Appendix E

Knife River Indian Villages NHS Fire Ecology

FIRE ECOLOGY OF SPECIFIC VEGETATION COMMUNITIES

VEGETATION

In 2002 vegetation communities at Knife River Indian Villages NHS were mapped as part of the service wide Inventory and Monitoring program.

The National Vegetation Classification System for the park included 13 natural and semi-natural associations. The natural associations are comprised of two woodland, three shrubland, seven herbaceous/grassland, one forest and one sparse vegetation types. The semi-natural associations are comprised of two herbaceous/grassland types. Note in the descriptions below, the "KNRI study area" includes 7493 acres including the park and surrounding lands.

Woodlands

Cold Deciduous Woodlands
- Fraxinus pennsylvanica - Ulmus americana / Prunus virginiana Woodland
  Temporarily Flooded Cold Deciduous Woodland
- Populus deltoides / Salix exigua Woodland
  Temporarily Flooded Cold Deciduous Woodland

Cold Deciduous Forests
- Fraxinus pennsylvanica - (Ulmus americana) / Symphoricarpos occidentalis Forest
  Cold-deciduous forest

Temporarily flooded sand flats
- Populus deltoides / Salix exigua
  Riverine Sand Flats - Bars Sparse Vegetation

Woodlands and forests make up approximately 50% of the vegetation composition with in the park; however, they are minor components of the regional vegetation, covering approximately 14.05% of the KNRI study area. These are generally restricted to floodplains, drainage bottoms, vegetated sandbars and draws.
The temporarily flooded cold deciduous woodland (river and creek bottoms) is the most

common woodland in the project area. The major species located in these areas are Fraxinus pennsylvanica, green ash - Ulmus Americana, American elm / Prunus virginiana, choke cherry / Populus deltoids, cottonwood / Acer negundo, box elder. The draws and drainages of higher elevation are inhabited by Ulmus Americana, American elm / Prunus virginiana, choke cherry / and Symphoricarpos occidentalis / western snowberry.

The riverine or sandbar areas, listed as sparse or void of vegetation are dominated by two species, Populus deltoids, cottonwood / Salix exigua, sandbar willow. The areas are found along the river banks of both the Knife and Missouri rivers in close proximity to the waters edge.

Shrublands

Cold-Deciduous Shrubland

• Shepherdia argentea Shrubland
  Cold-Deciduous Shrubland

Temporarily Flooded Shrubland

• Salix exigua Temporarily Flooded Shrubland
  Temporarily Flooded Shrubland

• Symphoricarpos occidentalis Shrubland
  Temporarily Flooded Shrubland

Shrublands make up approximately 4.63% of the study area. These areas are usually located adjacent to woodland areas or mesic areas on aged sandbars that the river has not been able to reclaim. Species composition of the cold deciduous shrublands consists mainly of Shepherdia argentea, buffaloberry. The composition of the temporarily flooded shrubland is made up of Salix exigua, sandbar willow and Symphoricarpos occidentalis, western snowberry.

Grasslands

Medium-tall bunch temperate or subpolar grassland

• Bromus inermis - (Pascopyrum smithii) Semi-natural Herbaceous Vegetation
  Medium-tall bunch temperate or subpolar grassland
  Bromus inermis, smooth brome

Tall sod temperate grassland
• Andropogon gerardii - Schizachyrium scoparium Western Great Plains Herbaceous Vegetation

Tall sod temperate grassland
Andropogon gerardii, big bluestem / Schizachyrium scoparium, little bluestem

Tall temperate or subpolar perennial forb vegetation
• Cirsium arvense - Weedy Forb Great Plains Herbaceous Vegetation

Tall temperate or subpolar perennial forb vegetation
Cirsium arvense, Canada thistle

Medium-tall sod temperate or subpolar grassland
• Pascopyrum smithii - Bouteloua gracilis - Carex filifolia Herbaceous Vegetation

Medium-tall sod temperate or subpolar grassland
Pascopyrum smithii, western wheatgrass / Bouteloua gracilis, bluegramma / Carex filifolia, threadleaf sedge

Semipermanently flooded temperate or subpolar grassland
• Schoenoplectus tabernaemontani Temperate Herbaceous Vegetation

Semipermanently flooded temperate or subpolar grassland
Schoenoplectus tabernaemontani, softstem bulrush

Diverse grassland communities dominate the landscape both in and around KNRI. Approximately 50% of the park is covered by grasslands, whether healthy stands of mixed prairie or tracts dominated by smooth brome and crested wheat. Almost all grasslands located within park boundaries have some exotic component, with a few tracts being a monoculture of either smooth brome or crested wheat.

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 Bailey1980). 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.

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.

Threadleaf sedge *(Carex filifolia)*--Neither May, August, or September wildfires nor early spring prescribed fire appeared to alter the frequency of this species. Data reported is inconclusive as to herbage yields except for a slight reduction following prescribed fire under relatively dry conditions and with fall burns. Spring burning tended to increase basal cover of this species (White and Currie 1983, Wright and Bailey 1980).

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).

Big sagebrush *(Artemisia tridentate)*White and Currie's (1983) report on Silver sagebrush includes a general statement that fire is a recognized, effective agent for controlling big sagebrush. Nothing is stated as to varied effects using different firing conditions. Research conducted as early as the late 1940's and early 1950's found fire to be an effective method of significantly reducing the occurrence of this species of shrub (Blaisdell 1953). For example, prescribed fires were conducted in a vegetation mix of Big sagebrush overstory and perennial grasses understory. The grasses were predominately wheatgrasses, needle and threat, bluegrasses, and sedges. Perennial grasses accounted for approximately 45% of the total vegetative cover, perennial forbs were 5%, sagebrush was 35%, bitterbrush was 10%, and 5% for other shrubs and annuals.
Conclusions drawn from these burns include findings that burning tended to increase the available area for growth of desired grasses and forbs. Soils were but slightly impacted and then for only a short, post-fire time. Light burns seemed to return the best results in opening stands to a wider growth of desired perennial grasses and forbs (Blaisdell 1953). additional generalizations concerning fire in this habitat type include: While total biomass production is reduced, herbaceous production is increased with duration of increase varying over time as a function of habitat type and existent ecological conditions. Production of herbaceous plants generally increase in the first 2-5 years and then lessens as perennials reach dominance, so long as repeated fires do not cause high plant mortality or the pre-fire community contains too few herbaceous plants (Bunting 1985).

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.

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 E(4)-9 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).

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]

Green ash *(Fraxinus pennsylvanic*a) - 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]

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]

Crested wheat grass *(Agropyron cristatum)* -fall burning of Crested wheatgrass results in only small changes in the stand. Density of plants often remains unchanged (Kay 1960), although yield may be reduced during the first growing season following burning (Lodge 1960). Over a 3 year period, yields by Crested wheatgrass have been observed to increase nearly seven times while being rested from livestock grazing (Ralph and Busby 1979). In North Dakota, Western wheatgrass was unchanged in frequency following fire regardless of site or soil (Dix 1960).

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).

Coyote *(Canis latran*s) - 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.

Fire backing across the prairie, NPS photo