Ocean of Grass: A Conservation Assessment for the Northern Great Plains

Northern Plains Conservation Network

Dedicated to the creation of healthy landscapes for all grassland species

2004

Acknowledgments

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Cover photo courtesy of Cliff Wallis

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Endorsing Organizations

Alberta Wilderness Association

Biodiversity Conservation Alliance

Defenders of Wildlife

Grasslands Naturalists

Wildlands Project — reconnect restore rewild

denver zoo — open every day

Badlands Conservation Alliance

The Big Open Project

Center for Native Ecosystems

Big Sky Conservation Institute — arts and technologies for a healthy world

Predator Conservation Alliance

Sierra Club — Founded 1892

The Conservation Alliance of the Great Plains

WWF

Central Montana Wildlands Association

Prairie Hills Audubon Society of Western South Dakota, Inc.

Executive Summary

The Great Plains occupies not only the center of the North American continent, but also figures centrally in our cultural consciousness. Images of a vast sky, blackened by swarms of migrating birds or insects, or vistas filled with spectacular numbers of bison, elk, and pronghorn to the horizon of a seemingly endless plain are etched in our collective memory, whether passed down through the stories of Native Americans or of Lewis and Clark and other early explorers. The contours of the indigenous landscape are, in many places, still clearly visible beneath a thin veneer of civilization only recently overlaid. This is a big landscape, and it inspired awe and appreciation of the wealth of nature in a way that perhaps was unrivaled in its time, a place where European nobility and North American artists came simply to marvel. But over the span of just a few decades in the late 1800s, nature's abundance in the Great Plains vanished, as the native grasslands were plowed for crops and fenced into tame pastures.

The region is at an historical divide as it comes full circle. Farming and ranching continue, but there is growing recognition, evidenced by the decline of prairie towns, out-migration of young people, and failing local economies, that the grand experiment that converted much of the ocean of grass into wheat and cattle production has had mixed results. At the same time, many Great Plains landscapes are now highly altered and the functional role of several key grassland species has been severely reduced or eliminated. As a result, much of the biological dynamism and resilience of the prairie ecosystem is missing. With less than 1.5% of the ecoregion's land area managed primarily for biodiversity conservation, it is increasingly difficult to maintain, much less restore, the region's remarkable flora and fauna and their ecological roles.

Our premise is that there is power in working with, rather than against, the natural processes that shaped the plants and animals attuned to this landscape. We also believe that by restoring the biodiversity of the plains we will help restore the spirit and livelihoods of those who live and work here, as well as recapture the imagination and interest of people throughout the world.

With this in mind, grassroots, regional, and national conservation organizations working in the Northern Great Plains formed the Northern Plains Conservation Network (NPCN) in 2000 to coordinate their mutual interests in grassland conservation and to chart a future that integrates conservation with the renewal of the human communities and economy of the Northern Great Plains. The focus of this effort is the Northern Great Plains Ecoregion (NGP), an area that World Wildlife Fund has identified among its "Global 200," one of the 238 most biologically significant places on Earth.

This ecoregional assessment of the Northern Great Plains is the first step in charting that course. A key result is the identification of ten terrestrial landscapes in the U.S. and Canadian plains where opportunities exist to restore large-scale ecological processes and provide habitat for significant populations of native wildlife. Some of

the largest blocks of untilled prairie remaining in North America are contained within them. Many offer restoration potential for the black-tailed prairie dog ecosystem, a key Great Plains ecosystem. Outstanding opportunities exist to restore and preserve habitat for a suite of endangered, sensitive, and keystone species within these areas. In short, these are areas that meet the goal of restoring a significant part of the natural heritage of the grasslands to its full biological potential.

This analysis also identifies 24 outstanding reaches of Northern Great Plains rivers and streams. Some of the longest reaches of undammed rivers in North America exist within the ecoregion, providing opportunities to conserve representative habitat for fish, other aquatic species, and riparian species.

The need to address scale as a component of the conservation landscape, particularly in grasslands, is becoming increasingly clear. Global climate change, declining species trends, invasive species, and widespread disturbance patterns (fire and drought) unique to the grasslands suggest the need to think at larger scales than in the past. This assessment is intended to stimulate and focus greater attention on those large landscapes in the Northern Great Plains with high biodiversity and exceptional restoration potential. These large areas complement more numerous, and often smaller, areas of biological importance identified by The Nature Conservancy and others. Comprehensive conservation will require attention to the entire suite of these biologically important areas. This assessment recognizes, however, that protecting these high-priority areas will not, by itself, maintain the biological health and integrity of the ecoregion. Good stewardship of the intervening landscape is crucial. The resulting matrix of conservation and working landscapes will support the full range of biodiversity, will be more resilient to environmental change, and will provide a more diverse economic base for the people that live there.

At this divide in history for the Northern Great Plains, the need and opportunity for biodiversity restoration and conservation, based on conservation areas both small and large across the ecoregion, has never been more evident. Conservationists, political leaders, tribal members, ranchers, farmers, recreationists, and local community members, working cooperatively, can build on these biological cornerstones to support both native biodiversity and economic alternatives provided by wildlife and other natural amenities. NPCN's efforts to this end are guided by four principles:

- *Sound stewardship of public, private and Tribal lands is necessary for restoring and conserving the ecoregion's biodiversity;*
- *The land and its wildlife are important culturally and spiritually for many people, but especially for North American native people;*
- *Conservation can often benefit local communities by stimulating a more diverse and healthier economy;*
- *Partnerships between conservationists and local*

communities will be crucial for achieving biodiversity conservation goals in the Northern Great Plains.

In the short term, we can start to improve the conservation landscape in the following ways:

- Expanding the amount of land designated as reserves or managed primarily for biodiversity conservation from the current 1.5%;
- Promoting ecologically sustainable management in both the agricultural and nonagricultural portions of the landscape that: (a) prevents further loss of native prairie; (b) limits spread of nonnative plant and animal species that are destructive to native biodiversity, and (c) leads to widespread adoption of grazing practices that restore and maintain native prairie habitats and species diversity;
- Restoring populations of native species and securing their long-term viability, including restoration of ecologically functional populations of bison; and
- Ensuring that flows in the Missouri River system and its significant tributaries, including the Milk, Cheyenne, and White Rivers, can support the full complement of aquatic and riparian species.

The modern conservation movement in North America can be said to have begun with the efforts to conserve the few remaining American Bison, whose last stronghold was on the prairies of the Northern Great Plains. It is fitting that we take up, at the beginning of a new century, the conservation challenge offered by those remaining few bison—to restore them and their fellow species to their functional roles in the biodiversity of the plains. As the author Richard Manning notes, "The grass can grow again."

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Chapter 1: Introduction

Almost 200 years ago, in 1805, Meriwether Lewis stood at the confluence of the Marias and Missouri Rivers in what is now Montana, and observed that:

> *"…the country in every derection around us was one vast plain in which unnumerable herds of Buffalow were seen attended by their shepperds the wolves; the solatary antelope which now had their young were distributed over it's face; some herds of Elk were also seen; the verdure perfectly cloathed the ground."*[1]

Today, most North Americans equate important and spectacular wildlife concentrations with far off places such as the East African Serengeti or the Amazonian rainforest. Yet the assemblages and numbers of plants and animals seen by Lewis 200 years ago in the North American plains were no less remarkable. Spanning a prairie landscape nearly 450 miles (750 km) long and 175 miles (300 km) wide through Canada and the United States, the Northern Great Plains was once, as Lewis's account testifies, North America's answer to Africa's Serengeti Plains. Tens of millions of bison (*Bison bison*), elk (*Cervus canadensis*), pronghorn (*Antilocapra americana)*, mule deer (*Odocoileus hemionus*) and other wildlife grazed an ocean of grass, pursued by wolves (*Canis lupus*), grizzly bears (*Ursus arctos*) and other predators. Prairie birds and waterfowl occasionally darkened the sky during their migrations. So magnificent was the region's wildlife that European royalty, artists and others commonly came on safari to hunt, paint or just to marvel.

Several Native American tribes made their homes in the midst of this wildlife spectacle. Indeed, human presence dates back 10,000 years. Plains peoples pursued the abundant game, or lived agrarian lifestyles in the fertile river bottoms. And figuring prominently in the lives and cultures of these people was the American bison – the largest land animal in the New World.[2] Perhaps no other species so dominated the cultural and biological history of any region, with numbers that may have totaled some 30 million or more.[3]

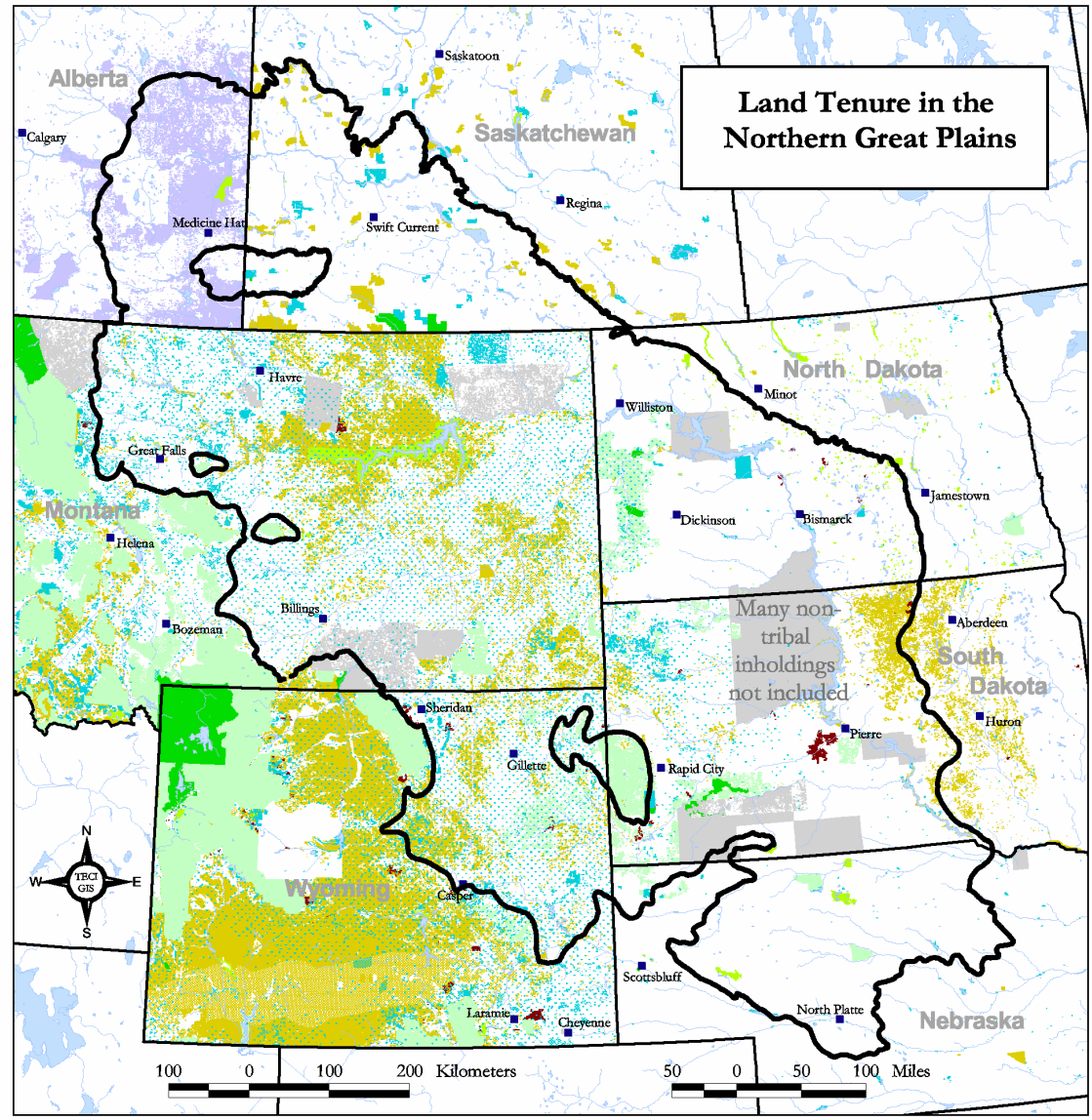
However, all this changed almost overnight. By the mid-19th century, technological and economic revolution came to the prairie in the form of railroads and a market for raw bison hides. The railroads brought not only the means to transport the hundreds of thousands of hides taken annually, but also European settlers, who sliced away at the

[1] DeVoto, B. 1953. The Journals of Lewis and Clark, Bernard DeVoto, ed. Houghton Mifflin Co., Boston, p. 125.

[2] Roe, F.G. 1951. The North American Buffalo: A critical study of the species in its wild state. Univ. of Toronto Press at 335; Callenbach, E. 1996. Bring back the buffalo: A sustainable future for America's Great Plains. University of California Press, Berkeley; Isenberg, A.C. 2000. The destruction of the bison. Cambridge University Press.

[3] Id. Others have placed the number much higher, generally around 65 million. A recent estimate based on forage productivity estimated historic bison carrying capacity at between 21-88 million. Weber, K.T. 2001. Historic Bison Populations: A GIS-based estimate. Proceedings of the 2001 Intermountain GIS users' Conference, Pp. 45-51.

Figure 1. Land Tenure in the Northern Great Plains



SOURCES

Alberta Natural Heritage Information Centre. Date unknown. Land ownership by quarter section.

Conservation Biology Institute/World Wildlife Fund. 2000. Protected Areas Database.

Ducks Unlimited. 2003. Holdings and easements.

Montana Natural Resources Information System. 2002. Major land ownership.

Sask. Natural Heritage Program. 2000. Ownership.

The Nature Conservancy. 2003. Holdings and easements.

U.S. Forest Service. 2001. Boundaries of National Grasslands.

U.S. Geological Survey. 2002. National Atlas of the U.S. - Federal land ownership.

Wyoming Gap Anaysis. 1996. Land ownership and management for Wyoming.

LEGEND

- Northern Great Plains Ecoregion boundary
- National Forests and National Grasslands
- National Wildlife Refuge or Wildlife Areas
- Other federal lands and easements
- Tribal/First Nations lands
- National Parks
- State or provincial lands
- Crown lands in Alberta
- Private preserves and conservation easements

WWF

native prairie with plows. Coupled with the thousands of professional hunters that spilled into the plains after the Civil War, the great bison herds were doomed. By the mid 1880s, the North American bison was virtually extinct, along with a human culture that had existed with it for thousands of years.

In the late 1880s, encouraged by ill-conceived government policies and disingenuous land developers, even more European settlers flocked to the Northern Great Plains. Hundreds of thousands established homesteads that were, even at the time, too small to support the families that farmed them. Warnings from 19th century visionaries like John Wesley Powell that the land west of the 100th meridian (figure 5) was not suitable for dry-land agriculture and would require an alternative approach to settlement went unheeded. Deceived by a period of relatively wet years and encouraged by the economic bonanza provided by World War I, thousands more arrived. "The Great Plow-up" saw cultivated land on the prairies of Montana rise from 250,000 acres (101,000 ha) to 3.5 million acres (5,500 sq miles, or 1.4 million ha) between 1909 and 1919.[4] The soils of the Great Plains are mostly "loess" soils, meaning they were deposited by the wind in millennia past. Without grass to hold them in place, the soils were once again free to move. And move they did when in the 1930s a severe drought combined with poor conservation practices to create the "Dust Bowl." In March 1935, geologists in Wichita weighed the atmosphere overhead and estimated that 5 million tons of dust was suspended above the 30-square-mile city.[5] To this day, the era remains one of the most sobering and widespread environmental catastrophes in North American history.

In his book *Grasslands*, the writer Richard Manning notes, "[t]he hubris of the industrial age was the belief that because we could make machines work, we could make the landscape into a machine and make it work like one."[6] The grasslands of the Northern Great Plains stubbornly resisted these attempts. Faced with the realization that one out of every three years was likely to be a drought year, and that those years were likely to be sandwiched between periods of prolonged drought, many abandoned the prairie for good. The exodus of would-be settlers, which totaled some 60,000 in Montana during the same 10-year period as the Great Plow-up,[7] continues to this day. Those settlers that remained stocked their untilled areas of native prairie with cattle or sheep. However, drought and occasional brutal winters also kept livestock producers living on the economic margin in many areas—the "Dirty Thirties" were followed by the "Filthy Fifties," as drought returned in its ongoing cycle. The result is that, after the initial surge of homesteading, there has been a long and continuous exodus of people and capital, particularly from the Northern Great Plains.

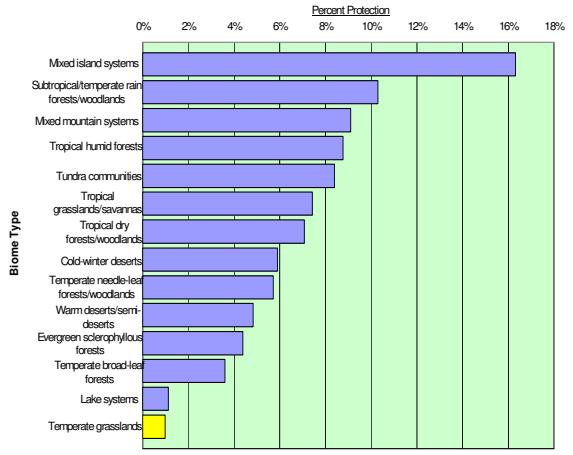
Meanwhile, biodiversity diminished in response to human exploitation of the plains. In most areas, colonies of the burrowing black-tailed prairie dog (*Cynomys ludovicianus*) were poisoned or plowed out of existence to make way

[4] Manning, R. 1995. Grassland. Penguin Books, New York. pp 145.

[5] Id. pp 149
[6] Id. pp 262
[7] Id. pp 143

for crops and livestock. Numerous species that depend on or benefit greatly from the prairie dog for survival, like its highly specialized predator, the diminutive black-footed ferret (*Mustela nigripes*) or the mountain plover (*Charadrius montanus*), a shorebird adapted to forage in the cropped

Figure 2. Global Biome Protection Less than 1% of the world's temperate grasslands are under some kind of protective status — 9 times less than tropical grasslands and savannas (Appendix K). Of all the world's biomes, temperate grasslands have the least protection.



grasses of prairie dog colonies, have subsequently become imperiled. Except for a few isolated populations, elk, which were once abundant on the prairies, have also faded from the landscape. Deprived of the herds of bison and elk on which they depended, and eliminated as pests when they occasionally preyed on the livestock that replaced the native grazers, grizzly bears and wolves no longer roam the prairie. River otters (*Lutra canadensis*) and beaver (*Castor canadensis*) were driven from prairie streams by overexploitation and dewatering for irrigation.

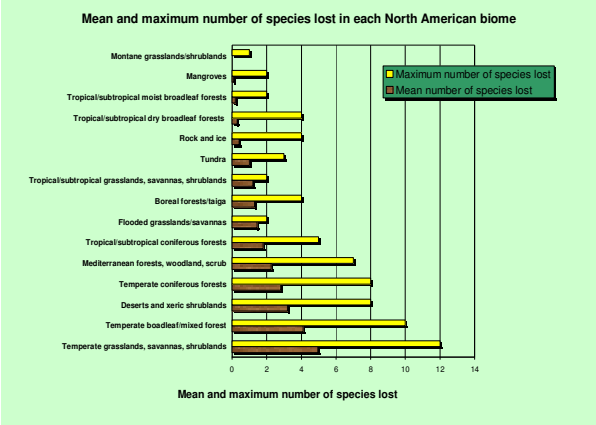
Perhaps the most profound ecological link that has been severed is the loss of the American bison. Although bison exist in a few small public herds and the species is gaining popularity as an alternative breed of domestic livestock, the bison of the Great Plains is today ecologically extinct. Bison disturbance (grazing, trampling, and wallowing) no longer influences native vegetation and species composition over large scales as it once did.[8] Bison-style grazing no longer creates the mosaic of vegetative structures over large areas that provided habitats for many other species. Gone, too, is a large and abundant food source for predators and scavengers. Finally, decomposing bison carcasses no longer create rich patches of nutrients for vegetative growth.[9] It has been argued that management of domestic livestock can be employed to mimic the effects of bison. The reality, however, is that livestock, and even few bison herds, are rarely managed in this way today.

The loss of biodiversity suffered by the plains would not have been as tragic were it not coupled with a lack of preservation of significant remnants of undeveloped grasslands in the process of settlement. North America's grasslands are not unique in this regard—temperate grasslands of the world have received little conservation attention relative to other biomes (Figure 2). Less than 16% of the NGP ecoregion (about 28 million acres/11 million ha) is managed primarily for natural resources conservation,[10] with about 2.5 million acres (1.01 million ha), or less than 1.5%, managed to ensure conservation of biodiversity, which includes lands like wildlife reserves and parks. We estimate that 99% of the

[8] Truett , J.C., M. Phillips, K. Kunkel and R. Miller. 2001. Managing bison to restore biodiversity. Great Plains Research 11:123-44.
[9] Lott, D. 2002. American bison: A natural history. University of Californa Press, Berkeley.
[10] Based on IUCN classification, see Appendices J and K.

non-urban landscape of the NGP is today either farmed or grazed by domestic livestock, including some of the areas we consider protected. For example, two-thirds of the 1.1-million-acre (0.4 million ha) Charles M. Russell National Wildlife Refuge, MT, the ecoregion's largest protected area,[11] is grazed by cattle. There is no correlate temperate grasslands protected area in North America on the scale of the 3.7 million ac (1.5 million ha) Serengeti/Masi Mara of Africa, which retains a remarkable representation of the African grasslands fauna. Lack of large-scale areas where biodiversity is the primary management objective on the North American grasslands may explain why 74% of 39 species we classify as grassland obligates with distributions centered in the NGP are listed as imperiled by federal, state, and provincial governments (Table 1). On average, temperate grassland biomes have suffered greater "loss" of species (more species are no longer found within the full range of their former habitats) and more species have been extirpated from at least part (and often an extensive part) of the grasslands than any other North American biome.[12]

Figure 3. Species Loss by Biome (after Laliberte, note 12).



Human communities of the Northern Great Plains are now also at an ecological and economic crossroads. The average age of farmers and ranchers across most of the ecoregion is around 60 years.[13] Children of farmers and ranchers are leaving the land for better opportunities in urban areas. Economies of prairie communities are in decline as foreign competition and other market forces, combined with a climate that is marginal or sub-marginal for efficient crop and livestock production, often leave producers in debt. And with a declining human population, important community services such as schools and medical facilities are disappearing as well. Those people that remain behind on the land find it increasingly difficult to maintain economic parity and are increasingly dependent on government subsidies. Meanwhile, pressure on the landscape persists, as government programs continue to encourage tilling of remaining native prairie.

In contrast to the descendents of European settlers, Native Americans,

[11] The actual land base of the CMR Refuge, which includes the Ft. Peck Reservoir, is smaller—about 871,000 acres (352,000 ha) excluding the area inundated by the reservoir.

[12] Laliberte, Andrea. 2003. Human Influences on Historical and Current Wildlife Distributions from Lewis & Clark to Today. Ph.D. Dissertation. Oregon State University. Also, Laliberte, A.S. and W.J. Ripple. 2003. Wildlife encounters by Lewis and Clark: A spatial analysis of interactions between Native Americans and wildlife. Bioscience 53:994-1003.

[13] See, e.g., U.S. Dept. of Agriculture, 1997 Census of Agriculture, Volume 1, National, State and County Tables. http://www.nass.usda.gov/census/census97/volume1/vol1pubs.htm

whose populations and cultures were decimated by European settlement, are among the few demographic groups growing in the NGP. Those few U.S. counties with positive population growth in the NGP over the last decade predominantly include Indian Reservations. However, Native Americans are not immune from the depressed conditions of plains economics. Native Americans have the highest poverty rate of any ethnic group in the U.S. (24.5% according to the 2000 census).[14] Yet tribal game and fish agencies have taken lead roles in reintroduction of native species, such as the black-footed ferret and swift fox (*Vulpes velox*)[15]. In addition, the Intertribal Bison Cooperative has successfully promoted the development of tribal bison herds, indicating continuing interest in restoration of this important cultural link with the landscape.

A report recently prepared by the Economics Research Service of the U.S. Department of Agriculture[16] concludes that three factors largely account for the rapid loss of population from rural counties during the last decade:

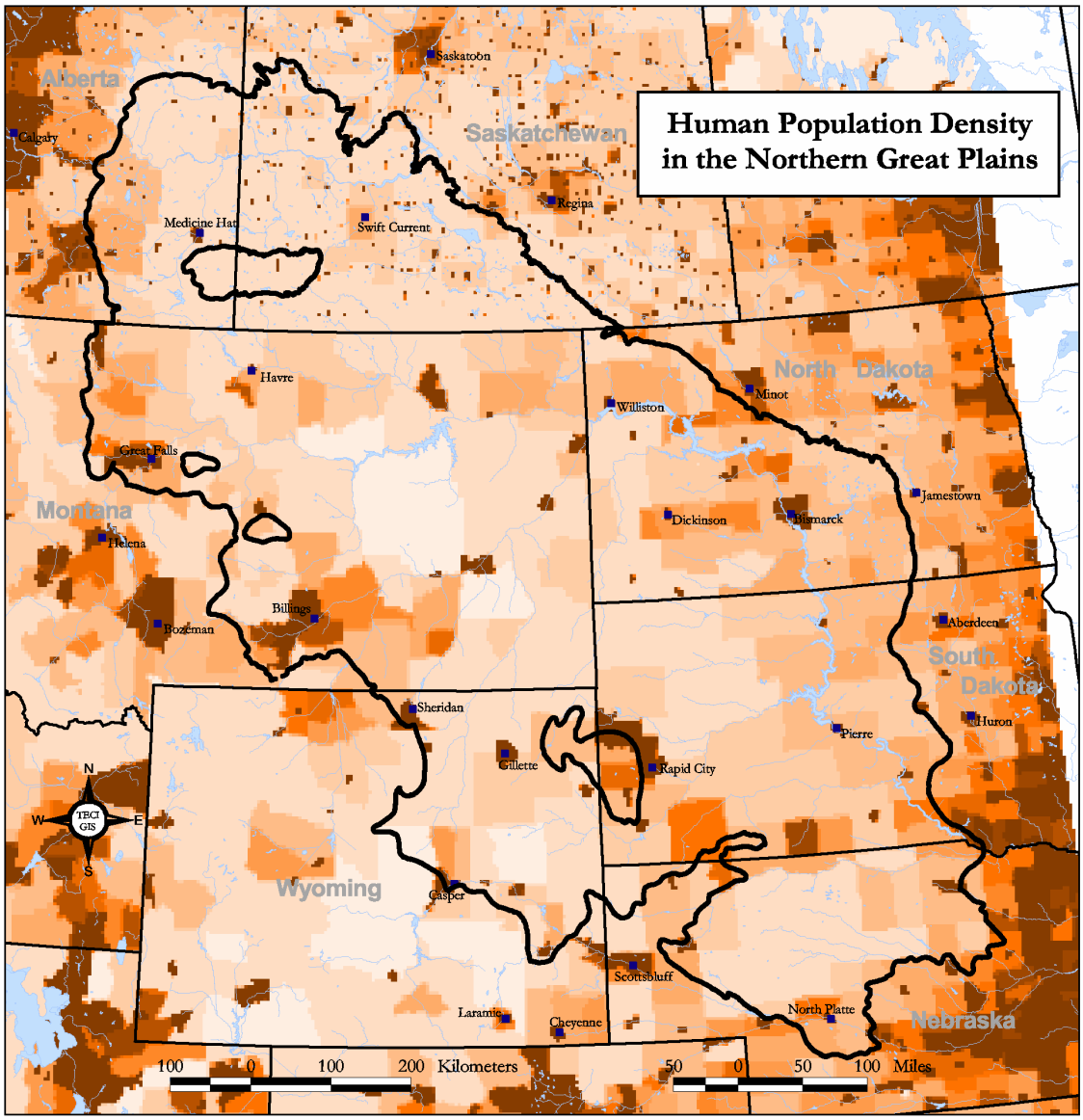
- **Low population density**: Counties with already low population densities, in particular counties with fewer than 2 people per square mile, were more likely to lose people than counties with higher densities;
- **Remoteness from metro areas**: Counties that are not adjacent to major population centers show a much greater tendency to lose population;
- **Recognition of natural amenities**: Counties that fail to recognize natural amenities for outdoor recreation, as measured in this study by the presence of lakes, mountains, and a favorable climate, where much more likely to have lost population than counties with good natural amenities.

