FINAL REPORT

A SURVEY OF THE VASCULAR PLANTS AND BIRDS OF LITTLE BIGHORN NATIONAL BATTLEFIELD

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PREFACE

The following report on vegetation and birds at the Little Bighorn National Battlefield includes three parts. The first is an annotated flora, based on a compilation of existing reports and on original field surveys. The second is an annotated checklist of birds seen at the Battlefield, based on original observations gathered in 1985-1986 and in 2002-2006. The third is a description of vegetative cover at the Battlefield, based on comparative analyses of data from 25 sampling plots, originally established and sampled in 1984-1986 and re-sampled in 2003. We also include in the final section an overall assessment of the condition of Battlefield vegetation and what we perceive to be issues of continuing and future management concern, including fire, invasive exotics, and the impacts of tourism and archaeological exploration.

Acknowledgments

First, we thank Maureen O'Shea-Stone, who generously helped with field work and with assembly of the flora. Our special thanks go to those who facilitated our work at Little Bighorn National Battlefield. Thanks to Neil Mangum who suggested that we come back up for a second look at our work that he had facilitated in the 1980s. Michael Stops lent us red vests and let us wander to those special places where the plants and the birds took us. He supplied us with documents, his experiences, and his welcome in every visit to the Battlefield. We treasure his friendship, and admire his ability to carry out responsibilities far beyond any one person's job description. Kitty Deernose let us work through photo archives again and again. John Doerner led us to literature that put everything else we did into the context of this unique place. Loreen Crooked Arm always greeted us with a smile at the front desk and knew where to find Michael and John. Mary Eggers of Little Big Horn College helped us put the Little Bighorn into a wider perspective.

Finally, we are grateful that the National Park Service has added the University of Colorado to their program. This enabled us to do this study, and we are very grateful for their financial support and encouragement. Some individuals need special mention. Tara Carolin and Lisa Gerloff kept us informed. Michael Britton, Brent Frakes, and Billy Schweiger made our data seem significant and helped us put this project into proper perspective.

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FLORA OF THE LITTLE BIGHORN NATIONAL BATTLEFIELD

The following flora of the Little Bighorn Battlefield is based on personal observations at the site in 1984-1986 and 2002-2006. We also consulted our final report to the National Park Service in 1987 (Bock et al. 1987), and the unpublished list of plants of the Battlefield compiled by Sara Simonson and others in 2000.

Plant systematics at the present time is undergoing major reorganizations based on modern developments in the fields of plant genetics and evolution. Therefore, the nomenclature we have used in this flora must be considered a work in progress. Our primary source for nomenclature was McGregor et al. (1986), supplemented by information in Dorn (1984, 1992) and Weber (1990). Throughout the study we consulted with and received help from the Herbarium staff of the University of Colorado's Museum.

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Flora of the Little Bighorn National Battlefield

Latin Name	Common Name	Family	Origin*
Yucca glauca	Yucca	Agavaceae	N
Rhus radicans var. rydbergii	Poison Ivy	Anacardiaceae	N
Rhus trilobata	Lemonade Bush	Anacardiaceae	N
Lomatium dissectum	Desert Parsley	Apiaceae	N
Musineon divaricatum	Leafy Musineon	Apiaceae	N
Asclepias speciosa	Showy Milkweed	Apocynaceae	N
Achillea millefolium	Yarrow	Asteraceae	N
Agoseris aurantiaca	False Dandelion	Asteraceae	N
Antennaria corymbosa	Pussytoes	Asteraceae	N
Antennaria parvifolia	Pussytoes	Asteraceae	N
Arnica parryi	Parry Arnica	Asteraceae	N
Artemisia cana	Silver Sagebrush	Asteraceae	N
Artemisia frigida	Pasture Sage	Asteraceae	N
Artemisia filifolia	Silver Womwood	Asteraceae	N
Artemisia ludoviciana	Sagebrush	Asteraceae	N
Artemisia tridentata	Big Sage	Asteraceae	N
Aster scopulorum	Aster	Asteraceae	N
Centauria repens	Russian Knapweed	Asteraceae	I
Chrysothamnus nauseosus	Rabbitbrush	Asteraceae	N
Cichorium intybus	Chicory	Asteraceae	I
Circium arvense	Canada Thistle	Asteraceae	I

Circium undulatum	Wavy-leaved Thistle	Asteraceae	N
Crepis acuminata	Hawksbeard	Asteraceae	N
Echinacea angustifolia	Echinacea	Asteraceae	N
Erigeron engelmannii	Daisy	Asteraceae	N
Grindelia squarrosa	Curlycup Gumweed	Asteraceae	N
Gutierrezia sarothrae	Broom Snakeweed	Asteraceae	N
Helianthella quinquenerus	Helianthella	Asteraceae	N
Helianthus annuus	Sunflower	Asteraceae	N
Heliomeris multiflora	Golden Eye	Asteraceae	N
Heterotheca villosa	Golden Aster	Asteraceae	N
Hymenoxys richardsonii	Bitterweed	Asteraceae	N
Lactuca canadensis	Canada lettuce	Asteraceae	N
Lactuca serriola	Prickly Lettuce	Asteraceae	I
Lactuca tatarica	Wild Lettuce	Asteraceae	N
Iva axillaris	Poverty Weed	Asteraceae	N
Lygodesma junca	Skeleton Plant	Asteraceae	N
Machaeranthera pinnatifida	Goldenweed	Asteraceae	N
Microseris nutans	False Dandelion	Asteraceae	N
Ratibiba columnifera	Coneflower	Asteraceae	N
Rudbeckia hirta	Coneflower	Asteraceae	N
Senecio plattensis	Groundsel	Asteraceae	N
Senecio integerrimus	Senecio	Asteraceae	N
Seriphidium canum	Silver Sagebrush	Asteraceae	N
Solidago canadensis	Canada Goldenrod	Asteraceae	N
Solidago nemoralis	Goldenrod	Asteraceae	N

Taraxacum officinale	Dandelion	Asteraceae	I
Tragopogon dubius	Salsify	Asteraceae	I
Cryptantha torreyana	Cryptantha	Boraginaceae	N
Lappula redowski	Beggers Tick	Boraginaceae	N
Lithospermum incisum	Narrowleaf Gromwell	Boraginaceae	N
Plagiobothys scouleri	Popcornflower	Boraginaceae	N
Alyssum allyssoides	Alyssum	Brassicaceae	I
Alyssum desertorum	Alyssum	Brassicaceae	I
Berteroa incana	Hoary False Madwort	Brassicaceae	N
Descurania sophia	Tansy Mustard	Brassicaceae	I
Draba brachycarpa	Draba	Brassicaceae	N
Erysimum asperum	Western Wallflower	Brassicaceae	N
Lepidium perfoliatum	Pepper Grass	Brassicaceae	I
Lesquerella alpina	Alpine Bladderpod	Brassicaceae	N
Sisymbrium altissimum	Jim Hill Mustard	Brassicaceae	I
Thlaspi arvense	Pennycress	Brassicaceae	I
Coryphantha missouriensis	Pincushion Cactus	Cactaceae	N
Echinocereus viridiflorus	Barrel Cactus	Cactaceae	N
Escobaria missouriensis	Foxtail Cactus	Cactaceae	N
Opuntia fragilis	Brittle Cactus	Cactaceae	N
Opuntia polyacantha	Plains Prickly Pear	Cactaceae	N
Lonicera tatarica	Tatarian Honeysuckle	Caprifoliaceae	I-R
Symphorocarpos erucoides	Snowberry	Caprifoliaceae	N
Symphoricarpos occidentalis	Snowberry	Caprifoliaceae	N
Dianthus armeria	Deptford Pink	Caryophyllaceae	N

Silene antirrhina	Campion	Caryophyllaceae	N
Silene conoidea	Catchfly	Caryophyllaceae	I
Ceratoides lanata	Winterfat	Chenopodiaceae	N
Chenoposidum album	Lambsquarter	Chenopodiaceae	I
Chenopodium berlandieri	Pitseed Goosefoot	Chenopodiaceae	N
Salsola kali	Russian Thistle	Chenopodiaceae	I
Sarcobatus vermiculatus	Greasewood	Chenopodiaceae	N
Tradescantia bractata	Spiderwort	Commelinaceae	N
Convolvulus arvensis	Field Bindweed	Convolvulaceae	I
Carex filifolia	Thread-leaved Sedge	Cyperaceae	N
Scirpus acutus	Bullrush	Cyperaceae	N-R
Eleagnus angustifolium	Russian Olive	Eleagnaceae	I-R
Eleagnus commutata	Silverberry	Eleagnaceae	N-R
Shepherdia argentea	Buffaloberry	Eleagnaceae	N-R
Chamaesyce glyptosperma	Spurge	Euphorbiaceae	N
Euphorbia escula	Leafy Spurge	Euphorbiaceae	I
Euphorbia robusta	Spurge	Euphorbiaceae	N
Astragalus aboriginum	Milkvetch	Fabaceae	N
Astragalus agrestis	Milkvetch	Fabaceae	N
Astragalus atropubescens	Milkvetch	Fabaceae	N
Astragalus crassicarpus	Milkvetch	Fabaceae	N
Astragalus drummondii	Milkvetch	Fabaceae	N
Astragalus hyalinus	Milkvetch	Fabaceae	N
Astragalus missouriensus	Milkvetch	Fabaceae	N
Dalea candida	Prairie Clover	Fabaceae	N

