES

COMPARTMENT 4

SHELF 1

REDUCERS

1 – 2.5” NH X 1.5” NH (FEMALE-MALE) REDUCER
1 – 2” NPSH X 1.5” NH (FEMALE-MALE) REDUCER-ADAPTER
3 – 1.5” NH X 1” NPSH (FEMALE-MALE) REDUCER-ADAPTER
3 – 1” NPSH X ¾” REDUCER

INCREASERS

1 – 1.5” NH X 2.5” NH (FEMALE-MALE) INCREASER
1 – 1” NPSH X 1.5” NH (FEMALE-MALE) INCREASER
1 – 1” NH X 1.5” NH (FEMALE-MALE) INCREASER
1 – ¾” GHT X 1” NPSH (FEMALE-MALE) INCREASER

ADAPTERS

1 – 1.5” NH X 1.5” NPSH (FEMALE-MALE) ADAPTER
1- 1.5” NPSH X 1.5” NH (FEMALE-MALE) ADAPTER
1 – 1” NH X 1” NPSH (FEMALE-MALE) ADAPTER
1- 1” NPSH X 1” NH (FEMALE-MALE) ADAPTER

DOUBLE MALES

2 – 1.5” NH X 1.5” NH DOUBLE MALE
1 – 1” NPSH X 1” NPSH DOUBLE MALE

DOUBLE FEMALE

2 – 1.5” NH X 1.5” NH DOUBLE FEMALE
1 – 1” NPSH X 1” NPSH DOUBLE FEMALE
1 - 2.5”NH X 2” NPSH DOUBLE FEMALE

NOZZLES

1 – 1.5” NH NOZZLE
5 – 1” NPSH NOZZLE
3 – ¾” GHT NOZZLE
1 – 1.5” NH MAD DOG FOAM NOZZLE
1- 1.5” NH FOG NOZZLE
1 – 1” NPSH FORESTRY NOZZLE
STRAIGHT STREAM TIPS
1 – 3/8”, 1 – ¼”, 1 – 3/16”
1 – ¾” BLIZZARD WIZARD FOAM NOZZLE

GATED WYES

3 – ¾” GHT GATED WYE

IN-LINE TEES

1 – 1” NPSH X 1” NPSH X 1” NPSH
1 – 1.5” NH X 1” NPSH X 1.5” NH

BALL VALVES

1 – 1.5” NH
1 – 1” NH
1 – 1” NPSH X ¾” GHT

HOSE CLAMPS

2 – STEEL HOSE CLAMPS

END CAPS

1 – 1.5” NH END CAP

MISCELLANOEUS

1 - ROLL TEFLON TAPE
1 - HOSE CLAMPS
2 - SMALL SPANNER WRENCHES
1- LARGE SPANNER WRENCH
1 - LARGE SPANNER WRENCH W/ HYDRANT CONNECTION

SHELF 2

1 – 35 FOOT 1.5" NH SUPPLY HOSE
1 – MOP-UP KIT
3-ACCESSARY KITS
1-GATED WYES 1" NPSH X 1" NPSH X 1" NPSH
1-STRAIGHT STREAM TIP
1-REDUCER ADAPTER 1.5" FEMALE NH TO 1" MALE NPSH
1-REDUCER ADAPTER 1" FEMALE NPSH TO ¾" MALE NH
1-PKG 1.5" RUBBER WASHERS
1-PKG 1" RUBBER WASHERS
1-PKG ¾" RUBBER WASHERS
6-ROLLS ¾" MOP-UP HOSE
1 – GREEN BAG
2 – GATED WYE 1.5" NH X 1.5" NH
2 - GATED WYE 1" NPSH X 1" NPSH

SHELF 3

1 – HAND CRANK FOR HOSE REEL
4 – GATED WYE 1.5" NH X 1.5" NH X 1.5" NH
1 – ROLL PLASTIC SHEET

COMPARTMENT 3

SHELF 1

1 – WATER BUCKET
1 – ROPE
3 – FIVE GALLON WATER PACKS

SHELF 2

3 – ATTACK PACKS
200 FOOT OF 1.5" NH HOSE
100 FOOT OF 1" NPSH HOSE
1.5" NH GATED WYE
1" NPSH BARREL NOZZLE

COMPARTMENT 2

COMPARTMENT 1

SHELF 1

1 – FIRE EXTINGUISHER
1 – AIR FILTER TRUCK
1 – AIR FILTER PUMP
1 – FLAT FILE
CHAMOIS
PAPER TOWELS
GARBAGE BAGS
1 – MICELLANEOUS BOX
CAN OF FLAAGING PAINT
CYALUME MARKER LIGHTS
BOX OF AA BATTERIES
ROLLS OF FLAGGING
PACKAGES OF EARPLUGS
ASSORTED BUNGEE CORDS
ASSORTED RUBBER WASHERS
1 – PAIR OF LEATHER GLOVES
1 – FLASHLIGHT
4 – MRES
2 – ROLLS OF TOLIET PAPER
1 – ROLL OF DUCK TAPE
1 – ROLL OF STRAPING TAPE
1 – WEATHER KIT
2 – RACHET STRAPS

SHELF 2

1 – TOW STRAP
1 – SET OF WHEEL BLOCKS
1 – TOOL BOX
1 – SET OF JUMPER CABLES
1 – EMS KIT
1 – TRIANGLE FLARE KIT
1 – BURN KIT
1 - CLEVIS

CAB INTERIOR

1 – ENGINE BOSS KIT
1 – ROAD ATLAS
2 – ROLLS OF FLAGGING
1 – FIRE EXTINGUSHER
1 – PAIR OF 10X50 BINOCULARS
1 – GARMIN GPS UNIT
GLOVE BOX

1 – RADIO CLAM SHELL
EAR PLUGS
FUSES

TOP RIGHT COMPARTMENT

3 – FLAPPERS
1 – PULASKI
1 – MCLEOD
1 – SHOVEL
1 – LEAF RAKE
1 – TINE RAKE
1 – COUNCIL RAKE
2 – COMBINATION TOOLS
1 – RHINO
3 – MOP UP WANDS

TOP LEFT COMPARTMENT

2 – 8 FOOT – 2" NPSH DRAFTEX DRAFT HOSE
1 – 25 FOOT – 1" NH ATTACK HOSE WITH NOZZLE
1 – 1.5" NH MEDIUM EXPANSION FOAM NOZZLE
1 – 10 FOOT SECTION OF 1" NPSH FOAM HOSE

TOP CENTER

1 – ICE CHEST
1 – 5 GAL DRIP TORCH FUEL
1 – 5 GAL BUCKET OF SILVEX

03/2004

CEDAR PASS FIRE ENGINE 626 INVENTORY (I264006)

COMPARTMENT 6

SHELF 1

1 – CHAINSAW KIT
- 1-AXE
- 1-TOOL KIT
- 1-1 PINT 2 CYCLE OUTBOARD OIL
- 2- FELLING WEDGES H8
- 2- FELLING WEDGES 5 ½ W
- 5- ROUND FILES
- 2- T-WRENCHES
- 1 – SIZE 42 CHAPS
- 1 – SIZE 36 CHAPS

1 - 5 GAL. WATER COOLER
1 – SPARE TIRE
3 - FIRE SHELTERS

SHELF 2

1 - CASE FUSES
1 – BOLT CUTTERS
2 – NOMEX COVERALLS

COMPARTMENT 5

1 - STHIL 044 CHAIN SAW
1 - DOLMAR
1 - 1 GAL. BAR OIL
1 - 1 QT. SAE 15W-40 OIL
1 – 1 QT. 2 CYCLE OIL
1 – 2 GALLON REGULAR GAS CONTAINER
3 - DRIP TORCHES

COMPARTMENT 4

SHELF 1

REDUCERS

1 – 2.5” NH X 1.5” NH (FEMALE-MALE) REDUCER
1 – 2” NPSH X 1.5” NH (FEMALE-MALE) REDUCER-ADAPTER
3 – 1.5” NH X 1” NPSH (FEMALE-MALE) REDUCER-ADAPTER
3 – 1” NPSH X ¾” REDUCER

INCREASERS

1 – 1.5” NH X 2.5” NH (FEMALE-MALE) INCREASER
1 – 1” NPSH X 1.5” NH (FEMALE-MALE) INCREASER
1 – 1” NH X 1.5” NH (FEMALE-MALE) INCREASER
1 – ¾” GHT X 1” NPSH (FEMALE-MALE) INCREASER

ADAPTERS

1 – 1.5” NH X 1.5” NPSH (FEMALE-MALE) ADAPTER
1- 1.5” NPSH X 1.5” NH (FEMALE-MALE) ADAPTER
1 – 1” NH X 1” NPSH (FEMALE-MALE) ADAPTER
1- 1” NPSH X 1” NH (FEMALE-MALE) ADAPTER

DOULBE MALES

2 – 1.5” NH X 1.5” NH DOUBLE MALE
1 – 1” NPSH X 1” NPSH DOUBLE MALE

DOUBLE FEMALE

2 – 1.5” NH X 1.5” NH DOUBLE FEMALE
1 – 1” NPSH X 1” NPSH DOUBLE FEMALE
1 - 2.5”NH X 2” NPSH DOUBLE FEMALE

NOZZLES

1 – 1.5” NH NOZZLE
5 – 1” NPSH NOZZLE
3 – ¾” GHT NOZZLE
1 – 1.5” NH MAD DOG FOAM NOZZLE
1- 1.5” NH FOG NOZZLE
1 – 1” NPSH FORESTRY NOZZLE
STRAIGHT STREAM TIPS
1 – 3/8”, 1 – ¼”, 1 – 3/16”
1 – ¾” BLIZZARD WIZARD FOAM NOZZLE

GATED WYES

3 – ¾” GHT GATED WYE

IN-LINE TEES

1 – 1” NPSH X 1” NPSH X 1” NPSH
1 – 1.5” NH X 1” NPSH X 1.5” NH

BALL VALVES

1 – 1.5” NH
1 – 1” NH
1 – 1” NPSH X ¾” GHT

HOSE CLAMPS

2 – STEEL HOSE CLAMPS

END CAPS

1 – 1.5” NH END CAP

MISCELLANOEUS

1 - ROLL TEFLON TAPE
1 - HOSE CLAMPS
2 - SMALL SPANNER WRENCHES
1- LARGE SPANNER WRENCH
1 - LARGE SPANNER WRENCH W/ HYDRANT CONNECTION

SHELF 2

1 - ONE PINT BOTTLE OF FOAM
1 – 35 FOOT 1.5" NH SUPPLY HOSE
1 – MOP-UP KIT
3-ACCESSARY KITS
1-GATED WYES 1" NPSH X 1" NPSH X 1" NPSH
1-STRAIGHT STREAM TIP
1-REDUCER ADAPTER 1.5" FEMALE NH TO 1" MALE NPSH
1-REDUCER ADAPTER 1" FEMALE NPSH TO ¾" MALE NH
1-PKG 1.5" RUBBER WASHERS
1-PKG 1" RUBBER WASHERS
1-PKG ¾" RUBBER WASHERS
6-ROLLS ¾" MOP-UP HOSE
1 – GREEN BAG
2 – GATED WYE 1.5" NH X 1.5" NH
2 - GATED WYE 1" NPSH X 1" NPSH
1 – HAND CRANK FOR HOSE REEL
4 – GATED WYE 1.5" NH X 1.5" NH X 1.5" NH
1 – ROLL PLASTIC SHEET

COMPARTMENT 3

SHELF 1

1 – WATER BUCKET
1 – ROPE
3 – FIVE GALLON WATER PACKS

SHELF 2

3 – ATTACK PACKS
200 FOOT OF 1.5" NH HOSE
100 FOOT OF 1" NPSH HOSE
1.5" NH GATED WYE
1" NPSH BARREL NOZZLE

COMPARTMENT 2

COMPARTMENT 1

SHELF 1

1 – FIRE EXTINGUISHER
1 – AIR FILTER TRUCK
1 – AIR FILTER PUMP
1 – FLAT FILE
CHAMOIS
PAPER TOWELS
GARBAGE BAGS
1 – MICELLANEOUS BOX
CAN OF FLAAGING PAINT
CYALUME MARKER LIGHTS
BOX OF AA BATTERIES
ROLLS OF FLAGGING
PACKAGES OF EAR PLUGS
ASSORTED BUNGEE CORDS
ASSORTED RUBBER WASHERS
1 - STRIKER
1 – PAIR OF LEATHER GLOVES
1 - FLASHLIGHT
4 – MRES
2 – ROLLS OF TOLIET PAPER
1 – ROLL OF DUCK TAPE
1 – ROLL OF STRAPING TAPE
1 – WEATHER KIT
2 – RACHET STRAPS

SHELF 2

1 – TOW STRAP
1 – SET OF WHEEL BLOCKS
1 – TOOL BOX
1 – SET OF JUMPER CABLES
1 – EMS KIT
1 – TRAILER HITCH
1 – TOW HOOK
1 – TRIANGLE FLARE KIT
1 – BURN KIT

CAB INTERIOR

1 – ENGINE BOSS KIT
1 – ROAD ATLAS
2 – ROLLS OF FLAGGING
1 – FIRE EXTINGUSHER
1 – PAIR OF 10X50 BINOCULARS
1 – GARMIN GPS UNIT
GLOVE BOX

1 – RADIO CLAM SHELL
EAR PLUGS
FUSES

TOP RIGHT COMPARTMENT

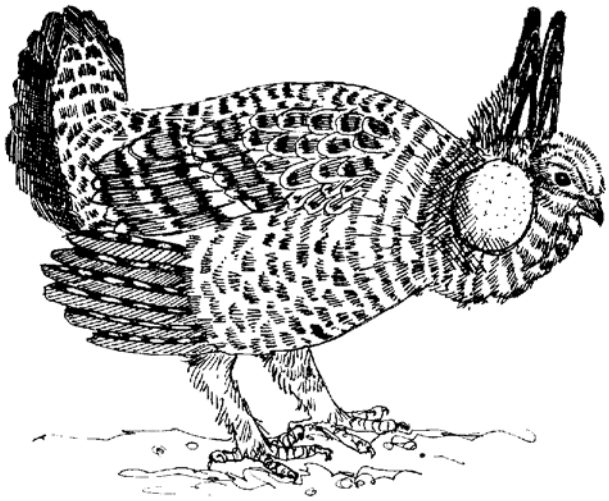
3 – FLAPPERS
1 – PULASKI
1 – MCLEOD
1 – SHOVEL
1 – LEAF RAKE
1 – TINE RAKE
1 – COUNCIL RAKE
2 – COMBINATION TOOLS
1 – RHINO
3 – MOP UP WANDS

TOP LEFT COMPARTMENT

2 – 8 FOOT – 2" NPSH DRAFTEX DRAFT HOSE
1 – 25 FOOT – 1" NH ATTACK HOSE WITH MED EXPANSION NOZZLE

TOP CENTER

1 – ICE CHEST
1 – 5 GAL DRIP TORCH FUEL
1 – 5 GAL BUCKET OF SILVEX



Appendix E(3)

AGREEMENTS

1. Reciprocal Fire Protection Act of May 27, 1955 (69 Stat 66; 42 USC 1856a)

2. Memorandum of Understanding between United States Department of Interior and Department of Agriculture, dated January 28, 1943

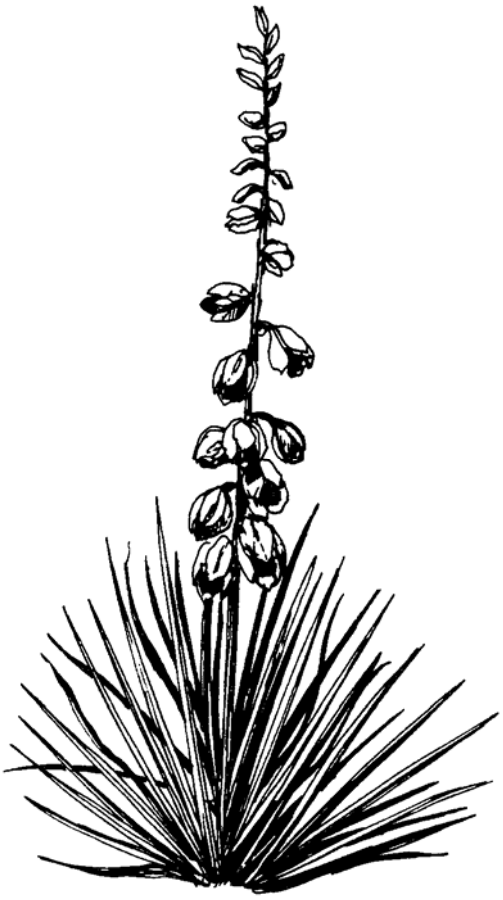
3. Protection Act of 1922 (16 USC 594)

4. Interagency Agreement between the Bureau of Land Management, Bureau of Indian Affairs, National Park Service, U.S. Fish and Wildlife Service, of the United States Department of Interior and the U.S. Forest Service of the United States Department of Agriculture, and Amendment No. 2 to Joint USDI Agencies and USDA Forest Service Interagency Fire Agreement No. 83-SIE, dated May 5, 1987

5. The Clean Air Act (42 USC 7401) provides the primary authority for protection and enhancing the nation's air quality

6. Interagency Cooperative Fire Protection Agreement (#1102-0005-95-013): Establishes specific dispatch procedures for initial attack and reimbursement procedures between the USDI, BLM-Montana State Office, BIA-Aberdeen Area Office, BIA-Billings Area Office, NPS-Rocky Mountain Region, USFWS-Region 6; USDA-Forest Service Region 1 & 2; and the State of South Dakota on forest and range fires.

7. 2000 In-State Forest Fire Suppression Agreement for the State of South Dakota: Specifies minimum qualifications, equipment specifications, and rates for use of wildland firefighting resources owned by local fire departments and private firefighting companies billed through the State of South Dakota as specified in the Agreement above.



Appendix E(4)

BADLANDS FIRE ECOLOGY

1. FIRE ECOLOGY OF SPECIFIC VEGETATION COMMUNITIES

VEGETATION

In 1999, vegetation communities of Badlands National Park were mapped as part of the servicewide Inventory and Monitoring Program's vegetation mapping project. The National Vegetation Classification System for the park included 28 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 and three grassland types. Note in the descriptions below, the "BADL study area" includes 0.9 million acres including the park and surrounding lands.

Woodlands

Dry Coniferous Forests and Woodlands

- *Juniperus scopulorum* / *Oryzopsis micrantha* Woodland
  Rocky Mountain juniper / Little-seed ricegrass Woodland
- *Pinus ponderosa* / *Juniperus scopulorum* Woodland
  Ponderosa pine / Rocky Mountain juniper Woodland

Riparian Deciduous Forests and Woodlands

- *Fraxinus pennsylvanica* - (*Ulmus americana*) / *Prunus virginiana* Woodland
  Green ash - (American elm) / Chokecherry Woodland
- *Populus deltoides* - (*Salix amygdaloides)* / *Salix exigua* Woodland
  *E*astern cottonwood - (Peachleaf willow) / Sandbar willow Woodland
- *Elaeagnus angustifolia* Semi-natural Woodland
  Russian-olive Semi-natural Woodland

Woodlands are minor components of the regional vegetation, covering approximately 1.8% of the BADL study area. 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 the side-slope slump, where additional moisture collects following the landslide.

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 more mesic sites. 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 mesic sites 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 and springs, and around ponds.

Shrublands

Dry Plains Shrublands

- *Artemisia filifolia* / *Calamovilfa longifolia* Shrubland
  Sand sagebrush / Prairie sandreed Shrubland
- *Chrysothamnus nauseosus* / *Pseudoroegneria spicata* Shrubland
  Rubber rabbitbrush Shrubland
- *Rhus trilobata* / *Carex filifolia* Shrub Herbaceous Vegetation
  Three-leaved Sumac / Threadlead Sedge Shrub Herbaceous Vegetation
- *Yucca glauca* / *Calamovilfa longifolia* Shrub Herbaceous Vegetation
  Soapweed Yucca / Prairie sandreed Shrub Herbaceous Vegetation

Mesic Plains Shrublands

- *Artemisia cana* / *Pascopyrum smithii* Shrubland
  Silver sagebrush / Western wheatgrass Shrubland
- *Prunus virginiana - (Prunus americana)* Shrubland
  Chokecherry - (American plum) Shrubland
- *Sarcobatus vermiculatus* / *Pascopyrum smithii* Shrubland
  Greasewood / Western wheatgrass Shrubland
- *Shepherdia argentea* Shrubland
  Silver buffaloberry Shrubland
- *Symphoricarpos occidentalis* Shrubland
  Western snowberry Shrubland

Riparian Shrubland

- *Salix exigua* Temporarily Flooded Shrubland
  Sandbar willow Temporarily Flooded Shrubland

Shrublands make up approximately 6.6% of the BADL study area and occur mainly along river and creek floodplains, and on sand deposits, mesic slopes, 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, although 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.

Mesic draws, swales, slopes, and drainages all through 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 conditions) 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 (Figure 15). One very large stand is located along the Conata Basin Road just outside of the Park boundary. 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 Sage Creek Wilderness of the North Unit. Finally, rabbitbrush (*Chyrsomthamnus nauseosus*) shrubs become dominant in disturbed sites throughout the project area, such as areas of road-construction.

Grasslands

- Prairie Dog Town Complex

Dry Mixedgrass Prairies

- *Bouteloua gracilis - Buchloe dactyloides* Xeric Soil Herbaceous Vegetation
  Blue grama - Buffalo grass Xeric Soil Herbaceous Vegetation
- *Calamovilfa longifolia - Carex inops ssp. heliophila* Herbaceous Vegetation
  Prairie sandreed - Long-stolon sedge Herbaceous Vegetation
- *Pascopyrum smithi - Bouteloua gracilis - Carex filifolia* Herbaceous Vegetation
  Western wheatgrass - Blue grama - Threadleaf sedge Herbaceous Vegetation
- *Schizachyrium scoparium - Bouteloua* (*curtipendula, gracilis*) - *Carex filifolia* Herbaceous Vegetation Little bluestem - (Sideoats grama, Blue grama) -Threadleaf sedge Herbaceous Vegetation
- *Stipa comata - Bouteloua gracilis - Carex filifolia* Herbaceous Vegetation
  Needle-and-thread - Blue grama - Threadleaf sedge Herbaceous Vegetation

Mesic Mixedgrass Prairies

- *Pascopyrum smithii - Nassella viridula* Herbaceous Vegetation
  Western wheatgrass - Green needlegrass Herbaceous Vegetation

Introduced Grasslands

- *Agropyron cristatum - (Pascopyrum smithii) Semi-natural* Herbaceous Vegetation
  Crested wheatgrass - (Western wheatgrass) Semi-natural Herbaceous Vegetation
- *Bromus inermis - (Pascopyrum smithii) Semi-natural* Herbaceous Vegetation
  Smooth brome - (Western wheatgrass) Semi-natural Herbaceous Vegetation
- *Poa pratensis - (Pascopyrum smithii) Semi-natural* Herbaceous Vegetation
  Kentucky bluegrass - (Western wheatgrass) Semi-natural Herbaceous Vegetation

Riparian/Wet Meadows

- *Eleocharis palustris* Herbaceous Vegetation
  Pale spikerush Herbaceous Vegetation
- *Panicum virgatum* Herbaceous Vegetation

Switchgrass Herbaceous Vegetation

- *Spartina pectinata* - *Carex* spp. Herbaceous Vegetation
  Prairie cordgrass - Sedge species Herbaceous Vegetation
- *Typha* spp. - *Scirpus* spp. - Mixed Herbs Great Plains Herbaceous Vegetation
  Cattail species - Bulrush species - Mixed herbs Great Plains HerbaceousVegetation

Sparse vegetation can be found within areas of established prairie dog towns (approximately 2% of the project area). Prairie dog towns occupy deeper soils on large flats dissected by many drainages, such as in the Conata Basin. Prairie dogs may alter grassland vegetation types over time through their cycle of burrow establishment, grazing, and burrow abandonment. This constant use causes the native vegetation to revert back to an early successional state, *i.e.* a weedy, forb-dominated community.

There is a diverse grassland mixture that intermingles in small units across the landscape. Western wheatgrass is the predominant grass occurring in the project area. This sod-forming grass thrives on clayey soils were 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 in drier areas or places with increased grazing by blue grama. 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 mesic sites on buttes in the South Unit.

Regions throughout the project area that were disturbed historically by agricultural or transportation activity are 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.

Badlands Sparse Vegetation

- Badlands Sparse Vegetation Complex
  Badlands Sparse Vegetation Complex
- *Artemisia longifolia* Badlands Sparse Vegetation

Long-leaf sagebrush Badlands Sparse Vegetation

- *Eriogonum pauciflorum - Gutierrezia sarothrae* Sparse Vegetation
  Small-flowered wild buckwheat - Snakeweed Sparse Vegetation
- Eroding Great Plains Badlands Sparse Vegetation
  Eroding Great Plains Badlands Sparse Vegetation
- Shale Barren Slopes Sparse Vegetation
  Shale barren slopes Sparse Vegetation

Four associations were found in the sparsely vegetated badlands (approximately 19.2% of the project area) ranging from completely barren slopes to vegetated erosion fans. Badlands sparse vegetation develops on siltstone, volcanic ash, and claystone eroded to form pinnacle, cliff, mound, outwash fan, and intermittent drainage habitats. Also, a relatively unique badlands formation occurs on large expanses of low hills covered by chalcedony, a flat, crystalline rock with properties similar to quartz. Drought-tolerant shrubs such as silverscale saltbush (*Atriplex argentea*) and broom snakeweed (*Gutierrezia sarothrae*) and annual forbs can be found dispersed throughout variable badlands environments/habitats.

2. FIRE EFFECTS

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 (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. Fires thus remove 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. More importantly, 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 without leading to increased erosion. 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. Herbivores often prefer post-fire vegetation because it is more palatable and nutritious. When fires burn in mosaic patterns, potential animal cover remains while vegetation increases. Fires tend to increase species diversity, and reduce woody species relative to grass and forb species. (Vogl 1979, Wright and Bailey 1980).