Other studies in the West have also shown that communities located near natural areas and wilderness have healthier economies than communities that are not so located.[17] Conservation areas generate economic activity for nearby communities in several ways:

- They **attract and retain as residents** people who bring money into the community; this includes businesses whose owners and employees want to be located near natural areas for recreation, as well as retirees and professional services (doctors, architects, etc.);

[14] Thurow, L.C. 2002. Poverty settles in Great Plains. USA Today, Monday, Sep. 30, 2002, p. 13A.
[15] Proctor, J., S.C. Forrest, and B. Haskins. In press. Identifying potential focal areas for black-tailed prairie dog restoration. *In,* Conservation Biology of the Black-tailed Prairie Dog, J. Hoogland, ed. Island Press.
[16] McGranahan, D.A. and C.A. Beale. 2002. Understanding rural population loss. Rural America 17:2-11.
[17] Rudzitis, G., and H.E. Johansen. 1991. How important is wilderness? Results from a United States survey. *Environmental Management* 15:227-233.

Figure 4. Human Population Density in the Northern Great Plains



SOURCE

Center for International Earth Science Information Network, International Food Policy Research Institute and World Resources Institute. 2000. Gridded Population of the World, Version 2.

LEGEND

Northern Great Plains Ecoregion boundary

Projected 2000 human population:

- <0.1 humans / sq mi
- >0.1 - 1
- >1 - 2
- >2 - 3
- >3 - 4
- >4 - 5
- >5 - 6
- >6 - 7
- >7 - 8
- >8 - 9
- >9 - 10
- >10

WWF

- They **attract tourists and recreationists** and the dollars they spend;
- Management of the conservation area results in **local employment and expenditures for local goods and services** as well as **production of some marketable products.**

Of the factors associated with significant population decline, the only one that can be directly altered in any practical way is the availability of natural amenities. In the Northern Great Plains, one of the most obvious natural amenities that could be greatly enhanced is public access to native prairie and increased wildlife populations.

The opportunity to achieve the dual and potentially mutually beneficial goals of rural renewal and restored biodiversity in the NGP has never been greater. Areas of low population density (less than 2 people/sq mile), as the data indicate, will probably continue their rapid downward demographic spiral. The aging ranch and farm population portends massive changes in land ownership over the next two decades. In some areas, industrial-scale agriculture that is ever-more effective at reaping government subsidies will take over,[18] while in others, particularly those lands with recognized natural amenities (abundant wildlife and native prairie, hunting, fishing, great scenery and solitude), new buyers will be people and corporations who want lands for their exclusive recreational use.[19] Either case results in less public access to these lands and their natural amenities and lost opportunities for large-scale ecological restoration.

The need for a conservation plan for the NGP that addresses the challenge of restoring NGP biodiversity in the context of these sweeping socioeconomic changes helped bring together in 2000 a group of local and national conservation organizations concerned about the ecoregion. These groups, acting together as the Northern Plains Conservation Network (NPCN), feel that a new and bold vision for the ecoregion is needed to serve as a guide to help rethink and redirect not only the efforts of conservationists, but of all those concerned about the region's future. For the benefit of human and natural communities, the intent of this document is to assess the conservation landscape in a way that will offer greater chances for conservation of the ecoregion's biodiversity at scales needed to restore the region's biological potential, while at the same time offering insights as to where this might be best accomplished.

[18] Large Family Farms, Very Large Family Farms and Nonfamily farms comprise only 8.2% of total U.S. farms yet own 33.5% of all farmland and receive 52.5% of all commodity support subsidies. Hoppe, R. and Weibe, K. 2002. Land ownership and farm structure. Chapter 1.3 i*n,* Agricultural Resources and Environmental Indicators, 2003. U.S. Dept. of Agriculture, Economic Research Service, Agriculture Handbook AH722. http://www.ers.usda.gov/publications/arei/ah722/arei1_3/DBGen.htm

[19] See, e.g., Tschida, R. 2003. Hunters find private land less accessible. Bozeman Daily Chronicle, February 23, 2003.

Chapter 2: The Northern Great Plains Ecoregion and Its Biodiversity Context

The Northern Great Plains Ecoregion spans some 279,000 square miles (722,600 sq km) and is the continent's largest grassland ecoregion.[20] In addition to native grazers, the NGP remains a critical breeding area for grassland birds, many of which are undergoing severe population declines. The fate of the black-footed ferret, one of North America's most endangered species, depends upon conservation success in this region. Further, the Missouri and Yellowstone Rivers are home to paddlefish (*Polyodon spathula*) and endangered pallid sturgeon (*Scaphirhynchus albus*), both large, ancient species whose populations have been fragmented by dams and altered by artifical flow regimes and habitat loss.[21]

Importantly, the Northern Great Plains still contains large unplowed areas of grasslands. As temperate and tropical grasslands globally are either widely tilled or intensively grazed by livestock, few opportunities exist to conserve grassland ecosystems and their native biota on a large scale. For these reasons, the NGP Ecoregion has been designated by World Wildlife Fund as a "Global 200" ecoregion—one of the 238 most biologically significant places on Earth.[22]

Description of the Northern Great Plains Ecoregion

Ecoregions are geographic units that contain a distinct assemblage of natural communities that share a large majority of species, dynamics and environmental conditions. An ecoregion is usually unified by a widely distributed and dominant vegetation type.[23] Because the dominant plant species strongly influence the suite of other species present, particular communities of animals often characterize ecoregions as well.

Ecoregion Boundary

"Ecoregion" boundaries are coarse by definition — they encompass large areas that mask local deviations from the criteria used to delineate them, and thus rather than "hard" lines, describe

[20] T. H. Ricketts, E. Dinerstein, D.M. Olson, and C.J. Loucks et. al. 1999. Terrestrial ecoregions of North America: A conservation assessment. Island Press, Washington, D.C. Ricketts et al. recognize some 116 North American ecoregions, including 16 grasslands.

[21] Bramblett, R. G. and White, R. 2001. Habitat Use and Movements of Pallid and Shovelnose Sturgeon in the Yellowstone and Missouri Rivers in Montana and North Dakota. Transactions of the American Fisheries Society 130:1006-1025. Also, Scarnecchia, D. L. and Schmitz, B. Montana Fish Species of Special Concern, Montana Chapter of American Fisheries Society at: http://www.fisheries.org/AFSmontana/SSC/Paddlefish.htm

[22] For the World Wildlife Fund Global 200 methodology generally, *See, e.g.*, David M. Olson and Eric Dinerstein, *The Global 200: A Representation Approach to Conserving the Earth's Distinctive Ecoregions*, 12 Cons. Biol. 502 (1998); For the index of Global 200 sites, see World Wildlife Fund at http://www/wwfus.org/global200/spacessection.cfm?sectionid=20(2002).

[23] E. Dinerstein et al. 2000. A workbook for conducting biological assessments and developing biodiversity visions for ecoregion-based conservation. Part I: Terrestrial Ecoregions. World Wildlife Fund, Conservation Science Program, Washington, D.C.

the area of transition from one area sharing common ecological attributes to another with different attributes. Because periods of drought and climate change affect the distribution of many plant and animal species, these boundaries are not fixed, but expand and contract with changes in the environment. The boundaries we have adopted for the Northern Great Plains ("NGP") Ecoregion are described by Ricketts et al. as the "Northwestern Mixed Grasslands"[24] and the "Nebraska Sandhills Mixed Grassland" (Figure 1).[25] The Northern Great Plains Ecoregion is generally bounded on the west by the Rocky Mountains and on the east by more humid tall-grass prairie. To the north the ecoregion grades into the Northern Mixed Grass Prairies,[26] which are wetter and contain extensive wetland complexes and prairie potholes. To the south lie the Southern Great Plains (or short-grass plains) that is characterized by higher elevation, longer growing season, and relatively mild temperatures. The region has also been generally described as the "Northern Great Plains Steppe,"[27] as the "Mixed Grass Prairie,[28] or the "West-central semi-arid prairies."[29] To the extent possible, we have tried to make the boundaries of the NGP consistent with the work of others who have previously described this region.[30]

Scientific/geographic foundation of WWF's Northern Great Plains boundary

The boundary for the Northern Great Plains is derived from Sims.[a] It corresponds to Omernik[b] ecoregion 46 (Northern Glaciated plains) in the U.S., and Küchler[c] unit no.60 (wheatgrass, bluestem, needlegrass). The comparable Bailey[d] sections south of the Canada-U.S. border are: 332A (Northeast Glaciated Plains) 332B (Western Glaciated Plains), 251B (North Central Glaciated Plains-extreme Western part). In Canada, most of this ecoregion is Moist Mixed Grassland (TEC 157), surrounding Fescue Grassland.

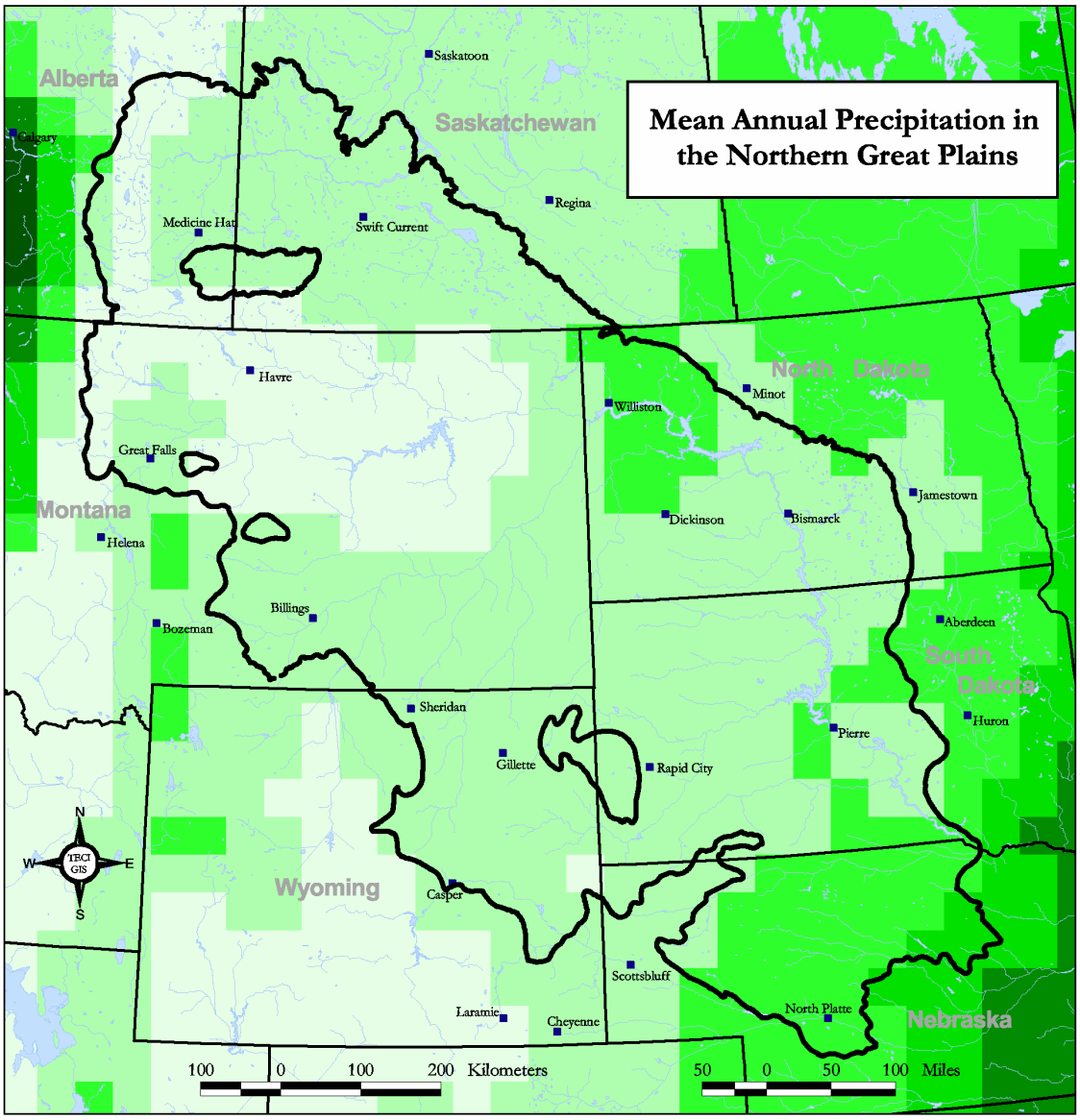
The boundary of the Sandhills is taken from Omernik[b] and is very similar to the boundary described in Bailey unit 332C-Nebraska Sandhills and Küchler unit 67 (Sandhills Prairie).

[A] Sims, P.L. 1988. Grasslands. Pp. 265-285 in M.G. Barbour and W.D. Billings, eds, North American terrestrial vegetation. Cambridge Univ. Press, Cambridge, England.
[b] Omernik, J.M. 1995. Level III ecoregions of the continent. Washington, D.C.: National Health and Environment Effects

The ecoregion constitutes the northwestern quarter of the Great Plains, the vast region of grasslands that extends from southern Canada to northern Mexico and from the Mississippi River to the Rocky Mountains. Lying in the rain shadow of the Rocky Mountains, most of the region receives less than 16 inches (40 cm) of precipitation a year. Mean annual precipitation varies from less than 12

[24] Unit 58, Ricketts et al. 1999, note 20 *supra*.
[25] Unit 62, Id.
[26] Id. Also referred to as the "Moist Mixed Grasslands." Id.
[27] The Nature Conservancy, Northern Great Plains Ecoregional Planning Team. 2000. Ecoregional Planning in the Northern Great Plains Steppe. The Nature Conservancy. 181 pp. http://www.conserveonline.org/csd;internal&action=buildframes.action
[28] Samson, F.B., F.L. Knopf, and W.R. Ostlie. 1998. Grasslands. Pp. 437-472 *In* Michael J. Mac et al., eds., Status and Trends of the Nation's Biological Resources, Vol. 2, U.S. Dept. of Interior, U.S. Geological Survey, Reston Va.
[29] Commission for Environmental Cooperation. 1997. Ecological Regions of North America. Map at: http://www.epa.gov/wed/pages/ecoregions/na_eco.htm#CEC%201997
[30] See, e.g., Ecological Stratification Working Group. 1995. A national ecological framework for Canada. Agriculture and Agri-Food Canada, Research Branch, Centre for Land and Biological Resources Research, and Environment Canada, State of the Environment Directorate, Ecozone Analysis Branch, Ottawa/Hull. Report and national map at 1:7 500 000 scale; Omernik, J.M. 2003. Level III Ecoregions of the Coterminous United States. U.S. EPA, map at: http://www.epa.gov/wed/pages/ecoregions/level_iii.htm.

Figure 5. Precipitation in the Northern Great Plains



SOURCE

Food and Agriculture Organization of the United Nations. 1991. Sustainable Development Department global climate maps.

LEGEND

Northern Great Plains Ecoregion boundary

Mean annual precipitation:

- 200 - 300 mm (7.9 - 11.8 in.)
- 301 - 400 mm (11.9 - 15.7 in.)
- 401 - 500 mm (15.8 - 19.7 in.)
- 501 - 600 mm (19.8 - 23.6 in.)
- 601 - 700 mm (23.7 - 27.6 in.)
- 701 - 800 mm (27.7 - 31.5 in.)

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inches (30 cm) in the west to 18 inches (45 cm) in the east.[31] Furthermore, precipitation is highly variable. Variable precipitation, prolonged drought, and periodic fire characterize the area, an ecological regimen to which native prairie species are adapted, but which prevents the establishment of forests except on some moister upland sites.

Mixed grass prairie is the dominant vegetation type in the ecoregion, with western wheatgrass (*Pascopyrum smithii*), northern wheatgrass (*Elymus lanceolatus ssp. lanceolatus*), green needlegrass (*Nasella viridula*), blue gramma (*Bouteloua gracilis*), and needle-and-thread (*Stipa comata*) as dominant species.[32] Bluebunch wheatgrass (*Pseudoroegneria spicata ssp. spicata*), little bluestem (*Schizachyrium scoparium*), sideoats gramma (*Bouteloua curtipendula*), Sandberg's bluegrass (*Poa secunda*), and thread-leaved sedge (*Carex filifolia*) may become locally abundant. Ponderosa pine (*Pinus ponderosa*) woodlands are common in portions of the ecoregion. Additionally, extensive areas of shrub steppe (big sagebrush (*Artemesia tridentata*) is most abundant), coniferous woodlands, riparian forests, hardwood draws (scrubby aspen (*Populus tremulus*), willow (*Salix* spp.), cottonwood (*Populus* spp.), and box-elder (*Acer negundo*) occur), and wetlands are found in the ecoregion.[33] Saline areas support alkali grass (*Puccinellia* spp.), wild barley (*Hordeum* spp.), greasewood (*Sarcobatus vermiculatus*), red samphire (*Salicornia rubra*), and sea blite (*Suaeda depressa*).[34]

Sub-ecoregions

Sub-ecoregions are often delineated to account for biogeographic variation within an ecoregion and to assure that the range of biological features and environmental conditions that exist across the ecoregion are represented. The assumption is that similar habitats in different biogeographic subregions will have a distinctive suite of species. We divide the NGP ecoregion into four subecoregions based on generally recognized taxonomy: the Northwest Glaciated Plains, the Nebraska Sandhills, the Missouri Plateau (or Northwest Great Plains), and several inclusions of montane ecosystems,[35] which are actually distinct ecoregions or outliers of other ecoregions. At the next lower hierarchical level, the Glaciated Plains is further divided into several lower taxonomic units, including the Missouri Coteau, which we treat as a distinct subecoregion due to its ecological character and because it is recognized as such by other parallel planning efforts.[36]

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[31] Coupland, RT. 1992. "Mixed prairie" in Natural Grasslands: Introduction and Western Hemisphere, Robert T. Coupland editor. Ecosystems of the World 8A. New York: Elsevier.

[32] TNC 2000, note 27 *supra*

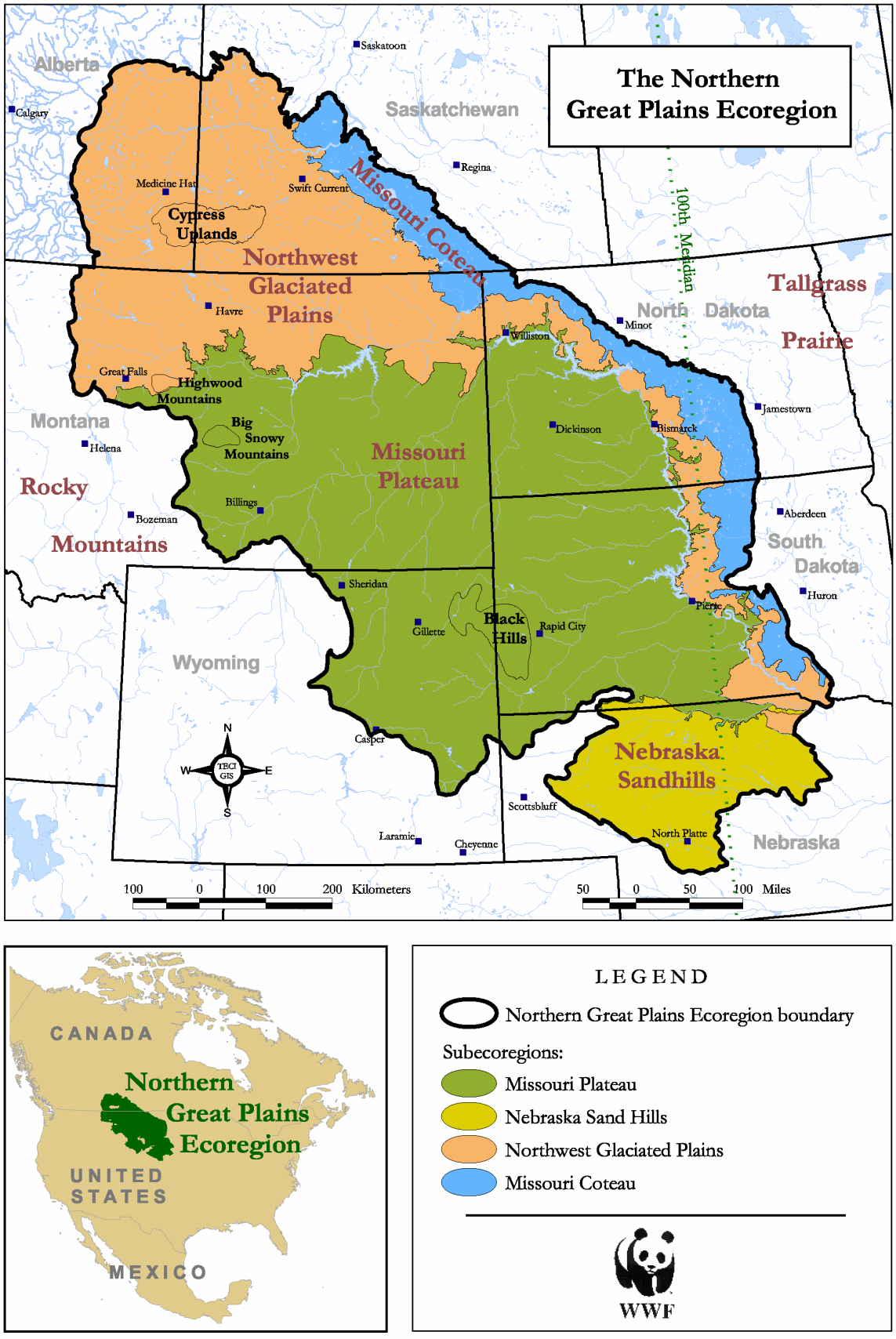
[33] Id.

[34] Ricketts et al. note 20 *supra*.

[35] See, e.g., Omernik 2003, note 30 *supra*.

[36] See, e.g., Bryce, S., J.M. Omernik, D.E. Pater, M. Ulmer, J. Schaar, J. Freeouf, R.Johnson, P. Kuck, and S.H. Azevedo. 1998. Ecoregions of North Dakota and South Dakota. Jamestown, ND: Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/1998/ndsdeco/ndsdeco.htm (Version 30NOV98). Ducks Unlimited, Ducks Unlimited Canada, and The Nature Conservancy all have planning and conservation programs directed specifically at the Coteau.

Figure 6. Northern Great Plains Ecoregion and Subecoregions.



LEGEND

Northern Great Plains Ecoregion boundary

Subecoregions:

- Missouri Plateau
- Nebraska Sand Hills
- Northwest Glaciated Plains
- Missouri Coteau

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Missouri Plateau

The Missouri Plateau is a semi-arid rolling plain of shale and sandstone punctuated by occasional buttes and river breaks. Native grasslands, largely replaced on level ground by spring wheat and alfalfa, persist in areas of broken topography. Agriculture is restricted by the erratic precipitation and limited opportunities for irrigation. The Missouri Plateau comprises a large part of the southern and western portions of the NGP ecoregion.

Northwest Glaciated Plains

The western and southern boundary of the Northwest Glaciated Plains roughly coincides with the limits of continental glaciation. As its name implies, glacial till covers gently undulating hills in the region, known as glacial till plain. In Canada, the area is also referred to as the Palliser Triangle, and is one of the driest parts of Canada.

Nebraska Sandhills Prairie

Although not characterized by mid grass vegetation and often considered a distinct ecoregion, we include the Sandhills of Nebraska in our ecoregion. Adjacent to the mixed-grass prairies, the Sandhills harbor some of the most intact natural habitat of the Great Plains. A mosaic of various dune formations, with shallow lakes and fens dotting interdunal valleys, characterizes the Sandhills landscape.[37] Sandhills biological communities represent a combination of species recruited from both adjacent tallgrass and shortgrass prairies. The mixture of species creates a unique assemblage of plants commonly recognized as "Sandhills prairie,"[38] to distinguish it from the mixed-grass prairie of which it is part.[39] The dunes are stabilized by grasses such as sand bluestem (*Andropogon hallii*), prairie sand-reed (*Calamovilfa longifolia*), and needle-and-thread.[40] The Sandhills are an important migration stopover for Sandhill cranes (*Grus canadensis*) and other birds. The area also serves as one of the last strongholds of the greater prairie chicken (*Tympanuchus cupido*).

Missouri Coteau

The Missouri Coteau forms the eastern edge of the NGP Ecoregion. The east-to-west rise in elevation that defines the Coteau also defines the beginning of the Great Plains. The Coteau is characterized by rolling hummocks of glacial till, dotted with numerous pothole wetlands. The potholes make the Coteau one of the most important waterfowl production areas in North America. Precipitation is 12-19 inches/year (30-48 cm/year). Predominant grasses include western wheatgrass, bluestem (*Schizachyrium scoparium)*, needle-and-thread and green needlegrass, with prairie cordgrass (*Spartina pectinata)* and northern reedgrass (*Calamagrostis stricta)* near wetlands.[41]

[37] Jones, S.R. 2000. The Last Prairie: a Sandhills journal. Camden Me.: Ragged Mountain Press/McGraw-Hill.

[38] Kaul, R. 1990. Plants. *In*, An Atlas of the Sandhills. A. Bleed and C. Flowerday, eds. Conservation and Survey Division, Institute of Agriculture and Natural Resources, Univ Nebraska, Lincoln, 260 pp. http://csd.unl.edu/csd/illustrations/ra5a/plants.html

[39] WWF describes this as "Nebraska Sandhills Mixed Grasslands." Ricketts et al. 1999, note 20 *supra*.

[40] Ricketts et al. 1999 *supra* note 20.

[41] Bryce et al. *supra* note 36.

Montane sky islands

Included within the NGP Ecoregion are several montane "sky island" ecosystems. The Cypress Upland of the Alberta-Saskatchewan boundary area is an isolated example of the montane vegetative zone that occurs on the lower slopes of the Rocky Mountains.[42] This ecosystem includes both grasslands and boreal forests, specifically aspen grove and northern foothills boreal forests.[43] The Cypress Uplands are believed to have escaped the last glaciation. Therefore, a large number of disjunct populations of flora and fauna typical of other ecoregions are found here. Similarly, the Black Hills represent an island ecosystem, more comparable to the forests of the South-Central Rockies. They have greater topographic relief and a distinct floristic assemblage, although some grassland species occur there as well.[44] Several other smaller mountain ranges (e.g., Little Rocky Mountains, Sweetgrass Hills, Judith Mountains, Bear Paw Mountains) also contain species that are more commonly found in montane systems to the west.

Because of their forest character, these island ecosystems are unique with respect to their conservation needs. Although they are included within the NGP Ecoregion, our focus is on grasslands and grassland species. Where these islands contribute to grassland biodiversity conservation they are included in our analysis, but for the most part this vision does not address conservation of the species and habitats associated with these montane ecosystems.

Native species

Remarkably, only a single species that we know existed in the NGP at the time of European settlement is perhaps extinct—the Rocky Mountain locust (*Caloptenus spretus*).[45] Some subspecies have disappeared, such as Audubon's bighorn sheep (*Ovis canadensis auduboni*). A few species have been largely extirpated within the ecoregion (e.g., grizzly bear and gray wolf), a few are highly endangered (e.g., black-footed ferret), some are displaying widespread population decline (e.g., many grassland birds; Appendix C2), and some are ecologically extinct (e.g., bison). While non-native species now account for 13%-30% of all species found on the prairie throughout North America,[46] major areas of the NGP remain relatively unaffected.