Dalea purpurea	Prairie Clover	Fabaceae	N
Glycyrriza lepidota	American Licorice	Fabaceae	N-R
Medicago sativa	Alfalfa	Fabaceae	I
Melilotus officinalis	Sweetclover	Fabaceae	I
Oxytropis lambertii	Locoweed	Fabaceae	N
Oxytropis monticola	Locoweed	Fabaceae	N
Oxytropis sericea	Locoweed	Fabaceae	N
Psoralea argophylla	Silverleaf Scurf Pea	Fabaceae	N
Psoralea esculenta	Prairie Turnip	Fabaceae	N
Psoralea tenuiflora	Prairie Pea	Fabaceae	N
Thermopsis rhombifolia	Golden Banner	Fabaceae	N
Vicia americana	American Vetch	Fabaceae	N
Ribes aureum	Wild Current	Grossulariaceae	N
Ribes cerium	Golden Current	Grossulariaceae	N-R
Hypericum perforatum	St. Johnswort	Hypericaceae	I
Mentha arvensis	Field Mint	Lamiaceae	N
Monardo fistulosa	Wild Bergamot	Lamiaceae	Ñ
Prunella vulgaris	Common Selfheal	Lamiaceae	N
Allium geyeri	Wild Onion	Liliaceae	N
Allium textile	Wild Onion	Liliaceae	N
Calochortus nuttallii	Mariposa Lily	Liliaceae	N
Leucocrinum montanum	Sand Lily	Liliaceae	N
Smilacina racemosa	False Solomon's Seal	Liliaceae	N
Smilacina stellata	False Solomon's Seal	Liliaceae	N
Zigadenus venenosus	Death Camas	Liliaceae	N

Linum lewisii	Blue Flax	Linaceae	N
Linum sulcatum	Yellow Flax	Linaceae	N
Sphaeralcea coccinea	Scarlet Mallow	Malvaceae	N
Fraxinus pennsylvanica	Green Ash	Oleaceae	N
Epilobium angustifolium	Fireweed	Onagraceae	N
Gaura coccinea	Gaura	Onagraceae	N
Gayophytum diffusum	Gayophyton	Onagracee	N
Oenothera albicaulis	Evening Primrose	Onagraceae	N
Oenothera caespitosa	Evening Primrose	Onagraceae	N
Oenothera laciniata	Evening Primrose	Onagraceae	N
Juniperus scopulorum	Rocky Mountain Juniper	Pinaceae	N
Larix occidentalis	Western Larch	Pinaceae	N
Plantago patagonica	Plantago	Plantaginaceae	N
Andropogon gerardii	Big Bluestem	Poaceae	N
Agropyron dasystachyum	Thickspike Wheatgrass	Poaceae	N
Agropyron desertorum	Crested Wheatgrass	Poaceae	I
Agropyron repens	Quackgrass	Poaceae	I
Agropyron smithii	Western Wheatgrass	Poaceae	N
Agropyron spicatum	Bluebunch Wheatgrass	Poaceae	N
Agrostis giganteum	Redtop	Poaceae	N
Agrostis hyemalis	Ticklegrass	Poaceae	I
Bouteloua curtipendula	Sideoats Grama	Poaceae	N
Bouteloua gracilis	Blue Grama	Poaceae	N
Bromus hordeaceus	Soft Brome	Poaceae	I
Bromus inermis	Smooth Brome	Poaceae	I
Bromus japonicus	Japanese Brome	Poaceae	I

Bromus secalinus	Rye Brome	Poaceae	I
Bromus tectorum	Cheat Grass	Poaceae	I
Calamagrostis inexpansa	Northern Reedgrass	Poaceae	N-R
Calamovilfa longifolia	Prairie Sandreed	Poaceae	N
Elymus trachycaulus	Wild Rye	Poaceae	N
Festuca pratense	Meadown Fescue	Poaceae	I
Koeleria macrantha	Junegrass	Poaceae	N
Muhlenbergia cuspidata	Plains Muhly	Poaceae	N
Panicum virgatum	Switchgrass	Poaceae	N-R
Phragmmites australis	Common Reed	Poaceae	N-R
Poa bulbosa	Bulbous Bluegrass	Poaceae	I
Poa canbyi	Canby's Bluegrass	Poaceae	N
Poa compressa	Canada Bluegrass	Poaceae	N
Poa juncifolia	Alkali Bluegrass	Poaceae	I
Poa palustrus	Fowl Bluegrass	Poaceae	N
Poa pratensis	Kentucky Bluegrass	Poaceae	I
Poa sandbergii	Sandberg Bluegrass	Poaceae	N
Sporobolus airoides	Alkali Sacaton	Poaceae	N
Sporobolus cryptandrus	Sand Dropseed	Poaceae	N
Stipa comata	Needle and Thread	Poaceae	N
Stipa viridula	Green Needlegrass	Poaceae	N
Triticum aestivum	Wheat	Poaceae	I
Collomia linearis	Mountain Trumpet	Polemoniaceae	N
Phlox hoodii	Hood's Phlox	Polemoniaceae	N
Eriogonum pauciflorum	Wild Buckwheat	Polygonaceae	N

Rheum rhabarbarum	Rhubarb	Polygonaceae	I
Rumex crispus	Curly Dock	Polygonaceae	I
Androsace occidentalis	Rock Jasmine	Primulaceae	N
Dodecantheon conjugens	Shooting Star	Primulaceae	N
Anenome patens	Pasque flower	Ranunculaceae	N
Clematis ligustifolia	Clematis	Ranunculaceae	N
Delphinium nuttallianum	Larksspur	Ranunculaceae	N-R
Thalictrum occidentale	Meadow Rue	Ranunculaceae	N
Rhamnus alnifolia	Buckthorn	Rhamnaceae	N-R
Prunus virginiana	Chokecherry	Rosaceae	N
Rosa arkansana	Wild Rose	Rosaceae	N
Rosa woodsii	Wild Rose	Rosaceae	N
Galium aparine	Cleavers	Rubiaceae	N
Galium obtusum	Smooth Bedstraw	Rubiaceae	N
Galium triflorum	Sweet-scented Bedstraw	Rubiaceae	N
Populus deltoides	Plains Cottonwood	Salicaceae	N-R
Salix amygdaloides	Peachleaf Willow	Salicaceae	N-R
Salix exigua	Sandbar Willow	Salicaceae	N-R
Comandra umbellata	Toadflax	Santalaceae	N
Lithophragma parviflorum	Prairie Star	Saxifragiaceae	N
Castilleja angustifolia	Indian Paintbrush	Scrophulariaceae	N
Castilleja sessiliflora	Downy Paintbrush	Scrophulariaceae	N
Collinsia parviflora	Blue-eyed Mary	Scrophulariaceae	N
Linaria dalmatica	Butter-and-Eggs	Scrophulariaceae	I
Orthocarpus luteus	Owls Clover	Scrophulariaceae	N

Penstmon angustifolius	Narrow Beardtongue	Scrophulariaceae	N
Penstemon nitidus	Penstemon	Scrophulariaaceae	N
Penstemon virens	Penstemon	Scrophulariaaceae	N
Typha latifolia	Cat Tail	Typhaceae	N-R
Viola nuttallii	Yellow Prairie Violet	Violaceae	N

*I = introduced species
*N = native species
*R = riparian habitats only

BIRDS OF THE LITTLE BIGHORN NATIONAL BATTLEFIELD

The attached annotated checklist is based on observations at both the main part of the battlefield and at the Reno-Benteen site. Fieldwork was conducted in June of 1985 and 1986, and on fourteen days between July 2002 and May 2006. The earliest date was May 11 and the latest date was October 21, so we have no data for the winter season. We recorded the presence of 60 species in five different habitat types: open grassland, sage-grassland, shrubby swales and ravines, river bottomland, and landscaped areas around the Battlefield headquarters and cemetery.

The 1985 and 1986 observations were part of a study examining habitat selection by songbirds in burned versus unburned sage-grasslands (Bock and Bock 1987), which demonstrated the importance of big sagebrush to birds such as grasshopper sparrow, Brewer's sparrow, lark bunting, and lark sparrow. In those years, these species were common only at the Reno-Benteen site, which had not burned and which supported good stands of big sage. The only common grassland birds on burned sage-free grasslands at LIBI proper were the vesper sparrow and western meadowlark. By 2006, grasshopper sparrows, Brewer's sparrows, and lark sparrows had become relatively common at the main LIBI site, associated with increasing cover of shrubs such as *Prunus virginianus* and *Rhus trilobata* in swales and ravines. By contrast, fires at the Reno-Benteen site had killed big sage, and the shrub-dependent bird species were no longer common there. These results are generally consistent with avian responses to fire in sage-grasslands elsewhere in North America (Knick et al. 2005), and they illustrate the importance of at least some scattered emergent shrub cover to a variety of grassland birds. From an avian perspective, loss of big sage from fires at LIBI has had a negative impact on its biological diversity.