Research data relative to fire's effects on a great number of mixed-grassland vegetation species are lacking. However, there are some data available for some species. It must be restated that some data seem to be in conflict. This may result from the type of fire (wildfire vs. prescribed

fire; head fire vs. backing fire), season of fire (spring, summer, fall, winter); climatic conditions (lightning fires accompanied by rain vs. lightning starts during drought conditions); area of study (Park or Park-type lands vs. similar lands located further from the Park); and research methods used. Thus, data summarized here can serve as only general guides for expected effects of fire on a particular species. It is imperative that as part of the overall fire management program, site specific/species specific monitoring be conducted and observations permanently recorded in order that more accurate conclusions can be drawn as to the best method of returning the Park to a more natural fire regime and the result of using prescribed fires to aid the return to and continuation of that natural regime.

3. EXISTING FINDINGS PERTINENT TO FIRE MANAGEMENT OF SEVERAL PLANT AND ANIMAL SPECIES FOUND IN THE PARK INCLUDE:

Western wheatgrass *(Agropyron smithii)* - Herbage yield reduced for up to three years following wildfire and prescribed fire in semi-arid mixed prairie; remained the same or increased following May, September, and August wildfires, though herbage yield may be reduced in mesic mixed prairie; increases found following prescribed burns in April and March with some decrease following late May prescribed burn. There was also a decline noted in unburned areas (Wright and Bailey 1980). Near Miles City, Montana, another study of prescribed fire results showed the amount produced substantially lower following early spring burning versus fall burning (but both higher than on unburned control plots) although yields similar by the following spring. June yields were greater on burned plots versus unburned, control plots. Soil moisture found to have strong influence. Forage production may or may not be increased where this species is dominant. The time of year measurements are taken can vary findings substantially (White and Currie, 1983).

Little bluestem *(Andropogon scoparius)* -Data from prescribed fires in the forest-grass ecotone in the South Dakota Black Hills area indicate that burning in the spring to late spring promoted an increased production by this species. Conversely, a late winter/early spring burn (early March) resulted in severe harm to little bluestem. The conclusion drawn was that late spring burns under normal to above average moisture conditions are useful to increase yields of this species. Other spring prescribed fires in the eastern edge of the mesic mixed prairie had similar results (Wright and Bailey 1980). For comparison, data exist to show that fires in dry years in the southern Great Plains can greatly decrease yields while fires in wet years can greatly increase the yields. Similar results were found following wildfires in the central Great Plains in both the mixed grass and tall grass prairies. The key seems to be to conduct the burns in the late spring in years of at least average moisture conditions to get an increase of this species (Wright and Bailey 1980).

Blue grama *(Bouteloua gracilis)* - Some reduction of yield resulting from a spring prescribed burn, with full recovery by the third following year in a semi-arid mixed prairie locale; frequency reduced following late-May and fall wildfires in a mesic mixed prairie setting; although with early spring burns increases were found (Wright and Bailey 1980). Another study near Miles City, Montana revealed that using prescribed fire, blue grama yields were reduced early in the growing season and increased in late summer. However, results differed between this study and those following wildfires. Probably, by reduction of other competing species, blue grama had its highest herbage yield following spring burning (although better reduction of the other competing species may be greater using fall burns).

Upland sedges *(Carex spp.)* - Sedges generally tolerate fire very well. The season of a fire has the greatest effect on these plants (Wright 1978). For the Threadleaf Sedge, (Carex filifolia), a low postburn precipitation may delay full recovery until postfire year 2 or 3 or longer, depending on the severity of the burn. In South Dakota, productivity was increased by burning in April and October when precipitation was above average but was reduced when postburn precipitation was low (Whisenant and Uresk 1989). To maintain a good stand, plants should not be burned during period of drought, and burn severity should be light to moderate (Brand 1980). Therefore, if postfire precipitation is adequate, it appears that light-moderate severity fires (particularly spring fires) often cause only minimal damage to threadleaf sedge.

Needle and thread grass *(Stipa comata)* - Needle-and-thread is severely damaged by fire. This grass is generally killed when aboveground vegetation is consumed by fire. Fire effects depend on the season of burn and phenology, as well as on fire intensity and severity. Site conditions and climatic factors can also play a significant role. Needlegrasses are among the least fire resistant of the bunchgrasses (Young, Evans, and Major 1977). This species begins growth in the spring or early summer and lacks the pronounced dormant period in late summer that is typical of many other grasses. Consequently, fire is most injurious in midsummer and least detrimental in late spring or fall (Volland and Dell 1981).

Green needle grass *(Stipa viridula)* **-** Specific effects of fire depend on the season of burn, phenology, size of individual plants, and fire intensity and severity. During some high-severity fires, heat may be transferred below the soil surface by the foliage of green needlegrass, thereby increasing the amount of damage the plant receives. Needlegrasses often exhibit subsurface charring. In general, green needlegrass plants with a lower ratio of dead to living plant material and less fuel volume generally respond more favorably to fire than larger plants do (Wright and Klemmedson 1965).

Japanese brome *(Bromus japonicus)* **-**Except in wet years, fire tends to reduce Japanese brome (non-native) populations. The reduction usually lasts for only 1 or 2 years (Gartner and White 1986). Some seed is killed by fire, but seedbank reserves, reproductive capacity, and competitive ability of Japanese brome are usually sufficient to allow for re-population of an area within 2 years unless the site is reburned (Whisenant 1985). Since litter accumulations are more critical for germination and seedling establishment when precipitation is low, drastic population reductions can be expected when burning is followed by below-average precipitation (Whisenant 1990). Kirsch and Kruse (Kirsch and Kruse 1973) hypothesized that the successful establishment and spread of Japanese brome across the Northern Great Plains is a direct result of fire suppression: the resulting thicker surface mulch created a more mesic microenvironment for seeds and seedlings (Kirsch and Kruse 1973). Japanese brome populations will probably continue to increase in the absence of fire (Whisenant 1990). However, he cautions managers to balance the benefits of litter against the need to reduce Japanese brome when preparing fire management plans. Benefits of litter include soil stabilization and insulation, moisture retention, and promotion of perennials (Vogl 1974).

Smooth brome *(Bromus inermis)* **-** Smooth brome is a cool season exotic that is especially troublesome in disturbed portions of old pastures in the tallgrass and mixed prairie regions. Although less invasive than Kentucky bluegrass, with which it often occurs and is managed, it is also less responsive to management. The optimal timing for control of Smooth brome by burning appears to be in boot stage, which may be as early as mid-April in the central Great Plains or in the northern plains. Early spring (late March-April) or late-season (late summer-fall) fire can increase Smooth brome productivity (Higgins, Kruse, Piehl 1989 and Hughes 1985) especially when Smooth brome has become sod-bound. Late spring fire generally damages cool-season grasses such as Smooth brome (Bailey 1978 and Masters, Vogel 1989). Old,

Kirsch and Kruse, and Blankespoor have reported reductions in Smooth brome with late spring burning. Blankespoor and Larson's 1994 prescribed fire-water treatment study suggests that prescribed late spring fire will most effectively control smooth brome in wet years. They recommend continuing a program of prescribed burning through drier years, however. Since they found that smooth brome increased in importance without burning, and that increases were greatest when initial smooth brome biomass was low, they concluded that failing to burn smooth brome in dry years is likely to accelerate its expansion.

Downy brome/Cheatgrass *(Bromus tectorum)* -This non-native grass is not appreciably affected by burning although production may be reduced the first year. The earlier the fire, the greater the degree of reduction (Stewart and Hull 1949). Fires in pure cheatgrass stands tend to be less common in the spring or early summer. Fires generally occur in the summer after seed is shed and is less vulnerable to burning. Reduction of cheatgrass under these conditions is not great (Tisdale and Hironaka 1981). Fire reduces cured plants to ash, but fire intensity may not be great enough to consume the litter layer, even if associated shrubs burn. Since cheatgrass produces prolific quantities of seed, even a large reduction in the seed pool will not prevent it from regaining dominance on a site (Young, Evans, and Weaver 1976). Must be cautious with this non-native grass because early summer fires can also kill perennial grasses and facilitate increases in cheatgrass.

Kentucky bluegrass *(Poa pratensis)* -There is some disagreement whether Poa pratensis is native in the northern tier of states and Canada (Fernald 1950, Great Plains Flora Assoc 1986, Gleason and Cronquist 1953) or native in Eurasia and introduced throughout its North American range (Hitchcock 1950, Mohlenbrock 1972, USDA 1948). This species is a major problem throughout the tallgrass and mixed grass prairies. In natural areas it competes with native species, reducing species diversity and altering the natural floristic composition. In northern mixed prairie (north of Nebraska sandhills) Poa is believed to compete directly with cool season native grasses (Steuter pers. comm.). North of the Nebraska sandhills in the Dakotas, there is a more even mix of native warm and cool season grasses (Steuter pers. comm.). There is only a short period of one or two weeks between the greening-up of Poa and of native co-dominant Stipa species. Unless fires are timed exactly within this spring period, the advantage of controlling Poa will be offset by damage to native cool season grasses. Results from a study by Schacht and Stubbendieck (1985) in Nebraska suggest that it is not only spring injury to Poa, but the shift of competitive advantage to warm season natives that makes fire an effective tool for range conversion in mixed prairie. Because natural area management goals involve the replacement of Poa by native species, it is important to monitor not only the decrease in Poa, but the increase or retention of desired native species. This is important because under sod-bound conditions Poa could decrease without any benefit to native species (Kruse pers. comm, Volland pers. comm.).

Canada thistle *(Cirsium arvense)* -Canada thistle is a herbaceous perennial in the aster family. It is an exotic weed that was introduced to the U.S., probably by accident, in the early 1600's and by 1954, had been declared a noxious weed in forty three states. In Canada and the U.S., it is considered one of the most tenacious and economically important agricultural weeds, but only in recent years has it been recognized as a problem in natural areas. At Badlands National Park it has invaded ~10,000 acres depending on the year and the mapping techniques used at the time. To keep this weed from expanding its range you must eliminate or control, to the greatest extent possible, seed production. Complete control is difficult because of the perennial root system, abundant seed production, and widespread and diverse habitat of the plant. Prescribed spring burning may be a useful means of slowing the spread of Canada thistle. Spring fires would reduce the number of mature plants. They would also reduce the number of

functional flower heads, resulting in lower seed production and a slow-down in the spread of new plants. Dormant-season fire is also beneficial to many native grass species, would interfere with Canada thistle growth and reproduction, and possibly its spread (Young 1986). Patches of Canada thistle were reduced in Minnesota after 4 years of consecutive spring burning of low to moderate intensity (Becker 1989). Density and aboveground biomass were unchanged after a spring fire (May, before growth began) and increased after both summer (August, peak of growth) and fall (October, winter dormancy) fires in Manitoba. The increase on the fall fire was lower than on the summer fire (Thompson and Shay 1989).

Silver sagebrush *(Artemisia cana ssp. cana)* - Unlike the majority of woody Artemisias, the silver sagebrush complex is moderately resistant to fire-caused mortality. Following fire, plains silver sagebrush resprouts vigorously via root sprouts and rhizomes, and preburn coverages are rapidly regained. Research results from Montana indicate that as burn intensity and severity increase, plant mortality increases and regrowth decreases. [excerpted from Fire Ecology Information System, for references see www. fire.org/feis]

Western snowberry *(Symphoricarpos occidentalis)* - Western snowberry sprouts vigorously from the root crown and rhizomesfollowing fire; stands are usually denser in burnedthan in adjacent unburned areas. Spring and fall fires inducewestern snowberry sprouting, but frequent fires may reduce cover. Western snowberry probably establishes from off-site seed dispersed bybirds and mammals. [excerpted from Fire Ecology Information System, for references see www. fire.org/feis]

Chokecherry *(Prunus virginiana)* - Generalized fire effects information indicates that chokecherry is well-adapted to disturbance by fire. This species is moderately resistant to fire mortality, and, although easily top-killed,sprouts vigorously from surviving root crowns and rhizomes following most fires. To a lesser degree, postfire regeneration also involves the germination of off-site seed dispersed by mammals and birds. Recovery is relatively rapid following fire. Although initially damaged, plant numbers and coverages are typically enhanced for several years. [excerpted from Fire Ecology Information System, for references see www. fire.org/feis]

Silver buffaloberry *(Shepherdia argentea)* - Silver buffaloberry has fair tolerance to fire in the dormant state andsprouts from rootstocks following fire. In North Dakota the green ash/chokecherry and boxelder/chokecherry habitat types, in which silver buffaloberry is common, are adapted to fire. When main trunks of most shrubs and trees in these habitat types are damaged by fire, the plants sprout from the root crown. [excerpted from Fire Ecology Information System, for references see www. fire.org/feis]

Soapweed yucca *(Yucca glauca)* - Soapweed yucca is described as "extremely difficult to kill with fire". This species produces underground rhizomes which are presumably well-protected from the effects of heat by overlying soil and a thick, protective bark-like covering. Seed germinates well and seedlings establish readily on newly disturbed areas with little vegetation, such as recently burned sites. [excerpted from Fire Ecology Information System, for references see www. fire.org/feis]

Ponderosa pine *(Pinus ponderosa)***—**Interior ponderosa pine depends on frequent surface fires to maintain stand health and stability (Biswell, Kallander and Komarek 1973). Fire exclusion has profoundly influenced the stability of interior ponderosa pine stands (Cooper 1960). The following management problems are associated with reduced fire frequencies: (1) overstocked sapling patches, (2) reduced growth, (3) stagnated nutrient cycles, (4) increased disease, insect infestations, and parasites, (5) decreased seedling establishment, (6) increased fuel loadings,

(7) increased vertical fuel continuity due to dense sapling patches, and (8) increased severity and destructive potential of wildfires (Covington and Sackett 1984). The effect of fire on interior ponderosa pine is generally related to tree size, fire intensity, and tree density (Alexander 1987). Low intensity fires readily kill seedlings less than 12 inches in height (Biswell, Kallander and Komarek 1973). Larger interior ponderosa pine seedlings can sometimes survive heat generated by low intensity surface fires, especially dormant season fires (Fischer and Clayton 1983). Larger seedlings, saplings, and pole-sized trees are damaged but not killed by low intensity fires. Beyond the pole stage, interior ponderosa pine is quite resistant to the majority of ground fires (Schuber, Heidmann and Larson 1970). For the season of burn: Interior ponderosa pine usually survives fires during the dormant season, largely because insulating scales form once leader growth stops (Ryan 1982) and because dormant season fires are usually relatively cool (Dieterich 1979). Trees are least resistant to thermal damage during early spring and most resistant in the fall when dormant (Hare 1961). Trees can withstand up to 50 percent crown scorch from fall burning but only 30 percent crown scorch from spring burning (Mohr 1984).

Green ash *(Fraxinus pennsylvanica)* - Generalized fire effects information indicates that green ash is adapted to disturbance by fire. If the fire is hot enough to girdle even mature trees, which have little protection from burning because of their relatively thin bark, this species will sprout prolifically from the root crown when the main stem is damaged. To a lesser degree, postfire regeneration most likely involves the germination of on-site canopy stored seed and/or off-site wind or water dispersed seed as well. [excerpted from Fire Ecology Information System, for references see www. fire.org/feis]

Rocky Mountain Juniper *(Juniperus scopulorum)* - Young Rocky Mountain juniper which has a compact crown and thin bark, is easily killed by fire. It can be killed when the stem or crown is scorched. Older Rocky Mountain junipers have thicker bark and an open crown, and can survive cool fires. Older trees are generally killed by hot fires or when low-hanging branches allow the fire to enter the crown. Rocky Mountain juniper does not re-sprout after fire. Reestablishment is primarily through water or animal-dispersed seed. [excerpted from Fire Ecology Information System, for references see www. fire.org/feis]

Eastern Cottonwood *(Populus deltoides)* - The bark of older cottonwoods can be up to 4 inches (10 cm) thick at thebase, affording fire protection. Trees less than 20 years old are susceptible to fire but may re-sprout. Plains cottonwood (var.occidentalis) is able to produce sprouts from the root crown and the stump after fire. The literature is unclear whether eastern cottonwood (var. deltoides) is adapted to fire in this way. Cottonwood seedling regeneration is favored following disturbances suchas fire and flood. Fire thins the overstory, allowing more light penetration, and exposes the mineral soil so that seeds are able to establish if soil moisture is adequate. [excerpted from Fire Ecology Information System, for references see www. fire.org/feis]

Pronghorn/Antelope *(Antilocapra americana)* - As a primarily 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 (Higgins, Kruse and Piehl 1989). Nutritional benefits of fire on forage may last up to 4 postfire years with an increase in primary productivity for a longer period depending upon plant species (Badlands National Park Conservation Plan 1966).

Bison *(Bison bison)* - Fire is important in creating and maintaining bison habitat. Fire regenerates grasslands and enhances production, availability, and palatability of many bison forage species (Campbell and Hinkes 1983). Prescribed fire is effective in mitigating bison

impacts on black-tailed prairie dog colonies. Bison use of a black-tailed prairie dog colony was compared before and after a prescribed fire on adjacent, uncolonized grassland at Badlands National Park, in 1979 and 1980. Cow-calf herds increased their use (measured as hours of feeding time) of the burned grasslands by a factor of 12 and decreased their use of the colony by 30 to 63 percent following the burn. To decrease bison impacts on black-tailed prairie dog colonies, burns should be located a "considerable" distance from colonies (Coppock and Detling 1986).

Black-tailed Prairie dog *(Cynomys ludovicianus)* -Fire can be used to stimulate the growth of dogtowns as well as to temporarily halt their rate of growth or to even reduce their size. Prescribed burns immediately adjacent to dogtowns can enhance dogtown expansion by reducing the height and density of bordering ground cover. Fires on areas removed from dogtowns will significantly reduce ungulate use of colony sites. Under such conditions prairie dogs must on their own accomplish the reduction of ground cover required for expansion into uncolonized areas (Klukas 1988).

Bighorn Sheep (*Ovis canadensis*) - Prescribed burning and its associated human activity in bighorn sheep range may increase stress levels in a population. Herd condition should be considered when planning time of fire. No information is available regarding the direct effects of fire on bighorn sheep.

Many bighorn sheep populations originally occurred in areas with frequent fire intervals. Fire exclusion, which has allowed conifers to establish on grasslands, has decreased both the forage and security values on many bighorn sheep ranges. Burning may regenerate range lands 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 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, especially elk, are attracted to prescribed burns intended to benefit bighorn sheep.

Prescribed burning has been widely used to increase the quantity and nutritional quality of bighorn sheep forage throughout North America. In areas where the available bighorn sheep range is large and provides alternative and distant wintering sites, fires should be prescribed or located in areas that would minimize the stress on sheep. Early spring fires, particularly on south and southwest aspects, may provide more spring forage than would otherwise be available for bighorn sheep.

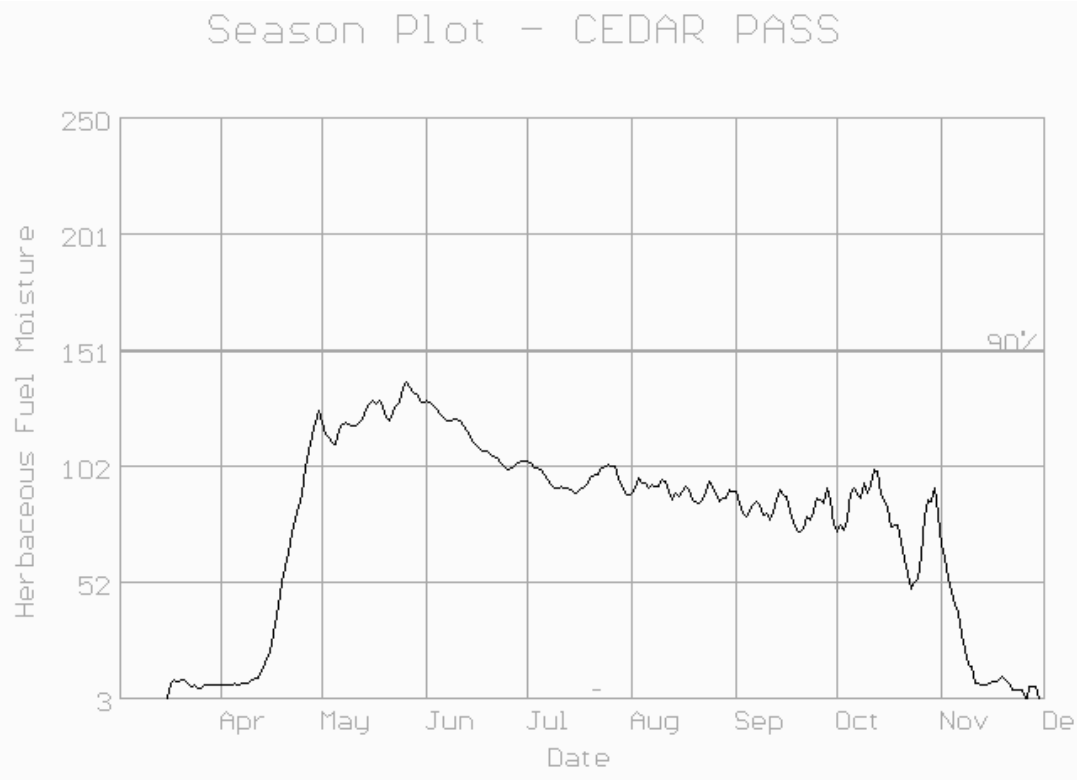
Coyote (*Canis latrans*) - Coyotes are very mobile and can probably escape most fires. There are no reports of direct coyote mortality due to fire.

Fire may improve the foraging habitat and prey base of coyotes. Fires that reduce vegetation height and create open areas probably increase hunting efficiency by coyotes. Periodic fire helps to maintain habitat for many prey species of coyote. Fires that create a mosaic of burned and unburned areas are probably the most beneficial to many coyote prey species. Several studies indicate that many small mammal populations increase rapidly subsequent to burning in response to increased food availability. Fire often improves hare and rabbit forage quality and quantity for two or more growing seasons. Additionally, fire stimulates grass production, which should lead to an increase in small mammal populations. Prescribed burning that favors small

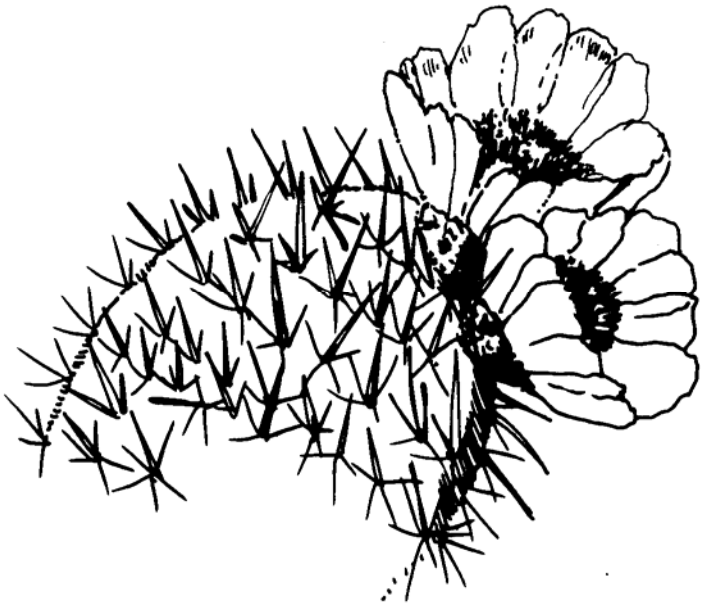
mammals by creating ecotones and different age classes of vegetation would increase the prey base for coyotes and make hunting easier by opening up the habitat.