[42] Ecological Stratification Working Group 1995, note 30 *supra*.

[43] Rowe, J.S. 1972. Forest regions of Canada. Canadian Forestry Service, Dept. of Fisheries and the Environment, Ottawa. Text and national map at 1:6:700,000.

[44] Ricketts, et al. 1999, note 20 *supra*.

[45] Yoon, C.K. 2002. Scientists look back to 1800's and the days of the locust. New York Times Science, April 23, 2002, pg. D1; Lockwood, J. 2002. Voices from the past: Learning from the Rocky Mountain locust. Wild Earth.

[46] Samson et al., note 28 *supra*.

ENDEMICS

Endemic species are generally considered to be those that have evolved in a specific environment and whose distribution is limited to that environment. Endemics are particularly important to biodiversity conservation because their existence and health is closely tied to the biotic integrity of the local environment. Within the NGP we recognize several classes of organisms: 1) True (narrow) endemics—species whose distributions are limited to the NGP; 2) Species that have been described by others as "endemics," but might be more properly classified as "obligates." For example, Mengel (footnote 54) described 12 North American birds as "grassland endemics," even though most of these are not endemics in the generally accepted sense—most are migratory species that are also found in other biomes, though all have a very strong affinity for grassland habitat wherever they occur; and 3) Species with distributions centered in the NGP or Great Plains generally. Because conservation success in the ecoregion will likely be critical for the long-term viability of all of these species, we follow, for example, Knopf and Samson's list of vertebrate "endemics" as important target species in NGP conservation.

Plants (Appendix B)

The NGP supports a relatively high level of plant species richness,[47] with some 1,595 species.[48] Many of these, such as Great Plains stickseed (*Lappula cenchrusoides*), secund bladderpod (*Lesquerella arenosa* var. *arguillosa*), Dakota wild-buckwheat (*Eriogonum visheri*), and dense-flower knotweed (*Polygonum polygaloides* ssp. *confertiforum*) are endemic to the ecoregion (Appendix B).[49] Others are of significant conservation interest because they are either near-endemics, listed as endangered/threatened by the US and Canadian governments, or considered at risk according to Natural Heritage Network standards. Although there are relatively few "rare" plants—ranked "globally" at risk (G1-G3) by The Nature Conservancy—(see Appendix B) in the NGP (0-2.5% of the native flora[50]), many endemic species are of conservation interest. Consideration of plants within a conservation plan for the NGP is especially critical because "plants of the Great Plains have the lowest levels of protection, with [for example] only 293 of 404 species [in Wyoming] present on protected lands and less than 15% of the flora having over 10% of their populations preserved."[51]

Blowout penstemon (*Penstemon haydenii)* is endemic to the Nebraska Sandhills. It is also a U.S. listed endangered species. Ute ladies' tresses (*Spiranthes diluvialis*), a U.S. threatened species, occurs marginally in the NGP. Canadian threatened and endangered species include small-flowered sand verbena (*Tripterocalyx micanthus*), tiny cryptanthe (*Cryptantha minima*), western spiderwort (*Tradescantia occidentalis*), soapweed (Yucca-*Yucca glauca*), western blue-flag (*Iris missouriensis*), hairy (silky)

[47] Ostlie, W. R., R. E. Schneider, J. M. Aldrich, T. M. Faust, R. L. B. McKim and S. J. Chaplin. 1997. The status of biodiversity in the Great Plains. The Nature Conservancy, Arlington, VA. USA. 326 pp. + XII. http://www.greatplains.org/resource/biodiver/biostat/biostat.htm

[48] Ricketts et al 1999, note 20 *supra*.

[49] TNC 2000, note 27 *supra*.

[50] Id.

[51] Fertig, W. and R. Thurston. 2001. Gap analysis of the flora of Wyoming. Gap Analysis Program Bulletin No. 10. http://www.gap.uidaho.edu/Bulletins/10/florawyo.htm

Table 1. Status of Grassland Obligates and Species with Affinity for the NGP Ecoregion (following classification of Knopf and Samson). See Appendices B-G for references.

Northern Great Plains Endemics		ESA[10]	COSEWIC[1]	TNC Global Rank[2]	BLM[3]	MT[4]	SD[5]	NB[6]	WY[7]	AB[8]	SK[9]
Mountain plover	*Charadrius montanus*	P	E	G2	X	X	X	X	X	X	
Baird's sparrow	*Ammodramus bairdii*			G4	X	X			X		
Sprague's pipit	*Anthus spragueii*		T	G4		X					X
Long-billed curlew	*Numenius americanus*		conc	G5	X			X	X		
Lark bunting	*Calamospiza melanocorys*			G5							
Chestnut-collared longspur	*Calcarius ornatus*			G5				X	X		
McCown's longspur	*Calcarius mccownii*			G5				X	X		
Ferruginous hawk	*Buteo regalis*		conc	G4	X			X			
Marbled godwit	*Limosa fedoa*			G5							
Wilson's phalarope	*Phalaropus tricolor*			G5					X		
Franklin's gull	*Larus pipixcan*			G4		X					
Pallid sturgeon	*Scaphirhynchus albus*	L	N/A	G1	X	X	X	X	N/A	N/A	N/A
Sturgeon chub	*Macrhybopsis gelida*		N/A	G2	X	X	X	X	X	N/A	N/A
Sicklefin chub	*Macrhybopsis meeki*		N/A	G3	X	X	X	X		N/A	N/A
Plains topminnow	*Fundulus sciadicus*			G4	X			X			
Western silvery minnow	*Hybognathus argyritis*		T	G5					X	X	
Blacknose shiner	*Notropis heterolepsis*			G5			X	X			
Plains leopard frog	*Rana blairi*			G5							
Plains spadefoot	*Spea bombifrons*			G5							
Ornate box turtle	*Terrapene ornata*			G5		N/A			X	N/A	N/A
Plains garter snake	*Thamnophis radix*			G5						X	
black-footed ferret	*Mustela nigripes*	L	ext	G1	X	X	X	X	X	N/A	EXT
black-tailed prairie dog	*Cynomys ludovicianus*	C	conc	G4	X	X	sc		X	N/A	X
swift fox	*Vulpes velox*		E	G3	X	X	X	X	X	X	X
eastern (plains) spotted skunk	*Spilogale putorius*		N/A	G5	X	N/A		X	X	N/A	N/A
bison (free ranging)	*Bison bison*			G3		X			X		
plains pocket mouse	*Perognathus flavescens*		N/A	G5		N/A			X	N/A	N/A
olive-backed pocket mouse	*Perognathus fasciatus*			G5				X		X	
hispid pocket mouse	*Perognathus hispidus*			G5		X			X		
plains harvest mouse	*Reithrodontomys montanus*			G5					X		
northern grasshopper mouse	*Onychomys leucogaster*			G5						X	
prairie vole	*Microtus ochrogaster*			G5						X	
Franklin's ground squirrel	*Spermophilus franklini*			G5							
Richardson's ground squirrel	*Spermophilus richardsoni*			G5							
Thirteen-lined ground squirrel	*Spermophilus tridecemlineatus*			G5							
plains pocket gopher	*Geomys bursarius*			G5							
pronghorn	*Antilocapra americana*			G5							
white-tailed jackrabbit	*Lepus townsendii*			G5							

[1] Committee on the Status of Endangered Wildlife in Canada. T=threatened; E=endangered; Conc=species of concern; ext=extirpated.

[2] G1 = Critically imperiled; G2 = Imperiled; G3 = Vulnerable; G4 = Apparently secure, but rare; G5 = Demonstrably secure.

[3] Sensitive, Montana or Wyoming

[4] Species of concern

[5] Listed pursuant to statute, endangered or threatened; sc=species of concern

[6] Species of concern

[7] Species of concern

[8] Tracking

[9] Species at risk; ext=extirpated

[10] Endangered Species Act, U.S.: L= listed; P=Proposed; C=Candidate

prairie clover (*Dalea villosa var. villosa),* and slender mouse-ear cress (*Halimolobus virgata*).

Vertebrates

Approximately 1,100 vertebrate species inhabit the Great Plains.[52] Of these, roughly half occur in the NGP, including 300 species of birds, 95 mammals, 28 reptiles, 13 amphibians[53] and 121 fish (See also Appendices C - F).
Knopf and Samson list 73 vertebrates as "endemic" (their term for species that we classify as obligates or species whose distribution is centered in the NGP) in the Great Plains.[54] The NGP Ecoregion contains 11 of 12 (92%) bird species classified as Great Plains endemics by Knopf and Samson, all of the 17 mammals, 5 of the 10 (50%) reptiles and amphibians, and 6 of the 34 (18%) fish (See Table 2; Appendices C-F). Of these 39 species, 15% are listed as endangered or threatened in Canada or the U.S., 17% are vulnerable or imperiled globally, and 74% are listed as species of concern by one or more states or provinces.

BIRDS (Appendices C1, C2)
The number of bird species that reside in or migrate through the ecoregion (n=352) includes about 216 that can be considered either winter or summer residents of the mixed-grass subecoregions and 23 that reside in the Sandhills but not any of the other mixed grass subecoregions. Another 65 species regularly use habitats in the ecoregion on fall and spring migrations and thus are resident for extended periods seasonally. Forty-eight other species are observed to occasionally occur in the NGP.

NGP bird life is most notable for the rich diversity of raptors—about half of North America's predatory bird species breed in the NGP. A surprising number of resident birds are not grassland dependent. Over half are riparian or water dependent, and a large number depend on shrubs or trees as part of their habitat (Appendix C1). The remaining species that would be considered grassland "obligates" include representatives from nearly every bird family. Among these are several "shorebirds" evolved as true prairie birds, including the mountain plover, which has evolved to use its beach foraging adaptation to hunt for insects in heavily grazed prairie grasslands, the upland sandpiper (*Bartramia longicada*), the long-billed curlew (*Numenius americanus*), and the killdeer (*Charadrius vociferous*). The burrowing owl (*Athene cunicularia*) is a grassland obligate which nests underground, in the burrows created by prairie dogs and ground squirrels. Many grassland birds exhibit preferences for large grassland patches, and are less abundant or absent where there are not large areas in grassland.[55]

In general, grassland birds are adapted to a continuum of habitats that probably reflects the mosaic of vegetative patterns that occurred historically. For

[52] Knopf, F.L. and F.B. Samson. 1997. Conservation of Grassland Vertebrates. Ecological Studies 125:273-289.
[53] See also, Ricketts et al. 1999, note 20 *supra*.
[54] Id. See also, Mengel, R.M. 1970. The North American Central Plains as an isolating agent in bird speciation. Pp. 279-340 *in* Pleistocene and recent environments of the Central Great Plains, W. Dort Jr. and J.K. Jones, Jr., eds. University Press of Kansas, Lawrence.

[55] Johnson, D.H. and L.D. Igl. 2001. Area requirements of grassland birds: a regional perspective. Auk 118:24-34.

example, several species are prairie dog associates, such as the burrowing owl, mountain plover and ferruginous hawk. Baird's sparrow (*Ammodramus bairdii*), Sprague's pipit (*Anthus spragueii*) and the chestnut-collared longspur (*Calcarius ornatus*) require lightly grazed areas with plentiful residual cover. The greater sage grouse (*Centrocercus urophasianus*), loggerhead shrike (*Lanius ludovicianus*), and sage thrasher (*Oreoscoptes montanus*) are associated with mixed shrub habitatats. The interior (least) tern (*Sterna antillarum*), piping plover (*Charadrius melodus*), and upland sandpiper (*Bartramia longicauda*), are associated primarily with riverine, lake or wetland habitats.

Grassland birds are undergoing greater population declines than any other avian guild in North America (Appendix C2). Of the 12 grassland species with distributions centered on the NGP,[56] 8 are ranked as conservation priorities "Tier II or I"[57] by the combined Partners in Flight planning areas[58] that fall within the NGP ecoregion. Four species within the ecoregion (the mountain plover, interior (least) tern, piping plover, and greater sage grouse) are listed or have been petitioned for listing under the U.S. Endangered Species Act, and 6 species (mountain plover, piping plover, greater sage grouse, Sprague's pipit, loggerhead shrike and sage thrasher) are listed by the Committee on the Status of Endangered Wildlife in Canada (COSEWIC) as endangered or threatened (Appendix C2). The U.S. Fish and Wildlife Service lists all the NGP "endemics" (with the exception of Franklin's gull, *Larus pipixcan*) and 77% of grassland obligates occurring in the NGP at risk of being listed in the future absent management changes to their benefit.[59] A primary factor in decline of almost all of these species is human-caused fragmentation and/or alteration of habitat.[60]

[56] Knopf, F.L. 1996. Prairie Legacies—birds. Pp. 135-48 in Prairie Conservation, F.B. Samson and F.L. Knopf, eds., Island Press, Washington, D.C.

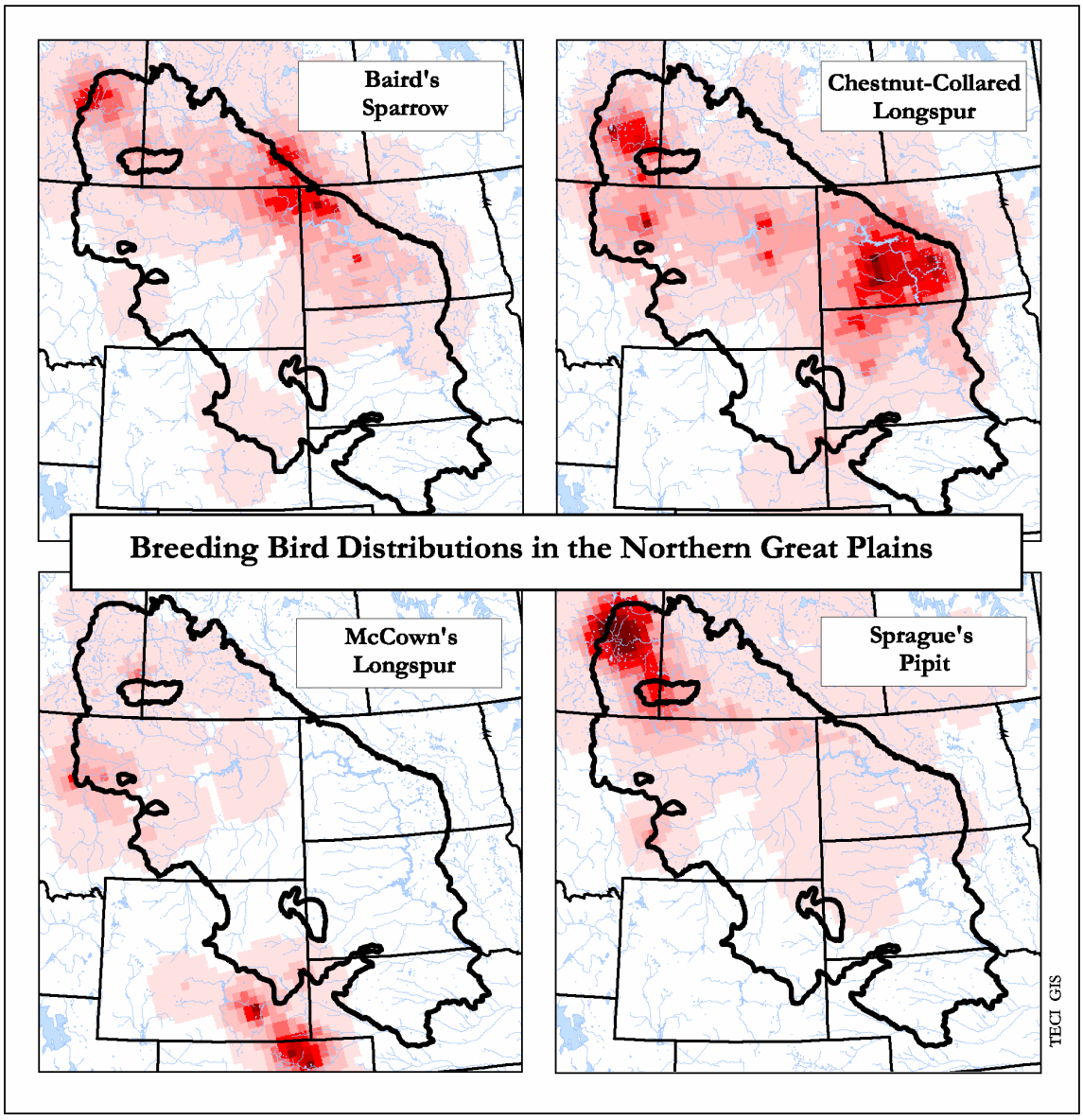
[57] Tier I includes species that are typically of conservation concern throughout their range. These are species showing high vulnerability in a number of factors. Tier II includes species that are of moderate overall priority, but are important to consider for conservation within a region because of various combinations of high vulnerability factors. Panjabi, A. 2001. The Partners In Flight Handbook on Species Assessment & Prioritization Version 1.1. Partners in Flight and Rocky Mountain Bird Observatory. http://www.rmbo.org/pubs/downloads/Handbook.pdf

[58] Partners in Flight is a consortium of groups that have come together to promote conservation of North American Birds, and include representative from many state and federal wildlife management agencies as well as other expertise. http://www.partnersinflight.org/description.cfm

[59] U.S. Fish and Wildlife Service. 2002. Birds of conservation concern 2002. Division of Migratory Bird Mgmt, Arlington, VA. http://migratorybirds.fws.gov/reports/bcc2002.pdf. Include all species thought to be at risk in order to focus conservation attention on them "well in advance of a possible or plausible need" for ESA protection.

[60] Gillihan, S.W., D.J. Hanni, S.W. Hutchings, T. Toombs, and T. VerCauteren. 2001. Sharing your land with shortgrass prairie birds. Rocky Mountain Bird Observatory, Brighton, CO. 36pp.

Figure 7. Breeding Bird Distributions in the Northern Great Plains



SOURCES

Sauer, J. R., J. E. Hines, and J. Fallon. 2002. The North American Breeding Bird Survey, Results and Analysis, 1966 - 1996.

WWF and TECI GIS reclassified breeding bird survey data to a scale of 1-10 across the range of each species.

LEGEND

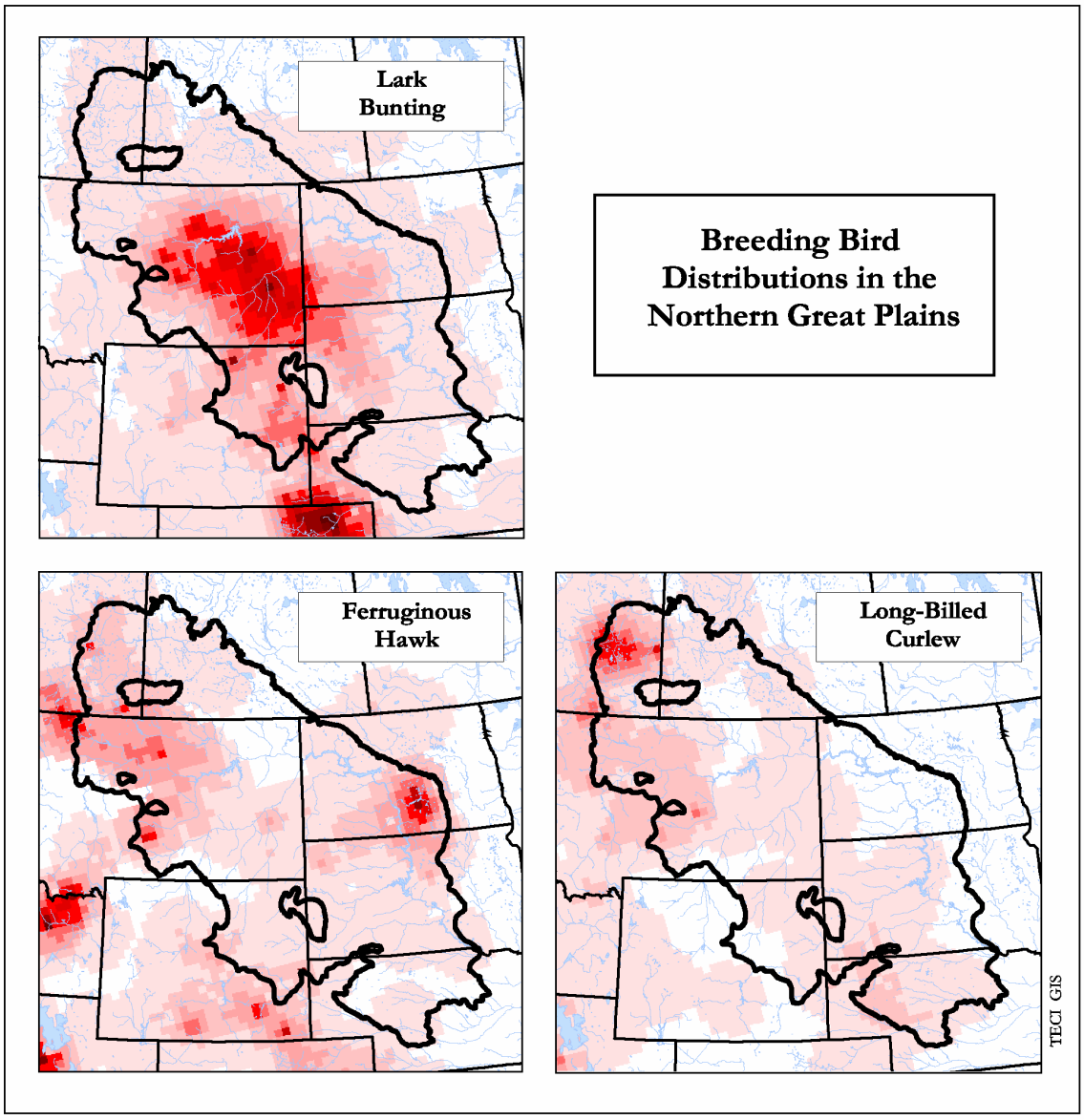
Northern Great Plains Ecoregion boundary

Relative abundance during breeding season (highest observed abundance = 10):

1 2 3 4 5 6 7 8 9 10

WWF

Figure 8. Breeding Bird Distributions in the Northern Great Plains



SOURCES

Sauer, J. R., J. E. Hines, and J. Fallon. 2002. The North American Breeding Bird Survey, Results and Analysis, 1966 - 1996.

WWF and TECI GIS reclassified breeding bird survey data to a scale of 1-10 across the range of each species.

LEGEND

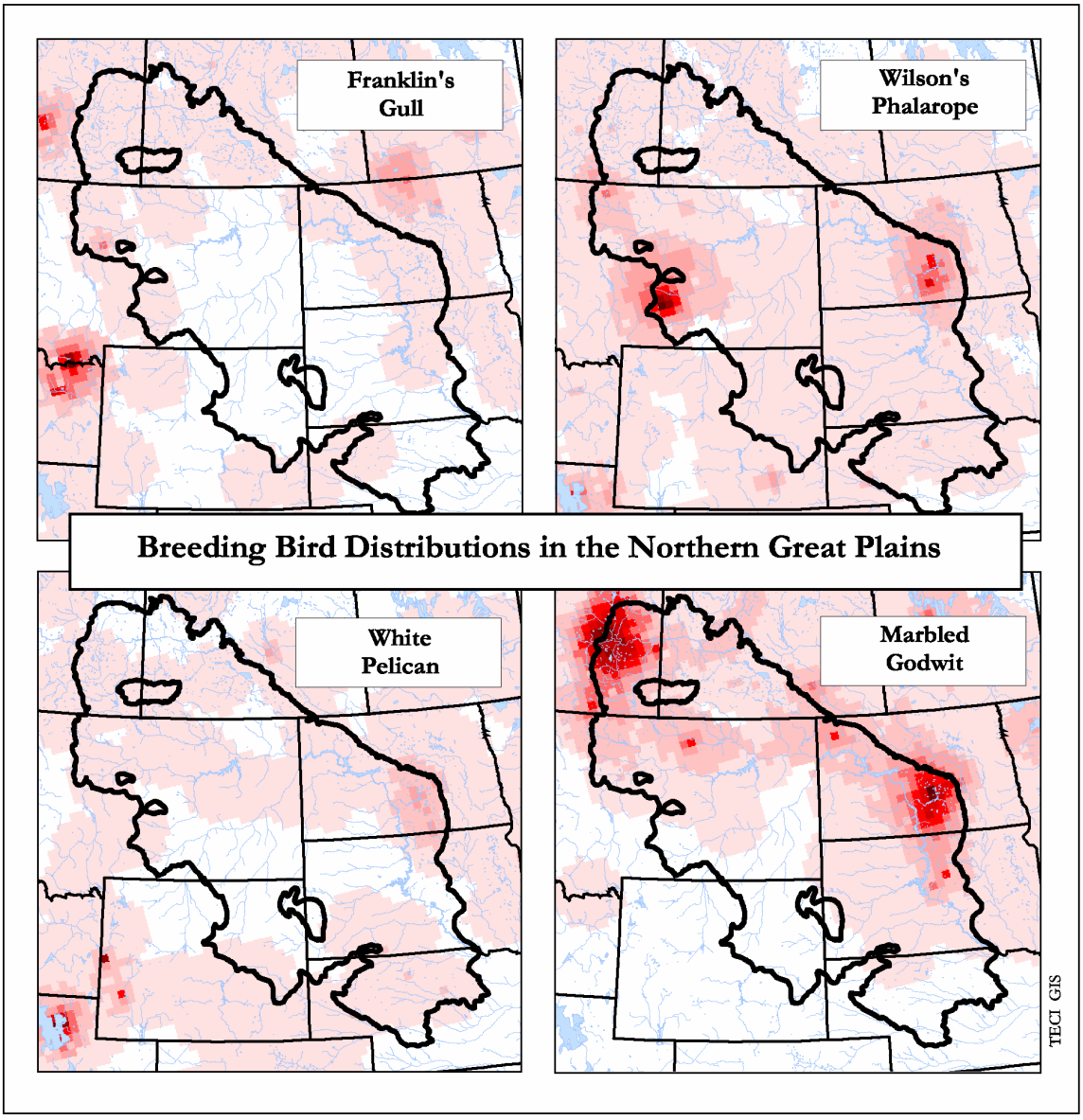
Northern Great Plains Ecoregion boundary

Relative abundance during breeding season (highest observed abundance = 10):

1	6
2	7
3	8
4	9
5	10

WWF

Figure 9. Breeding Bird Distributions in the Northern Great Plains—Riparian and Wetland obligates.



SOURCES

Sauer, J. R., J. E. Hines, and J. Fallon. 2002. The North American Breeding Bird Survey, Results and Analysis, 1966 - 1996.

WWF and TECI GIS reclassified breeding bird survey data to a scale of 1-10 across the range of each species.