By far the richest avian habitat at LIBI is the river bottomland, with its open water, riparian trees, and rich shrubby understory. Riparian habitats have similar value for birds throughout arid parts of western North America, as has long been recognized and studied (e.g., Johnson and Jones 1977, Skagen et al. 1998, Saab 1999). Protection of the LIBI river bottomlands from livestock grazing doubtless is responsible for their well-developed understory, which can benefit a variety of birds dependent on heavy ground cover (e.g., Saab et al. 1995, Stanley and Knopf 2002). Riparian birds likely dependent on understory vegetation at the Battlefield include veery, gray catbird, brown thrasher, spotted towhee, and song sparrow. By contrast, birds such as the ring-neck pheasant, mourning dove, black-billed magpie, American crow, and perhaps some of the flycatchers, are likely to be more abundant in riparian areas outside the Battlefield that are dedicated to agriculture and housing, and that support relatively low and sparse understory vegetation.

Future ornithological inventory and research work at LIBI could profitably be focused on three aspects. The first would be to monitor responses of birds to increases in upland shrubby vegetation that are continuing following the 1983 fire, since understanding of long-term fire-effects on birds in sage-grasslands remains limited (Knick et al. 2005). The second would be more work in the LIBI river bottomlands, both to search for uncommon species that may have been missed in earlier surveys and to confirm nesting status for as many species as possible. A third possibility would be to expand the scale of riparian bird surveys (Knopf and Samson 1994), to include nearby agricultural areas along the river, in order to place the distinctive undisturbed bottomlands on the battlefield in a wider landscape context.

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Stanley, T. R., and F. L. Knopf. 2002. Avian responses to late-season grazing in a shrub-willow floodplain. Conservation Biology 16:225-231.

Bird species recorded at the Little Bighorn Battlefield National Monument, during summer, spring, and fall of 1985-1986 and 2002-2006, by Carl Bock and Jane Bock.

Species	Status[1]	Open Grassland[2]	Sage Grassland[3]	Monument Headquarters	River Bottomland[4]	Shrubby Ravines[5]
		Habitat Type/Area				
Canada Goose (*Branta canadensis*)	R				X	
Mallard (*Anas platyrhynchos*)	S				X	
Common Merganser (*Mergus merganser*)	S				X	
Ring-necked Pheasant (*Phasianus colchicus*)	R	X	X		X	X
Sharp-tailed Grouse (*Tympanuchus phasianellus*)	R	X	X			
Great Blue Heron (*Ardea herodias*)	S				X	
Turkey Vulture (*Cathartes aura*)	S	X	X		X	

Species	Status[1]	Open Grassland[2]	Sage Grassland[3]	Monument Headquarters	River Bottomland[4]	Shrubby Ravines[5]
Northern Harrier (*Circus cyaneus*)	S	X				X
Swainson's Hawk (*Buteo swainsoni*)	S	X	X		X	
Red-tailed Hawk (*Buteo jamaicensus)*	R	X	X		X	
Ferruginous Hawk (*Buteo regalis*)	R	X				
American Kestrel (*Falco sparverius*)	R	X	X		X	
Killdeer (*Charadrius vociferus*)	S				X	
Spotted Sandpiper (*Actitis macularia*)	S (M?)				X	
Upland Sandpiper (*Bartramia longicauda*)	S (M?)	X	X			
Mourning Dove (*Zenaida macroura*)	S	X	X	X	X	X

Species	Status[1]	Open Grassland[2]	Sage Grassland[3]	Monument Headquarters	River Bottomland[4]	Shrubby Ravines[5]
Rock Pigeon (*Columba livia*)	R			X	X	
Eurasian Collared Dove (*Streptopelia decaocto*)	S?[6]			X		
Belted Kingfisher (*Ceryle alcyon*)	S				X	
Downy Woodpecker (*Picoides pubscens*)	R				X	
Hairy Woodpecker (*Picoides villosus*)	R				X	
Northern Flicker (Colaptes auratus)	S	X	X	X	X	X
Western Wood Pewee (*Contopus sordidulus*)	S				X	
Eastern Kingbird (*Tyrannus tyrannus*)	S	X		X	X	
Western Kingbird (*Tyrannus verticalis*)	S	X	X	X	X	X

Species	Status[1]	Open Grassland[2]	Sage Grassland[3]	Monument Headquarters	River Bottomland[4]	Shrubby Ravines[5]
Loggerhead Shrike (*Lanius ludovicianus*)	S	X	X			
Black-billed Magpie (*Pica hudsonia*)	R				X	
American Crow (*Corvus brachyrhynchos*)	R				X	
Horned Lark (*Eremophila alpestris*)	R	X				
Northern Rough-winged Swallow (*Stelgidopteryx serripennis*)	S				X	
Cliff Swallow (*Petrochelidon pyrrhonota*)	S	X	X		X	
Barn Swallow (*Hirundo rustica*)	S			X	X	
Black-capped Chickadee (*Parus atricapillus*)	R				X	
White-breasted Nuthatch (*Sitta carolinensus*)	R				X	

Species	Status[1]	Open Grassland[2]	Sage Grassland[3]	Monument Headquarters	River Bottomland[4]	Shrubby Ravines[5]
House Wren (*Troglodytes aedon*)	S				X	
Veery (*Catharus fuscescens*)	S (M?)				X	
American Robin (*Turdus migratorius)*	S			X	X	X
Gray Catbird (*Dumetella carolinensis*)	S				X	
Brown Thrasher (*Toxostoma rufum*)	S				X	X
European Starling (*Sturnus vulgaris*)	R	X	X	X	X	X
Cedar Waxwing (*Bombycilla cedrorum*)	S				X	
Yellow Warbler (*Dendroica petechia*)	S				X	X
Wilson's Warbler (*Wilsonia pusilla*)	S				X	X

Species	Status[1]	Open Grassland[2]	Sage Grassland[3]	Monument Headquarters	River Bottomland[4]	Shrubby Ravines[5]
Spotted Towhee (*Pipilo maculatus*)	S				X	X
Brewer's Sparrow (*Spizella breweri*)	S		X			
Chipping Sparrow (*Spizella passerina*)	S			X		X
Vesper Sparrow (*Pooecetes gramineus*)	S	X	X			X
Lark Bunting (*Calamospiza melanocorys*)	S		X			
Lark Sparrow (*Chondestes grammacus*)	S		X			X
Grasshopper Sparrow (*Ammodramus savannarum*)	S	X	X			
Song Sparrow (*Melospiza melodia*)	S				X	X
White-crowned Sparrow (*Zonotrichia leucophrys*)	M				X	X

Species	Status[1]	Open Grassland[2]	Sage Grassland[3]	Monument Headquarters	River Bottomland[4]	Shrubby Ravines[5]
Black-headed Grosbeak (*Pheucticus melanocephalus*)	S			X	X	
Western Meadowlark (*Sturnella neglecta*)	S	X	X	X	X	X
Brewer's Blackbird (*Euphagus cyanocephalus*)	S				X	
Common Grackle (*Quiscalus quiscula)*	S	X	X	X	X	X
Brown-headed Cowbird (*Molothrus ater)*	S	X	X		X	
Bullock's Oriole (*Icterus bullockii*)	S			X	X	
House Finch (*Carpodacus mexicanus*)	R			X	X	
American Goldfinch (*Carduelis tristis*)	S				X	

[1]R = likely year-round resident; S = likely summer resident, probably nesting; M = likely migrant only. These designations are not based on year-round surveys of the Battlefield, but on published information about species distributions in the region.

[2]Open grasslands are those without sagebrush - principally areas with a history of fire

[3]Sage grasslands were sampled primarily on the Reno-Benteen site in 1985 and 1986, prior to fire, but also on the few remaining sage-dominated parts of the Battlefield in 2002-2006.

[4]Includes the woodlands along the Little Bighorn River, cliffs adjacent to the river, and the water and shorelines themselves.

[5]Includes especially Deep Ravine and similar areas on the Battlefield, dominated by shrubs such as chokecherry and snowberry.

[6]Status uncertain; first seen at Battlefield headquarters area in May, 2006.