Seasonal Graphs of Average 10 and 100-hour Dead Fuel Moisture

Seasonal Graphs of Average Live Woody and Herbaceous Fuel Moisture



Seasonal Graphs of Average Burning Index and Energy Release Component



Appendix E(5)

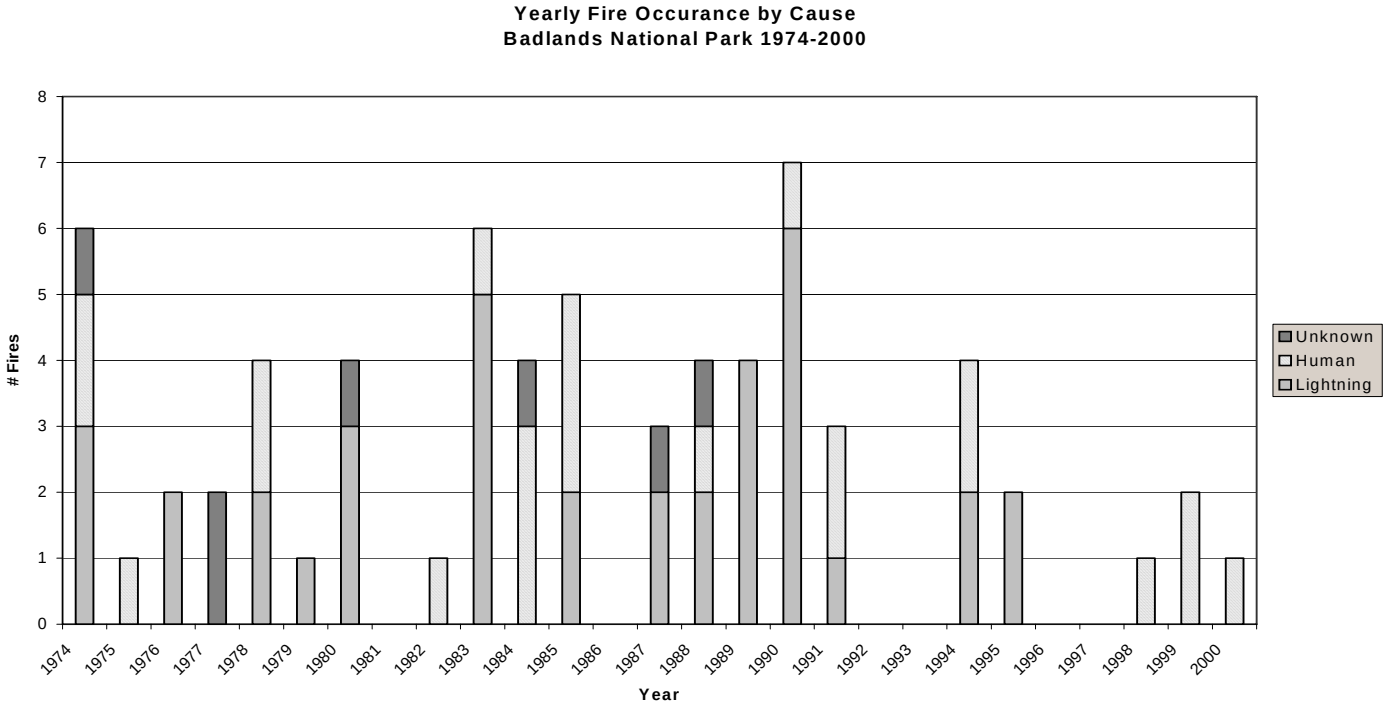
PARK FIRE HISTORY 1974-2003

Year	Fire Name/Location	Start Date	Out Date	Area (acres)	Cause
1974	Railroad	4/9	4/9	4	human
1974	Quinn Road	6/20	6/20	15	lightning
1974	Buffalo Corral	6/20	6/20	2	lightning
1974	State Radio Towers	6/25	6/25	5	human
1975	Hamms Draw	10/17	10/18	77	human
1976	Temple	7/15	7/15	40	lightning
1976	Hare	8/30	8/30	37	lightning
1977	Chadron	7/26	7/26	2	human
1977	Crooked Creek	8/24	8/24	180	human
1978	Roberts	7/13	7/13	20	lightning
1978	Rocket	7/17	7/17	4	human
1978	Haystack	9/10	9/10	2	lightning
1978	Silo	10/11	10/11	50	human
1979	Banded Buttes	7/21	7/21	0.6	lightning
1979	Red Shirt	9/9	9/9	20	lightning
1979	Sheep Mountain	12/27	12/27	30	human
1980	Burns Basin	2/5	2/5	5	human
1980	Sheep Mtn. Finger	6/21	6/22	30	lightning
1980	Norbeck Pass	7/2	7/2	1	lightning
1980	NE Entrance	7/2	7/2	1	lightning
1980	Quinn Road East	7/8	7/8	35	lightning
1980	Sage Crk.(Larsen)	7/31	8/1	900	lightning
1980	Crew Ranch	8/9	8/9	3	lightning
1982	Power Pole	8/17	8/17	2	human
1983	Rifle Range	4/15	4/15	5	prescribed
1983	Sage Creek	4/19	4/19	200	prescribed
1983	Bighorn	4/20	4/20	1	prescribed
1983	Pinnacles	7/15	7/15	3	lightning
1983	Hamms Draw	7/29	7/29	1	lightning
1983	Bigfoot Pass	8/12	8/12	5	lightning
1983	Northeast	8/12	8/12	1	lightning
1983	Hay Butte	8/17	8/17	80	lightning
1983	Crown	10/27	10/27	35	human
1984	Postage Stamp	4/15	4/15	2	prescribed
1984	Sheep Mountain	4/20	4/20	60	human
1984	Quinn Table	4/24	4/24	400	prescribed
1984	Grasslands	5/8	5/8	450	prescribed
1984	Buffalo Corrals	6/20	6/20	100	prescribed
1984	Conata Picnic	9/4	9/4	6	human
1985	Sage Creek Basin	4/10	4/11	3700	prescribed
1985	Dearborn	6/16	6/16	1	human
1985	Conata Boundary	6/20	6/20	25	lightning
1985	Red Shirt	6/25	6/25	15	lightning

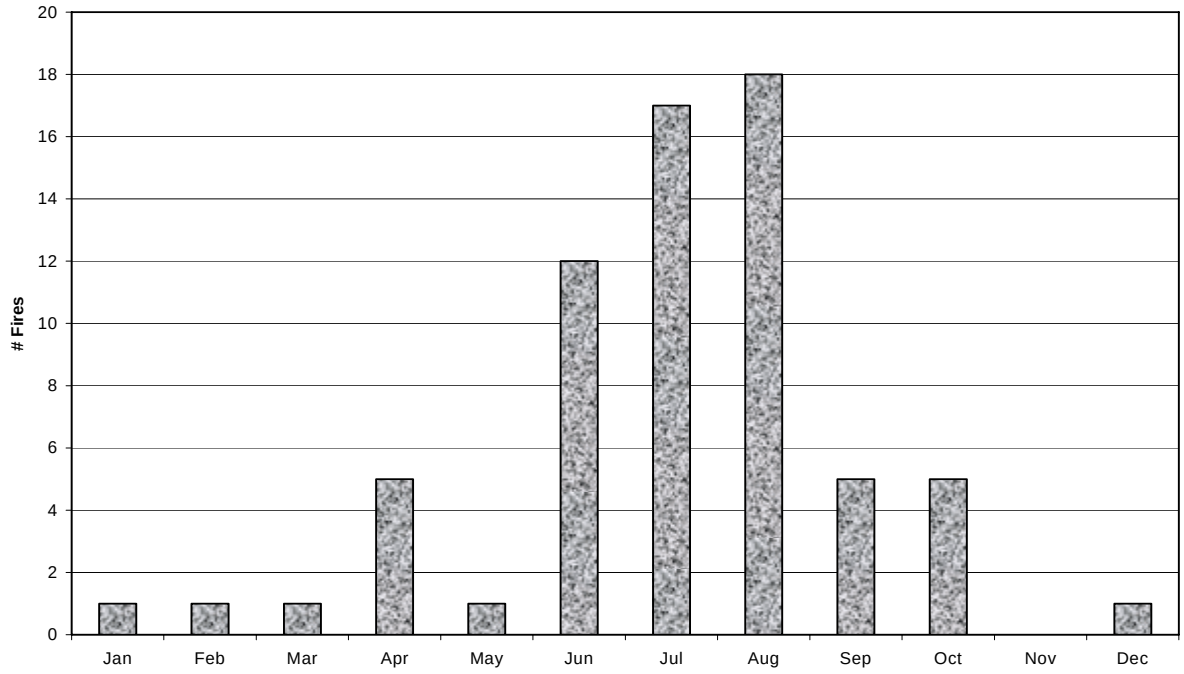
Year	Fire Name/Location	Start Date	Out Date	Area (acres)	Cause
1985	Campgrd.CedarPass	6/28	6/28	1	human
1985	Clastic Dikes	7/4	7/4	1	human
1985	DoubleShot	7/7	7/7	250	lightning
1985	OBRYAN	7/7	7/7	100	lightning
1985	INTERSTATE	7/12	7/12	25	lightning
1986	Stirk Table	8/19	8/19	5	lightning
1987	Pinnacles Burn	4/16	4/17	640	prescribed
1987	Sage Creek Gap	7/7	7/7	.10	lightning
1987	Circle 10	7/15	7/15	2	human
1987	Stirk Skool	7/27	7/27	41	human
1987	Exit 121	8/1	8/1	5	lightning
1987	Red Shirt	8/3	8/3	200	lightning
1987	Red Shirt	8/3	8/7	200	lightning
1987	Visitor Center	8/17	8/17	0.1	human
1988	Crooked Creek	3/25	3/25	22	human
1988	Sage Creek	4/29	5/1	300	lightnig
1988	White Butte	4/29	5/1	70	lightning
1988	Cuny Table	6/24	6/24	5	lightning
1988	Sheep Mtn Block 1	7/13	7/13	400	prescribed
1988	Sheep Mountain	7/30	8/03	600	prescribed
1988	Sheep Mtn Block 2	8/10	8/10	200	prescribed
1988	Grasslands	9/16	9/16	30	prescribed
1989	SU Developed Area	4/6	4/6	10	prescribed
1989	Roadside	4/10	4/12	930	prescribed
1989	Labyrinth	4/14	4/14	220	presrcibed
1989	Rockyford	6/19	6/19	60	lightning
1989	Sampson	7/7	7/7	30	lightning
1989	Elsa	8/24	8/24	2	lightning
1989	Temple	8/30	8/31	2000	lightning
1989	Upper Quinn	9/19	9/28	15	prescribed
1990	Quinn	4/3	4/5	1800	prescribed
1990	Stronghold	7/5	7/5	15	human
1990	West Interior	7/16	7/16	0.1	lightning
1990	Cuny Table	8/9	8/9	1	lightning
1990	Butterfly	8/9	8/9	20	lightning
1990	Bureny	8/9	8/9	10	lightning
1990	County Line	8/21	8/21	1	lightning
1990	Thunder	8/22	8/22	15	lightning
1991	Northeast	4/3	4/4	1280	prescribed
1991	Housing	4/4	4/4	48	prescribed
1991	Antler	4/21	4/21	.05	prescribed
1991	Sheep Mountain	4/23	4/23	13	prescribed
1991	Windows	7/31	7/31	0.1	lightning
1991	Woodydraw	10/26	10/31	12	prescribed
1991	Westinteri	10/26	10/26	655	prescribed
1992	Westinteri	3/14	3/14	160	prescribed
1992	Cedar Pass	3/14	3/14	44	prescribed

Year	Fire Name/Location	Start Date	Out Date	Area (acres)	Cause
1992	Quinn T able	3/15	3/15	50	prescribed
1992	Norbeck	3/23	3/23	700	prescribed
1992	Whiteriver	4/6	4/6	4	prescribed
1992	Smoothbrome	5/1	6/12	5	prescribed
1992	Bighorn	9/17	9/18	221	prescribed
1992	Bighorn	9/19	9/19	45	prescribed
1993	Bighorn	3/25	3/25	180	prescribed
1993	Bloombasin	3/26	3/27	623	prescribed
1993	Bighorn	4/5	4/5	10	prescribed
1993	Bighorn	4/17	4/17	31.50	prescribed
1993	Bigfoot	4/28	4/29	1200	prescribed
1993	Conata 1	4/29	4/30	15	prescribed
1993	Conata 2	6/22	6/23	16	prescribed
1993	Quinn Table	10/21	10/22	300	prescribed
1994	Pronghorn	6/6	6/6	0.2	lightning
1994	Twister	6/7	6/7	0.1	lightning
1994	Sheep	7/2	7/3	2.5	human
1994	Northfork – South	9/26	9/26	220	prescribed
1994	Cottonwood	9/27	9/28	35	lightning
1994	Whitcher	10/11	10/11	0.1	lightning
1995	Grasslands	7/11	7/11	10	lightning
1995	Red Shirt	8/17	8/18	225	human
1995	Baysinger	9/12	9/19	1397	prescribed
1996	Rainbow	7/29	7/29	3	human
1996	Galigo Table	8/2	8/2	275	lightning
1996	Horse Pasture	8/2	82/	20	prescribed
1996	Fortune	9/2	9/2	20	lightning
1996	Picnic	10/9	10/11	640	prescribed
1998	BigfootRoad	7/9	7/9	1	human
1998	Sage Creek (Lopez)	10/8	10/8	5	human
1999	Mile Marker 4	7/12	7/12	28	human
1999	Horse Pasture	8/17	8/20	660	prescribed
1999	Big Buffalo	9/9	9/12	4785	prescribed
1999	Sage Creek	7/12	7/12	1	human
2000	Pinnacles	4/47	4/29	587.6	prescribed
2000	Bud Point	1/24	1/24	510	human
2000	Roadside	4/17	5/4	395	prescribed
2000	Cottonwood	7/7	7/7	240	lightning
2000	Prairie Wind	7/7	7/7	1	lightning
2000	Stronghold	7/14	7/14	1.5	lightning
2000	Horn	9/6	9/6	30	lightning
2000	Southgate	9/7	9/7	.01	human
2000	Southgate 2	9/7	9/7	.01	human
2000	Birthday	9/28	9/28	15	human
2001	Battleship	3/16	3/16	1	human
2001	Circle 10	4/18	4/18	15	human
2001	Roadside	5/8	5/8	287.5	prescribed

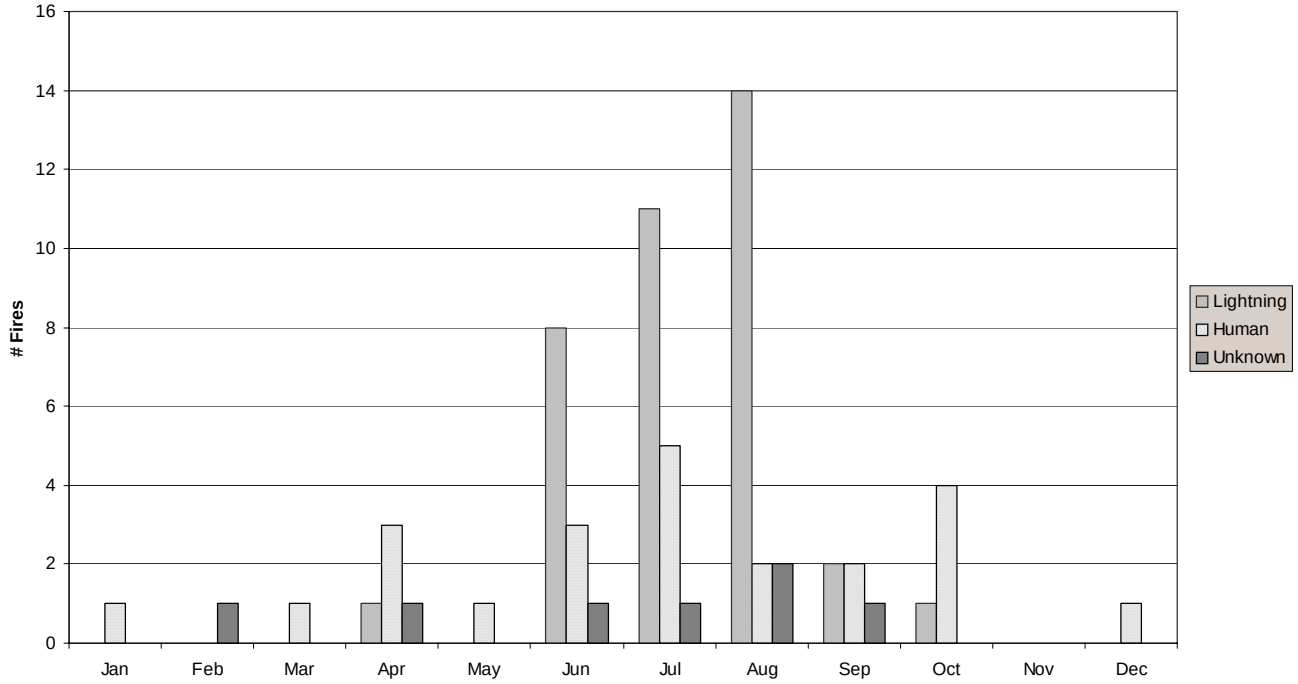
Year	Fire Name/Location	Start Date	Out Date	Area (acres)	Cause
2001	Rodeo Point	8/22	8/23	.5	lightning
2001	West Sage Creek	10/16	10/16	15	prescribed
2001	West Sage Creek	10/28	10/29	3572	prescribed
2002	Black	1/15	1/15	.5	human
2002	MRP	4/23	4/24	1.08	human
2002	Roadside	4/25	4/25	240	prescribed
2002	Cedar	6/1	6/2	9.72	lightning
2002	St. Barnubus	6/20	6/20	250	lightning
2002	Red Shrit Table	6/28	6/29	3	human
2002	Red Shirt Overlook	7/3	7/3	1	human
2002	Whitcher	8/29	8/30	5	lightning
2002	Gibbons Creek	9/5	9/5	5	lightning
2002	Dillon	10/9	10/10	40	prescribed
2002	Dillon	11/21	11/22	3132	prescribed
2003	Evan	7/03	7/03	.10	lightning
2003	505	7/28	7/28	10	human
2003	Palmer Creek	7/15	7/16	200	lightning
2003	129	8/05	8/05	108	human
2003	Kalkbrenner	8/08	8/08	99	lightning
2003	Deadtree	8/19	8/19	.25	lightning
2003	Indian Creek	8/24	8/24	81	lightning
2003	Campground	9/23	9/30	250	prescribed



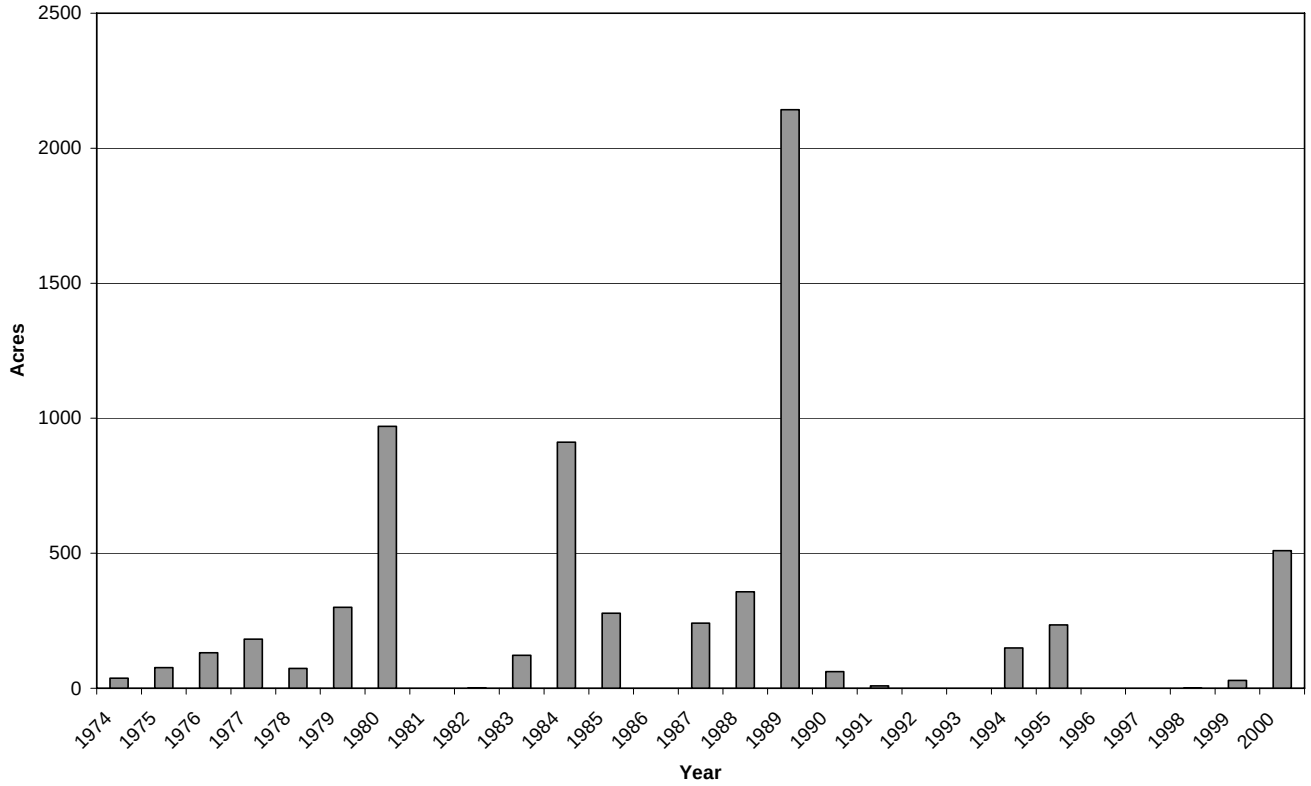
Wildland Fire Ignitions by Month
Badlands National Park 1974-2000



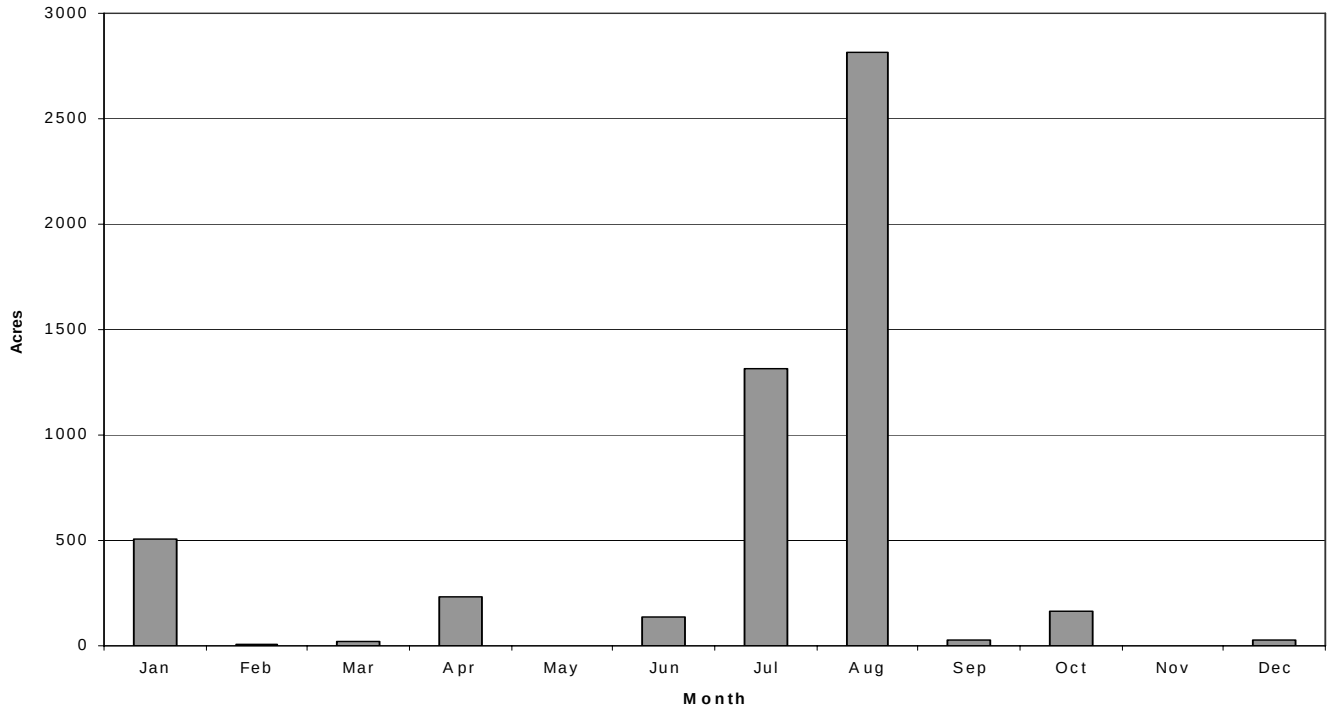
Monthly Fire Occurance by Cause
Badlands National Park 1974-2000



Wildland Fire Acreage by Year
Badlands National Park 1974-2000



Wildland Fire Acreage by Month
Badlands National Park 1974-2000



National Park Service
Badlands National Park, South Dakota
Fire Monitoring Plan

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CONTENTS

INTRODUCTION

Badlands National Park (BADL) is located in southwestern South Dakota. The park encompasses 242,756 acres; 64,144 acres are designated as Wilderness. The park is characterized by barren canyons, peaks, and ridges--known as badlands--intermixed with large areas of mixed-grass prairie providing habitat for large numbers of wildlife and plant species. Recent vegetation mapping shows two dominant land cover types (Von Loh et al., 1999). Sparsely vegetated badlands cover 45% of the park and a western wheatgrass alliance covers 37%. No other type covers even 5 percent of the park. Western wheatgrass (*Pascopyrum smithii*) mixed-grass prairie is believed to be the pre-settlement vegetation for the area but the exact composition of the communities before settlement is unknown. Kuchler (1964) described the potential vegetation for the BADL area as wheatgrass-needlegrass prairie.

Large and small-scale disturbances shaped the landscape of BADL and surrounding areas. Disturbances included seasonal bison grazing, extended wet and dry periods, soil disturbance (buffalo wallows and prairie dog towns) and fire. These disturbances continue in BADL today. Fires started both by lightning and Native Americans maintained the prairies and kept shrubs and trees limited to wetter areas or areas of broken topography until the area was settled in the 1880s. Fire suppression, overgrazing and plowing for farming broke up the areas of continuous fuels and significantly reduced the number of fires and acres burned. The lack of trees with fire scars make interpreting fire history for the area difficult. Wendtland and Dodd (1990) considered historical accounts and fire scar data from the edges of the Black Hills. They estimated fire return intervals from as short as 5 years in level to gently rolling topography to 15-30 years in more broken topography at Scotts Bluff National Monument, Nebraska.

Collins and Gibson (1990) documented the need for an interaction of four different disturbance types to maintain diverse community structure in mixed-grass prairie. The interaction of drought, grazing, fire and soil disturbance--both buffalo wallows and prairie dog towns--alters community structure. In the absence of any one of these disturbances, species richness (the number of species per unit area), evenness (the distribution between dominance among species) and patch structure (the association of species at various spatial scales) may change. The absence of fire tends to increase woody species and reduce species richness and patch structure. The absence of grazing by large ungulates and/or soil disturbance reduces species diversity and decreases community heterogeneity. Management actions that include all disturbance types should be considered to maintain diverse community structure.

Prescribed and wildland fire for resource benefits (wildland fire use fires) will be used to maintain and restore the fire adapted ecosystems at Badlands. National Park Service (NPS) **Reference Manual 18** states, “Monitoring is a critical component of fire management and the Fire Monitoring Plan is important to identify why monitoring will be done, what will be monitored, how it will be monitored, where it will be done, and how often it will be completed.” Monitoring of these fires is mandated in **Director’s Order #18: Wildland Fire Management** issued in 1998. Section 5.2, *Fire Management Plans* (no. 10) states, “Include procedure for short and long term monitoring to document that overall program objectives are being met and undesired effects are not occurring”. Section 5.8 directly addresses *Prescribed Fire Monitoring*:

a) Fire effects monitoring must be done to evaluate the degree to which objectives are accomplished.

b) Long-term monitoring is required to document that overall programmatic objectives are being met and undesired effects are not occurring.
c) Evaluation of fire effects data is the joint responsibility of fire management and natural resource management personnel.

There are three main communities at Badlands that will initially be monitored: (1) Western Wheatgrass Mixed-grass Prairie, (2) Non-native Grasslands, and (3) Woody Draws. Much of the park has not burned since its establishment in 1939. Fire will initially be used to restore these communities to more native conditions and then will be used in maintaining systems by burning within the predicted range of return intervals. A more complete discussion of fire effects and management follows.

DESCRIPTION OF THE ECOLOGICAL MODEL

I. NORTHERN GREAT PLAINS MIXED-GRASS PRAIRIE

The vegetation of BADL is mixed-grass prairie. Mixed-grass prairie is characterized as having a mixture of mid-height and shortgrasses as well as a mixture of grasses with different photosynthetic pathway types (C_3: cool-season and C_4: warm-season) (Singh et al. 1983). This diversity of species found on the Northern Great Plains is a result of great and repeated migrations of species that responded to changes in climate during periods of glaciation (Weaver and Albertson 1956, Wells 1970). One of the unique traits of the Northern Great Plains mixed-grass prairie is the dominance of cool-season grasses (Singh et al. 1983). A complex disturbance regime of biotic and abiotic disturbances (including periodic drought, grazing, fire, and soil disturbances) have interacted to form and continue to maintain grasslands of the Northern Great Plains (Anderson 1990, Collins and Gibson 1990). These disturbances also interact with climate, topography, soils, and competition among plant species to influence grassland composition (Fig. 1) (Wells 1970, Wright and Bailey 1980, Collins and Gibson 1990).