LEGEND

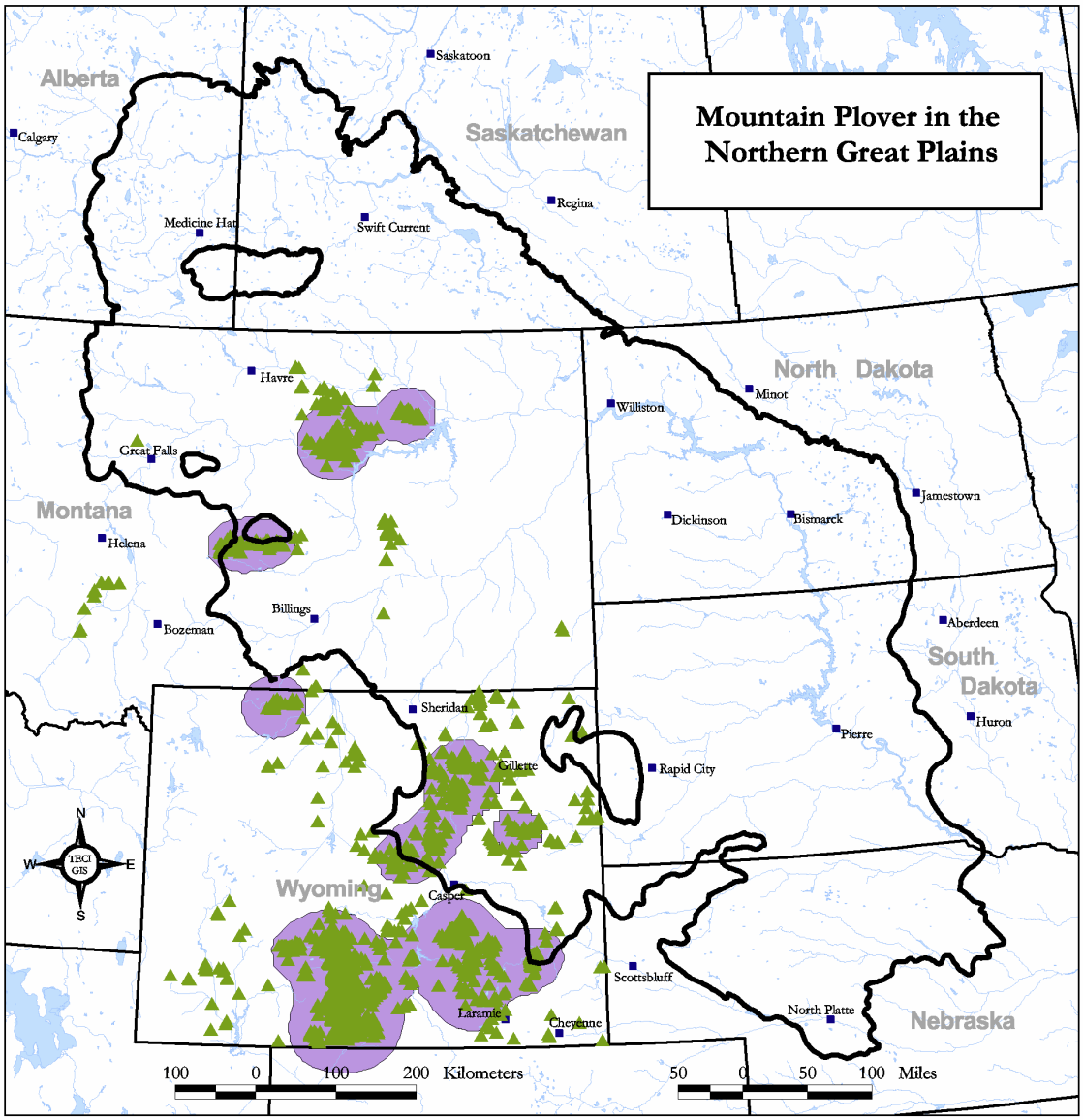
Northern Great Plains Ecoregion boundary

Relative abundance during breeding season (highest observed abundance = 10):

1	6
2	7
3	8
4	9
5	10

WWF

Figure 10. Mountain Plover in the Northern Great Plains



SOURCES

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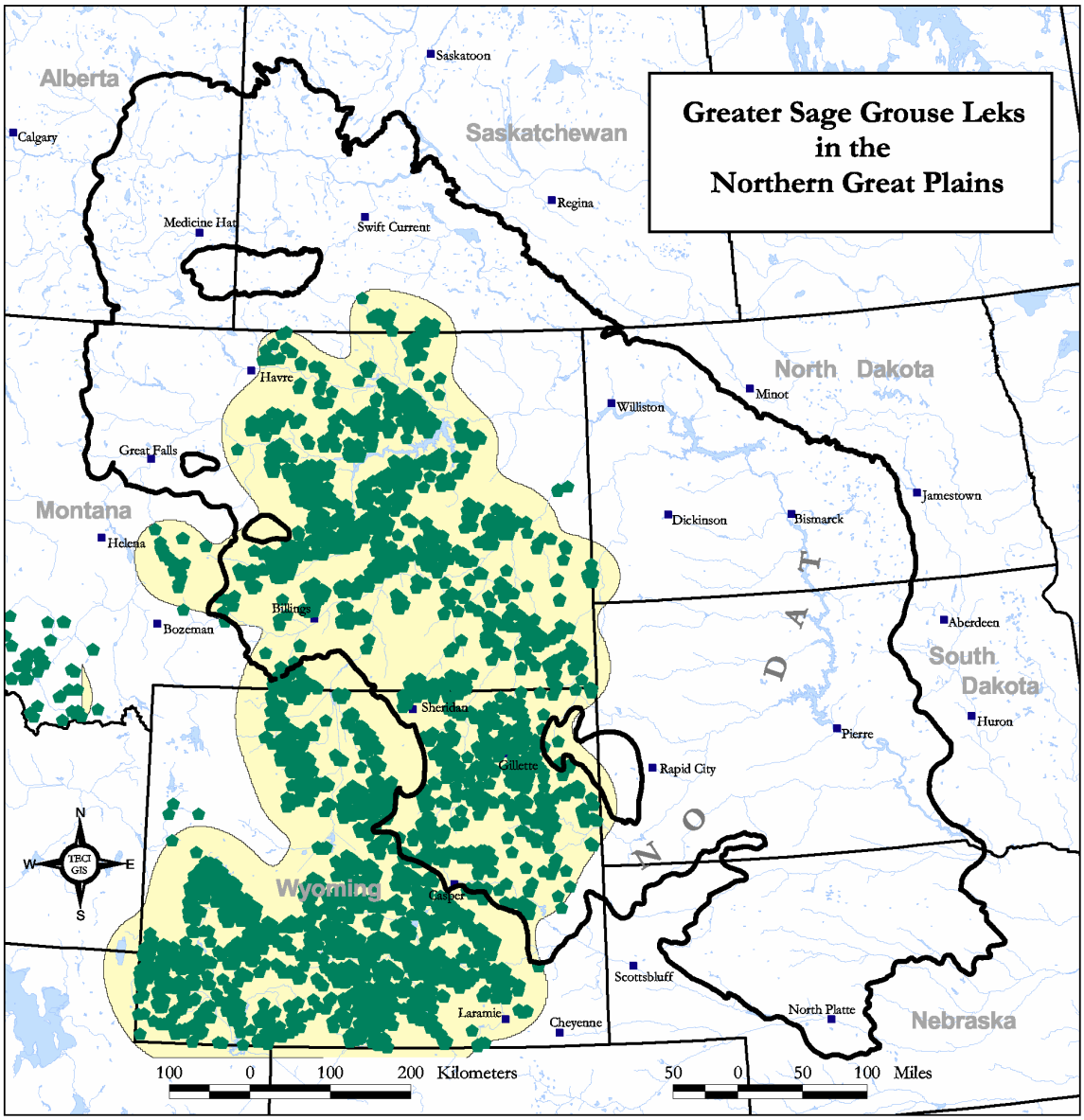
TECI GIS defined isopleths by applying fixed kernal home range analysis (see P. N. Hooge and B. Eichenlaub. 1997. Animal movement extension to arcview. ver. 1.1. Alaska Science Center - Biological Science Office, U.S. Geological Survey, Anchorage, AK, USA.)

LEGEND

- Northern Great Plains Ecoregion boundary
- Mountain plover occurrence locations
- 95% isopleth for distribution of occurrence locations

WWF

Figure 11. Sage Grouse Leks in the Northern Great Plains



SOURCES

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Wyoming Game and Fish. 2003

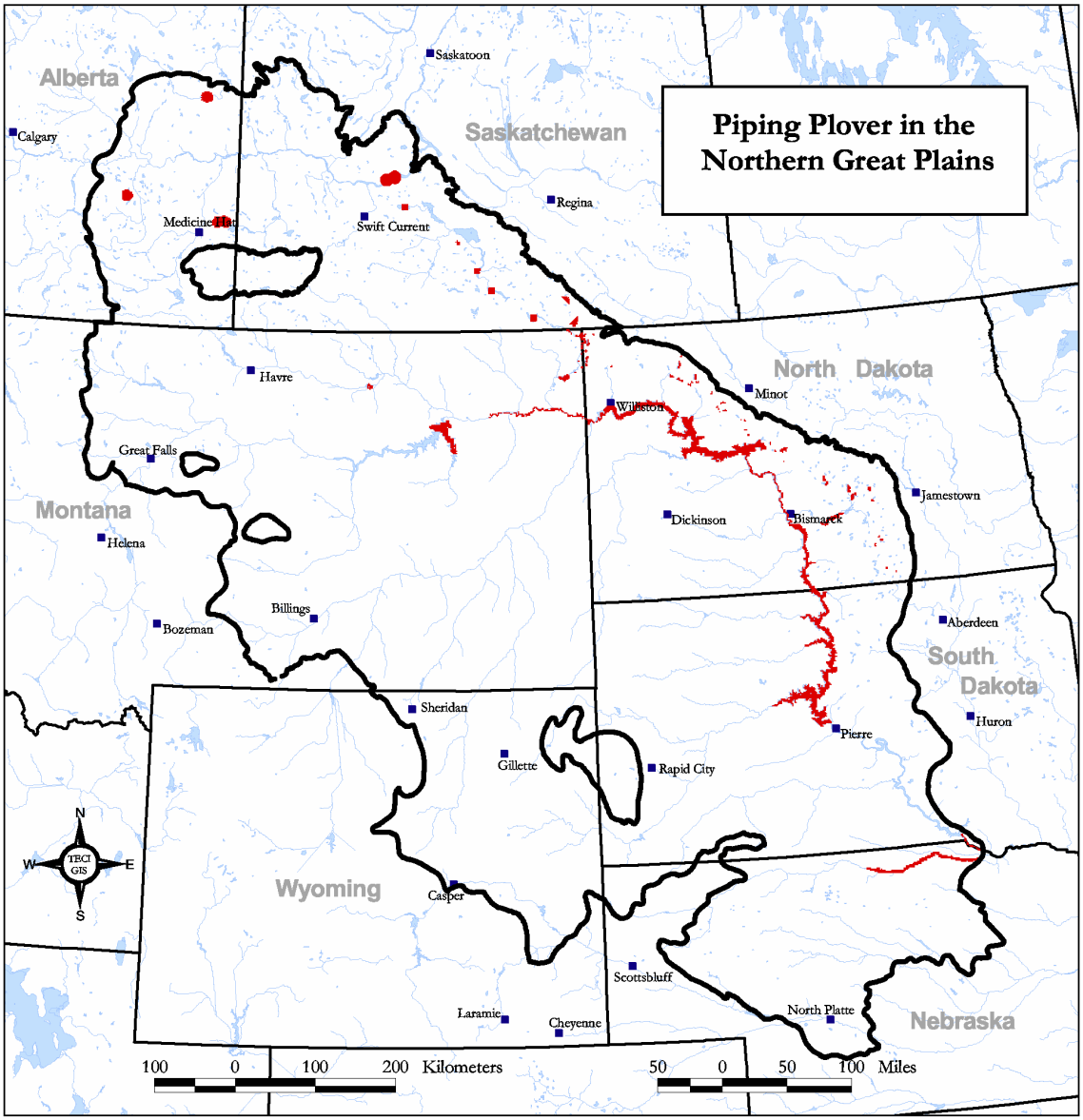
TECI GIS defined isopleths by applying fixed kernal home range analysis (see P. N. Hooge and B. Eichenlaub. 1997. Animal movement extension to Arcview. ver. 1.1. Alaska Science Center - Biological Science Office, U.S. Geological Survey, Anchorage, AK)

LEGEND

- Northern Great Plains Ecoregion boundary
- Active or historic lek locations
- 95% isopleth for distribution of leks

WWF

Figure 12. Piping Plover in the Northern Great Plains



SOURCES

Prescott, D. R. C. 1997. Status of the Piping Plover (Charadrius melodus) in Alberta. Alberta Environment, Wildlife Management Division, Wildlife Status Report No. 1, Edmonton, AB. 19 pp.

Saskatchewan Conservation Data Centre; Fish and Wildlife Branch, Saskatchewan Environment. 2004. Known piping plover areas in Saskatchewan.

U.S. Fish and Wildlife Service. 2002. Piping plover Critical Habitat.

LEGEND

Northern Great Plains Ecoregion boundary

Critical Habitat in the U.S.; known breeding habitat in Canada

WWF

MAMMALS (Appendices D1, D2)
Of the 95 mammal species in the NGP, 20 (21%) are carnivores. Over half of all carnivore species occurring north of Mexico occur in the NGP. Also common are insectivorous mammals (shrews and bats), with 23 species in the NGP.

In general, prairie carnivores have been more affected than other taxa by human settlement of the prairie landscape.[61] The grizzly bear and gray wolf are extirpated from the ecoregion (although populations exist in the adjacent Yellowstone Ecosystem and along the Rocky Mountain Front). River otters (*Lutra canadensis*), and wolverines (*Gulo luscus*) were historically present in the NGP, but now are found only outside the region (though individuals may occasionally stray into the ecoregion).[62] Although still present, mountain lions (*Felis concolor*) are listed as threatened under state law in South Dakota and Nebraska. The black-footed ferret is highly endangered, occurring in only 6 reintroduced populations within the NGP. The swift fox, formerly more common than the red fox or gray fox, is listed as a species at risk by every state and province in the ecoregion, occupying perhaps only 40% of its former range.[63] Moreover, the abundance and distribution of populations of mid-size predators ('mesopredators'), such as coyotes (*Canis latrans*), have changed due to various factors—large changes in prey abundance, disappearance of the wolf, and predator control programs.

Ungulate populations are dramatically reduced from historic times. Elk, which historically were primarily a plains species, number far fewer in the NGP than herds described as "emmence" and "innumerable" by early chroniclers of the plains.[64]

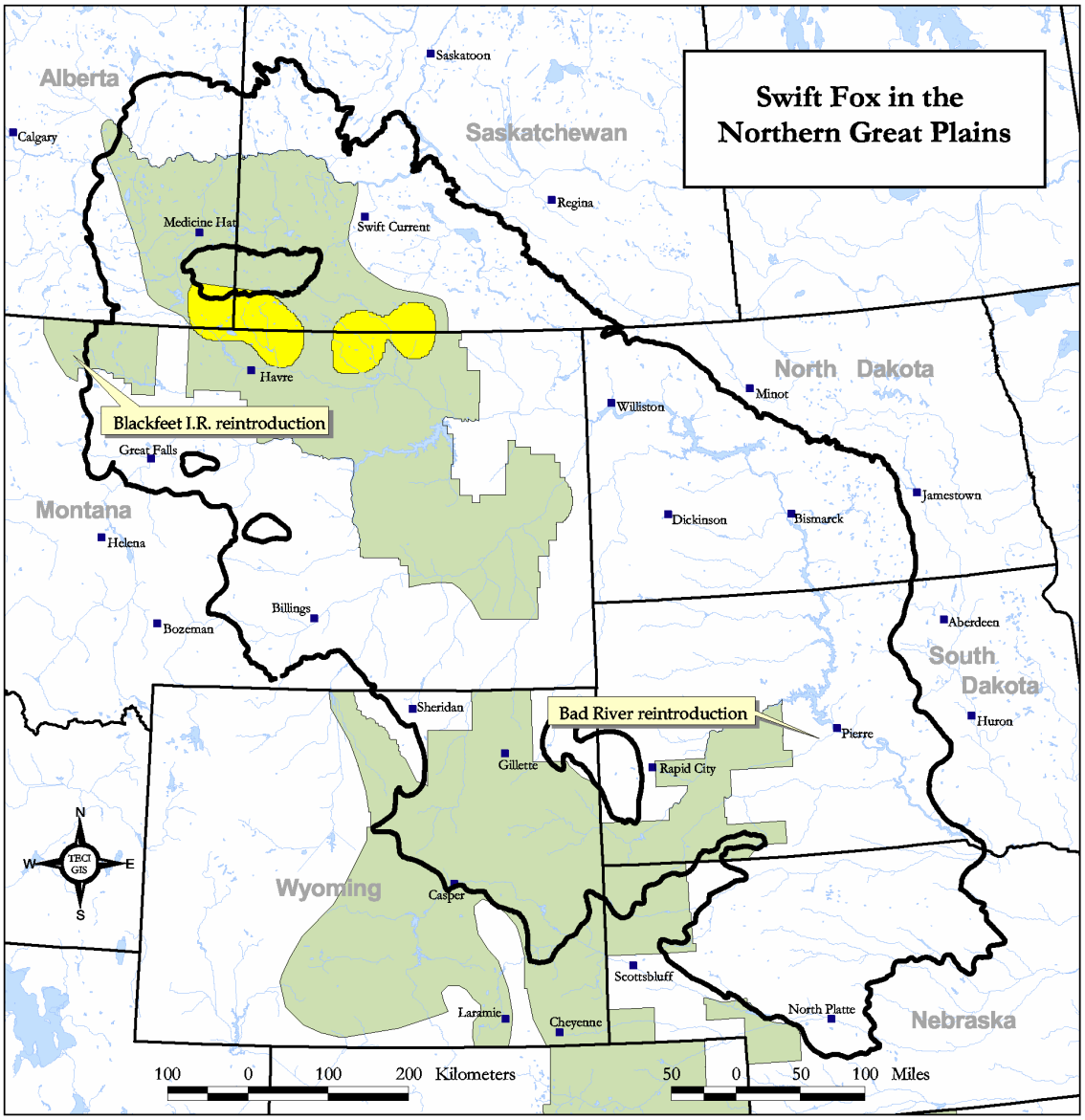
Beaver, although locally common, are today less prevalent in many prairie streams than historically. Beaver strongly influence hydrologic regimes and associated plant species composition that affect the distribution and abundance of other NGP species, such as waterfowl and amphibians.[65]

The black-tailed prairie dog, a prairie keystone species, is currently on the candidate list for Endangered Species Act protection in the U.S. Other species regarded as being at risk include the

[61] Laliberte. 2003, note 12 *supra.*
[62] R.J. Greenwood and M.A. Sovada. 1998. Population trends for prairie pothole carnivores. Pp. 461-463 *In* Michael J. Mac et al., eds., Status and Trends of the Nation's Biological Resources, Vol. 2, U.S. Dept. of Interior, U.S. Geological Survey, Reston Va.(1998).
[63] Moehrenschlager, A. and C. Moehrenschlager. 2001. Census of swift fox (Vulpes velox) in Canada and Northern Montana: 2000-2001. Alberta sustainable Resource Development, Fish and Wildlife Division, Alberta Species at Risk Report No. 24, Edmonton, AB. 21 pp; Schmitt, C. and R. Gregory, ed. 2000. 1999 Swift fox conservation team annual report.
[64] Audubon, for example, describing elk in the vicinity of the Little Missouri in North Dakota in 1835 observed, "We saw three elk swimming across it [the Little Missouri] and the number of this fine species of deer that are about us now is almost inconceivable." Bailey, V. 1926. A biological survey of North Dakota. North American Fauna 49, U.S. Department of Agriculture, Bureau of Biological Survey, Washington, DC. http://www.lib.ndsu.nodak.edu/govdocs/text/fauna/
[65] Cunningham, J.M., A.J.K. Calhoun and W.E. Glanz. 2002. The effect of beaver on the spatial and temporal distribution of pond-breeding amphibian species. University of Maine, Orono. Abstract presented at the *Society for Conservation Biology* 16th Annual Meeting *July 14-July 19 2002.* http://www.ukc.ac.uk/anthropology/dice/scb2002/abstracts/Wednesday/carone.html

eastern spotted skunk (*Spilogale putorius*), Townsend's big-eared bat (*Corynorhinus townsendii*), Preble's meadow jumping mouse (*Zapus hudsonius preblei*-marginal to the ecoregion), Merriam's shrew (*Sorex merriami*), and the fringed myotis (*Myotis thysanodes*) (Appendix D2).

Figure 13. Swift Fox in the Northern Great Plains



SOURCES

Schmitt, C.G. 2000. Swift fox conservation team, 1999 annual report. New Mexico Department of Game and Fish. 201 pp.

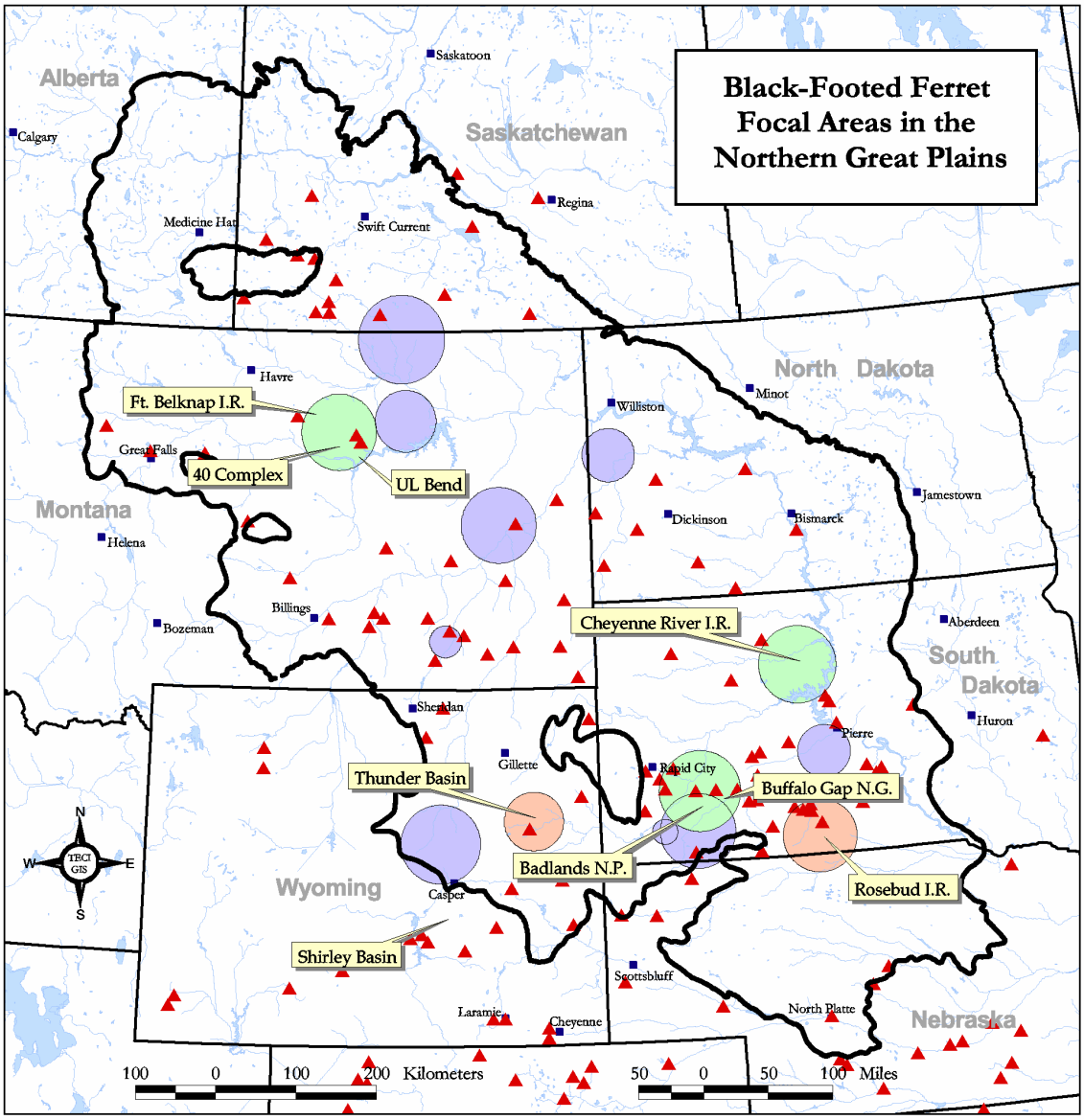
Moehrenschlager, A. and C. Moehrenschlager. 2001. Census of swift fox (Vulpes velox) in Canada and Northern Montana 2001-2001. Alberta Species at Risk Report No. 24, 21 pp.

LEGEND

- Northern Great Plains Ecoregion boundary
- Probable current range of swift fox
- Known distribution in Montana and Canada

WWF

Figure 14. Black-Footed Ferret in the Northern Great Plains



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Matchett, R. 2003. Black-footed ferret recovery in Montana: where do we go from here? Paper presented at the Montana Chapter of The Wildlife Society, February 17, 2003.

LEGEND

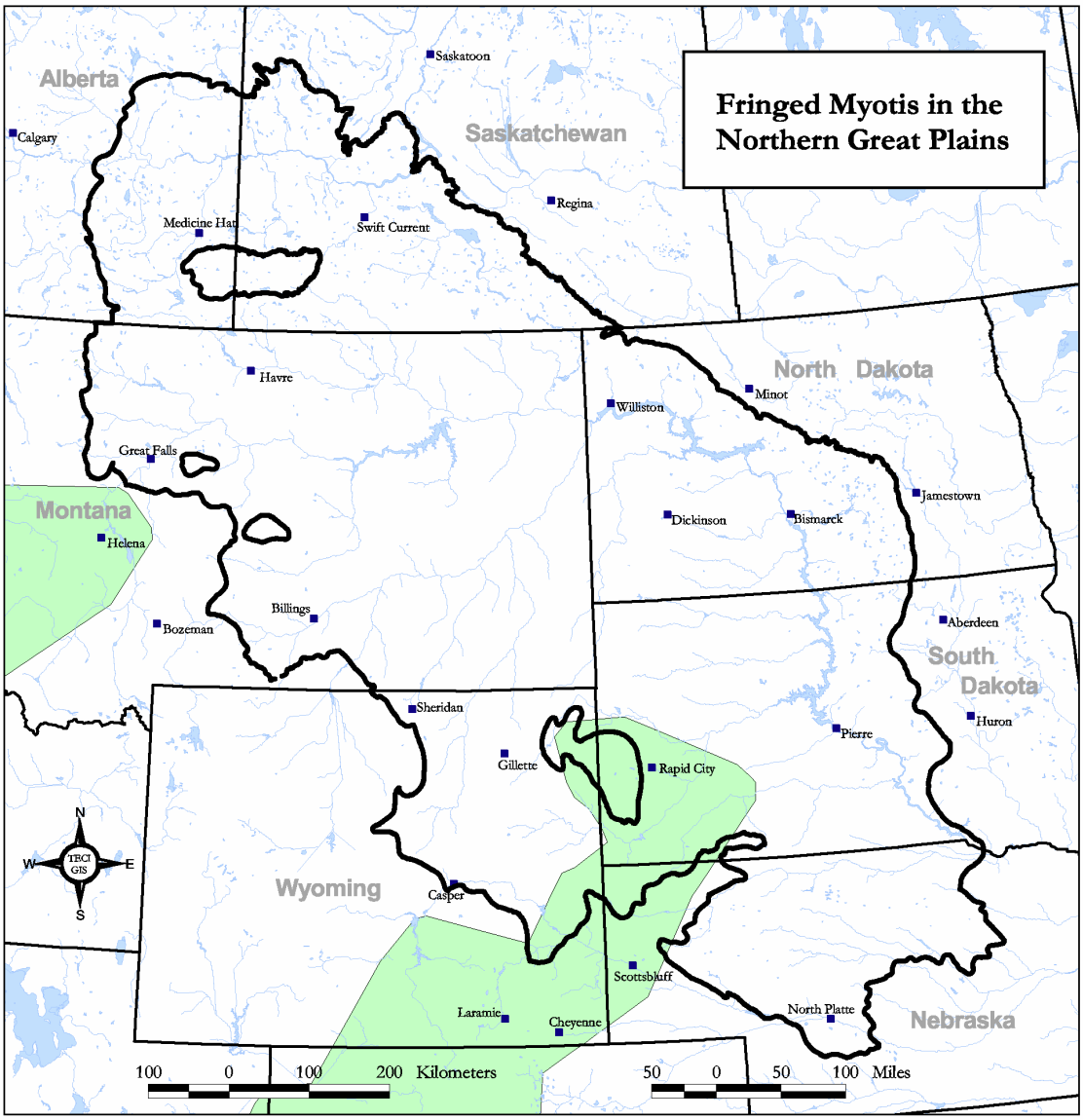
- Northern Great Plains Ecoregion boundary
- Historic records of ferret occurence

Black-footed ferret focal areas:

- Existing reintroduction sites
- Proposed reintroduction sites
- Other black-footed ferret focal areas

WWF

Figure 15. Fringed Myotis in the Northern Great Plains



SOURCE

England, A.E. 2002. North American bat ranges. Bat Conservation International, Inc.