VEGETATION OF THE LITTLE BIGHORN NATIONAL BATTLEFIED

Abstract

A 1983 wildfire burned about 90% of upland mixed grass prairie at the Little Bighorn National Battlefield (LIBI) in south-central Montana. In May 2003 we sampled vegetation on 20 plots that had burned 20 years earlier and on 5 plots spared by the fire. Our goals were to evaluate any residual impacts of that fire, and to assess overall condition of Battlefield vegetation. The 1983 fire killed 100% of the dominant upland shrub, big sagebrush (*Artemisia tridentata*), and there was no evidence of big sage recovery after 20 years. Other shrubs (especially *Symphoricarpos occidentalis, Rosa arkansana, Prunus virginiana*, and *Artemisia cana*) survived or recovered from the fire, and these were particularly abundant in 2003 in swales and small ravines on the Battlefield. Although the small number of unburned plots limited the power of our statistical comparisons, the data suggest that even after twenty years certain native grasses and forbs continued to benefit from effects of the 1983 fire, whereas exotic grasses (especially *Bromus japonicus*) remained more common on unburned sites. Given 1) the vulnerability of big sagebrush to burning, 2) the lack of recruitment even after 20 years, and 3) the value of big sage cover to birds and likely to other animals, we recommend suppression rather than prescribed use of fire for LIBI at the present time. Future prescribed burning might be indicated if there is some recovery of big sagebrush in areas that could be exempted from fire, and/or if there is a trend toward decreasing relative abundance of native vs. exotic grasses and forbs.

Continuing threats to native Battlefield vegetation include the spread of introduced exotic plant species, especially *Poa bulbosa*, Russian olive (*Eleagnus angustifolia*), and honeysuckle (*Lonicera tatarica*). At the same time, native willows (*Salix* spp.) appear to have declined since the time of the Battle, and these are candidates for judicious re-introductions into riparian bottomlands. Other potential threats to native vegetation include the impacts of tourists walking the Battlefield, and of future archaeological excavations.

Introduction

The Little Bighorn National Battlefield (LIBI) lies in and adjacent to the valley of the Little Bighorn River, in Bighorn County, Montana. Upland portions of the Battlefield consist largely of northern mixed grass prairie, dominated by perennial grasses in the genera *Agropyron, Poa, Stipa, and Bouteloua* (Risser et al. 1981). The Battlefield has been ungrazed since it was fenced in 1891, whereas the majority of regional grasslands have long been dedicated to livestock grazing. Numerous bison (*Bison bison*) grazed the prairies of eastern Montana prior to the introduction of livestock (Lyman and Wolverton 2002). However, their migratory and nomadic behavior would have resulted in relatively episodic grazing compared to that of fenced domestic livestock (Berger 2004).

Our general impression of the Battlefield's grasslands is that they are in good condition overall, and that certain areas represent outstanding examples of regional grassland communities. However, LIBI grasslands have in the distant and recent past experienced degradation from a variety of sources. Perhaps the earliest exogenous threat came from horses. Based on the earliest historic records, the region of the Big Horn, Little Big Horn, Rosebud, and Tongue Rivers was noted for its large herds of bison during late spring and summer, and for concentrations of Indians whose horses doubtless had a major impact on regional grasslands beyond that of the native bison (Marquis 1987, Robinson 1995). Subsequent threats have included livestock grazing, alteration of natural fire regimes, and the introduction and spread of non-native plants.

We cannot know the exact appearance of the Battlefield on 25 June 1876, but we have significant clues about its general appearance, both from the early photographic record (see Battlefield archives) and from descriptions of the site provided by participants in the Battle. The Indian interviews are especially valuable because of their apparent knowledge of the natural surroundings. Of particular significance in light of current Battlefield condition, there are many references to big sagebrush (*Artemisia tridentata*) at the scene on the day of the battle. For example, the Cheyenne Two Moons mentions the sage-covered hills on the day of the battle, while the Cheyenne Big Beaver and others recalled Captain Keogh's scalp hanging from a sage bush (Hardorff 1995). Most of the soldiers were from elsewhere and their knowledge of plant life in the western Great Plains was lacking. Interestingly, the individuals who might have been able to give the most detailed descriptions were Custer himself, who was an amateur botanist, along with another Battle casualty, reporter Mark Kellogg (Progulske 1974).

A wildfire on 10 August 1983 burned approximately 90% of the upland areas on the main Battlefield site. Because of the long history of protection from livestock grazing, the 1983 LIBI burn provided an unusual opportunity to study fire effects in a mixed grass prairie that carried fuel loads perhaps comparable to those of some but not all pre-historic times and places (Brockway et al. 2002). Evidence from pre-burn photographs and from the small areas spared by the 1983 fire suggest that the majority of LIBI uplands supported stands of big sagebrush (*Artemisia tridentata*) mixed into the prairie, probably since the time of the battle and likely before (Bock et al. 1987).

In the summers of 1984-1986 we sampled vegetation on upland portions of the Battlefield, on 25 permanent 20 x 20-m plots, five of which had not burned and 20 of which had burned in the 1983 fire. Results (Bock et al. 1987) indicated that the fire killed virtually 100% of the big sagebrush, and that no sage recruitment occurred over the first three post-fire years. Other fire effects were relatively minor. Most other shrubs and succulents appeared to survive or to recover quickly from the fire. The data suggested that native grasses and certain native forbs may have benefited from the fire, while exotic grasses (especially *Bromus japonicus*) may have declined. However, the data supporting these conclusions were limited by the lack of pre-burn information, by the relatively small unburned area and resulting small number of unburned plots (five) that we sampled, and by the short (three-year) duration of the study.

In May 2003 we re-sampled vegetation on the 25 permanent plots that were used in the earlier study. Our study had two objectives. The first was to gain a longer-term perspective on effects of the 1983 fire, and specifically to determine 1) whether any recruitment of big sagebrush had occurred after 20 years, 2) whether other shrubs and succulents had increased in abundance or distribution, and 3) whether native grasses and forbs had continued to hold their apparent edge over exotic species in the burned sites. Our second objective was to assess the overall condition of Battlefield vegetation, in terms of native versus exotic species, and to make recommendations about ways to manage the site for conservation of native biological diversity.

Methods

In May, 1984, we established twenty-five 20x20-m vegetation sampling plots at the Little Bighorn National Battlefield, twenty of which had burned in the 11 August 1983 wildfire that covered most of the main battlefield, and five of which were located on those small portions of the site spared by the fire (Bock et al. 1987). Prior to the start of vegetation data collection in 1984, an archaeological team had mapped the Battlefield on a 100-m grid, using short pieces of rebar that stood about 15 cm above the ground. Each rebar stake was covered with a yellow plastic cap marked with a north (N) by east (E) coordinate; the grid ran parallel to the northwestern and northeastern monument boundaries, rather than following true N-S, E-W compass directions. We used these rebar stakes to mark the southeastern corner of 24 of the 25 plots.

Our first task in 2003 was to relocate the 25 plots, by which time most of the plastic rebar caps had deteriorated to the point where the grid marks were no longer legible. However, we were able to relocate all but one of the plot markers, and we then gave each a GPS notation from its southeastern corner (Table 1). The plot we could not relocate was adjacent to and partly beneath the new Indian Memorial that was not present at the time of our earlier study. We located another plot near this area for our sampling in 2003 (Table 1; the former plot B20).

For analysis and comparison of 2003 vegetation data, we designated 16 of the 20 plots burned in 1983, and all five of the unburned plots, as “unburned uplands” (Tables 2-5), based on their similar topographic positions and vegetative condition. The remaining four burned plots were located in swales and small ravines that by 2003 had begun to support distinctive assemblages of shrubs; there were no topographically-comparable sites on the battlefield that had been spared by the 1983 fire.

We collected three sorts of vegetation data on the plots in May 2003, modeled after our earlier study. First, we set out three 20-m transects, one on the east boundary, one on the west boundary, and one crossing the middle of each plot. We then determined plant canopy cover at 120 points spaced at 0.5-m intervals along the three transects. Plants were identified to species, and unoccupied points were categorized as either bare ground or litter. We pooled data from each of the 120 points on each plot to generate a single percent canopy cover estimate for each plant species on each of the 25 plots. Second, we measured percent frequency of occurrence for each plant species on each plot, by recording its presence versus absence inside fifteen 250 cm^2 quadrats, spaced at 5-m intervals along two sides and one interior transect on each plot. Finally, we counted the total numbers of each shrub and succulent inside the entirety of each plot, as a measure of its density. We also measured the maximum height and maximum width (cm) of up to 30 individuals of each shrub and succulent species on each plot, for future comparison with similar data collected in 1984-1986.

We computed the mean and standard error of percent cover, percent frequency, and (for shrubs and succulents only) density of each plant species, for plots in each of the three habitat categories (Tables 2-4). We also pooled cover and species occurrence (richness) data into various plant categories (Table 5). Because data for most plant species violated assumptions for analyses of variance (Zar 1999), we computed the Kruskal-Wallis *H*-statistic as a nonparametric alternative for testing for significant differences among habitats. All statistical tests were performed in Statview 5.0.1 (SAS Publishing, 1999), with $P < 0.05$ considered significant, and $0.05 < P < 0.10$ as marginally significant. Given the large number of comparisons involved, *P*-values > 0.01 should be interpreted with caution.