Although cool-season species tend to dominate northern mixed-grass prairies, warm-season species co-dominate on more xeric sites since these species are generally better adapted to warm, dry conditions (Singh et al. 1983). Light to moderate grazing also favors warm-season species while heavy grazing can shift composition toward warm-season shortgrasses like buffalograss (*Buchloe dactyloides*) and blue grama (*Bouteloua gracilis*) (Weaver and Albertson 1956, Ode et al. 1980, Singh et al. 1983). Native ungulates generally favor graminoids over forbs which may lead to increases in occurrence of forb species (Krueger 1986). Annual forbs colonize small-scale soil disturbances such as prairie dog mounds or buffalo wallows (Collins and Gibson 1990).

Historically, fire was a frequent and large-scale disturbance on northern mixed-grass prairies and continues to be a tool that managers use. Historic fire frequencies are very difficult to determine largely due to a lack of trees on the plains to record fire scars (Wright and Bailey 1980). Most fire frequency estimates have been based on accounts of early settlers or known fire frequencies needed to prevent woody plant encroachment into grasslands. Mean fire return intervals have been estimated at 4 to 9 years for the sandhills of north-central Nebraska (Steinauer and Bragg 1987), 10 to 12 years for the forest-prairie ecotone of the Black Hills of South Dakota (Brown and Sieg 1999), and 15 to 30 years for the broken topography of Scotts Bluff National Monument, Nebraska (Wendtland and Dodd 1990).

Ignition sources for fires in presettlement times are believed to be mainly lightning and both intentional and unintentional ignition by American Indians. A study of lightning-ignited fires in the Northern Great Plains over the past five decades indicates that nearly 75% of lightning-ignited fires occurred during July and August and lightning-ignited fires were recorded every month from April to September (Higgins 1984). It is presumed that this pattern has not changed significantly for at least a few centuries. Historical documents and accounts of early settlers suggest that there were two seasonal periods for fires ignited by American Indians, one during the spring with a peak in April and one during the fall with a peak in October (Higgins 1986).

Effects of fire can vary depending on the season burn occurred, time since last burned, grazing history, precipitation before and after burn, vegetation composition, fire intensity and severity, and topography (Anderson 1990, Collins and Gibson 1990). Fire can influence both plant community productivity and structure. Productivity may be increased following fire as a result of reduction in the litter layer and grazing may have similar effects (Anderson 1990). In mixed-grass prairie, with both warm- and cool-season species, season of burn can strongly affect species composition. Generally, spring and fall burns favor warm-season grasses while summer burns tend to favor cool-season grasses (Steuter 1987, Howe 1994).

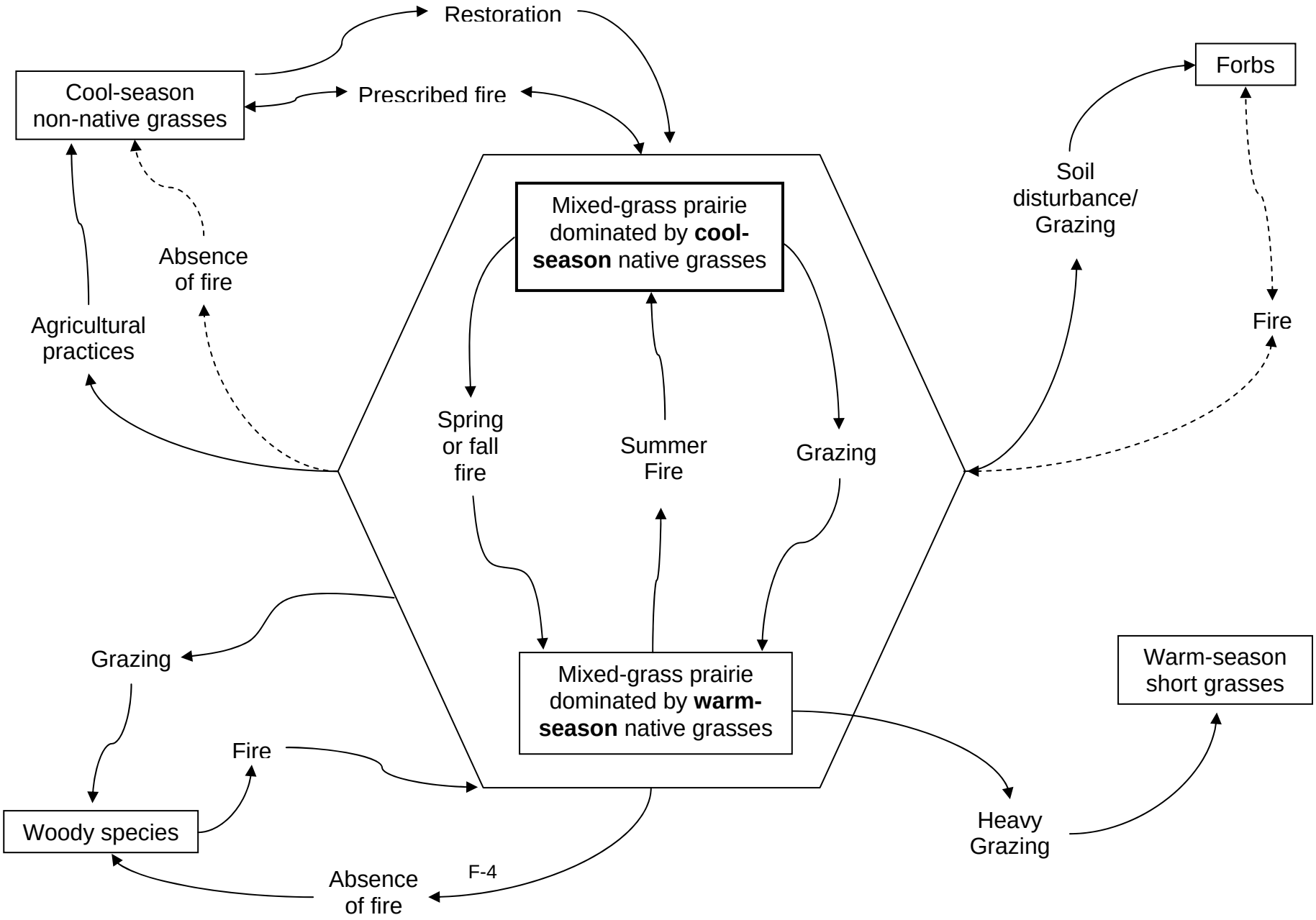
II. VEGETATION OF BADLANDS NATIONAL PARK

Kuchler (1964) described the potential vegetation for the BADL area as wheatgrass-needlegrass prairie and wheatgrass-grama-buffalograss prairie. A vegetation survey was conducted in the park in 1983, but the wheatgrass-grama-buffalograss type was not located. It was suggested that this vegetation type, observed in the early 1960s, was the result of drought and overgrazing and had shifted to the wheatgrass-needlegrass type since the earlier survey (Stubbendieck and Willson 1986).

The wheatgrass-needlegrass type is dominated by western wheatgrass, blue grama, needle-and-thread (*Stipa comata*), and green needlegrass (*Stipa viridula*) (Kuchler 1964). Other graminoids present include slender wheatgrass (*Elymus trachycaulus*), sedges (*Carex* spp.), Junegrass (*Koeleria macrantha*), little bluestem (*Schizachyrium scoparium*), buffalograss, and prairie sandreed (*Calamovilfa longifolia*). The non-native grasses smooth brome (*Bromus inermis*), crested wheatgrass (*Agropyron cristatum*), and Kentucky bluegrass (*Poa pratensis*) are common in some areas of the park. Common forbs are pussytoes (*Antennaria* spp.), heath aster (*Aster ericoides*), sagewort (*Artemisia* spp.), purple coneflower (*Echinacea angustifolia*), goldenrod (*Solidago* spp.), and the non-natives yellow sweetclover (*Melilotus officinalis*), and Canada thistle (*Cirsium arvense*). Shrub species like leadplant (*Amorpha canescens*), wild rose (*Rosa* spp.), yucca (*Yucca glauca*), and prickly pear (*Opuntia* spp.) are common in the grassland areas.

Shrublands and woodlands are a minor component of the park and are generally associated with draws and floodplains. Rocky Mountain juniper (*Juniperus scopulorum*), ponderosa pine (*Pinus ponderosa*), green ash (*Fraxinus pennsylvanica*), American elm (*Ulmus americana*), plains cottonwood (*Populus deltoides*), willow (*Salix* spp.), silver sagebrush (*Artemisia cana*), skunkbush sumac (*Rhus aromatica*), chokecherry (*Prunus virginiana*), and American plum (*Prunus americana*) are generally found in these areas.

Figure 1. The Northern Great Plains mixed-grass prairie is characterized as having a mixture of mid-height and shortgrasses with different photosynthetic pathway types (cool- and warm-season). Cool-season grasses are dominant. A complex disturbance regime of biotic and abiotic disturbances (including periodic drought, grazing, fire, and soil disturbances) have interacted to form and continue to maintain grasslands of the Northern Great Plains. These disturbances also interact with climate, topography, soils, and competition among plant species to influence grassland composition.



MONITORING TYPES

Park resource management staff selected three plant communities as the current priorities for short and long-term monitoring. These communities are based on the vegetation communities described by Von Loh et al. (1999). They were chosen by evaluation of acreage across the park, presence of rare species that would be impacted by fire, importance as habitat for a number of different animal species, estimated fire return intervals, known and unknown fire effects, and opportunities for non-native plant reduction. A description of other community types found and relative acreage can be found in Appendix E(4) of the Badlands Fire Management Plan (FMP) or Von Loh et al. (1999). Each monitoring type has a "Desired Future Condition" statement developed by a team consisting of the park superintendent, resource management staff and the Northern Great Plains lead fire effects monitor. These are described in the Management Objectives section of this plan.

I. WESTERN WHEATGRASS MIXED-GRASS PRAIRIE

Western wheatgrass alliance covers 88,252 acres or 37% of the park area (Von Loh et al., 1999). Because of the extent of this community, it was one of the first to be monitored when Fire Monitoring Handbook (FMH) plots were installed at Badlands in 1996.

This community occurs in a wide a variety of habitats throughout the park. Sites are generally flat to moderately steep in slope and occur on all aspects. Associations of the type occupy clay, silt, loam and sandy soils of flats, swales, drainages, hills and slopes. (Von Loh et al., 1999) Elevations range from 2,400 to 4,000 feet. Soils are clayey, silty, claypan, and badlands overflow. Soil types are Blackpipe clay loam, Blackpipe-Norrest complex, Blackpipe-Wortman Complex, Cedarpass silty clay loam, Cedarpass-Denby complex, Cedarpass-Interior-Badlands, and Interior-Cedarpass-Denby (USDA-SCS, 1987). Stands of this type have moderate to complete herbaceous cover, between 40-100%. Western wheatgrass is strongly dominant in ungrazed stands, and less so in stands subjected to annual livestock grazing. Species dominance can vary locally within a stand, depending on soils and use factors (Von Loh et al., 1999). Dominant graminoids are western wheatgrass, blue grama, and green needlegrass (Table 1). Shrubs are plains prickly pear (*Opuntia polyacantha*), skunkbush sumac, sand sage (*Artemisia frigida*), and silver sagebrush (*Artemisia cana*). Forbs include heath aster, yarrow (*Achillea millefolium*), and Missouri goldenrod (*Solidago missouriensis*). Non-native species including Kentucky bluegrass, smooth brome, Japanese brome (*Bromus japonicus*), cheatgrass (*Bromus tectorum*), and yellow sweetclover occur but are a minor component of this monitoring type.

Table 1. Dominant species of western wheatgrass mixed-grass prairie monitoring type.

Species	NATIVE	SEASON	ANNUAL/ PERENNIAL	GROWTH HABIT
western wheatgrass	Yes	Cool	Perennial	Sod-forming/ Rhizomatous
blue grama	Yes	Warm	Perennial	Tufted
green needlegrass	Yes	Cool	Perennial	Bunchgrass

II. NON-NATIVE GRASSLANDS

Non-native grassland covers 5,100 acres or 2% of the park area (Von Loh et al., 1999). These areas include prairie that is composed of 50 - 80% non-native species. Many of these areas are associated with disturbances such as roadsides, abandoned farm fields, and areas that were seeded with non-native grasses to "improve" the range for grazing. Certain areas with high disturbance include: areas adjacent to park roads and facilities, abandoned agricultural fields along the northern park boundary, and Sheep Mountain, Cuny, and Stronghold Tables. These areas historically supported western wheatgrass mixed prairie (Von Loh et al., 1999). Elevation ranges from 2,400 to 4,000 feet. Non-native grasslands occur on clayey, silty, claypan, and badlands overflow soils. Soil types are Blackpipe clay loam, Blackpipe-Norrest complex, Blackpipe-Wortman Complex, Cedarpass silty clay loam, Cedarpass-Denby complex, Cedarpass-Interior-Badlands, and Interior-Cedarpass-Denby (USDA-SCS, 1987).

Stands typically have moderate herbaceous cover, ranging from 40-90% and very dense litter over the ground surface. Areas tend to be dominated by one non-native grass species, often planted. Species often found dominating these sites include smooth brome, crested wheatgrass, or Kentucky bluegrass (Table 2). Other non-native species associated with these areas include Japanese brome, cheatgrass, alfalfa (*Medicago sativa*), yellow sweetclover, and common mullein (*Verbascum thapsus*). At the edge and occasionally interspersed are western wheatgrass, needle-and-thread, and green needlegrass. Very few native forbs or shrubs are seen in this type (Von Loh et al., 1999).

Table 2a. Common grass species of non-native grasslands monitoring type

Species	Native	Season	Annual/ Perennial	Growth Habit
Crested wheatgrass	No	Cool	Perennial	Bunchgrass
Kentucky bluegrass	No	Cool	Perennial	Sod-forming
Smooth brome	No	Cool	Perennial	Sod-forming/ Rhizomatous
Cheatgrass	No	Cool	Annual	
Japanese brome	No	Cool	Annual	Bunchgrass

Table 2b. Common forb species of non-native grasslands monitoring type

Species	Native	Annual/Biennial/ Perennial	Flowering	Reproduction
Yellow sweetclover	No	Biennial (sometimes annual)	May to September	Seeds
Common mullein	No	Biennial	June to July	Seeds

III. WOODY DRAWS

This habitat type encompasses several different plant communities as described in Von Loh et al. (1999). This grouping covers 3,909 acres or 1.6% of the park and is critical habitat for some species of birds and large mammals. Vegetation communities grouped into this monitoring type are based on a Green Ash-Elm Woody Draw and the surrounding communities. Associated

edge communities in drier areas are Rocky Mountain Juniper/Little-seed Ricegrass Woodland and Ponderosa Pine/Rocky Mountain Juniper Woodland. Shrublands that occur at draw sides and heads include chokecherry, western snowberry, and skunkbush sumac. These draws occur in less steep mesic draws, small perennial drainages, and at the base of sandhills (Von Loh et al., 1999). The vegetation normally occurs on the draw bottoms and lower sideslopes (Warner, 1993). Shrubby to wooded draws are found on all aspects with slopes 0 - 60% and elevations of 2,400 to 4,000 feet. Soils are clayey, silty, claypan, and badlands overflow. Soil types are Interior-Cedarpass-Denby, Interior loam, channeled, Midway silty clay loam, and Orella-Badlands (USDA-SCS, 1987). Stands typically have closed canopies dominated by green ash with some American elm (Table 3). Cottonwood and peachleaf willow (*Salix amygdaloides*) are often present near springs and seeps. Shrubs are sparse in the understory, but form dense communities along the edge. Shrubs include chokecherry, western snowberry (*Symphoricarpos occidentalis*), skunkbush sumac and poison ivy (*Toxicodendron rydbergii*). The herbaceous component includes Kentucky bluegrass, western wheatgrass, big bluestem (*Andropogon gerardii*), and littleseed ricegrass (*Oryzopsis micrantha*) (Von Loh et al., 1999).

Table 3. Common woody species of woody draws monitoring type

Species	NATIVE	GROWTH FORM	RESPONSE TO FIRE
Green ash	Yes	Tree	Top-kill, vigorous resprout
American elm	Yes	Tree	Easily damaged or killed by fire
Chokecherry	Yes	Shrub	Top-kill, vigorous resprout
Western snowberry	Yes	Shrub	Top-kill, vigorous resprout
Skunkbush sumac	Yes	Shrub	Top-kill, vigorous resprout

MANAGEMENT OBJECTIVES

Western wheatgrass mixed-grass prairie is believed to be the pre-settlement vegetation for the area but the exact composition of the communities before settlement is unknown. Kuchler (1964) described the potential vegetation for the BADL area as wheatgrass-needlegrass prairie. The fire return intervals reported vary from as short as 5 years in level to gently rolling topography to 15-30 years in more broken topography at Scotts Bluff National Monument, Nebraska (Wendtland and Dodd 1992). Desired future conditions and prescribed fire objectives for each monitoring type are described below.

I. WESTERN WHEATGRASS MIXED-GRASS PRAIRIE

Desired future condition for the western wheatgrass mixed-grass prairie is that the community, when maintained by fire, will have reduced numbers of non-native species, particularly cool season grasses. The current diversity of associated native species would be preserved or increased. There would be short-term (2-4 years post-burn) increase in native forbs, especially milkweed and other target species for butterflies. With continued burning and follow-up monitoring we will improve knowledge of fire effects in this community. The entire community would have 25-50% of the area burned within 5 years depending on topography, with a mosaic of different aged stands across the type.

Prescribed fire objectives for this type include:

1) *Immediate Post-burn* - Burn 60-80% of the burnable project area
2) *Two Years Post-burn* - Reduce mean relative cover of non-native grasses by at least 20%; increase mean relative cover of native grasses by at least 10%; increase mean relative cover of native forbs by at least 30%

II. NON-NATIVE GRASSLANDS

The non-native grasslands, when maintained by fire, will have reduced amounts of non-native cool season grasses; especially cheatgrass, Japanese brome, smooth brome, crested wheatgrass, and Kentucky bluegrass. Repeated spring burning will check the spread of these grasses into native prairie. The number of native grasses and forbs will increase, increasing the biodiversity of these areas. These areas are highly visible because they are often disturbed areas such as roadsides. This provides an opportunity for visitor understanding and education about prescribed fire and non-native species control. The park would like these areas to be returned to mostly native plant communities and eventually have no need for this monitoring type. Various methods of seeding of native species may follow prescribed fires.

Prescribed fire objectives for this type include:

1) *Immediate Post-burn* - Burn 80-100% of the burnable project area
2) *One Year Post-burn* - Reduce mean relative cover of non-native grasses by at least 30%; increase mean relative cover of native grasses by at least 10%; increase mean relative cover of native forbs by at least 10%
3) *Five Year Post-burn* - Maintain 30% reduction of non-native grass relative cover; maintain increase of relative cover of native grass and forbs, limit reduction of native cool-season grasses to less than 20% of the pre-burn conditions.

III. WOODY DRAWS

Woody draws are believed to be part of the pre-settlement landscape for the area (Boldt et al. 1978). The exact composition of the communities before settlement is unknown. Deciduous trees are reported to be no older than 50 years and juniper no older than 100 (Warner 1983). The fire return intervals of 15-30 years were estimated for more broken topography at Scotts Bluff National Monument, Nebraska (Wendtland and Dodd 1992). This return interval would have interacted with long term wet and dry periods for the area. The edges of these draws would have been impacted by the return intervals and fire frequencies of the surrounding prairie. The more mesic areas of the draws would have only been likely to burn in dry periods.

The community, when maintained by fire, will have a mosaic of different age classes within a watershed. Browse for ungulates will increase. Sheltering cover will remain within 25% of current levels. Canada thistle and associated non-native species related to homesteading will be reduced. The structural complexity of the community will be maintained. The length of the edge habitat will be increased or maintained within 10% of current levels.

Prescribed fire objectives for this type include:

1) *Immediate Post-burn* - Reduce total down and dead woody fuel load by 20-60%
2) *One Year Post-burn* - Increase density of desired woody browse species (*Prunus* spp., *Ribes* spp., and *Symphoricarpos occidentalis*) by 30 to 50%

3) Five Year Post-burn - Limit overstory tree mortality of native species to no more than 25%

MONITORING DESIGN

I. MONITORING OBJECTIVE

The precision required for measurement within the different communities at Badlands is somewhat variable. For example, in the western wheatgrass mixed-grass prairie type it is expected that we can accurately assess the cover of western wheatgrass because the grass is present in large amounts and doesn't vary annually based on precipitation patterns. Other variables, like native forb cover, vary greatly from year to year depending on precipitation. Lower precision is likely on these variables because of the impracticality of collecting a sufficient sample size. Below are the accuracy standards for each monitoring type:

A. WESTERN WHEATGRASS MIXED-GRASS PRAIRIE

1) Install enough plots to be 80% confident that the relative cover of native perennial grasses, non-native grasses, and native forbs are within 25% of the true population mean.
2) Install enough plots to be 80% confident that the average density of all brush species is within 25% of the true population mean.

B. NON-NATIVE GRASSLANDS

1) Install enough plots to be 80% confident that the relative cover for non-native grasses are with in 25% of the true population mean.
2) Install enough plots to be 80% confident that the relative cover of the target grass is within 25% of the true population mean.
3) Install enough plots to be 80% confident that the relative cover of native grasses and forbs are within 25% of the true population mean.

C. WOODY DRAWS

1) Install enough plots to be 80% confident that the density of overstory trees is within 25% of the true population mean.
2) Install enough plots to be 80% confident that the density of targeted browse species are within 25% of the true population mean.
3) Install enough plots to be 80% confident that the relative cover of herbaceous plants are within 25% of the true population mean.

II. SAMPLING DESIGN

There are a number of different monitoring efforts associated with the fire program at BADL. Current monitoring at BADL include: vegetation monitoring using standard FMH protocols, roadside sampling for prairie restoration, monitoring butterfly use of vegetation, and a study to examine impacts of prescribed fire on paleontological resources.

The sampling design for the FMH plots are contained in the individual monitoring type description sheets found in Appendix (f). Each of the subsequent sections refers to the FMH plots only.

III. FIELD MEASUREMENT AND PLOT LOCATION INFORMATION ARCHIVING

The individual variables to be measured are defined in the monitoring type descriptions found in Appendix (f). All plots are marked with steel rebar approximately half a meter in height. Each piece of rebar has a brass tag indicating its location within the plot. The rebar at the zero end of each plot has a tag with complete plot data as specified by the handbook. All locations have been georeferenced via GPS. A hard copy of each plot location is retained in the Resource Management Division Files at BADL. A digital text copy is on the computer network, on the common "P" drive, within the Resource Management folder in the "Fire" folder. A GIS data layer with plot locations is on the park network GIS drive in the "GIS data" folder. The Northern Great Plains Fire Monitoring Team will retain a copy in their office, and will be responsible for providing updated versions to BADL as needed.

IV. MONITORING LOCATIONS

Currently all plots are located in the North Unit of Badlands NP. See the map of all plot locations in Appendix (e) and the individual plot location sheets for location and directions to all plots.

V. PRESCRIBED FIRE MONITORING PARAMETERS

Badlands NP has adopted the NPS Fire Monitoring Handbook (2001) as a guide for fire effects monitoring. The handbook identifies four monitoring levels:

Level 1 – Reconnaissance	Fire Cause, location, size, fuel and vegetation types, relative fire activity, potential for spread, current and forecasted weather, resource or safety threats and constraints, and smoke volume and movement
Level 2 – Fire Conditions	Fire monitoring period, ambient conditions – topographic and fire weather, fuel model, fire characteristic, and smoke characteristic
Level 3 – Immediate Post fire Effects	Fuel reduction, vegetative change or other objective dependent variables with in 1 to 5 years after a burn
Level 4 – Long-term Change	Continued monitoring of Level 3 variables to measure trends and change over time

The FMH plots that have been described in this document thus far are being used to examine levels 3 and 4.

Wildland fires that are suppressed will be monitored at levels 1 and 2 with observations entered into the park's monitoring database. In the event that long-term fire effects plots are burned in a wildland fire, they will be read by the NGPA Fire Monitoring Team, according to the schedule of plot rereads following a burn treatment. Level 1 and 2 monitoring observations will be filed with the final fire package and a copy placed with the records for the Fire Management Unit that was burned.

Wildland Fires for Resource Benefit will be monitored as described in the NPS Fire Monitoring Handbook (Level 2 monitoring), and will be completed daily on the fire. During periods of forecasted growth greater than 100 acres per day, on-site observations of dry bulb, relative humidity, wind speed, wind direction, and cloud cover will be made one hour before activity begins to two hours after activity ceases, or minimally from one hour before sunrise to two hours after sunset. Fire characteristics as described in the NPS Fire Monitoring Handbook Level 2 will be collected on-site hourly when conditions and monitor safety permit. Smoke characteristics will be monitored hourly any time a forecasted wind direction would place the smoke plume toward a community and/or highway.

Prescribed fires will meet at least the Level 1 and 2 recommended standards. If there are FMH plots in a unit, information on Level 3 and 4 Variables will be collected.

VI. LEVEL 1 VARIABLES

Reconnaissance monitoring, Level 1, provides a basic overview of the fire event. The following variables will be collected on all fires.

- Fire cause (origin), location and size
- Fuels and vegetation type
- Relative fire activity
- Potential for further spread
- Current and forecasted weather
- Resource or safety threats and constraints
- Smoke volume and movement

Specific information on the collection of these variables can be found in the NPS Fire Monitoring Handbook (2001) or the RX-91 – Monitoring prescribed and wildland fire text.

VII. LEVEL 2 VARIABLES

Fire conditions monitoring, Level 2, provides information on fire weather, fire behavior and resource values at risk. The following variables will be collected and summarized in a monitoring report (see Appendix (h) for specific protocols, data sheets, and example reports) on all wildland fires for resource benefit and all prescribed fires.