LEGEND

Northern Great Plains Ecoregion boundary

Distribution of Fringed Myotis

WWF

FISH (Appendices E1, E2)
Around 120 species of fish occur in the NGP. Prairie fish are divided into two general categories: large river species dependent on highly turbid waters and those inhabiting smaller, often clearer, streams. There are approximately ten times as many small-stream species as large-river species.[66] Knopf and Samson list the pallid sturgeon (*Scaphirhynchus albus*), western silvery minnow (*Hybognathus argyritis*), sturgeon chub (*Macrhybopsis gelida*), sicklefin chub (*Macrhybopsis meeki)*, plains topminnow (*Fundulus sciadicus*), and blacknose shiner (*Notropis heterolepsis*) as Great Plains endemics that occur in the NGP ecoregion[67] (Table 2).

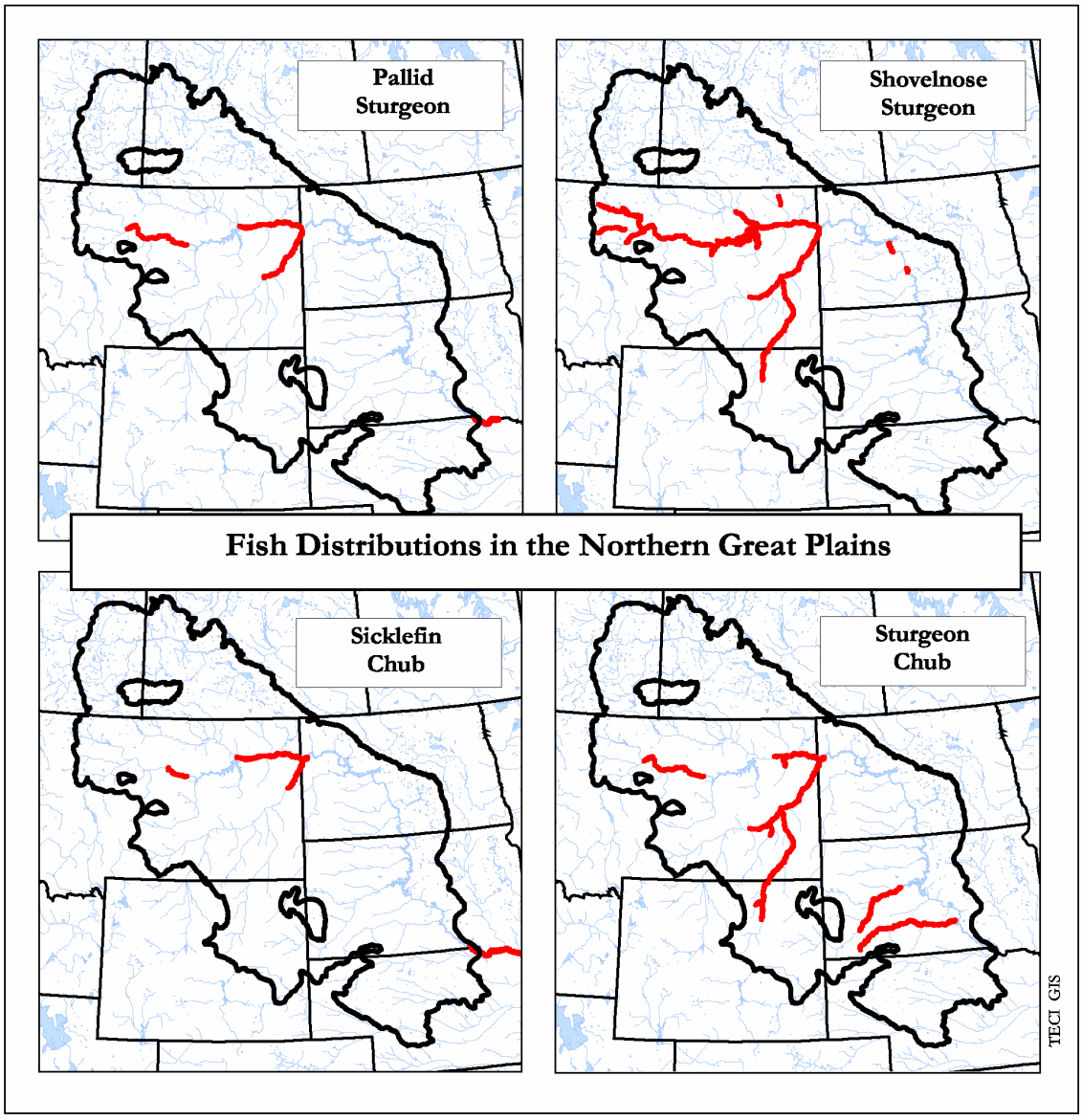
Intensive agriculture and modified flow regimes as a result of dams and diversions are responsible for much of the decline in populations of fish that live in both types of NGP stream environments.[68] Most affected are species found in shallow, sandy-bottomed streams.[69] Two species in the ecoregion are endangered: the pallid sturgeon and Topeka shiner (*Notropis topeka*). The Topeka shiner is largely marginal to the NGP, but has been found in the Loup River in the Nebraska Sandhills.[70] The pallid sturgeon is critically endangered in the upper Missouri—sturgeon below Ft. Peck dam and above the reservoir and in the Yellowstone River have not reproduced in 35 years, and though long-lived, are likely to go extinct by 2016 without changes to management of the Missouri.[71] Several other fish, including the sturgeon chub, sicklefin chub, and plains topminnow, have been candidates for listing under the U.S. Endangered Species Act in the past, but are currently not candidates. The western silvery minnow is undergoing rapid population declines over much of its range[72] and is listed as threatened in Canada.

The South Dakota GAP Analysis Project is producing a digitally based model to predict areas of high fish biodiversity based on species occurrence and landscape that will assist in identifying areas of conservation interest.[73] When completed, this work will likely point to additional areas where conservation efforts for fish should be focused.

[66] Samson et al. 1998, note 28 *supra*.
[67] Knopf and Samson 1997, note 52 *supra*.
[68] Id.
[69] Id.
[70] U.S. Fish and Wildlife Service. Undated. www.acad.carleton.edu/curricular/BIOL/faculty/pcamill/SLP00/kimH/Inside.htm. No ESA critical habitat for the Topeka shiner has been designated within the NGP: See U.S. Fish and Wildlife Service. 2002. Critical Habitat for the Topeka shiner. http://mountain-prairie.fws.gov/endspp/shiner/.

[71] Henckel, M. 2003. Death of a dinosaur: Pallid sturgeon a short step from extinction. Billings Gazette, Aug. 18, 2003, citing Ken McDonald, Montana Fish, Wildlife and Parks, Chairman, Upper Missouri River Pallid Sturgeon Recovery Group.
[72] U.S. Fish and Wildlife Service. 1995. North Dakota's federally listed endangered, threatened, and candidate species 1995. U.S. Fish and Wildlife Service, Bismarck, ND. Jamestown, ND: Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/distr/others/nddanger/nddanger.htm (Version 16JUL97).
[73] South Dakota State University, Department of Wildlife and Fisheries Science. http://wfs.sdstate.edu/sdgap/fish/Newsletter_August_02.pdf

Figure 16. Fish Distributions in the Northern Great Plains



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U.S. Fish and Wildlife Service. 1993. Pallid sturgeon recovery plan. Region 6. Denver, CO.

University of North Dakota. Undated. Fishes of North Dakota.

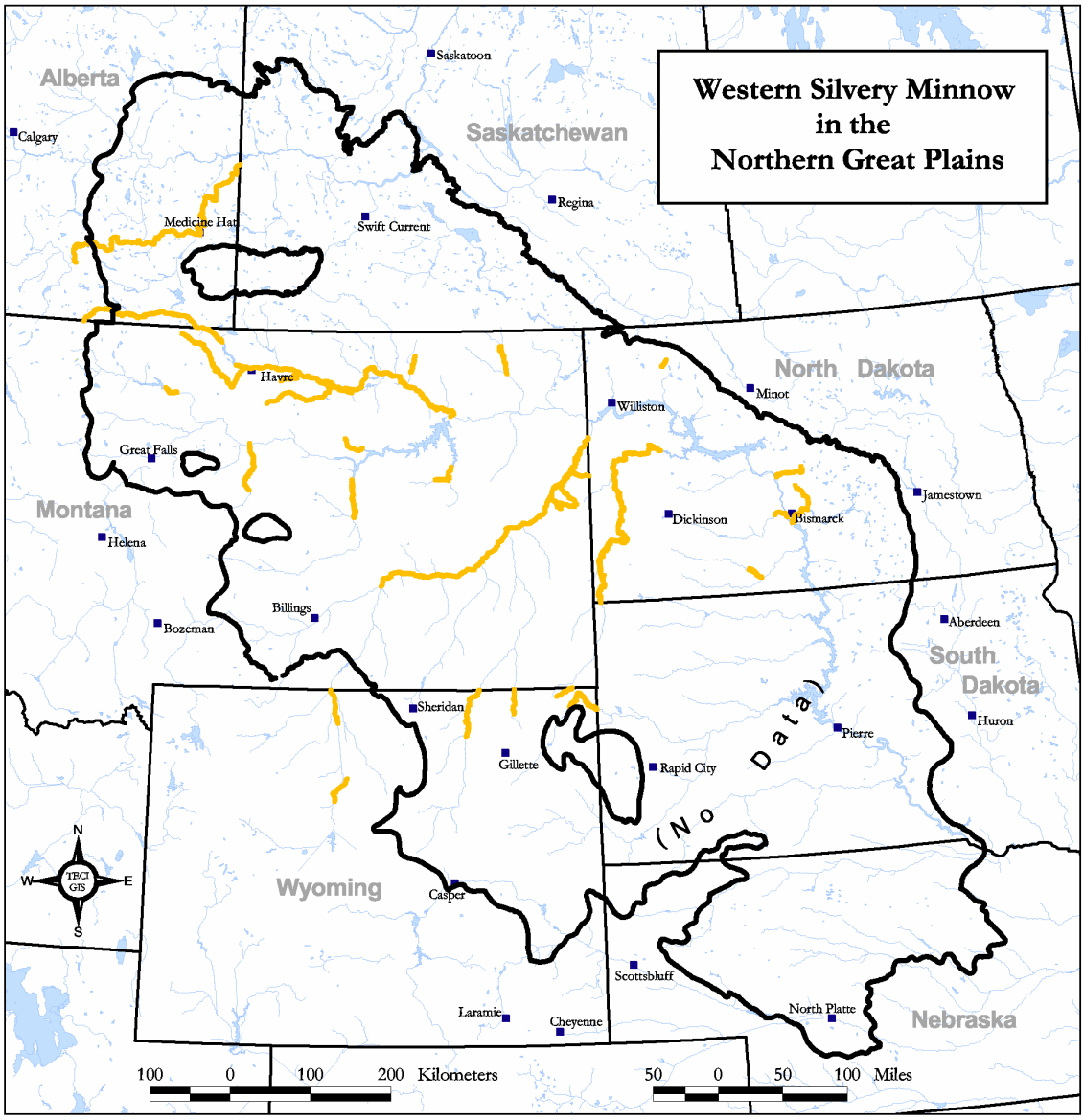
LEGEND

Northern Great Plains Ecoregion boundary

Fish distribution

WWF

Figure 17. Western Silvery Minnow in the Northern Great Plains



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LEGEND

Northern Great Plains Ecoregion boundary

Distribution of the western silvery minnow

WWF

REPTILES AND AMPHIBIANS (Appendices F1, F2)

Thirteen species of amphibians inhabit the NGP ecoregion. These include 5 species of toads, which are well adapted to the grasslands environment. The endemic plains spadefoot (*Scaphiopus bombifrons*), for example, uses an elongated spur on its hind feet to burrow as much as two feet below the surface to find moist soil.[74] All of the species exploit vernal or permanent water to breed, and estivate during hot dry weather and hibernate much of the winter.

Of 28 species of reptiles in the NGP ecoregion, 8 are turtles, 8 are lizards, and 12 are snakes. Species like the eastern short-horned lizard (the "horned toad" to many, *Phrynosoma douglassi*) rely on insects, which they pursue with a "sit and wait" strategy. Often they are found with ants, one of their primary foods.[75]

The status and trends of most prairie reptiles and amphibians are difficult to assess, but, with few exceptions, most populations in the NGP seem secure.[76] Sensitive species include: false map turtle (*Graptemys pseudogeographica*: restricted range in NGP), yellow mud turtle (*Kinosternon flavescens*: restricted range in NGP), and the leopard frog (*Rana pipiens*: declining rangewide) (Appendix F2).

Invertebrates

Invertebrate populations are crucial to healthy prairie ecosystems. Insects are essential menu items for most birds and many NGP mammals and herptiles. Burrowing beetles, bees, wasps, and ants aerate the soil, an especially important function in trampled rangelands.[77] "Tumblebugs" or dung beetles roll and bury manure balls. Some of the buried manure is broken down by bacteria and transformed into soil nutrients critical for vegetative growth. Beetles, bees, leafhoppers, walking sticks and, above all, moths and butterflies, are responsible for the cross pollination of innumerable plant species. Many of these pollinators are highly specialized so that the loss of any one may trigger the loss of the plant it pollinates. We have not attempted to catalog the entire invertebrate fauna in the NGP. However, we have identified 92 species of dragonflies and damselflies, 220 species of butterflies, and 82 species of grasshoppers that occur in the ecoregion (Appendices G1-G3). To give a sense of the importance of invertebrates, a square yard (1 m^2) of tallgrass prairie soil to a depth of 20 inches (50 cm) may have historically contained as many as 110,000 arthropods and 5.4 million nematodes.[78] We expect a comparable importance in mixed-grass prairies.

The Dakota skipper (*Hesperia dacotae*), a butterfly, is a federal candidate

[74] Fisher, T.D., D.C. Backlund, K.F. Higgins and D.E. Naugle. 1999. Field guide to South Dakota amphibians. SDAES Bull. No. 733, SD State Univ., Brookings. 52 pp.

[75] James, J.D., A.P. Russell, and G.L. Powell. 1997. Status of the Eastern Short-horned lizard (Phrynosoma douglassi brevirostre) in Alberta. Alberta Environmental Protection, Wildlife Management Division, Wildlife Status Rept. No. 5, Edmonton, AB. 20pp. http://www3.gov.ab.ca/srd/fw/status/reports/pdf/eshl.pdf.

[76] Samson et al. 1998, note 28 *supra*, at p. 449.

[77] Costello, D.F. 1969. The Prairie World. Minneapolis: University of Minnesota Press.

[78] Licht, D.S. 1997. Ecology and Economics of the Great Plains. Univ. of Nebraska Press, Lincoln. 225 pp.

species that occurs on the eastern margin of the ecoregion.[79] The American burying beetle (*Nicrophorus americanus*) is a federally endangered species that probably occurred historically where there were large amounts of carrion. This species lays its eggs in the carcasses of small mammals or other carrion, and then buries the host, where its hatchlings feed until emerging.[80] Several sites in the Sandhills region have been identified as important for protecting this species.[81] The yucca moth (*Tegeticula yuccasella*), an obligate of the soapweed (or yucca) plant is the only endangered invertebrate on the Canadian side of the NGP.[82] No aquatic invertebrates (e.g., mussels) have been identified as at risk in the ecoregion.

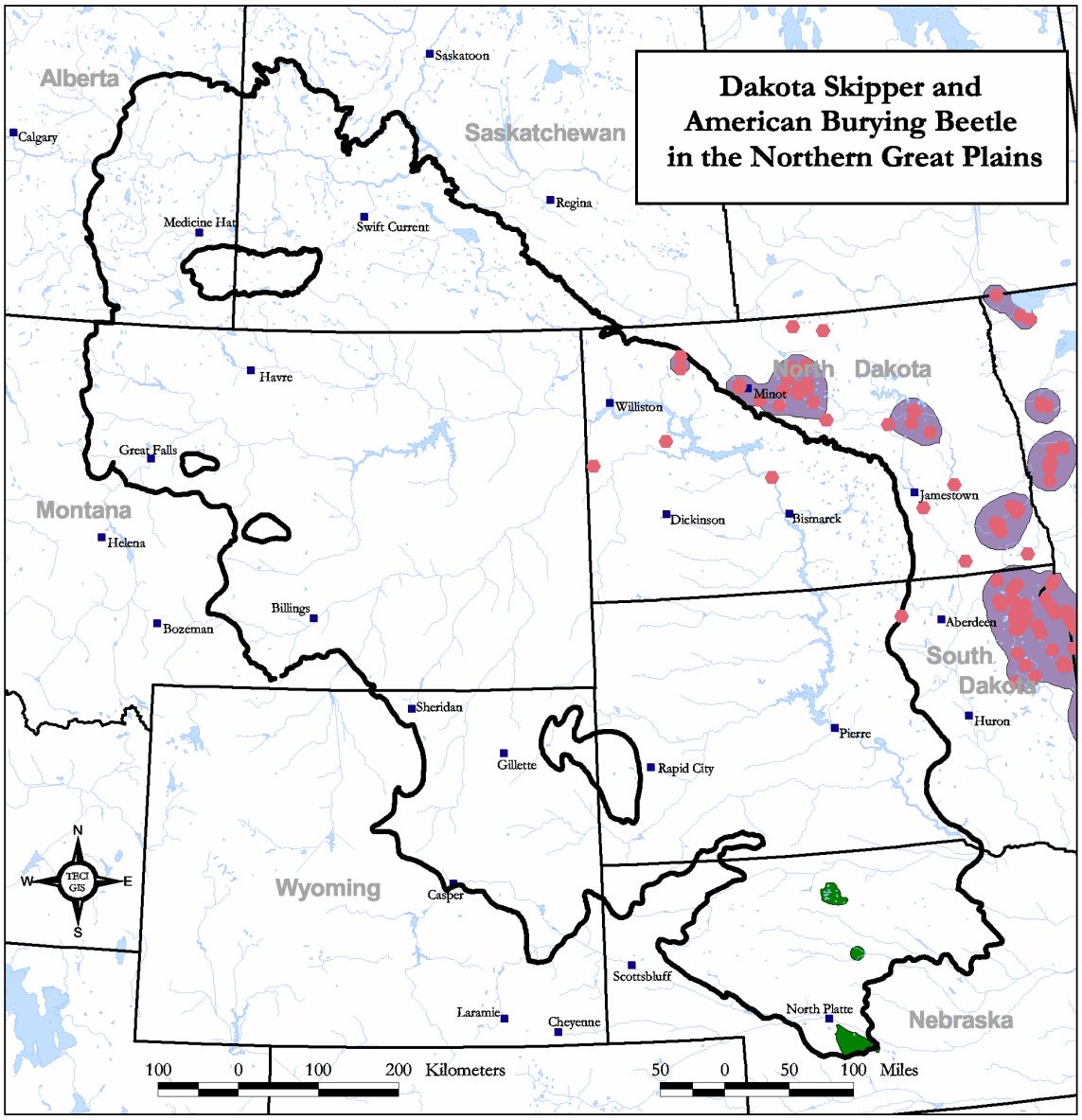
[79] Cochrane, J.F. and P. Delphey. 2002. Status assessment and conservation guidelines: Dakota Skipper. U.S. Fish and Wildlife Service, Twin Cities Field Office, Minneapolis, MN.

[80] Ratcliffe, B.C. and S. Spomer. 2002. Nebraska's Endangered Species Part 1: Introduction and the Insects. Museum Notes No. 113, Univ. Nebraska State Museum, Lincoln.

[81] Nebraska Game and Parks Commission. Undated. http://www.ngpc.state.ne.us/wildlife/beetle.html

[82] The yucca moth's status in Canada is largely due to range restriction in Canada, not global imperilment.

Figure 18. Distribution of the Dakota Skipper and American Burying Beetle in the Northern Great Plains



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TECI GIS defined isopleths by applying fixed kernal home range analysis (see P. N. Hooge and B. Eichenlaub. 1997. Animal movement extension to arcview. ver. 1.1. Alaska Science Center - Biological Science Office, U.S. Geological Survey, Anchorage, AK).

LEGEND

- Northern Great Plains Ecoregion boundary
- Dakota skipper occurrence locations
- 95% isopleth for distribution of Dakota skipper occurrence locations
- The Nature Conservancy's American burying beetle portfolio sites

WWF

Native plant communities

A preliminary assessment has identified 633 plant assemblages in the Great Plains as a whole, of which 17% are considered rare.[83] Communities that are rare within the Great Plains — and occur in the NGP Ecoregion — include buffalo grass-dominated communities, which comprise 5 of 8 short-grass communities, and little bluestem (*Schizachyrium scoparium*)-dominated communities, which distinguish 6 of 13 rare mixed-grass communities.[84] Certain non-grass-dominated communities are important in this region as well, including cottonwood (*Populus* spp.) floodplain forests, woody draws and sparse forests, and some sagebrush *(Artemisia tridentata)*, hawthorne (*Crataegus* spp.), and willow (*Salix* spp) shrub communities.

The most affected plant communities in the mixed-grass prairie appear to be the wheatgrass-bluestem-needlegrass vegetation type, with estimates of loss ranging from 69-83%, and the bluestem-grama prairie, with 65-92% estimated loss.[85] Fescue prairie from the northern edge of the NGP has also been severely reduced.[86]

A common characteristic of grassland communities is their resilience to disturbances like fire, grazing, and drought. Temporary, intense grazing by bison followed by abandonment induces changes in grass species composition and diversity. Fire stimulates growth and prevents invasion by woody species.

Most species are adapted to wait out the cycles of periodic drought, disappearing into deep root systems until moister periods. In fact, it could be argued that the life of the prairie is primarily underground. One square yard (one sq. m) of soil may contain 20 linear miles (32 km) of roots and root hairs.[87] Including invertebrates, 50-70% of all plains animals spend some part of their life cycle below ground—an enormous proportion of total prairie biodiversity.[88]

Native prairie

Approximately two-thirds of North America's mixed- and short-grass prairies have been tilled[89] (estimates for the mixed-grass prairies range from 30-83%[90]). This has led some to conclude that the Great Plains is one of the most altered ecosystems in North America. [91] However, we estimate that about 57% of the NGP grasslands are "untilled" (101 million acres/40.1 million ha)—a significantly higher percentage than the Great Plains in general.[92] The extent to which untilled areas remain in "native"

[83] Samson et al. 1998, note 28 *supra*.
[84] Id.
[85] Seig, C.H., C.H. Flather and S. McCanny. 1999. Recent biodiversity patterns in the Great Plains: Implications for restoration and management. Great Plains Research 9:277-313.
[86] Id.
[87] Licht, 1997, note 78 *supra.*
[88] Id.
[89] White, R.P.S. Murray and M. Rohweder. 2000. Pilot Analysis of Global Ecosystems: Grassland Ecosystems. World Resources Institute, Washington, DC. www.wri.org/wr2000.)
[90] Bragg, T.B., and A.A. Steuter. 1996. Prairie ecology – the mixed prairie. Pp. 53-63 in Prairie Conservation, F.B. Samson and F.L. Knoph, eds., Island Press, Washington, DC.
[91] Connor, R., A. Seidl, L. VanTassell, and N. Wilkins. 2001. United States Grasslands and related resources: an economic and biological trends assessment. Texas A &M Univ., College Station, TX. At: www.landinfo.tamu.edu/presentations/
[92] Based on GIS analysis of 1992 USGS land cover data. The estimate is for the amount of grassland only, and does not include untilled shrublands, which often contain significant grass components.

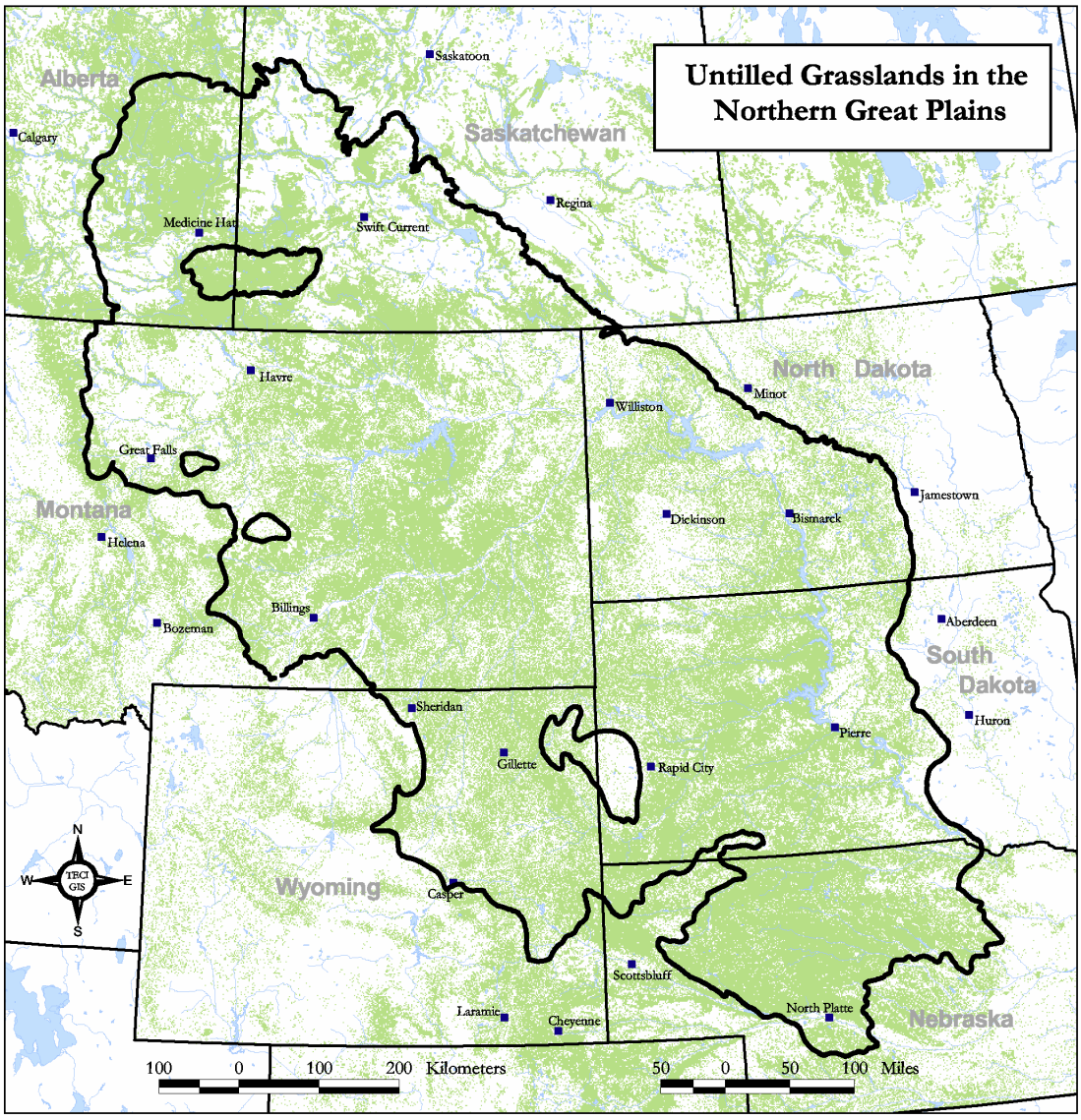
prairie varies considerably; many areas were revegetated as long as 50 years ago with crested wheatgrass (*Agripyron cristatum*), an introduced species from the Eurasian steppe. More accurate inventories of intact native prairie are needed.[93] In many areas untilled grassland remains our best surrogate for determining the amount of intact prairie remaining until further studies give us greater detail.