Results

Shrubs and succulents - Big sagebrush (*Artemisia tridentata*) was completely missing from all the plots that had burned in 1983, despite 20 years of post-fire vegetative growth (Table 2). By contrast, the shrub *Artemisia cana* was abundant in all three habitats. Various other shrubs (especially *Prunus virginianus, Rosa arkansana, and Symphoricarpos occidentalis*) were confined largely to the four plots located in swales and small ravines. Our data suggest that the cactus *Opuntia fragilis* may have been more abundant in level to rolling uplands than it was in swales (Table 2). Overall shrub canopy and combined shrub/succulent species richness were higher on unburned plots and in swales than on burned uplands (Table 5).

Graminoids - We recorded 13 grass and one sedge species on the 25 plots in 2003. There were few significant differences in either canopy or frequency among habitats (Table 3). However, the data suggest that canopy of native species may have been higher in areas burned in 1983, while an opposite (but non-significant) trend was apparent for exotic grasses, the most abundant of which was *Bromus japonicus* (Tables 3 and 5).

Forbs – We recorded 46 forb species on the 25 plots in 2003. Most were uncommon and did not differ in canopy or frequency among habitats (Table 4). Species richness of native forbs was marginally higher on burned than on unburned plots (Table 5), while combined canopy cover of native forbs showed a similar but nonsignificant trend.

Discussion

Residual Effects of the 1983 Fire.

As in our earlier study (Bock et al. 1987), the small number of plots at the Little Bighorn National Battlefield (LIBI) spared by the 1983 fire (n = 5) reduced the power of statistical comparisons of data from burned vs. unburned areas (Tables 2-5). The power of these tests was further reduced by our realization that four of the 20 burned plots were located in shrubby swales and small ravines not represented in unburned landscapes, so that it was necessary to treat these as a distinct habitat type. Despite these limitations, vegetation data gathered in 2003, twenty years after the 1983 fire, added a longer-term perspective to our earlier work, and confirmed some of our earlier conclusions.

Uplands at the Little Bighorn National Battlefield (LIBI) are part of the North American mixed grass prairie, an ecosystem in which fire has long been a regular and natural event (Risser et al. 1981, Pylypec and Romo 2003). However, fire frequency has been episodic in this region historically and pre-historically, related to climatic cycles (Umbanhowar 1996, Brown et al. 2005) and probably to fuel reductions caused by ungulate grazing (Briggs et al. 2002). Therefore, ecological opportunities have long existed across the northern Great Plains for plants that are intolerant of fire, as well as for those dependent upon or unaffected by it.

Photographic and other historic evidence suggests that big sagebrush (*Artemisia tridentata*) was a dominant upland shrub along the Little Bighorn since the time of the battle and likely before (Bock et al. 1987). Big sagebrush is well-known to be killed by fire, with post-burn recovery taking 35 to more than 200 years (Baker 2006). Our results at LIBI are entirely consistent with these other studies, since we did not record a single big sagebrush plant on any of our burned plots in 2003, 20 years after the 1983 fire killed all sagebrush. At the same time, the small unburned portions of the Battlefield have continued to support good stands of big sagebrush.

Ground cover at LIBI is relatively lush due to long-term absence of ungulate grazing, and this may have reduced opportunities for recruitment of big sagebrush seedlings after the fire (Austin and Urness 1998). However, the congeneric silver sage (*Artemisia cana*) has recovered and recruited well since the fire, both in uplands and in swales (Table 2). Shrubs largely restricted to swales and ravines at LIBI, such as chokecherry (*Prunus virginiana*), snowberry (*Symphoricarpos occidentalis*) and rose (*Rosa arkansana*), also apparently suffered little or no long-term negative effects of the 1983 fire (Table 2). Other studies confirm that these or closely related shrubby species either survive fire or recruit well post-fire (e.g., Bock and Bock 1984, Romo et al. 1993, Nadeau and Corns 2002). Because of lack of unburned (control) habitats on the Battlefield, we were unable to determine whether 2003 densities of shrubs in swales and small ravines were higher or lower or no different than they were prior to the 1983 fire. However, the 2003 abundances and distributions of these shrubs were comparable to those in 1985 and 1986 (Bock et al. 1987).

Invasions of the exotic annual cheatgrass (*Bromus tectorum*) throughout much of the Great Basin have increased fire frequency and caused widespread loss of big sagebrush (Knick and Rotenberry 1997, Baker 2006). Because *Bromus tectorum* thrives in the presence of fire, many former sage-dominated shrubsteppe ecosystems now exist as near monocultures of this self-perpetuating annual grass. A related species, *Bromus japonicus*, is common at LIBI. However, in contrast to its effects on cheatgrass, fire can negatively impact *Bromus japonicus* populations, by reducing litter accumulations that favor seed production, seedling survival, and growth (Whisenant 1990). Our data from LIBI are consistent with these findings, since *Bromus japonicus* was more common in 2003 in areas spared by the 1983 fire, although the small sample size and high variance among our unburned plots precluded statistical support for this conclusion (Table 3). Certainly there is no evidence from our work to suggest that future fire at LIBI would drive its uplands toward an alien-dominated grassland, since the trend was toward higher cover of native vs. exotic grasses in areas burned in 1983 compared to those that did not (Table 5). Canopy cover and frequency of native vs. exotic forbs showed the same trend (Table 5).

Species richness of succulents and shrubs was higher in burned swales and small ravines than in either burned or unburned uplands (Table 5), confirming the overall importance of this sort of topographic heterogeneity to plant species richness in the northern mixed grass prairie (Umbanhowar 1992). Species richness of native forbs was marginally higher on burned than on unburned plots, while species richness of native grasses showed the same trend (Table 5). These results suggest that most of the native flora of LIBI uplands is at least fire tolerant if not fire-dependent, which confirms the historic and continuing importance of fire in the region (Brown et al. 2005). However, big sagebrush is very important to the upland avifauna along the Little Bighorn (Bock and Bock 1987), and likely to other components of animal biodiversity as well, and our data show that fire will exclude big sagebrush for long periods.

Threats to the Battlefield Vegetation, and Management Recommendations.

Based upon our experiences at LIBI since 1983, the most obvious ongoing and increasing threat to Battlefield biodiversity comes from the enormous visitor pressure on this famous spot in American history. The potential visitor impacts on LIBI grasslands are similar to those that threaten ecotourism sites everywhere (Penksza et al. 2003, Kruger 2005), and include the destruction of native vegetation through trampling, and increased abundance and distribution of exotic species through propagule dispersal and creation of bare ground for colonization. The management decisions for LIBI that we have observed over these two decades earn our admiration. The re-working of visitor movement patterns and the excellent trail relocations, along with appropriate enforcement to keep visitors on the trails, have conserved and restored portions of the grassland.

Exotic vegetation is often a companion of tourists. The exotic bromes (*Bromus japonicus* and *B. tectorum*) are of relatively minor concern because of their inability to spread into the grassland at the expense of native grass species. Rather, they seem to fill in gaps where the native floral cover has been interrupted. But another exotic grass, *Poa bulbosa*, deserves special attention. It was not observed on the Battlefield or in the vicinity of Hardin, Montana, in the 1980s. We first observed it along some town streets in Hardin in 2003, and noted it then on one isolated field plot (B6) and in several areas along the road near Last Stand Hill. By May 2006, it lined the entrance road to the Battlefield and was conspicuous along the Battlefield roads themselves. It also had moved out from the roadsides into the grassland itself, although it has not yet established at the Reno-Benteen site in any major way. Judging by its behavior both in Hardin and at the Battlefield, disturbed roadsides are highly receptive to *Poa bulbosa*. It also is invading established grasslands away from roadsides and trails in places where vegetation cover is not dense. If control for this species is considered, we recommend pulling it by hand at the outer edges of its distribution in order to keep its spread under control. Pesticide use is not recommended because of the impact the pesticide would have on the less robust native species within the grassland. Directional natural selection has led many exotic invasives to resist pesticide dosages that are damaging or lethal to native plants, especially native dicotyledons and other broad-leaved species.

In the 1980s we observed some disturbance to LIBI grasslands related to archaeological excavations that followed the 1983 fire, which we discussed with Dr. Douglas Scott, head of the excavation team. Dr. Scott was aware of the potential destruction of vegetation on the site. He assured us that re-soding would take place following completion of the excavations, and it did. However, in 2003 we found a correlation between former excavation sites and the presence of exotics, especially *Poa bulbosa*, suggesting a residual disturbance effect. We hope and expect that any future explorations will involve less invasive methods now available in archaeological research, including ground penetrating radar, FLIR, SWIR, GPS, and aerial and ground-level LIDAR mapping.

It might be appropriate for the management of LIBI to call attention, through signage and interpretive events, to the inherent natural value and biodiversity of the healthy grass and shrub habitat. This should be of interest not only to those visitors oriented toward natural history, but also to those interested in the human history of the site in terms of the appearance of the Battlefield. Thanks to the regrowth and spread of *Artemisia cana*, the Battlefield must now rather closely resemble how it looked on the 25th of June, 1876, even though *A. tridentata* does not dominate the site as it did then. The physiognomy of *A. cana* is considerably less robust than *A. tridentata*, but it provides the same general aspect.