1. FIRE MONITORING PERIOD
   a) fire number and name
   b) observations data and time
   c) monitor's name

2. AMBIENT CONDITIONS
   a) Topographic variables
   b) Slope (%)
   c) Aspect
3. FIRE WEATHER VARIABLES
   a) Dry bulb temperature
   b) Relative humidity
   c) Wind speed
   d) Wind direction
   e) Fuel shading and/or cloud cover
   f) Time-lag fuel moisture
   g) Live fuel moisture
   h) Drought index
4. SOIL MOISTURE
5. FUEL MODEL
6. FIRE CHARACTERISTICS
   a) Linear rate of spread
   b) Perimeter or area growth
   c) Flame length
   d) Fire spread directions
7. SMOKE CHARACTERISTICS (BASED ON STATE AND LOCAL REQUIREMENTS)

VIII. INTENDED DATA ANALYSIS

Plot installations will be based on burn priorities and will reach a statistically valid sample size within five years for the priority monitoring types. The Northern Great Plains Fire Ecologist will be responsible for checking the minimum plot numbers in all types that have more than five plots installed. Each monitoring type description delineates the variables that will be analyzed. When minimum plot numbers have been reached, objectives will be evaluated after the data have been checked to meet the assumptions of the statistical test. If the data meet the assumptions, including normality, then confidence intervals will be used for change over time comparisons. If data do not meet the assumptions, a statistician will be consulted. Correlation of Level 2 data with vegetation data can be done with either regression or multivariate analysis.

The Northern Great Plains Fire Ecologist will compare data with fire effects research that has been completed in the park and area. Inconsistencies should lead the ecologist to examine different methodologies, data interpretation, and potential research questions.

IX. MONITORING IMPLEMENTATION SCHEDULE

A. BURN UNIT SCHEDULE

Appendix H of the Fire Management Plan identifies the planned burn schedule for the next several years. The unit rotation is based on a 5 to 15 year fire return interval. Units dominated by non-native species may require shorter burn intervals to meet desired objectives. A map prescribed fire units is also found in Figure 4. (pg. 22) of the Fire Management Plan.

B. TIMING OF MONITORING

All plots are currently monitored at peak diversity for the native forbs approximately halfway between the peak in cool and warm season grasses. With the addition of nested frequency monitoring the vegetative data may need to be read twice a year because of the two different peaks. This will need to be examined after pilot sampling. All plots are currently being read pre-burn, immediately post-burn, and 1, 2, 5, 10, and 20 years post-burn.

C. PRE-BURN SAMPLING

Pre-burn sampling will be done during peak phenology. Plots should be installed the growing season before prescribed burns. All plots that have not burned within 2 years of installation will not be reread until that unit is again scheduled to burn. These plots can also be considered for control plots depending on long-term burn planning.

D. POST-BURN SAMPLING

Post-burn sampling will be done immediately post-burn and 1, 2, 5,10, and 20 years after the burn. Plots that burn in the spring will be read at peak phenology that summer, and then at the regular 1, 2, 5, 10, and 20 year schedule. The 1-Year reads for grassland plots burned in the spring are during the growing season the same year as the burn, and the 2-year read occurs in the following year. The 1-year reads for forest plots burned in the spring are during the growing season one year after the burn. Fall burns will be read the following summer as 1 year post-burn reads. If a unit is scheduled to be burned for a second or third time between reads, an additional pre-burn read will be added. For example, the Pinnacles unit was burned in the spring of 2000. The post-burn reads would be an immediate post-burn read, 1 year read summer 2000, 2 year read summer 2001, and 5 year read summer 2004. The unit is then scheduled to burn again in 2008. A second pre-burn read should be added summer 2007.

DATA SHEET EXAMPLES

Most data sheets used are the standard FMH forms. Non-FMH forms used can be found in Appendix (i).

DATA MANAGEMENT

Other monitoring programs have shown that between 25-40% of the time associated with monitoring should be on data management. The data for BADL is collected and managed by the Northern Great Plains Fire Monitoring Team located at Wind Cave National Park, Hot Springs, South Dakota. All data collected at BADL will be entered and checked by this team at their office. Generally the seasonal field staff enters and checks data. This process is supervised the NGP Lead Monitor and Fire Ecologist. Original copies of all data will be kept at the team's office. Hard copies of the Plot Location Data Sheets will be archived at BADL in the Resource Management files. The Lead Monitor will provide monitoring data to the BADL Chief of Resource Management annually on CD for archiving. Data are currently entered and analyzed in the FMH software. Non FMH data may be entered and analyzed in a variety of programs. The current data are entered into Microsoft Excel spreadsheets for analysis. It is backed up to the server at Wind Cave. It will be sent annually to Badlands NP and the Midwest

Regional Ecologist in conjunction with the annual report. Global positioning data of plot locations are stored on CD at the Fire Monitoring Office at Wind Cave.

I. QUALITY CONTROL

Data quality will be insured through proper training of the crew in data collection and a system of checks in the data entry process. All data sheets will be checked by the lead crewmember before leaving a plot for data accuracy and completeness. Data will be summarized annually and results reported to the park and regional fire ecologist. A program review should happen every 3-5 years to maintain consistency of data collection and analysis and re-assessment of program requirements. More frequent review may be necessary if there are significant staffing changes, additional ecological concerns, or by request of the park or monitoring crew.

II. SOURCES OF DATA ERRORS

Errors in recording can be reduced by checking all data sheets for completeness and accuracy before leaving the plot. Standardized crew training at the beginning of the season will insure all data are being collected in the same manner by all crewmembers. Transcription errors will be corrected by checking all data once entered in the computer. Collecting voucher specimens and using the study collection to verify plant identifications can minimize incorrect identification of plant species. All unknown plant species will be photographed and added to the unknown plant database. These photos can be used as a field reference to insure that all unknowns are consistently observed. BADL Resource Management personnel will be notified of unknowns of particular concern so special attention can be given to identify it. Undersampling of less-frequently occurring species is a large problem in the grass types. An additional sampling technique, nested frequency, will be added after consulting with the regional fire ecologist to better sample the species richness found in these types.

The impacts of monitoring include compacting of fuels and vegetation and the collection of voucher plant specimens. Compaction can be minimized by crew awareness as to where data are collected. Voucher specimens are not collected in the plot – if no other specimen is found, the unknown plant will be photographed and added to the unknown plant photo database. Accurate plot locations including GPS data will aid in plot location and minimize vegetative compaction. Test all directions by having new crewmembers use previously written directions to ensure accuracy. Incomplete or missing data will be corrected as soon as possible. Plot protocols need to be reviewed annually with the seasonal crew prior to beginning work to insure that data are accurately collected. Problems encountered by the field crew must be brought to the attention of the lead monitor and fire ecologist.

RESPONSIBLE PARTIES

This **Fire Monitoring Plan** was written by Kara J. Paintner, formerly the Northern Great Plains Lead Monitor and currently the Fire Ecologist at Yosemite National Park.

Administrative duties will be assigned as follows:

- Plan revision, crew supervision, and data analysis will be done by the *Northern Great Plains Fire Ecologist*

- Park liaison will be done by the *Chief of Resource Management, Badlands NP*
- Data collection, data entry, data management and field crew supervision will be done by the *Northern Great Plains Lead Monitor*
- Program reviews will be coordinated by the *Midwest Regional Fire Ecologist*

FUNDING NEEDS ASSESSMENT

FIREPRO funding for the Northern Great Plains Fire Monitoring team will be used for all monitoring activities. The new funding matrix, FY 2002, allows for non-FMH plot types to be funded with regional approval. Travel for the standard plot reads will come out of the travel budget for the crew. Travel and overtime for all prescribed, wildland fires, and immediate post-burn reads will come from the project funds. Control plots will be done in conjunction with the Badlands Resource Management staff.

MANAGEMENT IMPLICATIONS OF MONITORING RESULTS

Monitoring results will be summarized and presented to the park in the fall meeting of the Fire Committee with the NGPA Fire management Officer, Prescribed Fire Specialist and Fire Ecologist. This meeting helps coordinate fire activities including prescribed fire for the park in the coming year. The annual report information can be conveyed to the Badlands Resource Management Division in an additional meeting as requested.

Review of the data summary and analysis by the NGP Fire Ecologist, Prescribed Fire Specialist, and Badlands Resource Management staff should determine if the current program is moving the vegetation towards the desired conditions and/or having unwanted results. Targets should be reviewed and refined, and burn prescriptions and other vegetation management techniques could be adjusted to compensate. This review could also generate questions that may lead to fire effects research being conducted in the park. Information from the Badlands program could be analyzed with other parks from the NGP group as appropriate and should be presented to other parks and at scientific meetings and publications.

CONSULTATION AND COORDINATION

The Northern Great Plains Fire Monitoring Team is responsible for coordination and consultation with other parks in the group, fire management personnel, and the Midwest Regional Fire Ecologist. Badlands Resource Management staff will be responsible for coordination and consultation with the park and all other cooperators including:

US Forest Service, Buffalo Gap National Grasslands
South Dakota State Forestry Department
Oglala Sioux Tribe
Bureau of Indian Affairs
Other local cooperators

The Badlands Resource Management Division participated in shaping and preparing this plan. The following provided assistance with, or review of, this plan:

Sandee Dingman, Resource Management Specialist, Badlands NP
Eddie Childers, Wildlife Biologist, Badlands NP
Brian Kenner, Chief of Resource Management, Badlands NP
Bill Supernaugh, Superintendent, Badlands NP

Andy Thorstenson, Lead Monitor, NPS, Northern Great Plains Fire Monitoring Team
Bill Gabbert, Fire Management Officer, NPS, NGPA Fire Management Office
Mike Beasley, former AFMO/Prescribed Fire Specialist, NPS, Northern Great Plains
Jim DeCoster, Regional Fire Ecologist, NPS, Midwest Region, Omaha
Cody Wienk, Fire Ecologist, NPS, NGPA Fire Management Office

PEER REVIEW

Peer/technical review for this plan was provided by:

Tonja Opperman
Fire Ecologist, US Forest Service, Bitterroot National Forest, Hamilton, MT

Linda Kerr
Regional Fire Ecologist, National Park Service, Intermountain Region, Denver, CO

Pam Benjamin
Botanist, National Park Service, Intermountain Region, Denver, CO

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APPENDIX (a): PLANT VOUCHER COLLECTION/PLANT LIST

FMH-6 Species Code List FMH Data - BADL Page: 0001
FMH version 3.10, Printed on 03/19/01, 10:11:56 am
Current directory: C:\TESTFMH

Sorted by: Scientific Name

Code	Nat.	Cycle	Form	Genus	Species	Subspecies	Variety	Common name
ACMI1	Y	P	F	Achillea	millefolium			Yarrow
AGCA1	Y	P	G	Agropyron	caninum			Slender Wheatgrass
AGCR1	N	P	G	Agropyron	cristatum			crested wheatgrass
AGSM1	Y	P	G	Agropyron	smithii			western wheatgrass
AGSP1*	Y	P	G	Agropyron	spicatum			bluebunch wheatgrass
AGSU1*	Y	P	G	Agropyron	subsecundum			western wheatgrass hybrid
ALTE1	Y	P	F	Allium	textile			wild onion
AMPS1*	Y	P	F	Ambrosia	psilostachya			western ragweed
AMFR1*	Y	P	S	Amorpha	fruticosa			False Indigo
AMNA1	Y	P	S	Amorpha	nana			dwarf wild indigo
ANAR1*	N	A	F	Anagallis	arevensis			Scarlet Pimpernel
ANGE1	Y	P	G	Andropogon	gerardii			big bluestem
ANSC1	Y	P	G	Andropogon	scoparius			little bluestem
ANPA1*	Y	P	F	Antennaria	parviflora			pussytoes
ARLO1	Y	P	G	Aristida	longiseta			three awn
ARPU1	Y	P	G	Aristida	purpurea			three awn
ARCA1	Y	P	S	Artemisia	cana			silver sage
ARFR1	Y	P	F	Artemisia	frigida			fringed sagewort
ARLU1	Y	P	F	Artemisia	ludoviciana			white sage
ARXX1*	Y	P	F	Artemisia	species			unknown sage
ASPU1*	Y	P	F	Asclepias	pumila			plains milkweed
ASVE1*	Y	P	F	Asclepias	verticillata			whorled milkweed
ASVI1	Y	P	F	Asclepias	viridiflora			green milkweed
ASER1	Y	P	F	Aster	ericoides			white aster
ASXX1	N	A	F	Aster	species			aster
ASAG1	Y	P	F	Astragalus	agrestis			field milk-vetch
ASCR1*	Y	P	F	Astragalus	crassicarpus			groundplum milkvetch
BARE1	--	-	*	Bare				Bare Ground
BERE1*	Y	P	S	Berberis	repens			Oregon grape
BOCU1	Y	P	G	Bouteloua	curtipendula			side oats grama
BOGR1	Y	P	G	Bouteloua	gracilis			blue grama
BOHI1	Y	P	G	Bouteloua	hirsuta			hairy grama
BRJA1	N	A	G	Bromus	japonicus			Japanese brome
BRTE1	N	A	G	Bromus	tectorum			downy brome
BUDA1	Y	P	G	Buchloe	dactyloides			buffalo grass
CALO1	Y	P	G	Calamovilfa	longifolia			prairie sandreed
CAGU1	Y	P	F	Calochortus	gunnisonii			sego lily
CAMI1*	N	A	F	Camelina	microcarpa			smallseed flax
CABR1	Y	P	R	Carex	brevior			Fescue sedge
CAFI1	Y	P	R	Carex	filifolia			threadleaf sedge
CAXX1	Y	P	R	Carex	spp			
CAXX3*	Y	P	R	Carex	spp 1998			
CHAL1	N	A	F	Chenopodium	album			lambsquarter
CHNA1	Y	P	S	Chrysothamnus	nauseosus			rubber rabbitbrush
CIAR1	N	P	F	Cirsium	arvense			Canada thistle
CIUN1	Y	P	F	Cirsium	undulatum			wavyleaf thistle
CIVU1*	N	B	F	Cirsium	vulgare			Bull Thistle
COLI1*	Y	A	F	Collomia	linearis			narrowleaf collomia
COAR1	N	P	V	Convolvulus	arvensis			field bindweed
COCA1	Y	A	F	Conyza	canadensis			horseweed
COMI1	Y	P	F	Coryphantha	missouriensis			cactus
LICH3*	Y	P	N	Crustose	lichen			Crustose Lichen
DACA1*	Y	P	F	Dalea	candidum			white prairie clover
DAPU1	Y	P	F	Dalea	purpurea			purple prairie clover
DASP1*	Y	P	G	Danthonia	spicata			poverty oat grass
DAST1	Y	A	F	Datura	stramonium			jimson weed
DECA1	Y	P	F	Delphinium	carolinianum			prairie larkspur
DEVI1	Y	P	F	Delphinium	virescens			prairie larkspur
DEPI1	Y	A	F	Descurainia	pinnata			tansy mustard
DUFF1*	--	-	*	Duff				Duff
ECAN1	Y	P	F	Echinacea	angustifolia			purple coneflower
ELGL1*	Y	P	G	Elymus	canadensis			Canada wild rye
ELJU1	N	P	G	Elymus	junceus			Russian wild rye

FMH-6 Species Code List FMH Data - BADL Page: 0002

FMH version 3.10, Printed on 03/19/01, 10:11:57 am

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Sorted by: Scientific Name

Code	Nat.	Cycle	Form	Genus	Species	Subspecies	Variety	Common name
ELVI1*	Y	P	G	Elymus	virginicus			Virginia wild rye
ERPU1*	Y	P	F	Erigeron	pumilus			low fleabane
ERST1	Y	A	F	Erigeron	strigosus			daisy fleabane
ERXX1	Y	P	F	Erigeron	unknown			fleabane
EUES1*	N	P	F	Euphorbia	esula			leafy spurge
EUMA1	Y	A	F	Euphorbia	marginata			snow-on-the-mountain
EUSP1	Y	A	F	Euphorbia	spathulata			spurge
EUXX1	Y	A	F	Euphorbia	unknown			unknown euphorbia
FEOC1	Y	A	G	Festuca	octoflora			Six weeks Fescue
FEOV1*	Y	P	G	Festuca	ovina			sheep fescue
LICH1*	Y	P	N	Foliose	lichen			Foliose Lichen
LICH2*	Y	P	N	Fruticose	lichen			Fruiticose Lichen
GAAP1	Y	A	F	Galium	aparine			cathcweed bedstraw
GAXX1	Y	P	F	Galium	unknown			
GACO1	Y	P	F	Gaura	coccinea			scarlet gaura
GAPA1	Y	A	F	Gaura	parviflora			velvet gaura
GLLE1	Y	P	F	Glycyrrhiza	lepidota			wild licorice
GRSQ1	Y	B	F	Grindelia	squarrosa			curlycup gumweed
GUSA1	Y	P	F	Gutierrezia	sarothrae			broom snakeweed
HEHI1	Y	A	F	Hedeoma	hispidum			false pennyroyal
HEAN1	Y	A	F	Helianthus	annuus			sunflower
HOJU1*	N	P	G	Hordeum	jubatum			foxtail barley
JUSC1*	Y	P	T	Juniperus	scopulorum			Rocky Mountain juniper
KOPY1	Y	P	G	Koeleria	pyramidata			junegrass
LAOB1	Y	P	F	Lactuca	oblongifolia			blue lettuce
LAPU1	Y	A	F	Lactuca	pulchella			blue lettuce
LASE1	N	A	F	Lactuca	serriola			prickly lettuce
LAOC1	Y	A	F	Lappula	occidentalis			sticktight
LARE1	Y	A	F	Lappula	redowskii			western stickseed
LAPO1	Y	P	F	Lathyrus	polymorphus			Hoary vetchling
LIRI1	Y	A	F	Linum	rigidum			yellow flax
LITT1	--	-	*	Litter				Litter
LYJU1	Y	P	F	Lygodesmia	juncea			rush skeleton plant
MESA1	N	P	F	Medicago	sativa			alfalfa
MEAL1	N	A	F	Melilotus	alba			white clover
MEOF1	N	A	F	Melilotus	officinalis			yellow sweetclover
MIGR1	Y	A	F	Microsteris	gracilis			
MOSS1*	Y	P	N	Moss				Moss
MUCU1	Y	P	G	Muhlenbergia	cuspidata			plains muhly
MUDI1*	Y	P	F	Musineon	divaricatum			leafy musineon
NECA1	N	P	F	Nepeta	cataria			catnip
OPHU1	Y	P	S	Opuntia	humifusa			plains prickly pear
OPPO1	Y	P	S	Opuntia	polycantha			plains prickly pear
OPXX1*	Y	P	S	Opuntia	unknown			
ORXX1*	Y	P	G	Oryzopsis	unknown			Indian ricegrass?
OXSE1*	Y	P	F	Oxytropis	sericea			whitepoint crazyweed
PAVI1	Y	P	V	Parthenocissus	vitacea			woodbine
PEGR1	Y	P	F	Penstemon	gracilis			slender beardtoungue
PHHO1	Y	P	F	Phlox	hoodii			Hood's Phlox
PHXX1	Y	P	F	Phlox	unknown			unknown phlox
PHVI1	Y	P	F	Physalis	virginiana			lanceleaf groundcherry
PIPO1	Y	P	T	Pinus	ponderosa			Ponderosa Pine
PLPA1	Y	A	F	Plantago	patagonica			wooly plantain Indian wheat
POCO2	N	P	G	Poa	compressa			Canada bluegrass
POPR1	N	P	G	Poa	pratensis			Kentucky Bluegrass
POAL1	Y	P	F	Polygala	alba			white milkwort
POCO1	N	A	V	Polygonum	convolvulus			climbing or wild buckwheat
PRAM1	Y	P	S	Prunus	americanus			American plum
PRVI1	Y	P	S	Prunus	virginia			
PSAR1	Y	P	F	Psoralea	argophylla			silver-leaf scurf pea
PSCU1	Y	P	F	Psoralea	cuspidata			tall breadscurf pea
PSES1	Y	P	F	Psoralea	esculenta			prarie turnip
PSTE1	Y	P	F	Psoralea	tenuiflora			slender leaf scurfpea
QUMA1	Y	P	T	Quercus	macrocarpa			bur oak
RACO1	Y	P	F	Ratibida	columnifera			prarie coneflower
RHAR1	Y	P	S	Rhus	aromatica			skunkbush sumac

FMH-6 Species Code List FMH Data - BADL Page: 0003
FMH version 3.10, Printed on 03/19/01, 10:11:57 am

Current directory: C:\TESTFMH
Sorted by: Scientific Name

Code	Nat.	Cycle	Form	Genus	Species	Subspecies	Variety	Common name
RIAM1	Y	P	S	Ribes	americanum			wild black currant
RIMI1	Y	P	S	Ribes	missouriense			Missouri gooseberry
RISE1*	Y	P	S	Ribes	setosum			goosebery
RIXX1	Y	P	S	Ribes	unknown			Unknown currant
ROCK1*	--	-	*	Rock				Rock
ROOT1*	--	-	*	Root				Root
ROWO1	Y	P	S	Rosa	woodsii			wood rose
RUCR1	N	P	F	Rumex	crispus			curly dock
RUXX1	Y	P	F	Rumex	species			Unknown dock
SAIB1	N	A	F	Salsola	iberica			Russian thistle
SAVE1*	Y	P	S	Sarcobatus	vermiculatus			greasewood
SCAT1*	--	-	*	Scat	various species of fauna			Scat
SCPA1*	Y	P	G	Schedonnardus	paniculatus			tumblegrass
SECE1*	N	A	G	Secale	cereale			rye
SEDE1*	Y	P	A	Selaginella	densa			spikemoss
SIAL1	N	A	F	Sisymbrium	altissimum			tumbling mustard
SMST1	Y	P	F	Smilacina	stellata			False Solomon's Seal
SDED1*	--	-	*	Snag	dead tree			standing dead tree
SOMI1	Y	P	F	Solidago	missouriensis			Missouri goldenrod
SOXX1	Y	P	F	Solidago	unknown			unknown solidago
SPCO1	Y	P	F	Sphaeralcea	coccinea			scarlet globemallow
SPXX1	Y	P	G	Sporobolus	species			dropseed
STCO1	Y	P	G	Stipa	comata			needle-n-thread
STSP1*	Y	P	G	Stipa	sparta			porcupine grass
STVI1	Y	P	G	Stipa	viridula			green needlegrass
STMP1*	--	-	*	Stump				Stump
SYOC1	Y	P	S	Symphoricarpos	occidentalis			western snowberry
TAOF1	N	P	F	Taraxacum	officinale			dandelion
THAR1	N	A	F	Thlaspi	arvense			field pennycress
TORA1	Y	P	S	Toxicodendron	radicans			poison ivy
TORY1	Y	P	S	Toxicodendron	rydbergii			poison ivy
TRBR1	Y	P	F	Tradescantia	bracteata			
TRDU1	N	B	F	Tragopogon	dubius			goatsbeard, salsify
TRPR1*	N	B	F	Tragopogon	pratensis			meadow salsify
BOLE1*	--	-	*	Tree	bole			Tree Bole
UNKN1	N	A	F	Unknown				Unknown
UNAN1	N	A	F	Unknown				annual
UNKN2	N	A	F	Unknown	forb			ask kobza
UNKN4*	N	A	F	Unknown	forb 1998			broad leaves
BRXX1	N	A	F	Unknown	mustard			Unknown Brassicaceae
VETH1*	N	B	F	Verbascum	thapsus			mullein
VEST1	Y	P	F	Verbena	stricta			hoary vervain
VIAM1	Y	P	F	Vicia	americana			american vetch
WOOD1*	--	-	*	Wood				Wood
YUGL1*	Y	P	S	Yucca	glauca			yucca
ZIVE1	Y	P	F	Zigadenus	venenosus			death camas

* Species marked with an asterisk were not found in any data form

Entries.	175	(G) Grass.	34
Non-plants	10	(F) Forb	95
Plants	165	(S) Shrub.	21
		(T) Tree	3
Native	130	(N) Non-vascular	4
Non-native	35	(*) Substrate.	10
		(R) Grasslike.	4
Perennial.	122	(A) Fern or ally	1
Biennial	5	(V) Vine	3
Annual	38	( ) Unknown.	0
Native perennial	110		
Native biennial.	1		
Native annual.	19		
Non-native perennial . .	12		
Non-native biennial. . .	4		
Non-native annual. . . .	19		

APPENDIX (b): VEGETATION MAP

This map is too large to read at 8.5 x 11-inch size. The Vegetation Map classes are listed below and the map may eventually be viewed by quarterquad at http:\\biology.usgs.gov\npsveg

The Badlands Vegetation Map classes and codes are:

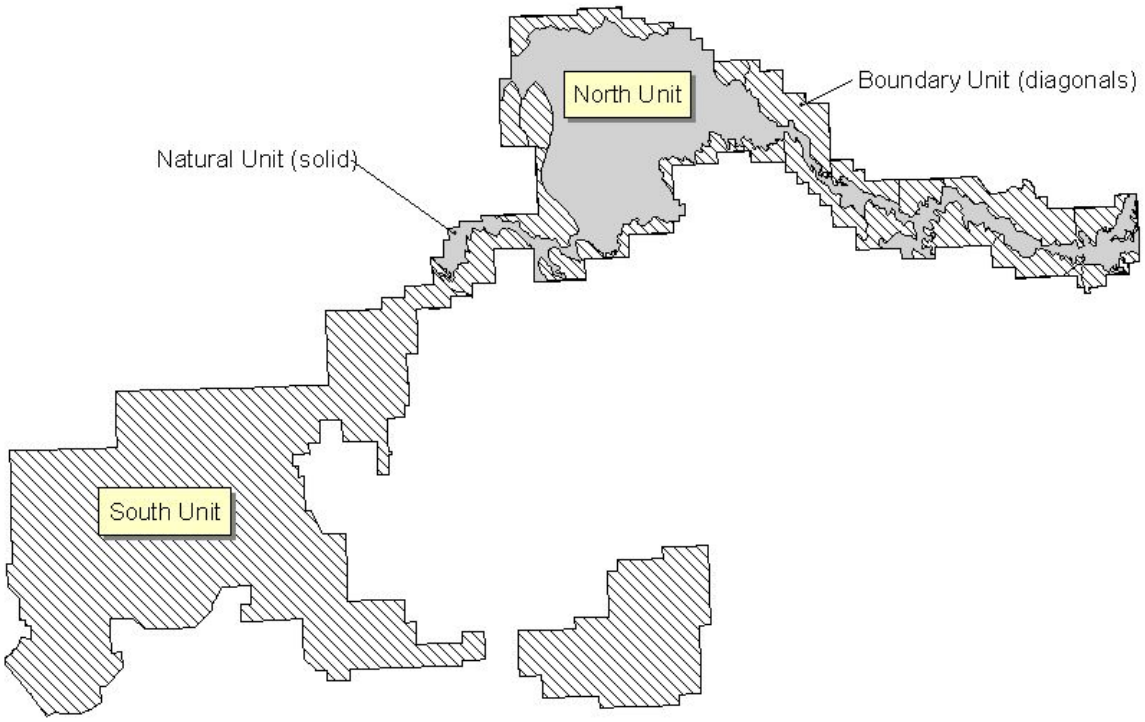
Land Use

50 Rivers – Perennial
51 Transportation, Communications, and Utilities
52 Croplands and Pasture
53 Seeded Mixed-grass Prairie
54 Other Agricultural Land
55 Streams and Canals
56 Reservoirs
57 Beaches and Sandy Areas Other Than Beaches
58 Strip Mines, Quarries, and Gravel Pits