Intact grasslands provide significant ecological services beyond providing habitat for native species. For example, intact prairie may be one of the leading global repositories of sequestered carbon. According to scientists, "…the soils in temperate grasslands contain more carbon per unit area than those of most other ecosystems, worldwide. For example, soil under grassland in Western Canada may contain, to one meter depth, up to 200 tonnes [220 U.S. short tons] of carbon per hectare in the black soil zone under fescue prairie."[94] As native prairie is tilled, the carbon stored is released to the atmosphere, contributing to rising global CO_2 levels. Rising interest in "carbon banking," sequestering carbon in soils over long periods, thus may prove to be an incentive to keeping native grasslands untilled.

[93] This information is currently available only for Alberta.

[94] Lethbridge Research Center, Agriculture and Agri-Food Canada. 2003. *Western rangeland plays hidden role as massive carbon storehouse.* Feb. 13, 2003. http://www.agri-ville.com/cgi-bin/newsroom/view.cgi?articleID=1752.

Figure 19. Untilled Grasslands in the Northern Great Plains



SOURCES

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LEGEND

Northern Great Plains Ecoregion boundary

Untilled grasslands

WWF

Functioning Streams, Rivers and Wetlands

The NGP ecoregion is to some extent defined by the watershed of the upper Missouri River.[95] Within the ecoregion is one of the longest undammed rivers in North America, the Yellowstone, a tributary of the Missouri. The Powder River has the most intact and extensive native fish biota in the entire Great Plains.[96] Yet the Powder, along with the Missouri, is listed as "endangered" by American Rivers, with the Missouri identified as "most endangered" in 2002.[97] A formal biological opinion by the U.S. Fish and Wildlife Service in 2000 found that the U.S. Army Corp of Engineer's operation of the mainstem Missouri reservoir system endangered the least tern, pallid sturgeon, and piping plover.[98] The Service's mitigation recommended increasing spring flows and restoring riverine habitat.[99] The segments of the Missouri River under formal protection in the NGP are a 149-mile (240 km) stretch of the National Wild and Scenic Upper Missouri River between Ft. Benton and the Charles M. Russell National Wildlife Refuge in Montana[100] and the Missouri National Recreational River below Ft. Randall Dam, SD to Niobrara, NB.[101] The Niobrara National Scenic River is designated east of Valentine, NB for 76 miles.[102] The Nationwide Rivers Inventory (NRI) provides classifies several stream reaches in the NGP as having "outstandingly remarkable values".[103] Federal agencies are required to avoid or mitigate adverse impacts to nri segments.

The NGP encompasses portions of two of the five major prairie wetland complexes, the Missouri Coteau, a part of what is more generally referred to as the "Prairie Potholes" (generally east and north of the NGP) and the Nebraska Sandhills Wetlands.[104] Wetlands in the mixed-grass prairie of Saskatchewan, Alberta, and Manitoba have been

[95] See, e.g., R.A. Abell et al. 2000. Freshwater ecoregions of North America: a conservation assessment. Island Press, Washington, DC.

[96] Hubert, W.S. 1993. The Powder River: A relatively pristine stream on the Great Plains. Pp. 387-395 in Proc. of the symposium on restoration planning for the rivers of the Mississippi River ecosystem. (Hesse, L.W., C.B. Stalnaker, and N.G. Benson, tech eds). Biological Report 19, U.S. Dept. of the Interior, National Biological Survey, Washington, D.C.

[97] American Rivers. 2002. http://www.amrivers.org/mostendangered2002/default.htm

[98] U.S. Fish and Wildlife Service. 2000. Biological Opinion on the Operation of the Missouri River Main Stem Reservoir System, Operation and maintenance of the Missouri River Bank Stabilization and Navigation Project, and Operation of the Kansas River Reservoir System. Nov. 2000. At: http://www.nwd-mr.usace.army.mil/mmanual/opinion.html.

[99] Id. Failure of the Corp to initiate mitigation prompted several environmental groups to sue in 2003. See, http://www.billingsgazette.com/index.php?display=rednews/2003/02/14/build/local/army-corps-sued.inc

[100] See, U.S. National Park Service. National Wild and Scenic River System. http://www.nps.gov/rivers/wsr-missouri-montana.html

[101] Id.

[102] Id. at http://www.nps.gov/niob/

[103] See, U.S. National Park Service. Nationwide Rivers Inventory. http://www.nps.gov/ncrc/programs/rtca/nri/. A river segment may be listed on the nri if it is free-flowing and has one or more "outstandingly remarkable values" including: exceptional scenery, fishing or boating, unusual geological formations, rare plant and animal life, and cultural or historical artifacts that are judged to be of more than local or regional significance.

[104] Batt, B.D. 1996. Prairie ecology/prairie wetlands. Pp. 77-90 *in* F.B. Samson and F.L. Knopf, eds. Prairie conservation: preserving North America's most endangered ecosystem. Island Press, Covelo, California.

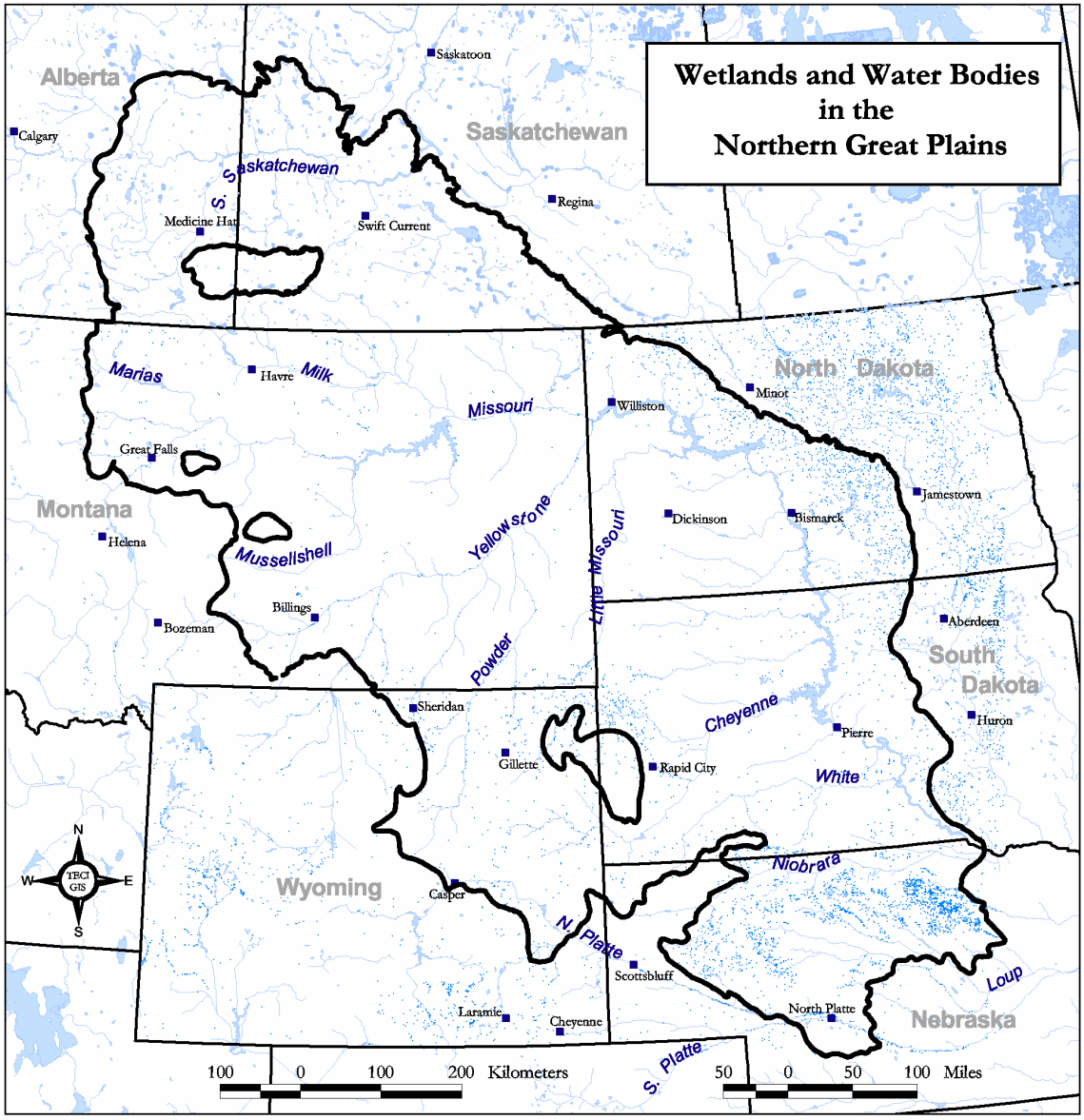
reduced by 10-40% from presettlement times.[105] Wetland loss (from the 1790s to present) for the U.S. in the NGP ranges from 27% for Montana to 49% for North Dakota.[106] While there are numerous wetland conservation opportunities offered through federal programs in both the U.S. and Canada, wetlands are still at risk. In eastern South Dakota, for example, 78% of wetlands are at risk, despite 40 years of conservation efforts by the U.S. Fish and Wildlife Service to enroll properties in wetland protection programs.[107]

[105] International Institute for Sustainable Development. Undated. Citing Ducks Unlimited. 1990. Continental Conservation Plan. http://www.iisd.org/wetlands/sci_abstrct1.htm

[106] Seig et al. 1999, note 85 *supra*.

[107] Higgins, K.F., D.E. Naugle, and K.J. Forman. 2002. A case study of changing land use practices in the Northern Great Plains, U.S.A.: An uncertain future for waterbird conservation. Waterbirds 25, Spec. Publ. #2:42-50.

Figure 20. Wetlands in the Northern Great Plains



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Ashton, J. 2001. Prairie Farm Rehabilitation Administration generalized landcover. Regina, Saskatchewan.

U.S. Geological Survey. 1992. National Land Cover Data.

U.S. Geological Survey. 2002. Waterbodies of the United States.

LEGEND

Northern Great Plains Ecoregion boundary

Wetlands and water bodies

WWF

Chapter 3: Threats to NGP Ecological Integrity

The effects of current human activities on biodiversity in the NGP occur at various scales ranging from relatively site-specific, such as plowing arable prairie grasslands, to ecoregion-wide and across multiple habitats, such as improper livestock grazing and climate change. The cumulative effects of site-specific activities, such as sodbusting or the poisoning of prairie dog towns, can have, over time, massive and ecoregion-wide impacts on biodiversity

Sodbusting: Tillage of previously intact grassland for production of grain crops (wheat, oats, barley) and alfalfa continues to be the most serious threat to native prairie. While, grassland area in the U.S. west of the Mississippi declined on average 2.6 million acres (1.05 million ha)/year from 1850-1950,[108] mixed and shortgrass prairie conversion did not begin until the 1880s.[109] Today, conversion of grassland continues for a number of reasons. For example, from 1982 to 1997 there was an estimated 5-10% decline in acreage of native prairie on privately owned land in north-central Montana (Blaine, Phillips and Valley counties).[110] Crop subsidies make it possible to earn a profit farming land that would otherwise stay unplowed. Furthermore, the Conservation Reserve Program in the U.S. has inadvertently encouraged sodbusting since landowners often plow additional native prairie to replace their cropland lost to the CRP, or native prairie is plowed in anticipation of later retiring it to receive CRP payments. The nearly 18 million acres (7.2 million hectares) of CRP grasslands in the Northern Great Plains are about the same amount of prairie that has been converted to cropland since the 1960s.[111] Other U.S. government programs provide more direct incentives to convert grassland to cropland. For example, crops are eligible for Loan Deficiency Payments under U.S. Deptartment of Agriculture policies, which can offset production losses from cultivation.[112] Hill County, Montana, is typical of many areas with cropland production containing rangeland that can be converted to marginal cropland. Range and pastureland declined there by 13% from 1982-1987.[113] Between 1971 and 1996, the area in cropland in the Canadian prairies increased by 28 percent and the area in "improved" pasture by 48 percent,[114] both at the expense of native prairie. The high cost of native reseeding and difficulty of ecological restoration of cultivated ground makes the prevention of further sodbusting a high priority.

Oil, gas and coal development: Substantial coal, oil, and gas reserves exist in many parts of the ecoregion. Alberta and Saskatchewan are Canada's two largest oil producers; currently, there are 104,000 active gas and oil wells in the Canadian prairies.[115]

[108] Connor et al. 2001, note 91 *supra*.
[109] Id.
[110] Id.
[111] Higgins et al. 2002, note 107 *supra*.
[112] Connor et al., note 91 *supra*, at pg. 107.
[113] Id. at 121.
[114] Statistics Canada. 1996. 1996 Census of Agriculture. Catalogue Number 93f0031xcb, Statistics Canada, Ottawa, Ontario, Canada.
[115] Gauthier, D.A., A. Lafon, T.P. Toombs, J. Hoth and E. Wiken. 2003. Grasslands: Toward a North American Conservation Strategy. Canadian Plains Research Center, University f Regina, Regina, SK,

Currently, Wyoming and Montana are experiencing a coalbed methane (CBM) boom; it is forecast that an additional 40,000 coalbed methane wells will be drilled over the next decade in the Powder River Basin, along with the accompanying spiderweb of roads and power lines.[116] Within the ecoregion, CBM development poses threats to biodiversity, ecosystem function, and vegetation and land cover types.[117] Biodiversity in the form of local species richness, patterns and evenness of species occurrence, and dominant species type may be affected as a result of road and well construction and use. The introduction of human activities into previously unoccupied areas will also likely bring with it an increased potential for predation as CBM facilities provide nesting, denning, and perching sites for predators.[118] Such predation could affect imperiled species like the mountain plover and black-tailed prairie dog. CBM development will likely result in alterations of disturbance regimes. Flooding may be affected by development as increased base flows in streams from surface discharge would result in decreased channel capacity to accommodate flood flows. Finally, vegetation and land cover may be affected in a variety of ways. Increased road density will elevate the potential spread of noxious weeds and displacement of native vegetation. Local vegetation type may also be altered by changes in surface water flows as waste water is discharged, also changes in stream flow from intermittent to perennial may substantially affect local vegetation cover.

Invasive nonnative species: Invasion by nonnative species is a threat to biodiversity all over the region. Old World grasses have evolved to tolerate heavy grazing and other disturbances. In North America, free from the Old World herbivores that may have kept their growth in check, introduced grasses rapidly displace native species and degrade high quality prairie habitat. Sixteen of the 56 grasses in Badlands National Park are non-indigenous.[119]

Leafy spurge (*Euphorbia esula)*, spotted knapweed (*Centaurea maculosa*), crested wheatgrass and yellow sweet clover (*Meliolotus officinalis*), among other nonnative species, are already well established in this region.[120] In 1994, leafy spurge was estimated to infest about 1.6 million acres (657,000 ha) in Wyoming, Montana, North and South Dakotas, resulting in an economic loss of $130 million annually.[121] Not only do invasive species represent a tremendous economic burden to

and Commission for Environmental Cooperation, Montreal, Quebec.

[116] Powder River Basin Resource Council. http://www.powderriverbasin.org/

[117] WY Bureau of Land Management. 2003. Final Environmental Impact Statement and Proposed Plan Ammendment for the Powder River Basin Oil and Gas Project. www.wy.blm.gov/nepa/prb-feis/ also available at www.prb-eis.org.

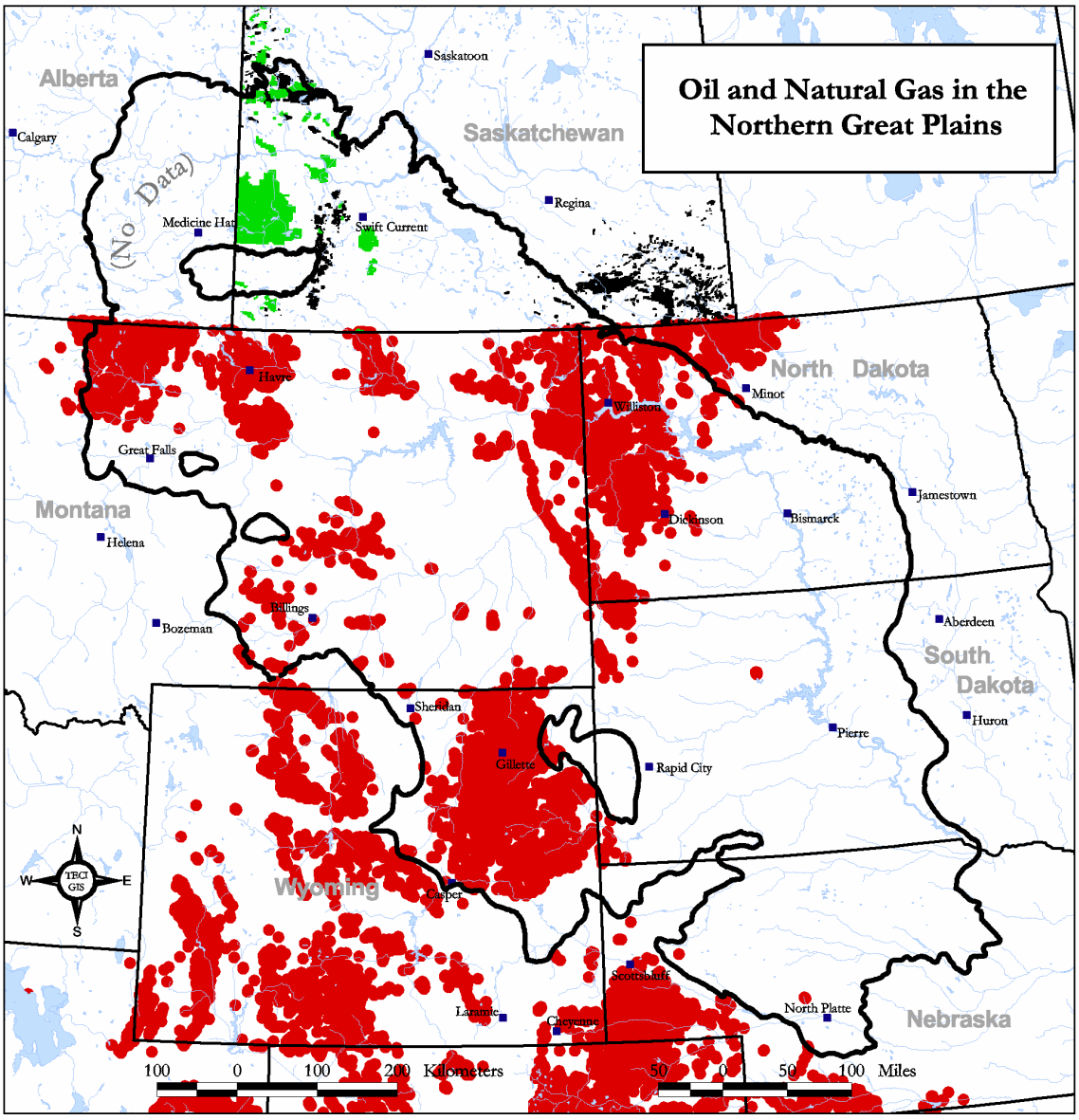
[118] WY Bureau of Land Management. 2003. note 117 *supra.*

[119] White, R.P., S. Murray and M. Rohweder. 2000. Pilot Analysis of Global Ecosystems: Grassland Ecosystems. World Resources Institute, Washington, D.C. www.wri.org/wr2000

[120] Cooper, S.V., C. Jean and P. Hendricks. 2001. Biological survey of a prairie landscape in Montana's Glaciated Plains. Rept. to the Bureau of Land Management. Montana Natural Heritage Program, Helena. 24 pp.

[121] Bangsund, D.A., F.L. Leistritz and J.A. Leitch. 1999. Assessing economic impacts of biological control of weeds: the case of leafy spurge in the northern Great Plains of the United States. J. Env. Mgmt. 56:35-43.

Figure 21. Oil Wells and Gas Fields in the Northern Great Plains



SOURCES

U.S. Geological Survey. 1995. National Oil and Gas Assessment. Reston, Virginia.

Saskatchewan Industry and Resources. 2001. Geological Atlas of Saskatchewan.

LEGEND

- Northern Great Plains Ecoregion boundary
- Productive oil or natural gas wells (U.S.)
- Oil pools (Saskatchewan)
- Natural gas pools (Saskatchewan)

WWF

farmers and ranchers from reduced forage for livestock, but they also displace native vegetation and reduce preferred habitat for native fauna.[122] If a biological control program to control leafy spurge were undertaken in the NGP, annual revenues for wildlife-associated recreation alone might increase by an estimated $1.8 million as a result[123] because of increases in wildlife populations that are limited by the forage replaced by weeds.

Tree plantings in shelterbelts have allowed invasion by numerous forest birds, like red-tailed hawks (*Buteo jamaicensis*), and contributes to prairie fragmentation.[124] Russian olive (*Elaeagnus angustifolia*), intentionally planted as an ornamental and as a windbreak, is an aggressive tree that outcompetes native cottonwoods in riparian areas. These intentionally introduced species also contribute to degraded prairie habitats.

Disease: Introduced and irruptive diseases pose significant problems for native wildlife. Chronic Wasting Disease (CWD) is a transmissible spongiform encephalopathy, currently known to affect free-ranging deer and/or elk in Wyoming, Nebraska, South Dakota and Saskatchewan, as well as many states and provinces outside the ecoregion. The disease has appeared in farmed elk herds in South Dakota, Nebraska, Montana, Alberta and Saskatchewan. There is no evidence that the disease is linked to any disease in humans or domestic animals, but the impact to wild populations of deer and elk could be severe if CWD spreads.[125] Due to recent understanding of its virulence, some experts predict that massive culling of herds may be necessary to limit its spread.[126]

Canine distemper particularly affects carnivore species. The most notable victim is the black-footed ferret, which appears to have little or no natural immunity to the disease.[127] Outbreaks of distemper in ferret populations are potentially catastrophic extinction events at reintroduction sites.

Sylvatic plague (*Yersinia pestis*) is a bacterial disease introduced from Europe or Asia around 1900. It has been spreading throughout the western U.S. since that time. From a wildlife standpoint, its biggest impact has been on small mammals, in particular prairie dogs, which seem unable to develop any natural immunity to the disease.[128] Plague is believed to be one of the most significant factors affecting the decline of black-tailed prairie dogs.[129] To date plague has been most active in the

[122] Id.
[123] Id.
[124] Licht, D 1997, note 78 *supra.*

[125] U.S. Animal and Plant Health Inspection Service (APHIS), http://www.aphis.usda.gov/oa/pubs/qacwd.html
[126] Miller, M.W. and E.S. Williams. 2003. Horizontal transmission of prion in mule deer. *Nature* 425: 35-36; Pilcher, H.R. 2003. Chronic wasting disease spreads with ease. Nature Science Update, 04 September, 2003. http://www.nature.com/nsu/030901/030901-5.html
[127] Miller, B.J., R. Reading and S. Forrest 1996. Prairie Night: Black-footed Ferrets and the Recovery of Endangered Species. Smithsonian Institution Press, Washington, D.C.
[128] Cully, B. In press. Plague. *In*, Conservation and Management of the Black-tailed Prairie Dog, J. Hoogland, ed. Island Press.
[129] U.S. Fish and Wildlife Service 2000. 12-Month Finding for a Petition to List the Black-tailed Prairie Dog as Threatened. 65 Fed. Reg. 5476, February 4, 2000.

western portion of the NGP, with some areas of South Dakota and Nebraska spared to date.[130]

West Nile virus is the latest newcomer to the prairies with a potential impact on biodiversity, the first cases in birds in the NGP being recorded in 2002.[131] Birds seem particularly sensitive to this mosquito-borne virus, the virus having been detected in over 60 North American species, including common NGP species as diverse as the killdeer, magpie, American goldfinch, gray catbird, mourning dove and northern harrier.[132] More recently, West Nile has killed greater sage grouse in the NGP in Wyoming and Montana.[133] The impact and/or disruption to populations of endemic and sensitive species is potentially significant given the rapid spread and virulence of the disease.

Artificial habitats: Barns, windbreaks and other human-made structures and habitats on the prairie provide habitat for both non-native species and create unusual conditions for native species. For example, cowbirds, a nest predator of prairie birds, are presumably much more widespread across the Great Plains because cows are more evenly distributed across the landscape than were bison, with the result in some areas that cowbird nest predation is a serious problem for nesting prairie birds.[134] Species that have an affinity for human habitation and structures, such as cats, raccoons, rats, and barn owls, may be exerting substantially heavier predation levels on prairie species in surrounding areas than occurred before European settlement.[135]

Grazing practices: Almost all of the public and private rangeland in the NGP is subject to domestic livestock grazing. This includes many of the ecoregion's most significant protected areas; for example, a major portion of the Charles M. Russell National Wildlife Refuge in Montana, the ecoregion's largest protected area, is subject to livestock grazing. Range management practices tend to favor the creation of a homogeneous grassland landscape, with no area "overgrazed" or "undergrazed." Different grassland bird species, however, require grasslands subject to different grazing intensities, from intensely grazed (e.g., mountain plover) to lightly grazed (e.g., Baird's sparrow). Thus, uniform grazing intensities and the resulting uniform vegetative structure across the landscape reduces biodiversity.

Riparian zones are also highly sensitive to grazing by domestic cattle. Cattle often congregate in riparian areas, which ecologically degrade quickly with

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[130] Id.

[131] U.S. Geological Survey. 2002. West Nile Virus Maps, 2002. http://cindi.usgs.gov/hazard/event/west_nile/

[132] U.S. Geological Survey. 2001. Wild Birds Implicated in Rapid Spread of West Nile Virus. Wildlife Health Alert #01-02. http://www.nwhc.usgs.gov/whats_new/wha/wha0102.html; Updated species list at: http://www.nwhc.usgs.gov/research/west_nile/wnvaffected.html

[133] Billings Gazette. 2003. West Nile found in sage grouse. Billings Gazette, Aug. 30, 2003.

[134] Davis, S. K., and S.G. Sealy. 2000. Cowbird parasitism and nest predation in fragmented grasslands of southwestern Manitoba. Pages 220-228 *in* Ecology and Management of Cowbirds and their Hosts (J. N. M. Smith, T. L. Cook, S. I. Rothstein, S. K. Robinson, and S. G. Sealy, Eds.). University of Texas Press, Austin.

[135] Licht 1997, note 78 *supra*.

repeated grazing.[136] It is estimated that, even if livestock were removed today, only "about 65% of BLM riparian areas would be properly functioning" due to degradation from livestock grazing.[137]

Livestock production also competes with wildlife production. While sometimes compatible, often wildlife numbers are capped for the benefit of higher rates of livestock production, resulting in fewer numbers of native grazers from prairie dogs to elk.[138] Furthermore, the pervasive extent of livestock production coupled with current grazing practices precludes the restoration of large carnivores in most places in the NGP.