Given the vulnerability of *Artemisia tridentata* to burning, and its recent losses at both the Reno-Benteen and main parts of LIBI, we recommend suppression rather than prescribed use of fire for the Battlefield at the present time. Future use of prescribed fire might be indicated if there is some recovery if big sagebrush in areas that could be exempted from burning, and/or if there is a trend toward decreasing relative abundance of native vs. exotic grasses and forbs.

Riparian habitats are uncommon in southeastern Montana as they are throughout much of the West, and remnants stands often are in severely degraded condition (e.g., Johnson and Jones 1977). Riparian areas of LIBI along the Little Bighorn River are particularly diverse because of their long history of protection from grazing, but they could benefit greatly from some active management. First, there are at least two non-native woody species that need to be removed or at least discouraged: honeysuckle (*Lonicera tatarica*) bushes and Russian olive (*Eleagnus angustifolia*). Both hold the potential for crowding out native riparian species. On the other hand, there are two woody species that need special nurturing and perhaps even some judicious plantings. These are the willows *Salix amygdaloides* (peachleaf willow) and S. exigua (sandbar willow). Willows are deserving of special attention at LIBI not only for their intrinsic value as part of the native flora, but also because of their particular significance to native peoples.

Willows have been documented in numerous archeological and ethno-botanical studies as being of great significance to Indians throughout the Americas. Uses ranged from medicinal (active ingredients from aspirin are in willow) to basket making and shelters (Duke 1997). Both willows at LIBI likely were present and used by the tribes involved in the gathering along the river at the time of the Battle. Noisy Walking was sheltered "under a willow dome" that was erected at the end of the Battle and that was visited by Wooden Leg and others (Michno 1997). Perhaps the most interesting detail concerning willow comes from an interview with Young Two Moons who said (Hardorff 1995: 133) "After the fight was over, we gathered in the river bottom and cut willow sticks, then some Indians were delegated to go and throw down a stick wherever they found a dead soldier, and then they were ordered to pick up the sticks again, and in this way we counted the number of dead. It was about six times we had to cut willow sticks, because we kept finding men all along the ridge. We counted four hundred eighty-eight with our sticks along the ridge." (Hardorff has a footnote about this number being in error.)

We found willows to be very scarce in the riparian bottomlands at LIBI, which suggests that they may have declined significantly since the time of the battle. However, we found numerous willows along the Little Bighorn at Garryowen, and also near the site of the Battle of the Rosebud. Cuttings from these trees could be used to revegetate riparian woodlands at LIBI.

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Table 1. Locations and descriptions of plots used to sample vegetation at Little Bighorn Battlefield in 1984-1986 and 2003.

Plot	Habitat Type	GPS Coordinates	Grid[1]	Description of Location
C1	Unburned upland	45° 34.14' N 107° 26.24' W	N80 E19	Along northwest fence, north of road to river
C2	Unburned upland	45° 34.09' N 107° 26.30' W	N80 E18	Along northwest fence, north of road to river
C3	Unburned upland	45° 33.87' N 107° 25.13' W	N67 E28	Calhoun Hill, inside road circle
C4	Unburned upland	45° 33.83' N 107° 25.17' W	N67 E27	Calhoun Hill, just west of main road
C5	Unburned upland	45° 33.75' N 107° 25.20' W	N66 E26	Northwest of road between Calhoun Hill and southern gate
B1	Burned upland[2]	45° 34.12' N 107° 25.76' W	N76 E24	West/southwest of Custer Hill, east of path
B2	Burned upland	45° 34.05' N 107° 26.26' W	N78 E19	Northwest corner, s. of road to river
B3	Burned upland	45° 34.02' N 107° 26.23' W	N78 E18	Northwest corner, s. of road to river
B4	Burned upland	45° 34.17' N 107° 25.41' W	N74 E28	East/northeast of road between Custer and Calhoun Hills
B5	Burned upland	45° 34.11' N 107° 25.38' W	N73 E28	East/northeast of road between Custer and Calhoun Hills
B6	Burned swale[3]	45° 34.01' N 107° 25.29' W	N71 E28	East/northeast of road between Custer and Calhoun Hills
B7	Burned upland	45° 33.93' N 107° 25.42' W	N71 E26	West/southwest of road between Custer and Calhoun Hills
B8	Burned swale	45° 33.93' N 107° 25.49' W	N71 E25	West/southwest of road between Custer and Calhoun Hills
B9	Burned swale	45° 33.79' N 107° 25.63' W	N70 E22	Central bottomland, side drainage to Deep Ravine
B10	Burned upland	45° 33.68' N 107° 25.71' W	N69 E20	Along north-facing slope south of Deep Ravine
B11	Burned upland	45° 33.66' N 107° 25.60' W	N68 E21	Along north-facing slope south of Deep Ravine
B12	Burned upland	45° 33.69' N 107° 25.43' W	N67 E23	On north-facing slope north/northwest of southern gate
B13	Burned swale	45° 33.73' N 107° 25.26' W	N66 E25	Northwest of road between Calhoun Hill and southern gate
B14	Burned upland	45° 33.88' N 107° 25.06' W	none	Calhoun Hill, northeast of loop road, near C3
B15	Burned upland	45° 33.93' N 107° 26.14' W	N76 E18	Northwest corner, southeast of road to river
B16	Burned upland	45° 33.99' N 107° 26.01' W	N76 E20	Northwest corner, southeast of road to river
B17	Burned upland	45° 33.97' N 107° 25.80' W	N74 E22	Near path, half way from hdqts to Deep Ravine overlook
B18	Burned upland	45° 33.83' N 107° 25.80' W	N72 E21	Near end of path at Deep Ravine overlook
B19	Burned upland	45° 33.70' N 107° 25.80' W	N70 E19	On north-facing slope, south of Deep Ravine

B20	Burned upland	45° 34.29’ N 107° 25.66’ W	N78 E27	Near site of new Native American monument

[1]Prior to the start of vegetation data collection in 1984, an archaeological team had mapped the Battlefield on a 100-m grid, using short pieces of rebar that stood about 15 cm above the ground. Each rebar stake was covered with a yellow plastic cap marked with a north (N) by east (E) coordinate; the grid ran parallel to the northwestern and northeastern monument boundaries, rather than following true N-S, E-W compass directions. We used these rebar stakes to locate the southeastern corner of 19 of our 20 20x20-m vegetation sampling plots. By 2003, most of the plastic caps had deteriorated to the point where the grid marks were no longer legible.

[2]These plots were located on slopes and level uplands without drainages, in areas that had been burned in the 1983 fire that we judged comparable to those portions of the Battlefield spared by the fire.

[3]These plots were in swales and small drainages on the Battlefield that burned in the 1983 fire; there were no comparable sites on portions of the Battlefield spared by the 1983 fire.

Table 2. Mean (standard error) of abundance of shrubs and succulents on twenty-five 400 m^2 plots, of three habitat types, at the Little Bighorn National Battlefield in summer 2003, in terms of density (numbers per plot), percent canopy cover, and percent of subplots occupied (frequency).

Species	Abundance variable	Unburned uplands (n = 5 plots)	Burned uplands[a] (n = 16 plots)	Burned swales[b] (n = 4 plots)	Kruskal-Wallis *H* (*P*)
Artemisia tridentata	Density	79.0 (28.2)	0	0	23.6 (< 0.001)
	Percent cover[c]	9.8 (2.9)	0	0	23.6 (< 0.001)
	Percent frequency[d]	21.3 (6.5)	0	0	18.1 (< 0.001)
Artemisia cana	Density	36.8 (27.2)	21.6 (16.9)	73.0 (71.7)	2.1 (ns)[e]
	Percent cover	1.0 (1.0)	0.2 (0.2)	1.3 (1.3)	1.6 (ns)
	Percent frequency	6.6 (6.6)	0.5 (0.4)	3.3 (1.5)	1.5 (ns)
Chrysothamnus nauseosus	Density	0	0.6 (0.4)	1.0 (1.0)	1.2 (ns)
	Percent cover	0	0	0	
	Percent frequency	0	0	1.7 (1.7)	5.3 (0.07)
Opuntia fragilis	Density	35.6 (14.9)	23.5 (6.2)	7.0 (5.1)	3.2 (ns)
	Percent cover	0.7 (0.3)	0.2 (0.1)	0	4.8 (0.09)
	Percent frequency	6.7 (3.7)	4.6 (1.6)	1.7 (1.7)	1.3 (ns)
Prunus virginiana	Density	0	0.1 (0.1)	11.3 (11.3)	2.2 (ns)
	Percent cover	0	0	3.1 (3.1)	5.3 (0.07)
	Percent frequency	0	0	5.1 (5.0)	5.3 (0.07)