Vegetation

1 Prairie Dog Town Community
2 Badlands Sparse Vegetation Complex
12 Switchgrass Grassland
14 Emergent Wetland
15 Little Bluestem - Grama Grasses - Threadleaf Sedge Grassland
16 Western Wheatgrass Herbaceous Alliance
17 Introduced Grassland
18 Blue Grama Grassland
19 Western Wheatgrass - Green Needlegrass Grassland
21 Soapweed Yucca / Prairie Sandreed Shrub Grassland
25 Silver Buffaloberry Shrubland
31 Silver Sagebrush / Western Wheatgrass Shrubland
32 Sand Sagebrush / Prairie Sandreed Shrubland
33 Rabbitbrush Shrubland
34 Chokecherry - (American Plum) Shrubland
35 Three-leaved Sumac / Threadleaf Sedge Shrub Grassland
37 Western Snowberry Shrubland
38 Sandbar Willow Temporarily Flooded Shrubland
39 Greasewood / Western Wheatgrass Shrubland
41 Eastern Cottonwood - (Peachleaf Willow) / Sandbar Willow Woodland
42 Green Ash - (American Elm) / Chokecherry Woodland
43 Ponderosa Pine / Rocky Mountain Juniper Woodland
44 Rocky Mountain Juniper / Littleseed Ricegrass Woodland

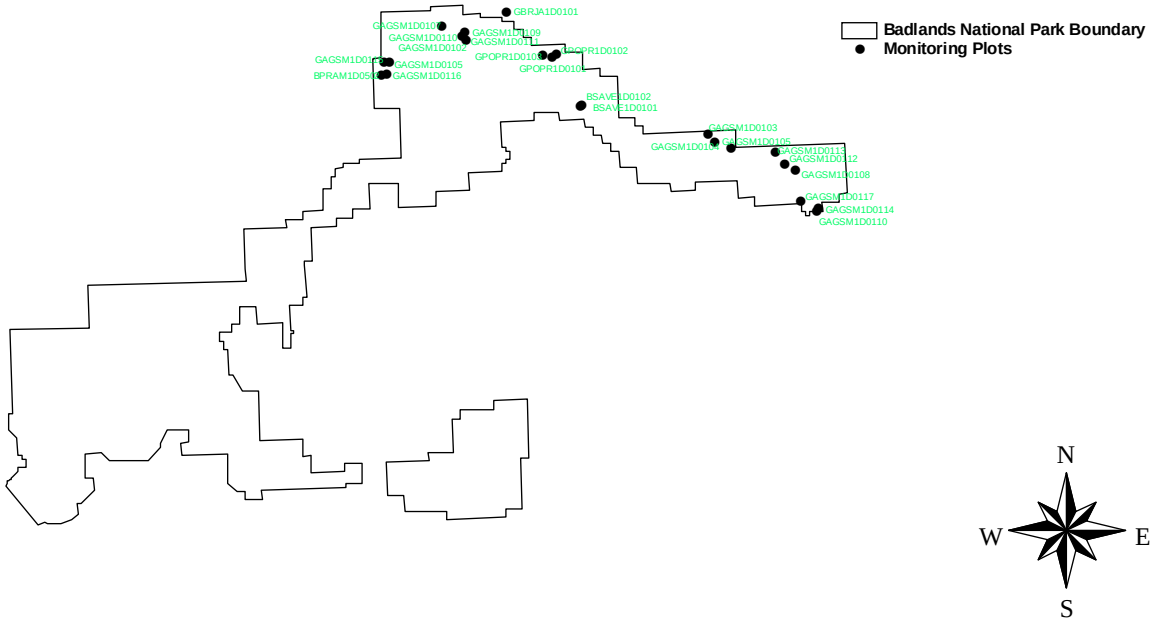
APPENDIX (c): FIRE MANAGEMENT UNIT MAP



APPENDIX (d): FUEL MODEL MAP

The park-wide map is too large to present at 8.5 x 11-inch scale. For each burn plan, a fuel model map is prepared.

APPENDIX (e): PLOT LOCATION MAP



APPENDIX (f): MONITORING TYPE DESCRIPTIONS

FMH-4 **MONITORING TYPE DESCRIPTION SHEET** Park: **BADL**

Monitoring Type Code: GAGSM1DO1 **Date Described:** 6/12/97

Monitoring Type Name: Western Wheatgrass Mixed-grass Prairie

Prepared by: A. Powers, G. Bradshaw, B. Braudis, B. Bessken, R. Runge, B. Adams, G. Kemp, P. Reeberg

Updated by: Supernaugh, Kenner, Childers, Dingman, and Paintner – January, 1999

Physical Description
This community occurs in a wide a variety of habitats through the park. Sites are generally flat to moderately steep in slope and occur on all aspects. Associations of the type occupy clay, silt, loam and sandy soils of flats, swales, drainages, hills and slopes. (Von Loh et al., 1999) Elevations range from 2,400 to 4,000 feet. Soils are clayey, silty, claypan, and badlands overflow. Soil types are: Blackpipe clay loam, Blackpipe-Norrest complex, Blackpipe-Wortman Complex, Cedarpass silty clay loam, Cedarpass-Denby complex, Cedarpass-Interior-Badlands, Interior-Cedarpass-Denby (USDA-SCS, 1987).

Biological Description
Stands of this type have moderate to complete herbaceous cover, between 40-100%. Western wheatgrass (*Pascopyrum smithii*) is strongly dominate in ungrazed stands, less so in stands subjected to annual grazing by livestock. Species dominance can vary locally within a stand, depending on soils and use factors (Von Loh et al., 1999). Dominant graminoids are western wheatgrass, blue grama (*Bouteloua gracilis*), and green needlegrass (*Stipa viridula*). Shrubs are plains prickly pear (*Opuntia polyacantha)*, skunkbush (*Rhus aromatica)*, sand sage (*Artemisia frigida),* and silver sagebrush (*A. cana)*. Forbs include: heath aster (*Aster ericoides)*, yarrow (*Achillea millefolium*), and Missouri goldenrod (*Solidago missouriensis*).

Rejection Criteria
Large outcroppings or barren areas >20% of the plot; areas with anomalous vegetation; edges of the following types that are closer than 50 m to the plot: monitoring type boundaries or transitions; riparian areas or areas dominated by trees; bio-control areas; roads, human-made trails, burn unit boundaries or human created clearings are to be rejected.

Desired Future Condition
Western wheatgrass mixed-grass prairie is believed to be the pre-settlement vegetation for the area but the exact composition of the communities before settlement is unknown. Kuchler (1964) described the potential vegetation for the BADL area as wheatgrass-needlegrass prairie. The fire return intervals reported vary from as short as 5 years in level to gently rolling topography to 15-30 years in more broken topography at Scotts Bluff National Monument, Nebraska (Wendtland and Dodd, 1992).

The community when maintained by fire would have reduced numbers of non-native species particularly cool season grasses. The natural diversity of associated native species would be preserved or increased. There would be short-term (2-4 years post burn) increase in native

forbs, especially milkweed and other target species for butterflies. With continued burning we will improve knowledge of fire effects in this community. The community would have 25-50% of the area burned within the last 5 years depending on topography with a mosaic of different aged stands across the type.

Burn Prescription
This prairie will be burned between April until green-up or late July through a season ending event in the fall. Head, flanking, and backing fire will be used as needed to meet burn objectives.

Fire Prescription Elements	
RH - 25-55%	**Live Fuel Moisture – NA**
Bulb - 30-85 o F	**Average Flame Length - 0.4-1.5 feet**
Average Mid-flame winds - 0-20 mph	**Average Rate of Spread - 0-3 chs/hour**
Fuel loading - 3-5 tons per acre	**1-hour TLFM - 6-14 %**
10-hour TLFM - 8-15 %	**100-hour TLFM - 10-30 %**

Monitoring Variables in Order of Importance
1. Native Grass Relative Cover
2. Non-native Grass Relative Cover
3. Native Forb Relative Cover

Prescribed Fire Project Objectives
Immediate Post Burn
1. Burn 60-80% of the burnable project area.

Two Years Post Burn:
1. Reduce relative cover of non-native grasses by at least 20%
2. Increase relative cover of native grasses by at least 10%
3. Increase relative cover of native forbs by at least 30%

Fire Monitoring Objectives
1. Install enough plots to be 80% confident that the relative cover for native perennial grasses, non-native grasses, and native forbs are within 25% of the true population mean.
2. Install enough plots to be 80% confident that the average density of all brush species is within 25% of the true population mean.

Data Analysis
1. Track relative cover of native grasses for each postburn read years 1, 2, and 5.
2. Track relative cover of non-native grasses for each postburn read years 1, 2, and 5.
3. Track relative cover and percent cover of native forbs for each postburn read years 1,2 & 5.
4. Track brush density and sprouting for each postburn read years 1,2, and 5.
5. Track specific forb or grass species cover requested by the wildlife biologist for each postburn read years 1,2, and 5
6. Track yellow sweetclover (*Melilotus officinalis*) cover for each postburn read years 1, 2, & 5.

Literature Cited

Kuchler, A.W. 1964. Potential natural vegetation of the coterminous Untied States. Am. Geogr. Soc. Spec. Publ. 36 (Manual), New York.

USDA Soil Conservation Service. 1987. Soil Survey of Jackson County, Northern Part, South Dakota. Washington, D.C. 216 pages plus maps

USDI National Park Service. 2001. Fire monitoring handbook. National Interagency Fire Center, Boise, ID. 288 pp.

Von Loh, J., Cogan, D., Faber-Langendoen, D., Crawford, D., and M.J. Pucherelli. 1999. USGS-NPS Vegetation Mapping Program Badlands National Park, South Dakota (Final Report). Technical memorandum No. 8260-99-03. US Bureau of Reclamation Technical Service Center. Denver, Colorado.

Wendtland, K. J., and J. L. Dodd. 1992. The fire history of Scotts Bluff National Monument. In: Smith, D. and C. Jacobs (eds.) Twelfth North American Prairie Conference. Cedar Falls, Iowa.

Notes: Brush density of snowberry (*Symphoricarpos* spp.) will be determined by stem count. Brush density for prickly pear (*Opuntia polyacantha*) will be counted by cluster immediately post burn because of increased visibility. Both species are rhizomatous. Please see brush sampling protocol in Fire Monitoring Handbook (USDI NPS 2001) for additional information.

FMH-4 PLOT PROTOCOLS

GENERAL PROTOCOLS		YES	NO		YES	NO
Preburn	Control Plots/Opt		•	Herb Height/Rec	•	
	Herbaceous Density/Opt		•	Belt Transect Width: 5 m		
	OP/Origin Buried		•	Abbreviated Tags	•	
	Voucher Specimens/Rec	•		Stakes Installed: 0P & 30P		
	Stereo Photography/Opt		•	Crown Intercept/Opt		•
	Brush Individuals/Rec	•		Herb. Fuel Load/Opt		•
	Herbaceous Data Collected at: 0P-30P					
Burn	Duff Moisture/Rec	•		Flame Zone Depth/Rec	•	
Postburn	Herbaceous Data/Opt: Not collected.			Herb. Fuel Load/Opt		•
	100 Pt. Burn Severity/Opt		•			

Rec = Recommended; Opt = Optional

FMH-4 **MONITORING TYPE DESCRIPTION SHEET** Park: **BADL**

Monitoring Type Code: FFRPE1D02 **Date Described:** 1/12/00

Monitoring Type Name: Woody Draws

Prepared by: Supernaugh, Kenner, Childers, Dingman, and Paintner

Physical Description
These draws occur in less steep mesic draws, small perennial drainages, base of sandhills (Von Loh et al*.,* 1999). The vegetation normally occurs on the draw bottoms and lower sideslopes (Warner, 1993). Shrubby to wooded draws. All aspects are acceptable, slopes 0 - 60%, elevation 2,400 to 4,000 feet. Soils are clayey, silty, claypan, and badlands overflow. Soil types are: Interior-Cedarpass-Denby, Interior loam, channeled, Midway silty clay loam, and Orella - Badlands (USDA-SCS, 1987).

Biological Description
This habitat type encompasses several different plant communities as described in Von Loh et al. (1999). Vegetation communities grouped into this monitoring type are based on a Green Ash-Elm Woody Draw and the surrounding communities. Associated edge communities in drier areas are Rocky Mountain Juniper/Little-seed Ricegrass Woodland and Ponderosa Pine/Rocky Mountain Juniper Woodland. Shrublands that occur at draw sides and heads include chokecherry, western snowberry, and skunkbush sumac. Stands typically have closed canopies dominated by green ash (*Fraxinus pennsylvanica*) with some American elm (*Ulmus americana*). Cottonwood (*Populus deltoides*) and peachleaf willow (*Salix amygdaloides*) will be present if there is a spring or seep. Shrubs are sparse in the understory, but form dense communities along the edge. Shrubs include; chokecherry (*Prunus virginiana*), western snowberry (*Symphoricarpos occidentalis*), skunkbush sumac (*Rhus aromatica*) and poison ivy (*Toxicodendron rydbergii*). The herbaceous component includes; Kentucky bluegrass (*Poa pratensis*), western wheatgrass (*Pascopyrum smithii*), and big bluestem (*Andropogon gerardii*) (Von Loh et al., 1999).

Rejection Criteria
Large outcroppings or barren areas >20% of the plot; areas with anomalous vegetation; edges of the following types that are closer than 50 m to the plot: monitoring type boundaries or transitions; bio-control areas; roads, human-made trails, burn unit boundaries or human created clearings are to be rejected. Because of the linear shape of these communities part of the plot may fall in another monitoring type. Plots should be installed with the long axis of the plot following the long axis of the draw.

Desired Future Condition
Woody draws are believed to be part of the pre-settlement landscape for the area (Boldt et al*.,* 1978). The exact composition of the communities before settlement is unknown. Deciduous trees are reported to be no older than 50 years and juniper no older than 100 (Warner, 1983). The fire return intervals of 15-30 years were estimated for more broken topography at Scotts Bluff National Monument, Nebraska (Wendtland and Dodd, 1992). This return interval would have interacted with long term wet and dry periods for the area. The edges of these draws would have been impacted by the return intervals and fire frequencies of the surrounding prairie. The more mesic areas of the draws would have only been likely to burn in dry periods.

The community when maintained by fire will have a mosaic of different age classes within a watershed. Browse for undulates will increase. Sheltering cover will remain within 25% of current levels. Canada thistle (*Cirsium arvense*) and associated non-native species related to homesteading will be reduced. The structural complexity will be maintained. The length of the edge habitat will be increased or maintained within 10% of current levels.

Burn Prescription
These draws will be burned in concert with the surrounding prairie. Typically the prairie will be burned between April until green-up, or late July through a season ending event in the fall. Firing methods and unit preparation will be used to exclude fire from some draws. Head, flanking, and backing fire will be used as needed to meet burn objectives.

Fire Prescription Elements	
RH - 25-55%	**Live Fuel Moisture - NA**
Bulb - 30-85 o F	**Average Flame Length - 0.4-1.5 feet**
Average Mid-flame winds - 0-20 mph	**Average Rate of Spread - 0-3 chs/hour**
Fuel loading - 3-5 tons per acre	**1-hour TLFM - 6-14 %**
10-hour TLFM - 8-15 %	**100-hour TLFM - 10-30 %**

Monitoring Variables in Order of Importance
1. Overstory Tree Density
2. Density of specific browse species as directed by the wildlife biologist
3. Total Herbaceous Relative Cover

Prescribed Fire Project Objectives
Immediate Post Burn
1. Reduce total down and dead woody fuel load by 20-60%

One Year Post Burn
1. Increase density of desired woody browse species (*Prunus* spp., *Ribes* spp., *Symphoricarpos occidentalis*) by 30 to 50%

Five Year Post Burn
1. Limit overstory tree mortality to no more than 25%

Fire Monitoring Objectives
1. Install enough plots to be 80% confident that density of overstory trees is within 25% of the true population mean.
2. Install enough plots to be 80% confident that density of targeted browse species is within 25% of the true population mean.
3. Install enough plots to be 80 % confident that the relative cover of herbaceous plants is within 25% of the true population mean

Data Analysis

1. Track density of overstory trees for each postburn read in year 1, 2, and 5.
2. Track density of specific targeted browse species for each postburn read in year 1, 2, and 5.
3. Track relative cover and percent cover of herbaceous plants including native grasses and forbs for each postburn read in year 1,2 and 5.
4. Track specific non-native species of concern for each postburn read in year 1,2, and 5
5. Track Kentucky bluegrass relative cover for each postburn read in year 1, 2, and 5.

Literature Cited

Boldt, C.E., C.W. Uresk, and K.E. Severson. 1978. Riparian Woodlands in Jeopardy on Northern High Plains. In: Johnson, R.R. and J.F. McCormick (eds.) National Symposium on Strategies for Protecting the Management of Floodplain Wetlands and other Riparian Ecosystems. USDA Forest Service General Technical Report WO-12. Atlanta, Georgia.

USDA Soil Conservation Service. 1987. Soil Survey of Jackson County, Northern Part, South Dakota. Washington, D.C. 216 pages plus maps

USDI National Park Service. 2001. Fire monitoring handbook. National Interagency Fire Center, Boise, ID. 288 pp.

Von Loh, J., Cogan, D., Faber-Langendoen, D., Crawford, D., and M.J. Pucherelli. 1999. USGS-NPS Vegetation Mapping Program Badlands National Park, South Dakota (Final Report). Technical memorandum No. 8260-99-03. US Bureau of Reclamation Technical Service Center. Denver, Colorado.

Warner, A.T. 1993. Soil and Hydrological Characterization of Woody and Grassy Draws Badlands National Park, South Dakota. MS Thesis. Colorado State University, Fort Collins. 108 pp.

Wendtland, K. J., and J. L. Dodd. 1992. The fire history of Scotts Bluff National Monument. In: Smith, D. and C. Jacobs (eds.) Twelfth North American Prairie Conference. Cedar Falls, Iowa.

Notes: Brush density of snowberry (*Symphoricarpos* spp.) will be determined by stem count. Brush density for prickly pear (*Opuntia polyacantha*) will be counted by cluster immediately post burn because of increased visibility. Both species are rhizomatous. Please see brush sampling protocol in Fire Monitoring Handbook (USDI NPS 2001) for additional information.

FMH-4 PLOT PROTOCOLS

GENERAL PROTOCOLS		YES	NO		YES	NO
Preburn	Control Plots/Opt		•	Herb Height/Rec	•	
	Herbaceous Density/Opt		•	Belt Transect Width:	1 meter *	
	OP/Origin Buried		•	Abbreviated Tags	•	
	Voucher Specimens/Rec	•		Stakes Installed:	All	
	Stereo Photography/Opt		•	Crown Intercept/Opt		•
	Brush Individuals/Rec	•		Herb. Fuel Load/Opt		•
	Herbaceous Data Collected at: **Q4-Q1**					
	*** see notes section.**					
Burn	Duff Moisture/Rec	•		Flame Zone Depth/Rec	•	
Postburn	Herbaceous Data/Opt: FMH - 17			Herb. Fuel Load/Opt		•
	100 Pt. Burn Severity/Opt		•			

FOREST PLOT PROTOCOLS		YES	NO		YES	NO
Overstory	Area sampled: 50 x20m	Q1 – Q4		DBH > 10 cm		
	Tree Damage/Rec	•		Crown Position/Rec	•	
	Dead Tree Damage/Opt		•	Dead Crown Position/Opt	•	
Pole-size	Area Sampled: 25 x10m	Q1		2.5 cm ≤ DBH ≤ 10 cm		
	Height/Rec	•		Poles Mapped/Rec	•	
Seedling	Area Sampled: 5 x 10m			Quarters Sampled: Subset of Q1		
	Height/Rec	•		Seedlings Mapped/Opt		•
Fuel Load	Sampling Plane Length (ft.): 6, 6, 12, 50, 50					
	Aerial Fuel Load/Opt		•	Fuel Continuity/Opt		•
Postburn	Char Height/Rec	•		Mortality/Rec	•	

Rec = Recommended; Opt = Optional

FMH-4 **MONITORING TYPE DESCRIPTION SHEET** Park: **BADL**

Monitoring Type Code: BPRUN1D05 **Date Described:** 1/12/00

Monitoring Type Name: Woody Draws--Chokecherry and Plum Shrubland

Prepared by: Supernaugh, Kenner, Childers, Dingman, Thorstenson and Rehman

Physical Description
These draws occur in less steep mesic draws, small perennial drainages, base of sandhills (Von Loh et al., 1999). The vegetation normally occurs on the draw bottoms and lower sideslopes (Warner, 1993). All aspects are acceptable, slopes 0 - 60%, elevation 2,400 to 4,000 feet. Soils are clayey, silty, claypan, and badlands overflow. Soil types are: Interior-Cedarpass-Denby, Interior loam, channeled, Midway silty clay loam, and Orella -Badlands (USDA-SCS, 1987).

Biological Description
This habitat type encompasses several different plant communities as described in Von Loh et al. (1999). Vegetation communities grouped into this monitoring type are based on a Green Ash-Elm Woody Draw and the surrounding communities. Associated edge communities in drier areas are Rocky Mountain Juniper/Little-seed Ricegrass Woodland and Rocky Mountain Juniper Woodland. Shrublands that occur at draw sides and heads include chokecherry, wild plum, western snowberry, and aromatic sumac. Stands typically will have moderate to dense canopies dominated by wild plum (*Prunus americana*) and chokecherry (*P. virginiana*). Other shrubs include snowberry (*Symphoricarpos occidentalis*), wild rose (*Rosa woodsii* and *R. arkansana*), gooseberry (*Ribes missouriense*) and wild black currant (*Ribes americanum*). Trees species associated with these shrublands include Green Ash (*Fraxinus pennsylvanica*), American Elm (*Ulmus americana*), and Rocky Mountain juniper (*Juniperus scopulorum*). Cottonwood (*Populus deltoides*) and peachleaf willow (*Salix amygdaloides*) will be present if there is a spring or seep. The herbaceous component includes; Kentucky bluegrass (*Poa pratensis*), western wheatgrass (*Pascopyrum smithii*), and big bluestem (*Andropogon gerardii*) (Von Loh et al., 1999).

Rejection Criteria
Large outcroppings or barren areas >20% of the plot; areas with anomalous vegetation; edges of the following types that are closer than 50 m to the plot: monitoring type boundaries or transitions; bio-control areas; roads, human-made trails, burn unit boundaries or human created clearings are to be rejected. Because of the linear shape of these communities part of the plot may fall in another monitoring type. Plots should be installed with the long axis of the plot following the long axis of the draw.

Desired Future Condition
Woody draws are believed to be part of the pre-settlement landscape for the area (Boldt et al., 1978). The exact composition of the communities before settlement is unknown. Deciduous trees are reported to be no older than 50 years and juniper no older than 100 (Warner, 1983). The fire return intervals of 15-30 years were estimated for more broken topography at Scotts Bluff National Monument, Nebraska (Wendtland and Dodd, 1992). This return interval would have interacted with long-term wet and dry periods for the area. The edges of these draws

would have been impacted by the return intervals and fire frequencies of the surrounding prairie. The more mesic areas of the draws would have only been likely to burn in dry periods.

The community when maintained by fire will have a mosaic of different age classes within a watershed. Browse for ungulates will increase. Sheltering cover will remain within 25% of current levels. Canada thistle (*Cirsium arvense*) and associated non-native species related to homestead will be reduced. The structural complexity of the community will be maintained. The length of the edge habitat will be increased or maintained within 10% of current levels.

Burn Prescription
These draws will be burned in concert with the surrounding prairie. Typically the prairie will be burned between April until green-up, or late July through a season ending event in the fall. Firing methods and unit preparation will be used to exclude fire from some draws. Head, flanking, and, backing fire will be used as needed to meet burn objectives.

Fire Prescription Elements	
RH – 25-55%	**Live Fuel Moisture – NA**
Bulb - 30-85 o F	**Average Flame Length - 0.4-1.5 feet**
Average Mid-flame winds - 0-20 mph	**Average Rate of Spread - 0-3 chs/hour**
Fuel loading - 3-5 tons per acre	**1-hour TLFM - 6-14 %**
10-hour TLFM - 8-15 %	**100-hour TLFM - 10-30 %**

Monitoring Variables in Order of Importance
1. Density of mature and resprout *Prunus* spp.
2. Density of specific browse species as directed by the wildlife biologist
3. Total herbaceous relative cover

Prescribed Fire Project Objectives
Immediate Post Burn
1. Reduce total down and dead woody fuel load by 20-60%

One Year Post Burn
1. Increase density of desired woody browse species by 30 to 50%

Five Year Post Burn
1. Maintain density of mature woody browse species.

Fire Monitoring Objectives
1. Install enough plots to be 80% confident that the density of *Prunus* spp. is within 25% of the true population mean.
2. Install enough plots to be 80% confident that the density of targeted browse species is within 25% of the true population mean.
3. Install enough plots to be 80% confident that the relative cover of herbaceous plants within 25% of the true population mean.

Data Analysis

1. Track density of specific targeted woody browse species for each postburn read in year 1, 2, and 5 years.
2. Track relative cover and percent cover of herbaceous plants including native grasses and forbs for each postburn read in year 1,2 and 5 years.
3. Track specific non-native species of concern for each postburn read in year 1,2, and 5 years.
4. Track Kentucky bluegrass relative cover for each postburn read in year 1, 2, and 5 years.

Literature Cited

Boldt, C.E., C.W. Uresk, and K.E. Severson. 1978, Riparian Woodlands in Jeopardy on Northern High Plains. In: Johnson, R.R. and J.F. McCormick (eds.) National Symposium on Strategies for Protecting the Management of Floodplain Wetlands and other Riparian Ecosystems. USDA Forest Service General Technical Report WO-12. Atlanta, Georgia.