Alteration of aquatic regimes:
Dams: Dams and reservoirs have been constructed on all the major river systems in the Canadian Prairie.[139] In the U.S., dams in the Missouri River basin have led to a recent U.S. National Academy of Sciences report warning that natural stream flows need to be restored to the Missouri River to avoid further ecological degradation and species endangerment in the river system.[140] Diversion of streams for irrigation has led to widespread dewatering and has caused problems for many native fish.

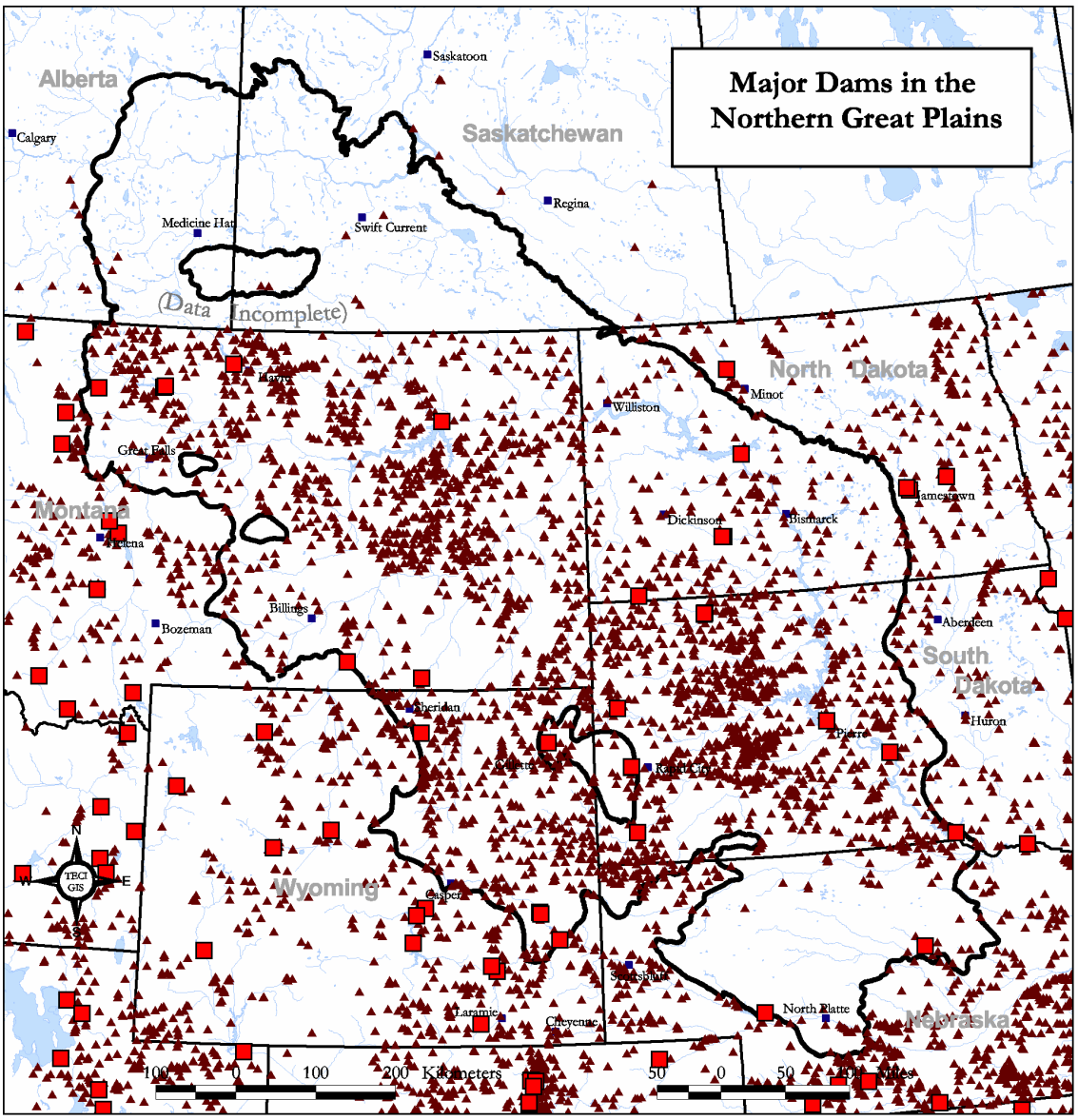
Smaller impoundments ("stock dams") cumulatively may be having major impacts on the hydrologic regime of thousands of miles of small, often seasonally flowing, prairie streams. Though good estimates are lacking, hundreds of thousands of these structures probably occur on tributaries of NGP streams.[141]

Wetlands: Prairie wetland complexes are threatened by residential development, drainage for agriculture, herbicide and pesticide contamination, dropping groundwater levels, and climate change.

Groundwater depletion: About 30 percent of the ground water used for irrigation in the United States is pumped from the High Plains aquifer of the Midwest, which underlies most of the

[136] Manning, note 4 *supra*.
[137] U.S. Dept. of Interior, Bureau of Land Management. 1994. Rangeland Reform '94: Executive Summary. Washington, D.C.
[138] See, e.g., legislation introduced in the Montana House to cap populations of deer, elk, and antelope by landowners. "Measures offer options for landowners hit by losses from wild game," Bozeman Daily Chronicle, Feb. 23, 2003, p. A6; McKean, A. 2003. "Hunters can harvest any elk in many Region 6 districts in general season." Phillips County News, August 27, 2003. Citing regulations issued by Montana Fish, Wildlife and Parks "In an effort to suppress elk populations" and "prevent herds from becoming problems to landowners."
[139] Gauthier, D.A. 2001. The socio-economic context for wildlife conservation on the prairies of Canada. In Sharing Common Ground, proceedings of the 6th Prairie conservation & Endangered Species Conference, Winnipeg, Manitoba, February 22-25, 2001.
[140] National Research Council. 2002. *The Missouri River Ecosystem: Exploring the Prospects for Recovery*. National Academy Press, National Academy of Science, Washington, D.C. http://www.nwd-mr.usace.army.mil/mmanual/mast-man.htmhttp://www.mrd.usace.army.mil/mmanual/MRMM_NAS_Study_EXSUMSections1%262.pdf.
[141] See, e.g., Johnson, R.R., K.F. Higgins, M.L. Kjellsen, and C.R. Elliott. 1997. Eastern South Dakota wetlands. Brookings: South Dakota State University. Jamestown, ND: Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/1998/eastwet/eastwet.htm (Version 02JUL98).

Figure 22. Dams in the Northern Great Plains



SOURCES

Natural Resources Canada. 2002. Geogratis 1:2 million atlas data.

U.S. Army Corps of Engineers. 2002. National Inventory of Dams.

LEGEND

- Northern Great Plains Ecoregion boundary
- Dam storage capacity greater than 100,000 acre-feet
- Dam storage capacity of greater than 100 acre-feet

WWF

Sandhills. Water level declines in some parts of this aquifer have been as much as 100 feet (30 m).[142]

Coalbed methane: The threat of saline discharge from coalbed methane development looms as a potentially devastating threat to stream and riparian habitats. Development in the Powder River Basin could result in the disposal of 1.4 trillion gallons of water over the life of CMB development in the Basin.[143]

Climate change: Extreme weather events caused by climate change make large-scale conservation even more important. It is critical that species have the ability to move and to migrate in response to changing climate conditions. National wildlife refuges in South Dakota are among the most vulnerable to climate change in the U.S., particularly in the prairie pothole region.[144] This is because, particularly with smaller wetlands, warmer temperatures result in less open water, independent of precipitation.[145]

Several climate change models suggest that not only will temperature continue to increase in the NGP over the next 50 years, but that the temperature rise expected will be greater than that predicted globally due to the NGP's location in the interior of the continent, where it is not mitigated by marine weather patterns.[146] Overall, soil aridity is predicted to change sufficiently over the coming decades in southern Canada and northcentral Montana to significantly impair non-irrigated agricultural production. This has the potential to not only profoundly affect land use, but likely the distribution and abundance of prairie wildlife as well.

Fragmentation:

High road densities and railroads: Roads provide avenues for introduction of invasive species, increase the likelihood of human/wildlife conflicts, and fragment some habitats.[147] The lower abundance of Sprague's pipits along roads may be attributed to the 20-30% reduction of suitable habitat associated with road rights-of-way within a l00 m radius.[148] Roads, however unobtrusive, may be barriers to small mammals[149] and soil-dwelling organisms. Road density often reflects how intensively an area is used, and is therefore also an indicator of potential conflicts with biodiversity conservation.

More significant is that tillage and other development activities (oil and gas production, residential subdivision) continue to parse the remaining intact

[142] U.S. Geological Survey. No date. http://water.usgs.gov/wid/html/GW.html#HDR0

[143] Powder River Basin Resource Council. http://www.powderriverbasin.org/

[144] U.S. Environmental Protection Agency. 1998. Climate change and South Dakota. Climate and Policy Assessment Division, U.S. EPA, Washington, D.C. EPA 236-F-98-007x

[145] Id.

[146] David Sauchyn, Canadian Climate Impacts and Adaptation Research Network, Univ. Regina, Regina, SK. See also, http://atlas.gc.ca/site/english/maps/climatechange/scenarios/globalwintertemp2050.

[147] Forman, R. T. T., and L. Alexander. 1998. Roads and their major ecological effects. Annual Review of Ecology and Systematics 29:207-231; Gelbard, J.L. and J. Belnap. 2003. Roads as conduits for exotic plant invasion in a semiarid landscape. Conservation Biology 17:420-432.

[148] Sutter, G.C., S.K. Davis, and D.C. Duncan. 2000. Grassland songbird abundance along roads and trails in southern Saskatchewan. Journal of Field Ornithology 71: 110-116.

[149] Licht 1997, note 78 *supra*.

landscape into smaller, less functional areas that are frequently separated by greater distances. Not only is less habitat available, but chances for animals and plants to move across the landscape are diminished.

Industrial agricultural activities: Inappropriate uses of fertilizers, pesticides, and herbicides, as well as development of confined animal feeding operations, have resulted in widespread contamination of surface and groundwater throughout the Great Plains.[150] However, the region fares better than most in terms of nitrate groundwater pollution risk.[151]

***Direct and incidental take of wildlife*:** Unregulated killing of prairie dogs, including both poisoning and shooting, continues in most states in the ecoregion despite the prairie dog's precarious conservation status. [152] Ground squirrel (*Spermophilus* spp.) populations are also suppressed through unregulated poisoning and shooting. Both are ecologically important as prey for other species and by churning soil and creating underground habitat through their burrowing activities.

Predator control activities affect the structure and composition of smaller predator and prey populations. [153] Because wolves kill coyotes and reduce coyote numbers, the eradication of wolves on the prairie has artificially created better habitat for coyotes. Without wolves, greater numbers of coyotes may result in greater predation on, and lower numbers of, coyote prey and competitors. Recovery of the imperiled swift fox, for example, may be significantly impeded in some regions because so many are killed by coyotes.

Legal and policy constraints: Some government policies restrict conservation efforts. In North Dakota, for example, state law prohibits non-profit land trusts that were not incorporated in the state prior to 1983 from owning land.[154] Those few nonprofits that qualify are restricted from owning more than 12,000 acres.[155] Saskatchewan's Farm Security Act (Ch. S-17.1, Statutes of Saskatchewan) also limits non-agricultural ownership of agricultural land.

[150] Mueller, D. K., Dennis. R.H. 1996 Nutrients in the Nation's Waters. Too Much of a Good Thing? U.S.Geological Survey Circular 1136.

[151] Nolan, B.T. and B.C. Ruddy. 2002. Probability of nitrate contamination of recently recharged groundwaters in the conterminous United States**.** U.S. Geological Survey. http://water.usgs.gov/nawqa/FS-092-96.html

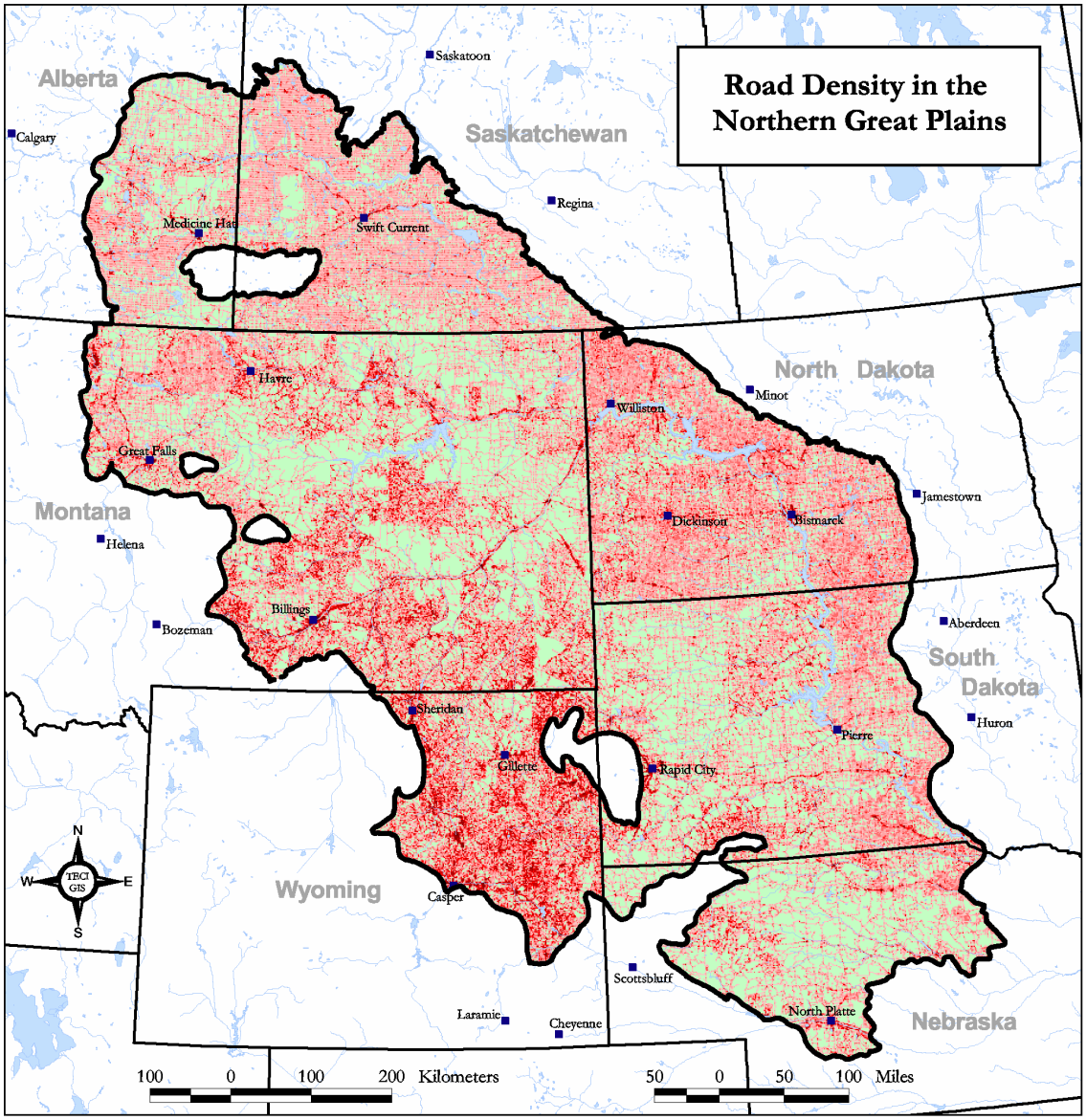
[152] U.S. Fish and Wildlife Service 2000. 12-Month Finding for a Petition to List the Black-tailed Prairie Dog as Threatened. 65 Fed. Reg. 5476, February 4, 2000.

[153] Wilcove, D.S. 1999. The Condor's Shadow: The Loss and Recovery of Wildlife in America. Freeman, New York.

[154] North Dakota Century Code 10-06.1-09. http://www.state.nd.us/lr/cencode/CCT10.pdf

[155] North Dakota Century Code 10-06.1-10.

Figure 23. Road Density in the Northern Great Plains



SOURCES

U.S. Census Bureau. 2000. TIGER Line Files.

DMTI Spatial Inc. 2002. CANSTREETS road fabric data.

TECI GIS derived road density using a circular moving window, 1.0 sq miles (2.6 sq km) in area, with a cell size of 0.093 mi (0.15 km). It was necessary to include all TIGER road classes in order to capture all rural maintained roads; walkways and foot trails were excluded. All CANSTREETS road types were included; trails were excluded.

LEGEND

Northern Great Plains Ecoregion boundary

Road density:

- 0 mi. / sq. mi.
- 0.1 - 1
- 1.1 - 2
- 2.1 - 3
- 3.1 - 4
- 4.1 - 6
- 6.1 - 10
- 10.1 - 14

WWF

Chapter 4: Ecoregional Conservation Planning

Why the Ecoregion Approach?

Planning at the ecoregion level allows us to capture large-scale processes that cannot be addressed at smaller sites. It allows us to evaluate and plan for species' health across large parts of their range. It allows us to better understand how critical components fit together and the role that different sites play in the conservation of biodiversity over the long term. Finally, it gives us an opportunity to look at multiple choices in selecting the best places for targeting our conservation efforts. If we are to strategically address the conservation needs of NGP species, then we need to assess biodiversity at multiple scales and address several key ecological issues:[156]

- All distinct natural communities within landscapes and protected areas should be represented;
- Ecological interactions and evolutionary mechanisms that generate and maintain species and biological communities should be restored and maintained;
- Viable populations of species should be maintained;
- Blocks of natural habitat large enough to be resilient to large-scale disturbances and long-term changes should be conserved;
- Invasive species need to be controlled;
- Migration routes and movement corridors between populations and subpopulations of native species should be maintained;
- Extirpated and declining native species should be restored to ecologically functional condition.

Benefits of ecoregion conservation planning

Conservation at the ecoregional level is an effective approach to developing and implementing conservation plans with lasting impacts because it:

- Recognizes the major driving ecological and evolutionary processes that create and maintain biodiversity;
- Addresses maintenance of populations of species that need large areas, a consideration that cannot be accommodated at the site scale;
- Indicates how local actions fit into regional conservation strategies;
- Identifies particularly vital landscapes within the ecoregion for targeted activity; and
- Incorporates local human needs and aspirations into an overall measure of success.

Restoration must occur at a significantly large scale in order to recreate the functionality of original prairie systems. Bison herds, for example, once roamed over hundreds of thousands of square miles of the Northern Great Plains. Fires burned over large areas. Drought occurred on a regional scale. Simply protecting small, isolated patches of prairie is therefore unlikely to conserve species that evolved in response to large-scale effects. Nor will simply saving existing pieces of remnant prairie conserve the full complement of prairie habitat types, since many of the most biodiverse and ecologically important landscapes in this ecoregion have been appropriated by humans and modified by agriculture. Restoration will not only

[156] These goals are adapted from Noss, R.F. 1992. The Wildlands Project: land conservation strategy. Pp.10-25 in Wild Earth Special Issue--The Wildlands Project.

have to be creative, but will require conservation work at scales that are seldom contemplated.

Restoration of the landscape should incorporate socioeconomic aspirations of local people as well. Since human communities are an integral part of the contemporary landscape, NPCN envisions an ecologically and economically sustainable relationship between people and the land in the Northern Great Plains. Much of this proposed conservation agenda is aimed at achieving a realistic and optimal balance between biodiversity conservation and socioeconomic development.

Building a Common Vision for the Northern Great Plains

The essence of NPCN's vision for the ecoregion is expressed in a statement adopted by NPCN members in February, 2001:

> "The overarching vision is clear: restoration of some areas of the Northern Great Plains to an ecosystem dominated by wild populations of large mammals, and transected by free-flowing rivers with healthy populations of native fish species. These areas are large enough to restore not only wildlife populations, but also traditional wildlife migration patterns and other natural processes. The restoration of other species, such as black-tailed prairie dogs, black-footed ferrets, and mountain plovers will reestablish the biological diversity that was once interwoven into the prairie landscape. Given the declining agricultural base of the region, existing land ownership patterns and a shrinking human population, wildlife restoration efforts also offer unique opportunities for helping rebuild and diversify regional communities and economies."

Features of the NPCN Vision for the Northern Great Plains

- An extensive connected network of native prairie grasslands with the full compliment of native biotic communities free of invasive species. These are linked to the Rocky Mountains and neighboring grassland ecoregions;
- Wildlands featuring large migratory and local herds of bison, pronghorn, elk, and other ungulates pursued by the entire guild of native carnivores and scavengers;
- A metapopulation of prairie dog colonies, Richardson ground squirrels (*Spermophilus richardsonii*), and other important small herbivores and their associated species throughout the region sufficient in density to restore degraded and missing ecological processes;
- Free-flowing rivers with populations of native fish and other aquatic species;
- Wetlands with abundant migratory waterfowl and other associated species;
- Natural processes and disturbance regimes, including floods, fires, droughts and animal migrations;
- Human population centers and landscapes modified by agriculture and other economic activities, core areas where natural processes predominate and humans are only visitors, and buffer areas in between where sustainable economic practices occur which maintain native flora and fauna;
- Respect for the dignity and aspirations of local peoples and communities, regardless of their origins or ethnicity.

In order to successfully accomplish these goals, NPCN also recognizes the need to adhere to the following principles:

- *Sound stewardship of public, private and Tribal lands is necessary for restoring and conserving the ecoregion's biodiversity:* The mosaic of land tenure in the NGP will necessitate that sound management practices be in place across the spectrum of land tenure types. At the same time, the scope of private-land ownership in much of the NGP means that private lands will have to be involved in restoration of large, contiguous landscapes. Private lands conservation involves various elements, but three key ones are:
    - *Stewardship*. Over most of the ecoregion, encouraging sound stewardship under existing land-use patterns will be the guiding principle for conservation planning and action. *V*oluntary participation in conservation programs should be relied on whenever possible. Conservation initiatives should bring benefits to existing landowners and the landscape, as well as to wildlife. When this occurs, residents will be pleased to participate in conservation activities. Enforced participation, especially without compensation, will seldom bring long-term success.
    - *Incentives*. In many cases, incentives, whether in the form of payments (e.g., the Farm Programs, Conservation Reserve Program, or other direct payments for conservation) or tax breaks (such as provided by conservation easements) for practices that yield conservation benefits will be needed to secure a heightened level of participation and cooperation. Federal, state and provincial governments will generally have the lead in establishing such incentives programs.
    - *Acquisition.* In some cases, purchase or donation from willing sellers or donors will be the only viable means to secure key landscapes and buffer existing protected areas from incompatible uses.
- *The land and its wildlife are important culturally and spiritually for many people, but especially for North American native people:* The ongoing conservation of land and restoration of bison, prairie dogs, black-footed ferrets and swift fox is often viewed as a step in the restoration of local human communities and cultures as well. Several Native American organizations and tribal

governments are restoring wildlife to tribal lands. Ultimately, larger-scale restoration opportunities should exist in cooperation with tribes and reservations where shared conservation goals exist.

- *Conservation can often benefit local communities by stimulating a more diverse and healthier economy:* Conservation initiatives by both the public and private sector in the NGP can stimulate economic activity. In most areas a viable farm and ranch economy combined with a wildlife-based economy will provide a more robust and resilient economic base for small towns and cities than either economic sector alone can provide. People are an integral part of the restored NGP landscape.

- *Partnerships between conservationists and local communities will be crucial for achieving biodiversity goals in the Northern Great Plains*: Many partnerships will be required to assemble large conservation areas in the NGP. The Northern Great Plains Ecoregion has a wide range of stakeholders, each with their particular interests and resources. The greatest success will come from acknowledging outcomes that will meet the needs of more than one stakeholder.

Chapter 5. Habitat Restoration at Ecologically Meaningful Scales.

Great Plains species tend toward widespread distributions, a consequence of the large-scale patterns and processes typical of this region and the small differences in ecological systems across vast areas.[157] Fire and drought, for example, operated on scales of many thousands of square miles.[158] For plains species to be conserved, ecologically intact landscapes are needed at scales that reflect adaptations to these processes.

Creating biologically functional conservation landscapes, i.e., areas that will support the full range of native species and ecological processes with minimal management interventions, requires that not only species and ecosystems be maintained, but that ecological processes be supported within their natural ranges of variability. Poiani et al.[159] recommend functionality be evaluated using four criteria; 1) composition and structure of the focal ecosystems and species; 2) dominant environmental regimes; 3) minimum dynamic area; and 4) connectivity.

Focal Ecosystems and Species

Focal ecosystems and species can be useful in identifying key habitats or processes for conservation in general because their attributes or trends can be monitored over time. Some potential choices of focal species include those that are sensitive to ecosystem change (i.e., indicator species) or play a primary role in sustaining key ecological processes (i.e., keystone species).[160]

Prairie dogs*:* Prairie dogs are a keystone species[161] that once occupied numerous and very large colonies. In north-central Montana between the Missouri and Milk Rivers, Messiter in 1880 described a prairie dog colony 30-40 miles (48-64 km) long.[162] In South Dakota, Hayden in 1863 observed a colony of 50 sq miles (130 sq km).[163] He also noted that prairie dogs occurred in great abundance between what is now Rapid City and Faith, South Dakota, a distance of 150 miles (240 km). In Niobrara County in northeastern Wyoming, biologists in the 1920s described a prairie dog colony that stretched for 100 miles (160 km).[164] As much as 8-15% of large areas of the NGP were likely occupied by prairie dogs.[165]

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[157] Chaplin, S.J., W.R. Ostlie, R.E. Schneider and J.S. Kenny. 1996. A multiple-scale approach to conservation planning in the Great Plains. Pp. 187-201 in Prairie Conservation, F.B. Samson and F.L. Knopf, eds., Island Press, Washington, D.C.

[158] Id.

[159] Poiani, K.A., B.D. Richter, M.G. Anderson and J.E. Richter. 2000. Biodiversity conservation at multiple scales: Functional sites, landscapes, and networks. Bioscience 50:133-146.

[160] Id.

[161] Miller, B., G. Ceballos, and R.P. Reading. 1994. The prairie dog and biotic diversity. Conservation Biology 8:677-681; Kotliar, N.B., B.W. Baker, A.D. Whicker, and G. Plumb. 1999. A critical review of assumptions about the prairie dog as a keystone species. Environmental Management 24:177-192. Kotliar, N.B. 2000. Application of the new keystone-species concept to prairie dogs: hwo well does it work? Conservation Biology 14:1715-1721; Miller et al. 2000. The role of prairie dogs as keystone species: a response to Stapp. Conservation Biology 14:318-321.

[162] Id.

[163] Id.

[164] Id.

[165] Knowles, C.J., J.D. Proctor, and S.C. Forrest. 2002. Black-tailed prairie dog abundance and distribution in the Great Plains based on historic and

The target of largely successful government programs designed to totally eradicate them in the early 1900s,[166] and more recently affected by recurring outbreaks of sylvatic plague,[167] prairie dogs now occupy a small fraction of their historically occupied area, in most places far less than 1% of the landscape.[168] Ecosystem functions performed by extensive prairie dog towns, such as soil formation and water filtration,[169] therefore no longer occur at significant scales.

In order to restore the ecosystem function of prairie dogs, substantially greater numbers than occur presently would be required. In Montana, for example, there are approximately 4.6 million acres (1.9 million ha) of suitable prairie dog habitat on BLM lands.[170] If 8-15% of this habitat were occupied by prairie dogs, this would result in around a half million acres (200,000 ha) of prairie dog colonies, 7 times the estimate of the area occupied by prairie dogs today (ca. 70,000 ac (28,000 ha)).[171] "Complexes" of prairie dog colonies (colonies that are closely interrelated by distance and genetics)[172] of 10,000-20,000 acres (4,000-8,000 ha) would probably capture some of the historic ecoregional impact given that restoration will not be feasible over most of the prairie dog's historic range. A number of opportunities exist on public lands within the ecoregion to restore prairie dogs at this scale. Some 23 million acres (9.3 million ha) of suitable prairie dog habitat exist on publicly owned lands in the ecoregion out of some 73 million acres (29.6 million ha) of total potential prairie dog habitat.[173] Plague complicates the management of prairie dogs and suggests that we must give attention to adding redundancy to the distribution of large blocks of prairie dogs in case one or more populations die out. For the time being, until we can better manage the impacts of plague, all of the sites that can be identified as having potential for large-scale prairie dog restoration ought to be included in planning for prairie dog restoration.

contemporary information. Great Plains Research 12:219-54.