Rhus trilobata	Density	0.2 (0.2)	0.1 (0.1)	1.8 (1.0)	5.3 (0.07)
	Percent cover	0.2 (0.2)	0	0	4.0 (ns)
	Percent frequency	0	0	0	
Rosa arkansana	Density	0	0.2 (0.1)	37.0 (17.4)	17.5 (< 0.001)
	Percent cover	0	0.1 (0.1)	0.4 (0.2)	5.8 (0.06)
	Percent frequency	0	1.3 (0.9)	13.3 (7.2)	9.5 (0.09)
Sarcobatus vermiculatus	Density	0.8 (0.8)	0.3 (0.3)	6.0 (6.0)	1.5 (ns)
	Percent cover	0.2 (0.2)	0	0.6 (0.6)	3.8 (ns)
	Percent frequency	0	0	1.7 (1.7)	5.3 (0.07)
Symphoricarpos occidentalis	Density	0	0	575.0 (275.8)	23.8 (< 0.001)
	Percent cover	0	0	3.7 (1.4)	23.8 (< 0.001)
	Percent frequency	0	0	21.7 (7.9)	17.1 (< 0.001)
Yucca glauca	Density	6.0 (4.3)	8.2 (3.8)	6.5 (2.7)	1.1 (ns)
	Percent cover	1.0 (0.7)	0.9 (0.4)	0.8 (0.6)	0.1 (ns)
	Percent frequency	1.3 (1.3)	3.3 (2.1)	3.4 (1.9)	1.2 (ns)

[a]Level to rolling uplands burned in the 1983 fire, in areas topographically similar to unburned portions of the Battlefield.

[b]Swales and small drainages burned in the 1983 fire; there were no comparable areas spared by the fire.

[c]Percent of 120 points where species canopy occurred; points were spaced at 0.5-m intervals along three 20-m transects on each plot.

[d]Percent of 15 50x50-cm subplots on each plot in which the species was rooted.

[e]Not statistically significant by Kruskal-Wallis *H*-test ($P > 0.10$).

Table 3. Mean (standard error) of abundance of grasses and sedges on twenty-five 400 m^2 plots, of three habitat types, at the Little Bighorn National Battlefield in summer 2003, in terms of percent canopy cover and percent of subplots occupied (frequency).

Species	Abundance variable	Unburned uplands (n = 5 plots)	Burned uplands[a] (n = 16 plots)	Burned swales[b] (n = 4 plots)	Kruskal-Wallis *H* (*P*)
Agropyron smithii	Percent cover[c]	11.5 (3.1)	14.4 (1.5)	13.9 (1.7)	0.5 (ns)[e]
	Percent frequency[d]	77.3 (9.6)	77.1 (5.3)	76.7 (8.0)	0.2 (ns)
Agropyron spicatum[f]	Percent cover	9.8 (4.6)	13.1 (2.3)	11.5 (9.5)	0.7 (ns)
	Percent frequency	41.3 (1.7)	51.7 (7.3)	48.3 (12.6)	0.3 (ns)
Bouteloua curtipendula	Percent cover	0	1.7 (0.6)	1.0 (1.0)	5.1 (0.08)
	Percent frequency	4.0 (2.7)	9.6 (3.9)	10.0 (4.3)	1.1 (ns)
Bouteloua gracilis	Percent cover	0.5 (0.3)	1.7 (0.7)	0.4 (0.4)	0.8 (ns)
	Percent frequency	6.7 (3.7)	8.3 (3.0)	6.7 (2.7)	0.1 (ns)
Bromus inermis	Percent cover	0	0	2.3 (2.3)	5.3 (0.07)
	Percent frequency	0	0	8.3 (8.3)	5.3 (0.07)
Bromus japonicus	Percent cover	24.8 (10.8)	14.3 (3.6)	12.7 (4.5)	1.1 (ns)
	Percent frequency	66.7 (17.9)	55.8 (9.0)	56.7 (20.6)	0.6 (ns)
Carex filifolia	Percent cover	0.5 (0.3)	2.4 (0.8)	1.7 (1.2)	1.5 (ns)
	Percent frequency	4.0 (1.6)	15.8 (5.6)	13.3 (6.1)	1.0 (ns)

Koelaria macrantha	Percent cover	0.2 (0.2)	0.3 (0.1)	0.2 (0.2)	0.1 (ns)
	Percent frequency	5.3 (5.3)	2.1 (1.3)	1.7 (1.7)	0.1 (ns)
Poa bulbosa	Percent cover	0	0	0	
	Percent frequency	0	0	5.0 (5.0)	5.3 (0.07)
Poa canbyi	Percent cover	1.5 (1.5)	1.7 (0.4)	0.8 (0.5)	2.3 (ns)
	Percent frequency	12.0 (9.0)	19.2 (3.7)	3.3 (3.3)	4.2 (ns)
Poa compressa	Percent cover	0.7 (0.3)	1.6 (0.5)	1.7 (0.6)	1.5 (ns)
	Percent frequency	4.0 (2.6)	9.2 (4.1)	11.7 (6.9)	0.7 (ns)
Poa pratensis	Percent cover	0.7 (0.7)	0.1 (0.1)	0	1.5 (ns)
	Percent frequency	12.0 (10.4)	0	0	8.3 (0.02)
Stipa comata	Percent cover	0	0.5 (0.2)	0	3.3 (ns)
	Percent frequency	0	7.5 (3.8)	0	2.5 (ns)
Stipa viridula	Percent cover	0.3 (0.2)	1.4 (0.4)	0.6 (0.4)	0.6 (ns)
	Percent frequency	0	4.6 (2.2)	3.4 (1.9)	2.5 (NS)

[a] Level to rolling uplands burned in the 1983 fire, in areas topographically similar to unburned portions of the Battlefield.

[b] Swales and small drainages burned in the 1983 fire; there were no comparable areas spared by the fire.

[c] Percent of 120 points where species canopy occurred; points were spaced at 0.5-m intervals along three 20-m transects on each plot.

[d] Percent of 15 50x50-cm subplots on each plot in which the species was rooted.

[e] Not statistically significant by Kruskal-Wallis *H*-test ($P > 0.10$).

[f] Based on work in 1984-86, this included a mix of *A. spicatum* and *A. daystachyum*, but these were not distinguishable in 2003 because they had not yet flowered at the time we sampled them.

Table 4. Mean (standard error) of abundance of forbs on twenty-five 400 m^2 plots, of three habitat types, at the Little Bighorn National Battlefield in summer 2003, in terms of percent canopy cover and percent of subplots occupied (frequency).

Species	Abundance variable	Unburned uplands (n = 5 plots)	Burned uplands[a] (n = 16 plots)	Burned swales[b] (n = 4 plots)	Kruskal-Wallis *H* (*P*)
Achillea milliflorum	Percent cover[c]	0.5 (0.2)	1.2 (0.4)	2.3 (1.5)	1.2 (ns)[e]
	Percent frequency[d]	14.7 (3.3)	15.0 (3.7)	10.0 (3.3)	0.7 (ns)
Allysum alyssoides	Percent cover	2.3 (1.7)	3.1 (0.8)	4.6 (2.6)	0.9 (ns)
	Percent frequency	30.7 (12.8)	58.8 (6.8)	58.3 (15.2)	3.1 (ns)
Allium geyeri	Percent cover	0	0	0	
	Percent frequency	0	1.3 (0.9)	0	1.2 (ns)
Androsace septentrionalis	Percent cover	0	0.1 (0.1)	0	1.1 (ns)
	Percent frequency	2.7 (2.7)	5.0 (1.8)	1.7 (1.7)	1.1 (ns)
Antennaria parvifolia	Percent cover	0	0.1 (0.1)	0	0.6 (ns)
	Percent frequency	0	0.4 (0.4)	0	0.6 (ns)
Arnica parryi	Percent cover	0	0.5 (0.3)	0	1.8 (ns)
	Percent frequency	0	3.8 (2.1)	0	1.8 (ns)
Artemisia frigida	Percent cover	0.3 (0.3)	0.2 (0.1)	0.2 (0.2)	0.4 (ns)
	Percent frequency	1.3 (1.3)	0.4 (0.4)	3.3 (3.3)	1.6 (ns)
Artemisia ludoviciana	Percent cover	0	0.2 (0.2)	0.8 (0.3)	10.7 (0.005)