USDA Soil Conservation Service. 1987. Soil Survey of Jackson County, Northern Part, South Dakota. Washington, D.C. 216 pages plus maps

USDI National Park Service. 2001. Fire monitoring handbook. National Interagency Fire Center, Boise, ID. 288 pp.

Von Loh, J., Cogan, D., Faber-Langendoen, D., Crawford, D., and M.J. Pucherelli. 1999. USGS-NPS Vegetation Mapping Program Badlands National Park, South Dakota (Final Report). Technical memorandum No. 8260-99-03. US Bureau of Reclamation Technical Service Center. Denver, Colorado.

Warner, A.T. 1993. Soil and Hydrological Characterization of Woody and Grassy Draws Badlands National Park, South Dakota. MS Thesis. Colorado State University, Fort Collins. 108 pp.

Wendtland, K. J., and J. L. Dodd. 1992. The fire history of Scotts Bluff National Monument. In: Smith, D. and C. Jacobs (eds.) Twelfth North American Prairie Conference. Cedar Falls, Iowa.

Notes: Brush density of snowberry (*Symphoricarpos* spp.) will be determined by stem count. Brush density for prickly pear (*Opuntia polyacantha*) will be counted by cluster immediately post burn because of increased visibility. Both species are rhizomatous. Please see brush sampling protocol in Fire Monitoring Handbook (USDI NPS 2001) for additional information.

FMH-4 PLOT PROTOCOLS

GENERAL PROTOCOLS		YES	NO		YES	NO
Preburn	Control Plots/Opt		•	Herb Height/Rec	•	
	Herbaceous Density/Opt		•	Belt Transect Width: 2 meters		
	OP/Origin Buried		•	Abbreviated Tags	•	
	Voucher Specimens/Rec	•		Stakes Installed: 0P & 30P; 1A & 1B		
	Stereo Photography/Opt		•	Crown Intercept/Opt		•
	Brush Individuals/Rec	•		Herb. Fuel Load/Opt	•	
	Herbaceous Data Collected at: 0P-30P					
Burn	Duff Moisture/Rec		•	Flame Zone Depth/Rec	•	
Postburn	Herbaceous Data/Opt: Collected.			Herb. Fuel Load/Opt		•
	100 Pt. Burn Severity/Opt		•			

Rec = Recommended; Opt = Optional

FMH-4 **MONITORING TYPE DESCRIPTION SHEET** Park: **BADL**

Monitoring Type Code: GPOPR1D01 **Date Described:** 6/12/97

Monitoring Type Name: Non-native Grass Prairie--Kentucky bluegrass

Prepared by: A. Powers, G. Bradshaw, B. Braudis, B. Bessken, R Runge, B. Adams, G. Kemp, P. Reeberg

Updated by: Supernaugh, Kenner, Childers, Dingman, and Paintner – January, 2000

Physical Description
Many of these areas are associated with disturbances such as roadsides, abandoned farm fields, and areas that were seeded with non-native grasses to 'improve' the range for grazing. Certain areas with high disturbance include next to the park access road and facilities, abandoned agricultural fields along the northern boundary and Sheep Mountain Tables and in seedlings on Cuny and Stronghold Tables. These areas historically supported western wheatgrass mixed prairie (Von Loh et al*.,* 1999). Topography is level to hilly grasslands, badlands crossed by grassy drains, isolated buttes, and lowland terraces. All aspects are represented with slopes from 0 - 45% and elevation 2,400 to 4,000 feet. Soils are clayey, silty, claypan, and badlands overflow. Soil types are: Blackpipe clay loam, Blackpipe-Norrest complex, Blackpipe-Wortman Complex, Cedarpass silty clay loam, Cedarpass-Denby complex, Cedarpass-Interior-Badlands, Interior-Cedarpass-Denby (USDA-SCS, 1987).

Biological Description
Stands typically have moderate herbaceous cover, ranging from 40-90 % and very dense litter over the ground surface. Areas tend to be dominated by one non-native grass species, often planted. These dominant grass could be smooth brome (*Bromus inermis*), crested wheatgrass (*Agropyron cristatum*), or Kentucky bluegrass (*Poa pratensis*). Other non-native species associated with these areas include: Japanese brome (*B. japonicus*), cheatgrass (*B. tectorum*), alfalfa (*Medicago sativa*), yellow sweet clover (*Melilotus officinalis*), common mullein (*Verbascum thapsus).* At the edge and occasionally interspersed are western wheatgrass (*Pascopyrum smithii*), needle and thread (*Stipa comata*), and green needlegrass (*S. viridula*). Very few native forbs or shrubs are seen in this type (Von Loh et al., 1999).

Rejection Criteria
Large outcroppings or barren areas >20% of the plot; areas with anomalous vegetation; edges of the following types that are closer than 50 m to the plot: monitoring type boundaries or transitions; riparian areas or areas dominated by trees; bio-control areas; roads, human-made trails, burn unit boundaries or human created clearings are to be rejected. The areas burned near the roadsides to reduce smooth brome will be monitored with an alternate protocol.

Desired Future Condition
The areas that are currently non-native cool season grasses would have been western wheatgrass historically. Western wheatgrass mixed-grass prairie is believed to be the pre-settlement vegetation for the area but the exact composition of the communities before settlement is unknown. Kuchler (1964) described the potential vegetation for the BADL area as wheatgrass-needlegrass prairie. The fire return intervals reported vary from as short as 5 years in level to gently rolling topography to 15-30 years in more broken topography at Scotts Bluff

National Monument, Nebraska (Wendtland and Dodd, 1992). Most areas of disturbance are flat to rolling and it is believed that the fire return interval in these areas would have been short.

The community when maintained by fire will have reduced amounts of non-native cool season grasses; especially cheatgrass (*Bromus tectorum*), Japanese brome (*B. japonicus*), smooth brome (*B. inermis*), crested wheatgrass (*Agropyron cristatum*), and Kentucky bluegrass (*Poa pratensis*). Repeated spring burning will check the spread of these grasses into native prairie. The number of native grasses and forbs will increase, increasing the biodiversity of these areas. These areas are highly visible because they are often disturbed areas such as roadsides. This provides an opportunity for visitor understanding and education about prescribed fire and non-native species control. The park would like these areas to be returned to mostly native plant communities and eventually have no need for this monitoring type.

Burn Prescription
This prairie will be burned when plant phenology is between green up and heading out. The preferable timing of fires will be when the seed head is in the developmental stage called the 'boot'. Backing and flanking fire will be used to generate relatively long residence times maximize damage to the undesired plants.

Fire Prescription Elements	
RH - 25-55%	**Live Fuel Moisture - NA**
Bulb - 30-85 o F	**Average Flame Length - 0.4-1.5 feet**
Average Mid-flame winds - 0-20 mph	**Average Rate of Spread - 0-3 chs/hour**
Fuel loading - 3-5 tons per acre	**1-hour TLFM - 6-14%**
10-hour TLFM - 8-15%	**100-hour TLFM - 10-30%**

Monitoring Variables in Order of Importance
1. Non-native Grass Relative Cover
2. Relative Cover of Target Species
3. Native Grass Relative Cover

Prescribed Fire Project Objectives
Immediate Post Burn
1. Burn 80-100% of the burnable project area.

One Year Post Burn
1. Reduce relative cover of non-native grasses by at least 30%
2. Increase relative cover of native grasses by at least 10%
3. Increase relative cover of native forbs by at least 10%

Five Year Post Burn
1. Maintain 30% reduction of non-native grass relative cover.
2. Maintain increase of relative cover of native grass and forbs.
3. Limit reduction of native cool-season grasses to less than 20% of the pre-burn level.

Fire Monitoring Objectives

1. Install enough plots to be 80% confident that the relative cover of non-native grasses is within 25% of the true population mean.
2. Install enough plots to be 80% confident that the relative cover of the target non-native grass is within 25% of the true population mean.
3. Install enough plots to be 80% confident that the relative cover of native grasses and forbs is within 25% of the true population mean

Data Analysis

1. Track relative cover of non-native grasses for each postburn read in year 1, 2, and 5.
2. Track relative cover of target grasses for each postburn read in year 1, 2, and 5.
3. Track relative cover and percent cover of native grasses and forbs for each postburn read in year 1,2 and 5.
4. Track relative cover of specific forb or grass species requested by the wildlife biologist for each postburn read in year 1,2, and 5
5. Track relative cover of sweet clover (*Melilotus officinalis*) and/or other non-native forb(s) of concern for each postburn read in year 1, 2, and 5.

Literature Cited

Kuchler, A.W. 1964. Potential natural vegetation of the coterminous Untied States. Am. Geogr. Soc. Spec. Publ. 36 (Manual), New York.

USDA Soil Conservation Service. 1987. Soil Survey of Jackson County, Northern Part, South Dakota. Washington, D.C. 216 pages plus maps

USDI National Park Service. 2001. Fire monitoring handbook. National Interagency Fire Center, Boise, ID. 288 pp.

Von Loh, J., Cogan, D., Faber-Langendoen, D., Crawford, D., and M.J. Pucherelli. 1999. USGS-NPS Vegetation Mapping Program Badlands National Park, South Dakota (Final Report). Technical memorandum No. 8260-99-03. US Bureau of Reclamation Technical Service Center. Denver, Colorado.

Wendtland, K. J., and J. L. Dodd. 1992. The fire history of Scotts Bluff National Monument. In: Smith, D. and C. Jacobs (eds.) Twelfth North American Prairie Conference. Cedar Falls, Iowa.

Notes: Brush density of snowberry (*Symphoricarpos* spp.) will be determined by stem count. Brush density for prickly pear (*Opuntia polyacantha*) will be counted by cluster immediately post burn because of increased visibility. Both species are rhizomatous. Please see brush sampling protocol in Fire Monitoring Handbook (USDI NPS 2001) for additional information.

FMH-4 PLOT PROTOCOLS

GENERAL PROTOCOLS		YES	NO		YES	NO
Preburn	Control Plots/Opt		•	Herb Height/Rec	•	
	Herbaceous Density/Opt		•	Belt Transect Width: 5 m		
	OP/Origin Buried		•	Abbreviated Tags	•	
	Voucher Specimens/Rec	•		Stakes Installed: 0P & 30P		
	Stereo Photography/Opt		•	Crown Intercept/Opt		•
	Brush Individuals/Rec	•		Herb. Fuel Load/Opt	•	
	Herbaceous Data Collected at: 0P-30P					
Burn	Duff Moisture/Rec	•		Flame Zone Depth/Rec	•	
Postburn	Herbaceous Data/Opt: Not collected.			Herb. Fuel Load/Opt		•
	100 Pt. Burn Severity/Opt		•			

Rec = Recommended; Opt = Optional

FMH-4 **MONITORING TYPE DESCRIPTION SHEET** Park: **BADL**

Monitoring Type Code: GBRJA1D01 **Date Described:** 6/12/97

Monitoring Type Name: Non-native grass prairie--Japanese brome

Prepared by: A. Powers, G. Bradshaw, B. Braudis, B. Bessken, R Runge, B. Adams, G. Kemp, P. Reeberg

Updated by: Supernaugh, Kenner, Childers, Dingman, and Paintner – January, 1999

Physical Description
Many of these areas are associated with disturbances such as roadsides, abandoned farm fields, and areas that were seeded with non-native grasses to 'improve' the range for grazing. Areas especially noted are adjacent to the park access road and facilities, and abandoned agricultural fields along the northern boundary (Von Loh et al., 1999). Topography is level to hilly grasslands, badlands crossed by grassy drains, isolated buttes, and lowland terraces. All aspects are acceptable, slopes 0 - 45%, elevation 2,400 to 4,000 feet. Soils are clayey, silty, claypan, and badlands overflow. Soil types are: Blackpipe clay loam, Blackpipe-Norrest complex, Blackpipe-Wortman Complex, Cedarpass silty clay loam, Cedarpass-Denby complex, Cedarpass-Interior-Badlands, Interior-Cedarpass-Denby (USDA-SCS, 1987).

Biological Description
A blend of tall-grass and short-grass prairies, typically dominated by *Bromus* spp., grasses include: Japanese brome (*B. japonicus*), downy brome (*B. tectorum*), western wheatgrass (*Pascopyrum smithii*), needle and thread (*Stipa comata*), and green needlegrass (*Stipa viridula*). Other species include: blue grama (*Bouteloua gracilis*), sideoats grama (*B. curtipendula*), little bluestem (*Andropogon scoparius*), and big bluestem (*A. gerardii*). Shrubs include: *Opuntia polyacantha* and *Rhus aromatica*. Forbs include: *Artemisia frigida, Artemisia cana,* heath aster (*Aster ericoides)*, yarrow (*Achillea millefolium*), and Missouri goldenrod (*Solidago missouriensis*).

Rejection Criteria
Large outcroppings or barren areas >20% of the plot; areas with anomalous vegetation; monitoring type boundaries; riparian areas or areas dominated by trees; bio-control areas; areas within 20 meters of roads, man-made trails, or human created clearings are to be rejected.

Desired Future Condition
The areas that are currently non-native cool season grasses would have been western wheatgrass historically. Western wheatgrass mixed-grass prairie is believed to be the pre-settlement vegetation for the area but the exact composition of the communities before settlement is unknown. Kuchler (1964) described the potential vegetation for the BADL area as wheatgrass-needlegrass prairie. The fire return intervals reported vary from as short as 5 years in level to gently rolling topography to 15-30 years in more broken topography at Scotts Bluff National Monument, Nebraska (Wendtland and Dodd, 1992). Most areas of disturbance are flat to rolling and it is believed that the fire return interval in these areas would have been short.

The community when maintained by fire will have reduced amounts of non-native cool season grasses; especially cheatgrass (*Bromus tectorum*), Japanese brome (*B. japonicus*), smooth brome (*B. inermis*), crested wheatgrass (*Agropyron cristatum*), and Kentucky bluegrass (*Poa*

pratensis). Repeated spring burning will check the spread of these grasses into native prairie. The number of native grasses and forbs will increase, increasing the biodiversity of these areas. These areas are highly visible because they are often disturbed areas such as roadsides. This provides an opportunity for visitor understanding and education about prescribed fire and non-native species control. The park would like these areas to be returned to mostly native plant communities and eventually have no need for this monitoring type.

Burn Prescription
This prairie will be burned between April until green-up, or Labor Day to the end of September. Backing and flanking fires will be used as needed to meet burn objectives.

Fire Prescription Elements	
RH - 25-55%	**Live Fuel Moisture - NA**
Bulb - 30-85 o F	**Average Flame Length - 0.4-1.5 feet**
Average Mid-flame winds - 0-20 mph	**Average Rate of Spread - 0-3 chs/hour**
Fuel loading - 3-5 tons per acre	**1-hour TLFM - 6-14 %**
10-hour TLFM - 8-15 %	**100-hour TLFM - 10-30 %**

Monitoring Variables in Order of Importance
1. Non-native Grass Relative Cover
2. Relative Cover of Target Species
3. Native Grass Relative Cover

Prescribed Fire Project Objectives
Immediate Post Burn
1. Burn 80-100% of the burnable project area.

One Year Post Burn
1. Reduce relative cover of non-native grasses by at least 30%
2. Increase relative cover of native grasses by at least 10%
3. Increase relative cover of native forbs by at least 10%

Five Year Post Burn
1. Maintain 30% reduction of non-native grass relative cover
2. Maintain increase of relative cover of native grass and forbs
3. Limit reduction of native cool-season grasses to less than 20% of the pre-burn level

Fire Monitoring Objectives
1. Install enough plots to be 80% confident that the relative cover of non-native grasses is within 25% of the true population mean.
2. Install enough plots to be 80% confident that the relative cover of the target non-native grass is within 25% of the true population mean.
3. Install enough plots to be 80% confident that the relative cover of native grasses and forbs is within 25% of the true population mean

Data Analysis
1. Track relative cover of non-native grasses for each postburn read in year 1, 2, and 5.
2. Track relative cover of specific target grass for each postburn read in year 1, 2, and 5.
3. Track relative cover and percent cover of native grasses and forbs for each postburn read in year 1,2 and 5.

4. Track relative cover of specific forb or grass species requested by the wildlife biologist for each postburn read in year 1,2, and 5
5. Track relative cover of sweet clover (*Melilotus officinalis*) and/or other non-native forb(s) of concern for each postburn read in year 1, 2, and 5.

Literature Cited

Kuchler, A.W. 1964. Potential natural vegetation of the coterminous Untied States. Am. Geogr. Soc. Spec. Publ. 36 (Manual), New York.

USDA Soil Conservation Service. 1987. Soil Survey of Jackson County, Northern Part, South Dakota. Washington, D.C. 216 pages plus maps

USDI National Park Service. 2001. Fire monitoring handbook. National Interagency Fire Center, Boise, ID. 288 pp.

Von Loh, J., Cogan, D., Faber-Langendoen, D., Crawford, D., and M.J. Pucherelli. 1999. USGS-NPS Vegetation Mapping Program Badlands National Park, South Dakota (Final Report). Technical memorandum No. 8260-99-03. US Bureau of Reclamation Technical Service Center. Denver, Colorado.

Wendtland, K. J., and J. L. Dodd. 1992. The fire history of Scotts Bluff National Monument. In: Smith, D. and C. Jacobs (eds.) Twelfth North American Prairie Conference. Cedar Falls, Iowa.

Notes: Brush density of snowberry (*Symphoricarpos* spp.) will be determined by stem count. Brush density of prickly pear (*Opuntia polyacantha*) will be counted by cluster immediately post-burn because of increased visibility. Both species are rhizomatous. Please see brush sampling protocol in Fire Monitoring Handbook (USDI NPS 2001) for additional information.

FMH-4 PLOT PROTOCOLS

GENERAL PROTOCOLS		YES	NO		YES	NO
Preburn	Control Plots/Opt		•	Herb Height/Rec	•	
	Herbaceous Density/Opt		•	Belt Transect Width: 5 m		
	OP/Origin Buried		•	Abbreviated Tags	•	
	Voucher Specimens/Rec	•		Stakes Installed: 0P & 30P		
	Stereo Photography/Opt		•	Crown Intercept/Opt		•
	Brush Individuals/Rec	•		Herb. Fuel Load/Opt	•	
	Herbaceous Data Collected at: 0P-30P					
Burn	Duff Moisture/Rec		•	Flame Zone Depth/Rec	•	
Postburn	Herbaceous Data/Opt: Not collected.			Herb. Fuel Load/Opt		•
	100 Pt. Burn Severity/Opt		•			

Rec = Recommended; Opt = Optional

APPENDIX (g): PROTOCOLS FOR FIRE EFFECTS MONITORS (FEMO) FOR PRESCRIBED FIRE: IMMEDIATE PRE-BURN, DURING BURN, AND IMMEDIATE POST-BURN

As stated in the BADL Fire Monitoring Plan, all fires within the Park will be monitored to insure their compliance with written policies and prescriptions. Badlands NP has adopted the NPS Fire Monitoring Handbook (2001) as a guide for fire effects monitoring. The following Table illustrates the Levels of Monitoring that will be implemented.

Level 1 – Reconnaissance	Fire Cause, location, size, fuel and vegetation types, relative fire activity, potential for spread, current and forecasted weather, resource or safety threats and constraints, and smoke volume and movement
Level 2 – Fire Conditions	Fire monitoring period, ambient conditions – topographic and fire weather, fuel model, fire characteristic, and smoke characteristic
Level 3 – Immediate Post fire Effects	Fuel reduction, vegetative change or other objective dependent variables with in 1 to 5 years after a burn
Level 4 – Long-term Change	Continued monitoring of Level 3 variables to measure trends and change over time

Wildland fires that are suppressed will be monitored at levels 1 and 2 with observations entered into the park's monitoring database. In the event that long-term fire effects plots are burned in a wildland fire, they will be read by the NGPA Fire Monitoring Team according to the schedule of plot rereads following a burn treatment. Level 1 and 2 monitoring observations will be filed with the final fire package and a copy placed with the records for the Fire Management Unit that was burned.

Wildland Fires for Resource Benefit will be monitored as described in the NPS Fire Monitoring Handbook (Level 2 monitoring) will be completed daily on the fire. During periods of forecasted growth greater than 100 acres per day, on-site observations of dry bulb, relative humidity, wind speed, wind direction, and cloud cover will be made one hour before activity begins to two hours after activity ceases, or minimally from one hour before sunrise to two hours after sunset. Fire characteristics as described in the NPS Fire Monitoring Handbook Level 2 will be collected on-site hourly when conditions and monitor safety permit. Smoke characteristics will be monitored hourly any time a forecast wind direction places the smoke plume toward a community and/or highway.

The plots described in the NPS Fire Monitoring Handbook are being used to examine variables at levels 3 and 4. Prescribed fires will meet at least the Level 1 and 2 recommended standards. If there are FMH plots in a unit, information on Level 3 and 4 Variables will be collected.

LEVEL 1 VARIABLES

Reconnaissance monitoring, Level 1, provides a basic overview of the fire event. The following variables will be collected on all fires.

- Fire cause (origin), location and size
- Fuels and vegetation type

- Relative fire activity
- Potential for further spread
- Current and forecasted weather
- Resource or safety threats and constraints
- Smoke volume and movement

Specific information on the collection of these variables can be found in the NPS Fire Monitoring Handbook (2001) or the RX-91 – Monitoring prescribed and wildland fire text.

LEVEL 2 VARIABLES

Fire conditions monitoring, Level 2, provides information of fire weather, fire behavior and resource values at risk. The following variables will be collected and summarized in a monitoring report on all wildland fires for resource benefit and all prescribed fires. Data forms for weather and fire behavior observations are found in the National Park Service National Fire Monitoring Handbook Appendix A.

Fire Monitoring Period
a) fire number and name
b) observations date and time
c) monitor's name

Ambient Conditions
a) Topographic variables
b) Slope (%)
c) Aspect

Fire Weather variables
a) Dry bulb temperature
b) Relative humidity
c) Wind speed
d) Wind direction
e) Fuel shading and/or cloud cover
f) Time-lag fuel moisture
g) Live fuel moisture
h) Drought index

Soil moisture

Fuel Model

Fire Characteristics
a) Linear rate of spread
b) Perimeter or area growth
c) Flame length
d) Fire spread directions

Smoke Characteristics (based on state and local requirements)

TIMING OF MONITORING

All plots are currently monitored at peak diversity for the native forbs approximately halfway between the peak in cool and warm season grasses. With the addition of nested frequency monitoring the vegetative data may need to be read twice a year because of the two different peaks. This will need to be examined after pilot sampling. All plots are currently being read pre-burn, immediately post-burn, and 1,2,5,10, and 20 years post-burn. The 1-Year read for plots that have burned in the spring is in the first growing season following the burn, and the 2-year read occurs in the following year.

PRE-BURN SAMPLING

Pre-burn sampling will be done during peak phenology according to National Fire Monitoring Handbook standards. Plots need to be installed in the summer before spring burns and at peak the summer before fall burns. All plots that have not burned within 2 years of installation will not be reread until that unit is again scheduled to burn. These plots can also be considered for control plots depending on long term burn planning.

IMMEDIATE PRE-BURN SAMPLING

Fuel loading samples will be taken adjacent to the long term monitoring plots within a week of the burn. Samples of a known area (usually 1 ft^2) are clipped to determine biomass or fuel loading at all plots. All samples taken were dried at 60 degrees Celsius for 24 hours then weighed to determine grams per square foot. Multiplying this by 0.048 gives a measure of tons of biomass per acre. This information will be shared with the burn boss to assist in calculating expected fire behavior.

IMMEDIATE POST-BURN SAMPLING

Plots burned in prescribed or wildfires will have an immediate postburn severity measurement as soon as it is safe to enter the area. Grassland plots are typically read within a week of the fire. Burn severity will be measured according to FMH standards. Forest plots will be read between 2 and 6 weeks post burn to assess scorch heights on trees. A monitoring report will be completed for every prescribed fire which includes staffing, observed weather, fire behavior, ignition patterns, smoke monitoring, and fire effects observations. An example monitoring report is attached at the end of the protocols section.

POST-BURN SAMPLING

Post-burn sampling will be done immediately post-burn and 1, 2, 5,10, and 20 years after the burn. Plots that burn in the spring will be read at peak phenology that summer as 1-year post burn reads, and then at the regular 2, 5, 10, and 20 year schedule. Fall burns will be read the following summer as 1 year post-burn reads. If a unit is scheduled to be burned for a second or third time between reads, an addition pre-burn read will be added. For example, the Pinnacles unit was burned in the spring of 2000. The post-burn reads would be an immediate post-burn read, a 1-year post-burn read that summer, 2 year read, and 5 year read. The unit is then

scheduled to burn again in 2008. A second pre-burn read should be added the year before the burn is scheduled.

LEVEL 3 and 4 VARIABLES

Level 3 and 4 Variables of importance are outlined in the Monitoring Type descriptions of each vegetation type. Information will be collected according to FMH protocols for each of the variables of importance. The postburn measurement schedule in the preceding paragraph outlines when these variables will be measured. Analysis of the results of the monitoring will be done each year with results of change over time, and observed trends presented to Park Management.

EXAMPLE MONITORING REPORT:

BADLANDS NATIONAL PARK
Horse Pasture Prescribed Fire
Fire Monitoring Report

Prepared by Kelly Mathis
Northern Great Plains Fire Monitoring Team

INTRODUCTION

The Horse Pasture burn unit is located south of the Badlands Loop Road (Highway 240) and southeast of the intersection of Highway 377 and Highway 240 in the Cedar Pass District of BADL. The unit consists of approximately 660 acres of mixed-grass prairie (predominantly native species) and badlands formations. Ignition occurred between the hours of 1230 and 1630 hours on 17 Aug 1999 and 0900 and 1800 on 18 Aug 1999. The primary goals for the burn were to increase the vegetative age class diversity in the park and to increase the vigor of the native species through and infusion of nutrients following the burn. The specific objectives contained in the burn plan were to:

- reduce non-native grass species by 10-30%
- increase the native perennial grass cover by 10-30%
- reduce blackthorn honey locust and Russian olive trees and shrubs by 20-40%
- burn 60 to 75% of the project area.

The status of burn objectives can be found in Conclusions table 3.

Staff for the Horse Pasture burn included Burn Boss Mike Beasley, Ignition Specialist Bob Kobza, Holding Specialist Shaun Larson, Lead Prescribed Fire Monitor Andy Thorstenson, Fire Monitor Kelly Mathis, Fire Monitor trainee Gayla Gabriel, and Safety Officer Bill Gabbert. Fire Personnel in the ignition and holding assignments were from Badlands National Park, Black Hills Fire Use Module, Northern Great Plains Fire Monitors, and Wind Cave National Park.

SUMMARY OF EVENTS

Badlands staff did the preparation for the burn which included a mow line along the south and east boundaries of the burn. Black lining occurred along the service road on the west perimeter and near the shooting range on the first day of ignition.

Burn overhead conducted a briefing for personnel on the morning of the burn. A National Weather Service spot forecast and on-site weather observations were obtained to assess compliance with prescription parameters. These are detailed in the section that follows.

WEATHER OBSERVATIONS

Monitoring of weather conditions on the Horse Pasture Burn began at 1000 hours and monitored every half-hour until ignition ceased after 1700 hours. Observations were communicated to all burn personnel. Maximum temperatures occurred about 1300 hours. The minimum relative humidity was recorded at 1700 hours.

Winds started the day light and variable from the north-northwest and continuing variable with a north component throughout the day. The strongest winds were recorded about 1435 hours at 7-9 mph with gusts of 13 mph. Weather conditions are summarized in Table 1. Figure 1 also shows status of temperature, relative humidity, and fine dead fuel moisture throughout the day.

Table 1: Weather Conditions

Condition	Prescription	Predicted	Observed
Temperature (F)	35-90	Hi 80's	63-86
Relative Humidity	20-60%	23%	27-61%
Wind Speed (mph)	2-10mph	5-10	1-9
Wind Direction	Any	variable N	variable N, NW
1-hr Fuel Moisture	4-10%	NA	5-12%

IGNITION PATTERN

Blackline ignition on 17 Aug began at approximately 1230 hours at the shooting range and proceeded along the service road on the west boundary. Ignition of the main unit began the next day at approximately 0900 at the NE corner of the burn and continued south to the SE corner with mainly flanking and backing fire. Ignition then proceeded west toward the shooting range, again with predominantly backing fire. Once a solid blackline was completed strips were run from the NW corner near the housing area to the east tying in with the backing fire. Firing was completed about 1730 hours. See attached map of ignition and fire growth (Attachment 1).

FIRE BEHAVIOR OBSERVATIONS

During the Horse Pasture burn, fire activity was monitored in various vegetative types, in all aspects, and on varying slopes. Fire direction, rate of spread, flame zone depths, and flame lengths were measured on the long term fire effects plots and as the fire moved through the burn unit. Monitoring took place throughout the day in order to assess changes in fire behavior.

The first fire behavior observations were taken during ignition on the east side. Fire was mostly backing and flanking through fire effects plots, so there are very few head fire observations. Observations, locations, and fuel types are detailed in Table 2.

Table 2: Fire Behavior Observations

FIRE TYPE	FUEL MODEL	LOCATION / TIME	RATE OF SPREAD (CH/HR)	FLAME LENGTH	FLAME ZONE DEPTH	COMMENTS
Head	1	NE corner/1030	60	5-7’	6-8”	
	1	GAGSM1D01-14 /1400	30	4-6’	6”	Kentucky bluegrass, western wheatgrass
Flanking	1	GAGSM1D01-06 /1035	12	3-6’	3’	Snowberry, Japanese brome
	1	GASM1D01-14/1300	5	2-2.5’	2-3’	western wheatgrass
	1	GAGSM1D01-06 /1400	5	2-4’	18-24”	Kentucky bluegrass, western wheatgrass
Backing	1	NE corner/1030	2	8-12”	6-8”	good consumption
	1	SE corner/1100	1.5	9”	7”	
	1	S line/1220	3	8-15”	6-12”	2’FL in dead clover
	1	GAGSM1D01-14 /1249	5	5-6”	5”	Canadian thistle, western wheatgrass
	1	GAGSM1D01-14 /1300	2.5	2’	15”	Kentucky bluegrass, western wheatgrass
	1	GAGSM1D01-06 /1412	3	3’	15”	

FUEL LOADING AND FUEL MOISTURE MEASUREMENTS

Fuel loading samples were taken adjacent to the long term monitoring plots a week before the burn. Eight samples of a known area were clipped to determine biomass or fuel loading at all plots. All samples taken were weighed and then dried at 60 degrees Celsius for 24 hours. The average pre-burn fuel loading was 4.06 tons/acre and varied from 2.65 to 5.33 tons/ acre. Fuel loading was high due to a very wet growing season and a thick thatch layer. Fuel loading post burn showed 0.77 tons/acre or an 82% reduction in biomass.

SMOKE MONITORING

North and Northwest winds caused smoke to drift over the line during ignition along the east and south boundaries. Visibility varied between 10 and 100m near the active ignition. Fireline visibility improved within ½ hr behind ignition. Smoke rose quickly off the fireline and mixing height was over 2,000’ at the end of ignition. There were no roads or heavily populated

areas affected during the burn, although one firefighter was treated for heat/smoke related illness.

FIRE EFFECTS OBSERVATION

Two long-term fire monitoring plots are located within the Horse Pasture unit and both were burned. These plots were read immediately postburn to determine burn severity and will be read 1, 2, 5, and 10 years after the fire to determine the vegetative effects of this prescribed burn. The Fire Monitoring Handbook has levels of fire severity that describe the intensity which material burned. Separate readings are taken for substrate (litter and soil) and vegetation to determine severity. The average severity for the substrate of both plots was lightly to moderately burned. The residence time of the fire allowed for partial consumption of the thatch layer leaving mostly black ash and charred dead stems. The vegetation burn severity of both plots showed the vegetation being moderately consumed. High fuel loading due to a heavy thatch layer caused the fire to burn intensely. The vegetation was mostly consumed leaving stems of shrubs and low stubs of grass behind.

CONCLUSIONS

Since it is the long term health of the ecosystem that is the focus of the prescribed burning program, may criteria need to be assessed. Some objectives are immediately measurable while others need to be viewed over the course of several years before results can be determined. The objective to burn 60-75% of the project area was met with fire blackening close to 80% of the unit. The reduction of non-native grass species and increase in native grasses will not be able to be assessed until new growth occurs next spring and in successive years. The goal to reduce blackthorn honey locust and Russian olive trees and shrubs is not valid, as there are none of these species present in the burn unit. With a long-term fire monitoring program in place, quantifiable assessment of prescribed fire goals can be made. A summary of results is shown in table 3.

Table 3	
Objective	**Results**
1. Reduce non-native grass species by 10-30%	Will be measured in 1,2,5,10 yr post rereads of FMH Plots
2. Increase the native perennial grass cover by 10-30%	Will be measured in 1,2,5,10 yr post rereads of FMH Plots
3. Burn 60 to 75% of the project area.	Achieved
4. Reduce blackthorn honey locust and Russian olive trees and shrubs by 20-40%	Not applicable

APPENDIX (h): PROTOCOL FOR ROADSIDE SMOOTH BROME PROJECT

Project: Roadside Burning for Control of Smooth Brome, a cooperative project for prairie restoration

Designed by: Kara J. Paintner and Sandee Dingman

Updated by: Cody L. Wienk and Andy Thorstenson (7/26/01)

Project Rationale

Smooth brome (*Bromus inermis* Leyss.) is a non-native cool season grass. Brought in to the Pacific Northwest in the 1880s (Archer and Branch, 1953), it has been planted in roadsides across the United States. Its spread into native prairies is a concern for managers across the northern Great Plains and tall grass prairies (Willson, 1992). Prescribed burning has had some success at reducing smooth brome in native prairie (Gates et al., 1982; Old, 1969). Willson (1992) burned the grass at different growth stages to determine the best phenological timing for reduction. He found that burning during tiller elongation significantly reduced fall tillering. This study and others (Becker, 1989) showed that burning too early has no effect. Willson quantified that elongated tillers have more than 5 leaves while unelongated have less than five. Other studies have shown that rainfall after the burn has a significant effect on the success of control (Willson and Stubbendieck, 1996).

Smooth brome was probably planted on the Loop Road at BADL around the 1950's, when the park roads were initially being surfaced. Spring prescribed fire will target these roadsides in three stages. Phase 1 is located between Bigfoot Road and Quinn Road (6 miles-FY00). Phase 2 is located between Quinn Road and the Pinnacles Entrance and is partially treated within the Pinnacles Prescribed Fire project (9 miles-FY00). Phase 3 is located between Bigfoot Road and the Northeast Entrance (13 miles-FY02). The area will be monitored to track brome coverage area and the composition of the brome strip and adjacent native prairie. During Phase 1 small plots will be seeded with native grasses to determine if seeding can help speed the recovery of these areas. All monitoring methods are described below. Areas may be reburned to maintain brome reduction either the following spring or two years later based on fuel availability and weather conditions.

Desired Future Conditions

The park resource management staff and superintendent put together a desired future conditions statement for the areas of the park that are currently non-native grass as part of the long term fire monitoring done at the park.

At this time a literature search has been initiated to determine the desired future conditions for non-native grass prairie at BADL, but is not complete. The areas now dominated by non-native cool season grasses would have been western wheatgrass previously. Western wheatgrass mixed-grass prairie is believed to be the pre-settlement vegetation for the area but the exact composition of the communities before settlement is unknown. Kuchler (1964) described the potential vegetation for the BADL area as wheatgrass-needlegrass prairie. The fire return intervals reported vary from as short as 5 years in level to gently rolling topography to 15-30 years in more broken topography at Scotts Bluff National Monument, Nebraska (Wendtland and Dodd, 1992). Most areas of disturbance are flat to rolling it is believed that the fire return interval in these areas would have been short.

The community when maintained by fire will have reduced amounts of non-native cool season grasses; especially cheatgrass (*Bromus tectorum*), Japanese brome *(B. japonicus*), smooth brome (*B. inermis*), crested wheatgrass (*Agropyron cristatum*), and Kentucky bluegrass (*Poa pratensis*). Repeated spring burning will check the spread of these grasses into native prairie. The number of native grasses and forbs will increase, increasing the biodiversity of these areas. The burns are highly visible due to the areas that are disturbed like roadsides. This provides an opportunity for visitor understanding and education about prescribed fire and non-native species control. The park would like these areas to be returned to mostly native plant communities and eventually have no need for this monitoring type.

Prescription and Burn Timing

Backing fire will be used for the longest residence time to damage the sensitive growing points. The burn will be timed to tiller elongation using the methods from Willson (1992). At least half of the smooth brome will have more than 5 green leaves per tiller before burning starts. The following prescription describes fire behavior as either a backing fire under the coolest conditions or a flanking fire in the windiest and driest conditions specified in the environmental prescription. This prescription was developed utilizing the Fire Behavior Prediction System developed by Rothermel (1972). The BEHAVE software package was used to apply this model mathematically to user provided inputs describing fuel and environmental conditions.

INPUTS	
Fuel Model and Vegetation	1 - Perennial Grasses, Western Grasses
Air Temperature	35-90
Relative Humidity	20-60
Mid-flame Wind Speed	2-10
Wind Direction	Any (roadside strips will always be lit as a backing fire to maximize damage to non-natives)
1-Hr. fuel moisture	4-11
OUTPUTS	
Rate of spread (m/min)	0.8-17
Heat/unit area (BTU/sq.ft.)	35-96
Fireline Intensity (BTU/ft/sec)	1-30
Flame Length (ft)	0.3-2.1

Monitoring Methods

1) Brome/native prairie interface: The interface between the brome and native prairie will be recorded every other year using a global positioning system (GPS). Spots of brome outside the interface will be georeferenced as points and the radius of each spot will be estimated to determine the spread of brome outside the general front.

2) Brome cover: Transects were installed in spring 2000 across the burn area to determine brome and native prairie composition. Transects were installed at mileposts (north side) and half way between mileposts (south side). These transects will be modified slightly for continued monitoring. Ten transects (5 north and 5 south of the road) will be sampled in 2002. Each transect will be 12 meters long. When possible the existing transects will be used. In this case, the rebar that marked the brome/native interface will become the END (11 m) of the transect. The START (0 m) rebar will be placed toward the road so that the transect is perpendicular to the road. The END rebar will continue to mark the original location of the brome/native interface.

   If the distance between the original rebar and the road is too small (< 11 m) there are three options: 1) move 50 m east and install transect, 2) move 50 m west and install transect, or 3) relocate to next milepost or half-mile beyond last transect. Try to install the transect so that the entire transect is between the road and the brome/native interface so that END is near the brome/native interface. Install one rebar for START and one for END. Transects should run perpendicular to the road. Record azimuth of transect from START to END for all the transects. Distance from START to brome/native interface should be measured if the brome/native interface is distinct. This measurement should be taken directly on the same line as the transect.

   Vegetation cover, litter, and bare ground will be sampled with a 0.1 m^2 Daubenmire frame (Daubenmire 1959). Each frame is 0.2-m X 0.5-m. Ten frames will be read on the right side (looking from START to END) of each transect, starting at 1.0 to 1.2 m and ending at 10.0 to 10.2 m on the transect. Six cover classes will be used: 1 (0-5%), 2 (6-25%), 3 (26-50%), 4 (51-75%), 5 (76-95%), and 6 (96-100%). Vegetation cover can equal greater than 100%, while litter and bare ground should equal 100% cover. Transects will be read at peak biomass, approximately mid-July.

3. Native seeding: Portions of the area will be seeded with native grass seeds in conjunction with treatments of prescribed fire. A ‘standard’ seed mix for Badlands will be seeded at a rate of 5 pounds of pure live seed (PLS) per acre. The seed mix consists of 40% PLS western wheatgrass, 20%PLS blue grama (*Bouteloua gracilis*), 20% PLS buffalograss (*Buchloe dactyloides*) and 20% PLS green needlegrass (*Stipa viridula*). Viability of the seed will be tested before it is used. Areas receiving the seeding treatment will be monitored with same methods as described above.

Sampling Schedule

Vegetation transects will be read at peak biomass, about mid July. Transects installed in Phase 2 or 3 will be installed during this same time period for future burning. Transects will be re-read at 1,2,3, and 5 years post burn. If areas burn more than once, the schedule will start over.

Data Analysis

All data will be entered into an Excel spreadsheet and analyzed in the fall of each year. The GPS data will be assessed to determine if large-scale shifts can be seen. The transect data will be analyzed to determine changes in cover of native and nonnative species. The weather data will be used to correlate relative wet and dry periods with both the burn and subsequent growing seasons. The Northern Great Plains fire ecologist will oversee all data analysis.

Future Management Direction

Phase 1 areas will be burned either the next spring or one year later to maintain potential brome reduction. Seeding will be examined to determine if recovery time is faster and worth the increased cost per acre. Sampling will be at 1, 2, 3 and 5 years postburn to determine both short and long term effectiveness.

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APPENDIX (i): NON FMH-DATA FORMS

Badlands NP – Roadside Smooth Brome Project

Plot ID: _____ **Date:** _____ **Recorder:** _____
Location: _____ **Azimuth:** _____
UTM Coord.: _____ **Datum:** _____
Treatment Status: _____

For each 0.2 x 0.5-m Daubenmire frame record cover class for each class and species present
Cover classes: **1**=0-5% **2**=6-25% **3**=26-50% **4**=51-75% **5**=76-95% **6**=96-100%
Frames read every meter, starting at 1 m, on the right side of the transect
TOCO = total cover, TOGR = total grass, TOFO = total forbs, TOSH = total shrubs

Species	1	2	3	4	5	6	7	8	9	10	Notes
TOCO											
TOGR											
TOFO											
TOSH											
LITT											
BARE											
BRIN											
AGSM											
BOGR											
STVI											
BUDA											

Notes or other observations:
For species codes see FMH-6

Appendix H(1)

TEN-YEAR PRESCRIBED FIRE SCHEDULE (10/2003)

Planned Year	Rx Fire Unit Name	Acres	Burn Season	Resource Goal for Fire	Total Rx Fire Acres for Year
2004	Sage Creek II	1000	Spring	Non-native reduction	
	Roadside	300	Spring	Non-native reduction	
	Sage Creek	800	Fall	Fuel reduction/ Prairie maintenance	
	Prairie Wind	3200	Fall	Fuel reduction/ Prairie maintenance	
	Quinn Table (CCCspring)	735	Spring	Non-native reduction	
					6035
2005	Conata II	1770	Spring	Non-native reduction/ Habitat improvement	
	Roadside	300	Spring	Non-native reduction	
	McGinty	2800	Fall	Fuel reduction/ Prairie restoration	
					4870
2006	Roadside	300	Spring	Non-native reduction	
	Conata I	2500	Spring	Non-native reduction	
	Interior	2300	Fall	Fuel reduction/ Prairie restoration	
	Mesa	200	Fall	Fuel reduction/ Prairie maintenance	
	Sage Creek II	1500	Fall	Fuel reduction/ Prairie restoration	
					6800
2007	Roadside	300	Spring	Non-native reduction	
	Basin	1800	Spring	Non-native reduction	
	Heck Table	650	Fall	Fuel reduction/ Prairie restoration	
	Door	1600	Fall	Non-native reduction	
					4350
2008	Castle	2485	Spring	Fuel reduction/ Prairie restoration	
	Big Hollow	1095	Spring	Fuel reduction/ restoration	
					3580

Planned Year	Rx Fire Unit Name	Acres	Burn Season	Resource Goal for Fire	Total Rx Fire Acres for Year
2009	Imlay	2757	Spring	Fuel reduction/ Prairie restoration	
	Bridge	2988	Fall	Fuel reduction/ Prairie restoration	
					5745
2010	Sheep Mountain	2441	Spring	Non-native reduction	
	Rake Creek	200	Fall	Fuel reduction/ Prairie restoration	
					2641
2011	Sixteen mile	353	Fall	Fuel reduction/ Prairie restoration	
	Sage Creek Pass	535	Fall	Fuel reduction/ Prairie restoration	
					888
2012	Horse Pasture	686	Spring	Non-native reduction	
	Big Buffalo	4950	Fall	Fuel reduction/ Prairie maintenance	
					5636
2013	Campground	250	Spring	Fuel reduction	
	Pinnacles	260	Spring	Non-native reduction	
	West Sage Creek	3500	Fall	Fuel reduction/ Prairie maintenance	
					4010
2014	Sage Creek II	1000	Spring	Non-native reduction	
	Dillon	4661	Fall	Non-native reduction	
					5661

Appendix I

FIRE PREVENTION PLAN

Objectives:

1. Reduce the threat of human-caused fires through visitor and employee education.
2. Integrate the prevention message into interpretive programs.

General Actions:

Twenty human-caused fires occurred at Badlands National Park from 1974 to 1999. The following General Action Items have been identified as elements in the park's overall Fire Prevention Program. They are designed to address the two major causes of human-caused fires at Badlands National Park in the last 16 years, those being fireworks and equipment.

- All members of the park's staff will be familiar with this plan and be able to explain it to other interested parties.

  Responsible person: All Division Chiefs, ongoing

- Fire prevention will be discussed at park safety meetings. Proper use of equipment by park staff will be emphasized.

  Responsible person: Park Safety Officer, ongoing

- The Pinnacles District Ranger will liasion with local fireworks vendors regarding park regulations pertaining to fireworks, June-August annually.

- Interpretive programs and visitor contacts will include fire prevention messages (particularly fireworks use) to alert visitors concerning current fire danger conditions.

  Responsible person: Chief of Resource Education, ongoing

- Entrance station personnel will include brief fire prevention messages to arriving visitors during periods of high fire danger. Additionally, "NO FIREWORKS ALLOWED" signs will be posted for Independence Day.

  Responsible person: Supervisory Visitor Use Assistant, ongoing

- Enforcement rangers will include fire prevention messages in their routine visitor contacts, particularly campground and back-country users.

  Responsible person: District rangers, ongoing.

Fire Prevention Analysis:

The fire prevention analysis is included in the following pages. The analysis contains the detailed prevention actions identified for specific areas or fire problems in eight Fire Prevention Zones. It will be reviewed annually and updated if changes occur which alter the identified Risks, Hazards, and Values.

Fire Prevention Zone #1: Boundary Interface

Hazard = *moderate* Mixed-grass prairie in continuous stands, some areas of north and west boundary are down-slope from adjacent lands (moderate slopes).

Value = *moderate* Political values; adjacent agricultural land users have low tolerance for fire. Some private structures located near boundary.

Risk = *low* Limited human use.

Specific Prevention Actions Required:

1. General fire prevention actions.
2. Liaison with neighbors and United States Forest Service permittees.
3. Ongoing hazard fuel reduction.

Responsible persons: Chief of Resource Management, Fire Program Coordinator, and District Rangers, ongoing

Fire Prevention Zone #2: Sage Creek Campground

Hazard = *high* Fine, flashy fuels continuous throughout campground. Moderate slopes on west side leading toward park boundary.

Value = *moderate* Visitor safety and property, limited improvements (pit toilets, bulletin board, refuse collection).

Risk = *high* History of illegal campfires, charcoal fires are permitted. Major entry point into Badlands Wilderness.

Specific Prevention Actions Required:

1. Campground bulletin board will contain fire prevention messages.
2. Education/enforcement in campground.
3. Fireworks enforcement.
4. General fire prevention actions.

Responsible persons: Pinnacles District Ranger and Resource Education staff, ongoing

Fire Prevention Zone #3: Buffalo Corrals

Hazard = *moderate* Fine, flashy fuels continuous. Located on gentle upslope.

Value = *high* Extensive corral complex of wood and steel construction.

Risk = *moderate* Risks are associated with bison round-up activities. Historical fire occurrence during round-up activities. Area closed to public, but some "curiosity" use occurs.

Specific Prevention Actions Required:

1. Proper use of equipment during work activities.
2. Safety message on smoking given prior to work activities.
3. Pre-position wildland engine at corrals during major round-up operations.
4. Enforcement of closed area regulations.
5. Ongoing hazard fuel reduction.

Responsible persons: Chief of Maintenance, Chief of Resource Management, Fire Program Coordinator, ongoing
Chief of Resource Protection, during round-up operations.

Fire Prevention Zone #4: Pinnacles Ranger Station

Hazard = *low*	Fine, flashy fuels adjacent to mowed residence area.
Value = *high*	Residence, ranger station, barns, corrals.
Risk = *high*	Primary visitor entry corridor, residents include children, historical fireworks use area nearby (Pinnacles Overlook), moderate equipment and off-road vehicle use.

Specific Prevention Actions Required:

1. General fire prevention actions.
2. Continued internal communications with residents and Pinnacles employees.
3. Ongoing hazard fuel reduction.

Responsible persons: Pinnacles District Ranger, Pinnacles residence occupants, seasonal Pinnacles District staff, Fire Program Coordinator, ongoing

Fire Prevention Zone #5: Cedar Pass Developed Area

Hazard = *low*	Grass fuels interrupted by numerous roads and trails.
Value = *high*	Residential area, numerous government buildings, concessioner developments, large campground, major traffic corridor.
Risk = *high*	Historical fire occurrence associated with campground and fireworks. Much human activity associated with visitors, park operations, and government housing area.

Specific Prevention Actions Required:

1. Ongoing hazard fuel reduction.
2. General fire prevention actions.
3. Education/enforcement in campground.
4. Fire prevention message delivered in evening interpretive programs during high fire danger periods.
5. Campground bulletin board will contain fire prevention message.
6. Continued internal communications with residents and employees.

Responsible persons: Division chiefs, Fire Program Coordinator, ongoing.

Fire Prevention Zone #6: White River Visitor Center

Hazard = *low*	Fine, flashy fuels adjacent to mowed developed area.
Value = *high*	Government buildings, residence.
Risk = *high*	Moderate visitor activity, major traffic corridor on two exposures, residents include children.

Specific Prevention Actions Required:

1. Ongoing hazard fuel reduction.
2. Education/enforcement.
3. Continued internal communications with residents and employees.

Responsible persons: Stronghold District Ranger, Residence occupants, Stronghold District seasonal staff, ongoing

Fire Prevention Zone #7: Backcountry/Wilderness

Hazard = *low*	Fine, flashy fuels intermixed with non-vegetated "badlands" features.
Value = *moderate*	No structures, cultural or natural resources that would be significantly threatened by wildfire.
Risk = *low*	Moderate to low back-country use. Open fires not permitted.

Specific Prevention Actions Required:

1. Backcountry handout contains fire prevention message.
2. General fire prevention actions.
3. Bulletin board at Sage Creek Campground contains fire prevention message.
4. Education/enforcement during back-country patrols.

Responsible persons: Pinnacles District Ranger, Resource Education staff, ongoing.

Fire Prevention Zone #8: Highway 240 Corridor

Hazard = *low*	Fine, flashy fuels and non-vegetated "badlands" features.
Value = *moderate*	Boardwalks, cultural or natural resource values which would be significantly threatened by wildfire.
Risk = *high*	Historical incidence of human caused fires; primarily fireworks. Major traffic corridor.

Specific Prevention Actions Required:

1. General fire prevention actions.
2. Education/enforcement.

Responsible persons: Cedar Pass and Pinnacles District rangers, ongoing

Fire Prevention Zone #9: Utility Corridors

Hazard =*moderate*	Fine, flashy fuels and non-vegetated "badlands" features. Smoke may arc electrical wires.
Value = *moderate*	Utility poles, junction boxes, and pipeline control valves.
Risk = *low*	No fires on record to substantiate risk.

Specific Prevention Actions Required:

1. General fire prevention actions.
2. Education/enforcement.

Responsible persons: District rangers, ongoing

FIRE PREVENTION ZONES

1. **Boundary Interface Zone**
   hazard: *moderate*
   value: *moderate*
   risk: *high*

2. **Sage Creek Campground Zone**
   hazard: *high*
   value: *high*
   risk: *high*

3. **Buffalo Corrals Zone**
   hazard: *moderate*
   value: *high*
   risk: *moderate*

4. **Pinnacles Ranger Station Zone**
   hazard: *moderate*
   value: *high*
   risk: *high*

5. **Cedar Pass Developed Area Zone**
   hazard: *low*
   value: *high*
   risk: *high*

6. **White River Visitor Center Zone**
   hazard: *low*
   value: *high*
   risk: *high*

7. **Backcountry/Wilderness Zone**
   hazard: *low*
   value: *moderate*
   risk: *low*

8. **Tour Road Corrider Zone**
   hazard: *low*
   value: *moderate*
   risk: *high*

9. **Utility Corridors**
   hazard: *moderate*
   value: *moderate*
   risk: *low*