	Percent frequency	0	0.8 (0.8)	5.0 (3.2)	6.1 (0.05)
Astragalus missouriensis	Percent canopy	0.5 (0.2)	0.8 (0.3)	0.4 (0.2)	0.3 (ns)
	Percent frequency	12.0 (2.5)	19.2 (4.3)	8.3 (5.0)	1.3 (ns)
Comandra umbellata	Percent canopy	0	0.1 (0.1)	0	0.6 (ns)
	Percent frequency	4.0 (2.7)	1.3 (0.9)	0	2.9 (ns)
Dalea purpurea	Percent canopy	0	0	0	
	Percent frequency	0	0.4 (0.4)	0	0.6 (ns)
Descurania sophia	Percent canopy	0	0	0.2 (0.2)	0.6 (ns)
	Percent frequency	0	0.4 (0.4)	0	0.6 (ns)
Dianthus armeria	Percent canopy	1.0 (0.6)	0.7 (0.2)	0.4 (0.4)	0.7 (ns)
	Percent frequency	33.3 (13.5)	23.7 (4.8)	10.0 (7.9)	2.6 (ns)
Echinacea angustifolia	Percent canopy	0.2 (0.2)	0	0	4.0 (ns)
	Percent frequency	0	0	0	
Erigeron engelmanii	Percent canopy	0.3 (0.3)	0.1 (0.1)	0	1.3 (ns)
	Percent frequency	1.3 (1.3)	0.4 (0.4)	1.7 (1.7)	1.4 (ns)
Eriogonum pauciflorum	Percent canopy	0	0.1 (0.1)	0	0.6 (ns)
	Percent frequency	0	0	0	
Galium diffusum	Percent canopy	0	0	0	
	Percent frequency	0	0	1.7 (1.7)	5.3 (0.07)
Gaura coccinea	Percent canopy	0	0.1 (0.1)	0	0.6 (ns)
	Percent frequency	0	2.1 (1.0)	1.7 (1.7)	1.5 (ns)

Gutierrezia sarothrae	Percent canopy	0	0.1 (0.1)	0	0.6 (ns)
	Percent frequency	0	0	1.7 (1.7)	5.3 (0.07)
Heterotheca villosa	Percent canopy	0	0.1 (0.1)	0	0.6 (ns)
	Percent frequency	0	0.5 (0.5)	0	0.6 (ns)
Hymenoxis richardsonii	Percent canopy	0.3 (0.3)	0	0.2 (0.2)	3.7 (ns)
	Percent frequency	0	0	0	
Lactuca canadensis	Percent canopy	0	0	0	
	Percent frequency	0	3.33 (1.8)	0	2.6 (ns)
Lappula redowskii	Percent canopy	0.2 (0.2)	0	0	4.0 (ns)
	Percent frequency	1.3 (1.3)	2.1 (1.0)	0	1.2 (ns)
Lesquerella alpina	Percent canopy	0	0	0	
	Percent frequency	0	0.4 (0.4)	0	0.6 (ns)
Lepidium perfoliatum	Percent canopy	0.2 (0.2)	0.3 (0.2)	0.2 (0.2)	0.3 (ns)
	Percent frequency	2.7 (2.7)	0.4 (0.4)	5.0 (5.0)	1.7 (ns)
Leucocrinum montanum	Percent canopy	0.2 (0.2)	0.6 (0.2)	0	3.2 (ns)
	Percent frequency	5.3 (3.3)	5.0 (2.5)	0	1.9 (ns)
Linum lewisii	Percent canopy	0	0	0	
	Percent frequency	2.7 (1.6)	0	1.7 (1.7)	6.3 (0.04)
Lithophragma parviflorum	Percent canopy	0	0.1 (0.1)	0	0.6 (ns)
	Percent frequency	0	0	0	

Lithospermum incisum	Percent canopy	0	0.2 (0.1)	0	1.8 (ns)
	Percent frequency	0	4.6 (2.2)	0	4.2 (ns)
Lomatium dissectum	Percent canopy	0.2 (0.2)	0.2 (0.2)	0	0.9 (ns)
	Percent frequency	4.0 (4.0)	1.3 (0.7)	0	0.9 (ns)
Melilotus officinalis	Percent canopy	0	0.1 (0.1)	0	0.6 (ns)
	Percent frequency	8.0 (6.5)	4.2 (1.5)	3.4 (1.9)	0.1 (ns)
Musineon divaricatum	Percent canopy	0	0.2 (0.1)	0.4 (0.2)	3.5 (ns)
	Percent frequency	0	5.0 (2.1)	6.6 (3.8)	4.1 (ns)
Oenothera caespitosa	Percent canopy	0	0.1 (0.1)	0	0.6 (ns)
	Percent frequency	0	0	0	
Oxytropis lambertii	Percent canopy	0	0	0	
	Percent frequency	0	0.8 (0.6)	1.7 (1.7)	1.3 (ns)
Phlox hoodii	Percent canopy	1.0 (0.5)	1.8 (0.5)	2.7 (0.4)	3.8 (ns)
	Percent frequency	12.0 (8.0)	25.8 (6.3)	30.0 (9.6)	2.3 (ns)
Plagiobothrys scouleri	Percent canopy	0	0	0	
	Percent frequency	0	0.4 (0.4)	0	0.6 (ns)
Psoralea tenuiflora	Percent canopy	0	0.1 (0.1)	0	0.6 (ns)
	Percent frequency	0	0.4 (0.4)	1.7 (1.7)	2.0 (ns)
Rudbeckia hirta	Percent canopy	0	0	0	
	Percent frequency	0	2.1 (1.3)	0	1.8 (ns)
Silene conoidea	Percent canopy	0	0	0	

	Percent frequency	1.3 (1.3)	0	0	4.0 (ns)
Sisymbrium altissimum	Percent canopy	0	0.2 (0.1)	0.4 (0.4)	1.4 (ns)
	Percent frequency	0	1.7 (1.3)	0	1.2 (ns)
Sphaeralcea coccinea	Percent canopy	0.3 (0.2)	0.7 (0.2)	0.2 (0.2)	2.1 (ns)
	Percent frequency	12.0 (12.0)	16.3 (3.6)	3.3 (3.3)	3.9 (ns)
Taraxacum officinalis	Percent canopy	0.2 (0.2)	0.1 (0.1)	0	1.2 (ns)
	Percent frequency	9.3 (3.4)	7.9 (3.1)	6.7 (2.7)	1.1 (ns)
Thermopsis rhombifolia	Percent canopy	0	0.1 (0.1)	0	0.6 (ns)
	Percent frequency	0	1.3 (1.3)	0	0.6 (ns)
Tragopogon dubius	Percent canopy	1.2 (0.6)	0.4 (0.2)	0.2 (0.2)	2.1 (ns)
	Percent frequency	18.7 (13.9)	8.8 (2.8)	5.0 (1.7)	0.2 (ns)
Viola nuttallii	Percent canopy	0	0	0	
	Percent frequency	2.7 (1.6)	0.8 (0.6)	3.4 (1.9)	3.2 (ns)
Zigadenus elegans	Percent canopy	0.5 (0.5)	0.2 (0.1)	0.2 (0.2)	0.1 (ns)
	Percent frequency	8.0 (8.0)	9.6 (2.8)	5.0 (3.2)	1.1 (ns)

[a] Level to rolling uplands burned in the 1983 fire, in areas topographically similar to unburned portions of the Battlefield.

[b] Swales and small drainages burned in the 1983 fire; there were no comparable areas spared by the fire.

[c] Percent of 120 points where species canopy occurred; points were spaced at 0.5-m intervals along three 20-m transects on each plot.

[d] Percent of 15 50x50-cm subplots on each plot in which the species was rooted.

[e] Not statistically significant by Kruskal-Wallis H-test ($P > 0.10$).

Table 5. Mean (standard error) of various measures of percent plant canopy cover and species richness on twenty-five 400 m^2 plots, of three habitat types, at the Little Bighorn National Battlefield in summer 2003.

	Unburned uplands (n = 5 plots)	Burned uplands[a] (n = 16 plots)	Burned swales[b] (n = 4 plots)	Kruskal-Wallis *H* (*P*)
Native graminoid canopy	25.0 (5.5)	38.0 (2.5)	31.9 (5.0)	4.7 (0.09)
Exotic graminoid canopy	25.5 (11.3)	14.4 (3.6)	15.0 (2.4)	1.0 (ns)[c]
Native forb canopy	5.5 (1.4)	8.2 (1.1)	7.9 (2.2)	1.8 (ns)
Exotic forb canopy	3.8 (2.4)	4.1 (0.9)	5.6 (2.3)	0.8 (ns)
Shrub canopy	11.2 (3.1)	0.3 (0.2)	9.1 (3.5)	19.9 (< 0.001)
Native grass species richness	5.2 (0.6)	6.4 (0.4)	6.5 (0.6)	2.5 (ns)
Native forb species richness	6.2 (0.7)	8.5 (0.6)	7.5 (1.0)	4.9 (0.09)
Shrub/Succulent species richness	3.2 (0.5)	2.2 (0.2)	5.8 (0.6)	12.6 (0.002)
Total native plant species richness	14.6 (1.5)	17.1 (0.9)	19.8 (2.0)	3.6 (ns)

[a]Level to rolling uplands burned in the 1983 fire, in areas topographically similar to unburned portions of the Battlefield.
[b]Swales and small drainages burned in the 1983 fire; there were no comparable areas spared by the fire.
[c]Not statistically significant by Kruskal-Wallis *H*-test ($P > 0.10$).