[166] Forrest, S.C. and J. Luchsinger. In press. Past and current chemical control of prairie dogs. *In*, Conservation and Management of the Black-tailed Prairie Dog, J. Hoogland, ed. Island Press.

[167] Cully in press, note 128 *supra*.

[168] Proctor et al. in press, note 15 *supra*.

[169] Whicker, A.D., and J.K. Detling. 1993. Control of grassland ecosystem processes by prairie dogs. In: Management of Prairie Dog Complexes for the Reintroduction of the Black-footed Ferret. J. Oldemeyer, D. Biggins, B. Miller, and R. Crete, Editors. Biological Report No 13. U.S. Fish and Wildlife Service, Washington, D.C. Pages 18-27.

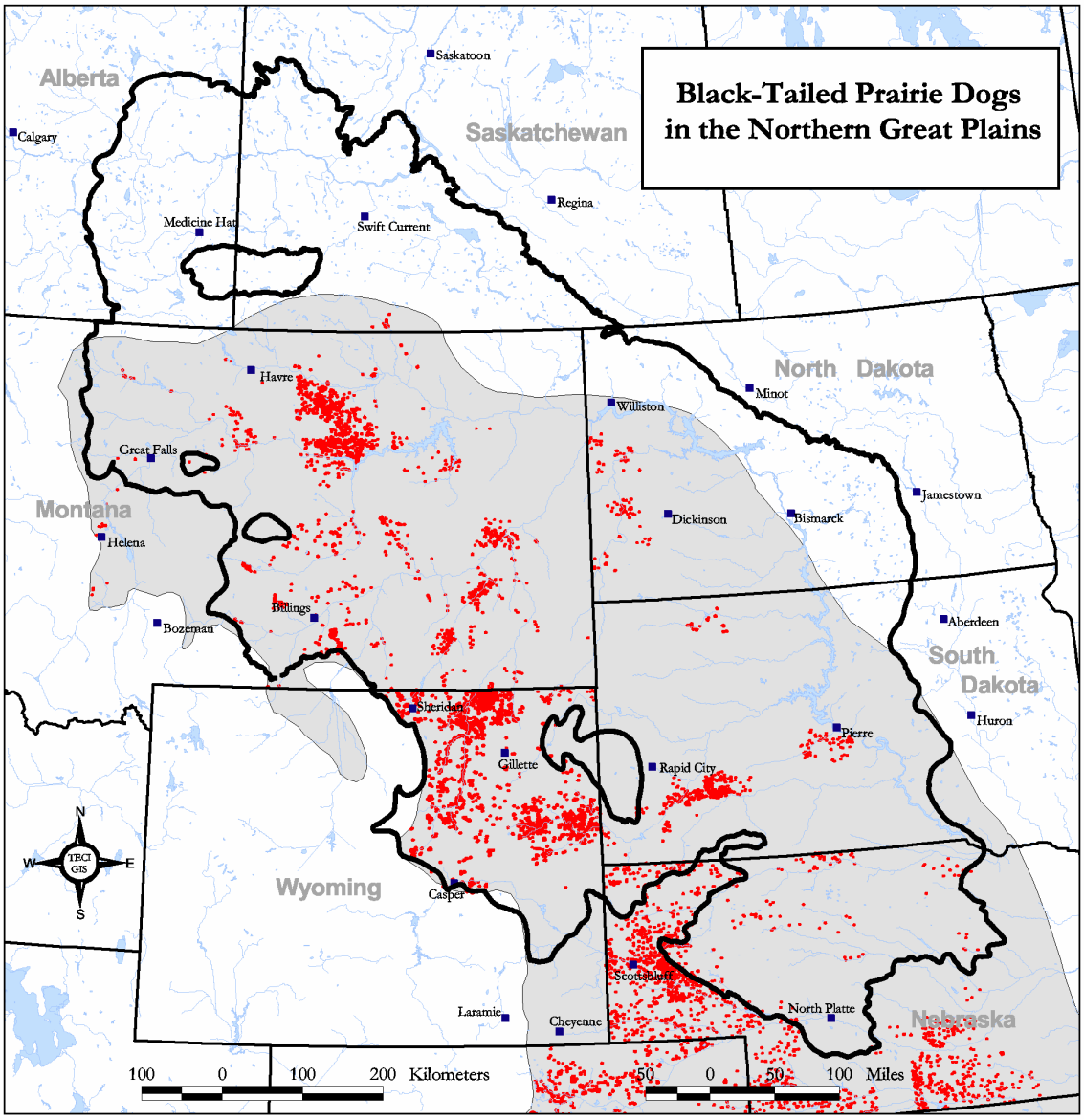
[170] Proctor et al in press, note 15 *supra*.

[171] Montana Prairie Dog Working Group. 1999. Conservation plan for black-tailed and white-tailed prairie dogs in Montana. Montana Department of Fish, Wildlife and Parks, Helena. 70 pp.

[172] Forrest, S.C., T.W. Clark, L. Richardson, and T.M. Campbell III. 1985. Black-footed ferret habitat: some management and reintroduction considerations. Wyo. Bur. Land Mgmt. Wildl. Tech. Bull. No. 2. 44 pp.

[173] This assessment and Proctor et al. in press, note 15 *supra*.

Figure 24. Black-Tailed Prairie Dog Distribution in the Northern Great Plains.



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Proctor, J., S.C. Forrest, and B. Haskins. In press. Identifying potential focal areas for black-tailed prairie dog restoration. J. Hoogland, ed. Island Press.

Survey data from: Bureau of Indian Affairs, U.S. Fish and Wildlife Service, National Park Service, Parks Canada, Turner Ranches, Bureau of Land Management, Montana Natural Heritage Program, Nebraska Game and Parks Commission, Wyoming Natural Diversity Database, U.S. Forest Service and Colorado Department of Natural Resources.

LEGEND

Northern Great Plains Ecoregion boundary

Existing prairie dog complexes (prairie dog towns buffered by 1.75 km or 1.1 mi.)

Historic range of the black-tailed prairie dog

Prairie dog colony locations were not available for significant areas of private and tribal lands. Sizable prairie dog complexes on tribal lands in the Dakotas are not shown.

WWF

***Prairie dog associates**:* Species that associate with prairie dogs have also declined. Well over 100 vertebrate species are associated with black-tailed prairie dog habitat, including four species of regional conservation concern: swift fox, ferruginous hawk, burrowing owl and mountain plover, and one listed species, the black-footed ferret. The ferret, which dines almost exclusively on prairie dogs, has been especially affected. Complexes of 12,000 to 15,000 acres (5,000-6,000 ha) of prairie dog colonies are probably needed to support a minimum viable ferret population. Ferret populations of 120-150 have an estimated 95% chance of persistence over 100 years,[174] and ferret "families" need about 100 acres/family.[175] Of the dozen proposed or currently ongoing reintroductions of black-footed ferrets, the sites that currently support positive ferret population growth without supplementation from captive stock are the largest prairie dog complexes.[176] Buffalo Gap National Grassland, South Dakota, which currently comprises about 13,000-acres (5,400 ha) of black-tailed prairie dogs, is one of these,[177] as is the Shirley Basin, Wyoming white-tailed prairie dog complex (minimum estimated acreage of 15,000 (6,000 ha) outside the NGP).[178] Meanwhile, recovery attempts in low-density complexes or in complexes smaller than 5,000 acres (2,000 ha) (such as CM Russell National Wildlife Refuge) have not maintained stable populations.[179] With an estimated 20 such populations needed to meet genetic requirements for long-term maintenance,[180] a minimum of approximately 260,000 acres (105,000 ha) of prairie dog colonies would provide the black-footed ferret a fighting chance of survival in the NGP over the long term. Estimates indicate there are currently around 160,000 total acres (64,000 ha) of prairie dogs, and only 1-3 complexes 13,000 acres or larger in the NGP.[i] Although the ferret may act as an umbrella species for other prairie dog associates like the burrowing owl and mountain plover, it is far from clear whether providing sufficient habitat for the ferret alone will also meet the needs of declining populations of these associates, as well as increasing opportunities for swift fox, badgers, coyotes, predatory birds, and other animals for which the prairie dog is an important source of food.

***Bison**:* Despite claims that the rescue of the American bison from extinction is one of the great conservation success

[174] Harris, R.B., T.W. Clark and M. Shaffer. 1989. Extinction Probabilities for Isolated Black-footed ferret populations. Pp. 69-82 *in*, U.S. Seal, E.T. Thorne, M.A. Bogan and S.H. Anderson, eds., Conservation Biology of the Black-footed Ferret, Yale Univ. Press, New Haven.

[175] Forrest et. al, note 172 *supra.*

[176] As defined by a 1.5 km separation rule: See, Lockhart, M. 2004. Black-footed ferret and allocation proposal guidelines, U.S. Fish and Wildlife Service, National Black-footed Ferret Conservation Center, Laramie, WY.

[177] Matchett, R. 2003. Black-footed ferret Recovery in Montana: Where Do We Go From Here? Presentation, Montana Chapter, The Wildlife Society, Feb. 27, 2003, Lewistown, MT.; Proctor et al. in press, note 158 *supra*.

[178] Grenier, M. 2003. Wyoming Game and Fish Department, personal communication.

[179] Matchett 2003, note 177 *supra*.

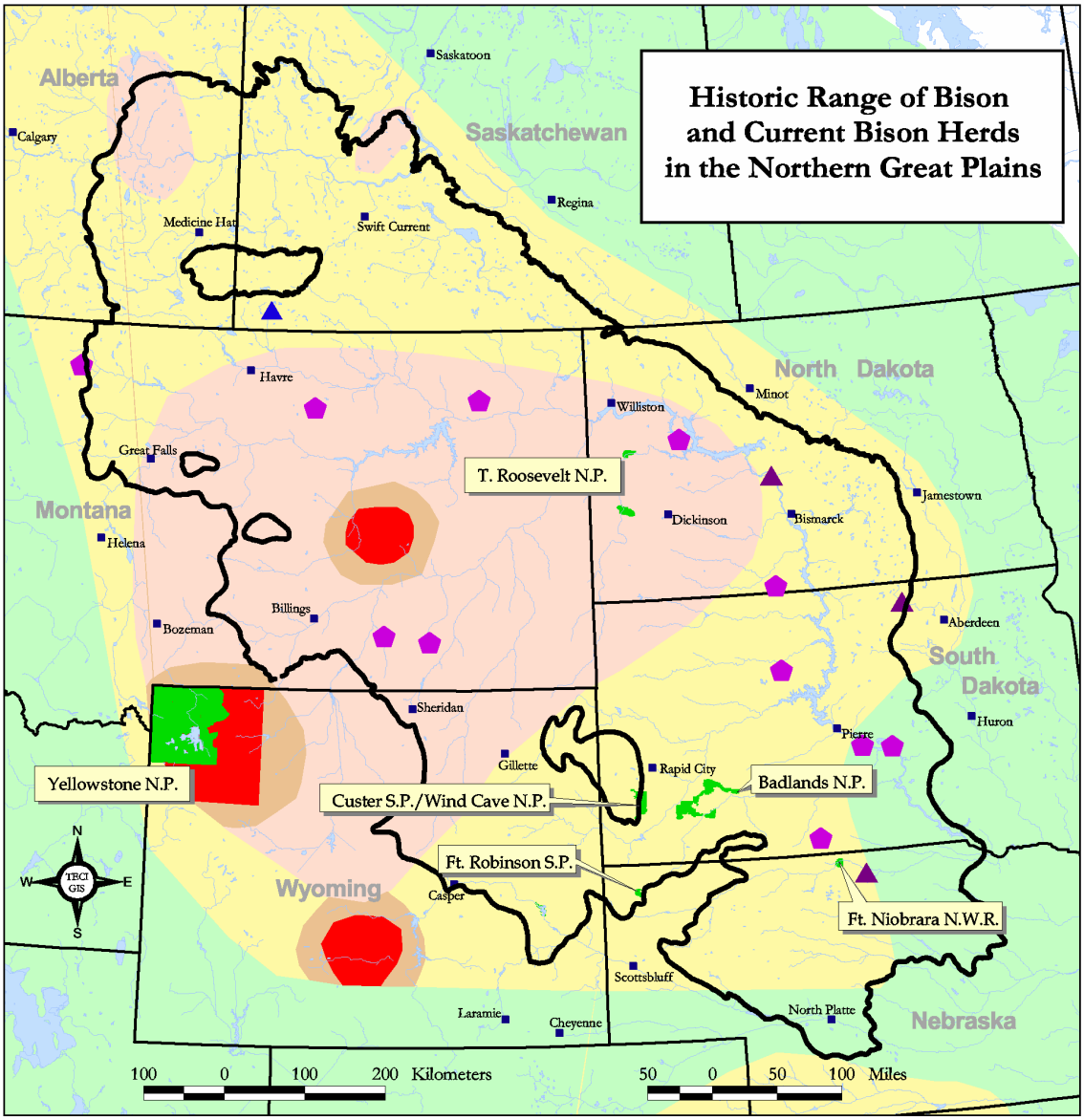
[180] Brussard, P.F. and M.E. Gilpin. 1989. Demographic and Genetic Problems of Small Populations. Pp. 37-48 *in*, U.S. Seal, E.T. Thorne, M.A. Bogan and S.H. Anderson, eds., Conservation Biology of the Black-footed Ferret, Yale Univ. Press, New Haven.

stories of the 20th century, the future of wild bison is still in doubt. Bison once served critical ecological functions within prairie ecosystems due to both their abundance and behavior. They provided prolific amounts of prey and carrion to carnivores.[181] Their grazing, wallowing, and the movement of the herds were instrumental in shaping the prairie landscape,[182] including influencing the distribution of many prairie birds.[183] They likely played a significant role in establishment of prairie dogs,[184] the distribution of other large herbivores, and nutrient cycling.[185] There are probably few communities or species in the NGP that in one form or another were not affected by the presence of bison.

Today, however, bison are ecologically extinct in all but a handful of places. There are approximately 50 "conservation herds" in North America—publicly owned and managed herds and those managed by private organizations like The Nature Conservancy with clear conservation objectives—comprising some 19,000 bison out of an estimated 500,000 bison in North America.[186] Of these, fewer than 2% (8,300) are "free-ranging" plains bison—those herds not kept behind a fence.[187] Only six of these herds—Henry's Mountains, UT, Antelope Island State Park, UT, Prince Albert National Park, SK, and Primrose Lake Air Weapons Range, AB/SK, Yellowstone National Park, WY/MT and Grand Teton National Park/National Elk Refuge, WY—occur within the former range of the plains bison,[188] and none are found within the NGP, once a stronghold for bison.[189] Captive bison in the nine conservation herds in the NGP now occupy a mere 280,000 acres (131,856 ha), less than 0.1% of their former range within the NGP,[190] which was, with few exceptions, all potential bison habitat. The few public herds that remain today are heavily managed (Appendix H).[191] The largest public herd in the NGP is in Badlands National Park, SD, comprising from 300-700 animals depending on carrying capacity. Bison there are confined to a small and partially fenced area of 64,000 acres (25,900 ha). They are, like bison elsewhere in the ecoregion, controlled when they move out of the area.[192]

[181] Truett et al, note 8 *supra*.
[182] Knapp, A. K., J. M. Blair, J. M. Briggs, S. L. Collins, D. C. Hartnett, L. C. Johnson, and E. G. Towne. 1999. The keystone role of bison in North American tallgrass prairie. Bioscience 49(1):39-50.
[183] See, e.g., Truett et al., note 8 *supra*.
[184] Id.
[185] Id.
[186] Boyd, D. 2003. Conservation of North American Bison: Status and Recommendations. Masters Thesis, Univ. of Calgary, Calgary, AB. 222 pp.
[187] Id. at p.54. "Captive" herds are those kept in enclosures and are generally subjected to intensive management—culling, roundups, and so forth.
[188] Id.
[189] Plumb, G. and W. Brewster. 2002. Conservation Management at Yellowstone National Park: Are Bison really Wildlife? Abstract presented at Annual Meeting of Society for Conservation Biology, June 2002. Yellowstone Center for Resources, POB 168, Yellowstone National Park, WY 82190, USA.
[190] Boyd, note 186 *supra*.
[191] Id.
[192] Berger, J. and C. Cunningham. 1994. Bison: Mating and Conservation in Small Populations. Columbia Univ. Press, New York.

Figure 25. Bison in the Northern Great Plains



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Intertribal Bison Cooperative. See also, citations in Appendix H.

LEGEND

- Northern Great Plains Ecoregion boundary
- Tribal bison herds in 2003
- Nature Conservancy Canada bison herds in 2003
- The Nature Conservancy bison herds in 2003
- Public bison herds in 2003
- Range in 1889
- Range in 1884
- Range in 1880
- Range in 1870
- Original range of bison

WWF

Today, 96% of all bison are in private herds that are subject to artificial selection for domestication, with ease of handling and marketable meat production major goals.[193] More troubling perhaps is the level of introgression of domestic cattle genes in the bison genome. Nearly every private bison herd tested to date contains individuals with cattle DNA,[194] though the full extent of genetic contamination and its management importance has yet to be determined.[195] In addition, most public herds also exhibit cattle gene introgression. Among plains bison, the only public herds known for which there is a good probability of genetic purity are Elk Island National Park (Alberta), Henry Mountains (Utah), Grand Teton National Park (Wyoming), Yellowstone National Park, and Wind Cave National Park.[196] Long-term conservation of these populations, however, may be compromised by small,herd size, non-native diseases, and (or) highly unnatural culling practices, among other factors. Efforts are just beginning to comprehensively address genetic issues in the management of these herds and of other herds that are important for conserving genetic diversity in bison but have cattle gene introgression.

Bison herds need to be established on a scale that reduces the risks of genetic erosion posed by small herd size and to allow the full expression of ecological, behavioral and evolutionary relationships and processes. For example, few populations of the plains bison are subject to the complete guild of native predators present before European settlement.[197] As probably the single most important food source for wolves, grizzly bears and probably some scavengers in the NGP historically, large bison herds will be needed to reestablish the full guild of predators and scavengers. Areas as large as 3.2 million acres (5,000 sq mi/12,500 sq km) have been suggested as necessary to sustain wild bison on ecologically meaningful scales.[198] At a density of one bison per 100 acres (1/40 ha), which would be considerably below current recommended stocking rates for most of the NGP, such an area would support more than 30,000 bison. Expansion potential for most existing herds is constrained—52% of bison managers report that there is no potential for expanding the range of their herds due to sociopolitical concerns—but some opportunities exist.[199] Thus the need to identify large landscapes where these concerns are minimized and large numbers of bison accommodated.

Birds: Several species of NGP birds are useful as focal species because they: a) are sensitive to different ends of the spectrum of grassland composition and structure, i.e., either require heavily grazed or lightly grazed conditions; b) are resident species whose population trends can be attributed to factors operating locally, as opposed to migrant

[193] Boyd, note 186 *supra*
[194] Id.
[195] Derr, M. 2002. Genetically, bison don't measure up to ancestors. New York Times, April 23, 2002. http://www.nytimes.com/2002/04/23/science/life/23BISO.html?ex=1020673478&ei=1&en=836b4f7dfeea4408u
[196] Halbert, N.D. 2003. The utilization of genetic markers to resolve modern management issues in historic bison populations: implications for species conservation. Ph.D. Dissertation, Texas A&M Univ., College Station, TX, xxpp.
[197] Boyd, note 186 *supra*.
[198] Lott 2002, note 9 *supra*.
[199] Boyd, note 186 *supra*.

species that may be affected by conditions in their winter or summer ranges; and/or c) have specialized habitats. Some potential focal species for the NGP include:

- *Mountain plovers*. The mountain plover, a listed species at risk in Canada[200] globally ranked as "imperiled,"(Table 1) is associated with heavy grazing. Mountain plovers are often associated with prairie dogs, but also with intensively grazed and sometimes even cropped land. The distribution records for sightings and known breeding concentrations in the NGP fall into a few well-defined areas.

- *Sage grouse lek density.* The greater sage grouse has been proposed for listing in the U.S. and is listed by COSEWIC as Endangered. Sage grouse occupy transition areas from grassland to shrubland, but are primarily shrub-dependent. Sage grouse gather to breed at "lek" sites in the spring. Sage grouse lek densities are indicators of habitat quality locally (since most nesting occurs within a small radius of the lek) and regionally (since a minimum number of birds is needed to support lekking behavior). Sage grouse are resident species, so their trend is indicative of local habitat quality.

- *Aquatic/Riparian species concentrations.* A number of species occurring in the Missouri River drainage and nearby lakes are former candidates for listing or have been proposed for listing. We included distributions for the piping plover and interior least tern, both listed species in the U.S.

***Fish**:* Fish, which are relatively long-lived and mobile, are good indicators of long-term and broad spatial-scale biotic integrity.[201] However, assessing aquatic integrity in western Great Plains streams is complicated by naturally variable flow regimes, low habitat diversity and resultant fish communities that are generally tolerant to physiochemical changes.[202] Therefore, a variety of focal species may be necessary to capture a faithful and complete image of a given stream's biotic integrity. The endangered pallid sturgeon *Scaphirhynchus albus* requires long reaches of free-flowing conditions in the larger river systems of the NGP, primarily the Missouri and Yellowstone Rivers, and may serve as a focal species for these rivers at a large scale. At smaller scales, potential focal species may include those classified as intolerant to habitat degradation. Examples include: sturgeon chub *Macrhybopsis gelida*, northern redbelly dace *Phoxinus eos*, and northern redbelly x finescale dace *P. eos x P. neogaeus*. In addition to the use of fish as focal species, the creation of

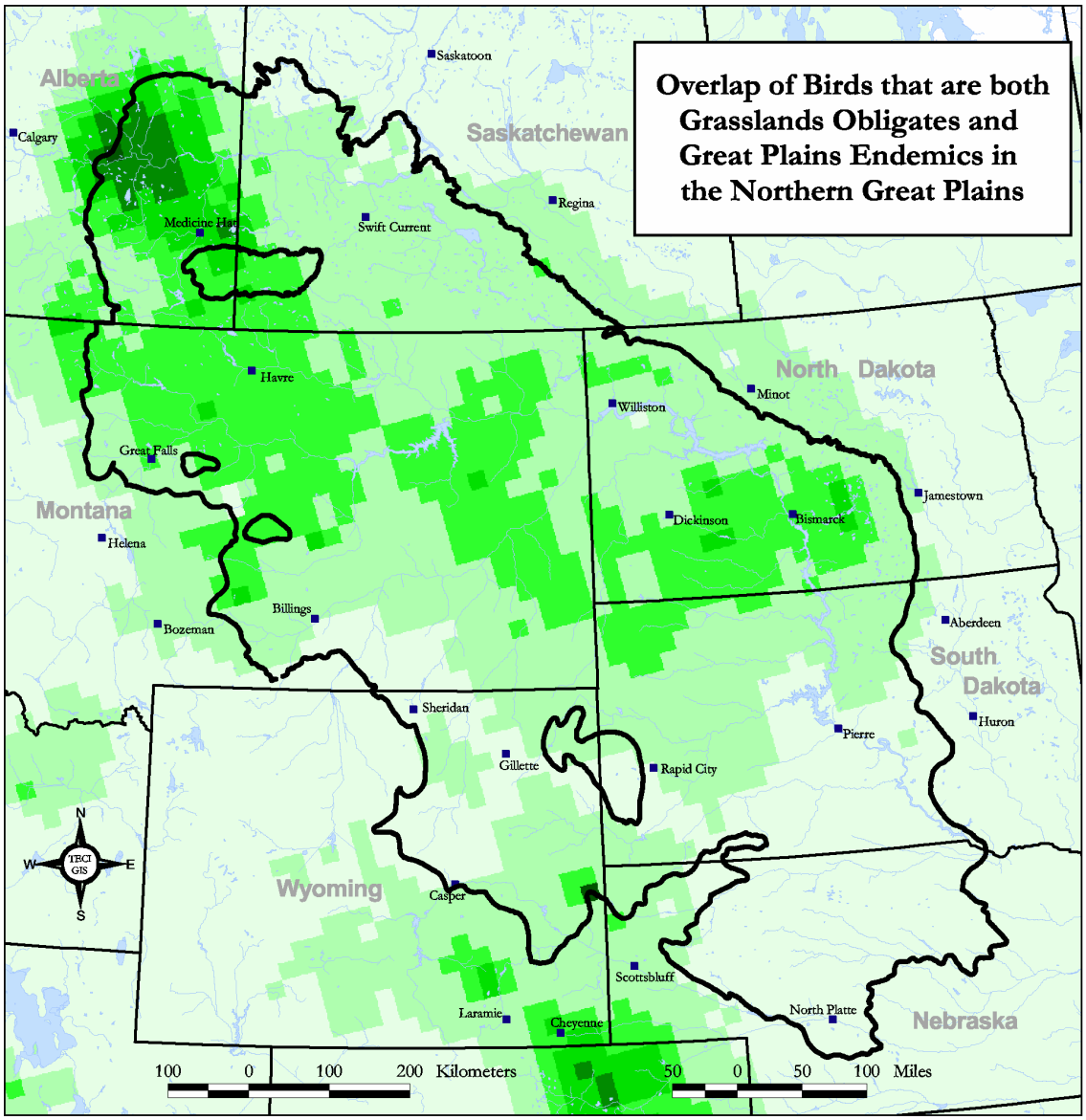
[200] COSEWIC. 2002. Canadian Species at Risk, May 2002. Committee on the Status of Endangered Wildlife in Canada. 34pp www.cosewic.gc.ca See appendix C2.

[201] Bramblett, R. G., et al. 2003. Unpublished. Development of Biotic Integrity Indices for Prairie Streams in Montana Using Fish, Macroinvertebrate, and Diatom Assemblages.

[202] Bramblett, R. G. and K.D. Fausch. 1991. Variable Fish Communities and the Index of Biotic Integrity in a Western Great Plains River. Transactions of the American Fisheries Society 120:752-769.

multimetric indices of biotic integrity which incorporate fish, macroinvertabrates and diatom assemblages could substantially improve the assessment of NGP streams. Ultimately, focal species and biotic indexes will aid in the identification of high quality habitat thus enabling the protection of stream reaches that are largely still functional while an increased understanding of anthropogenic habitat degradation will support stream rehabilitation.

Figure 26. Overlap of Birds that are both Grassland Obligates and Great Plains Endemics in the Northern Great Plains



SOURCES

Sauer, J. R., J. E. Hines, and J. Fallon. 2002. The North American Breeding Bird Survey, Results and Analysis, 1966 - 1996.

WWF and TECI GIS reclassified breeding bird survey data to a scale of 1-10 across the range of each species, then added all scores.

LEGEND

Northern Great Plains Ecoregion boundary

Relative amount of overlap of breeding distributions of bird species that are both grasslands obligates and Great Plains endemics (maximum possible value = 80):

- 0 - 5
- 6 - 11
- 12 - 16
- 17 - 22
- 23 - 27
- 28 - 33

WWF

Dominant Environmental Regimes

Restoration or maintenance of many natural ecological processes is impossible in small, fragmented patches of land. Successful restoration of ecological processes like fire and heterogeneous grazing patterns that occurred over large areas requires conservation management of large landscapes. In turn, this scale of management will often require a coordinated effort involving many public and private stakeholders.

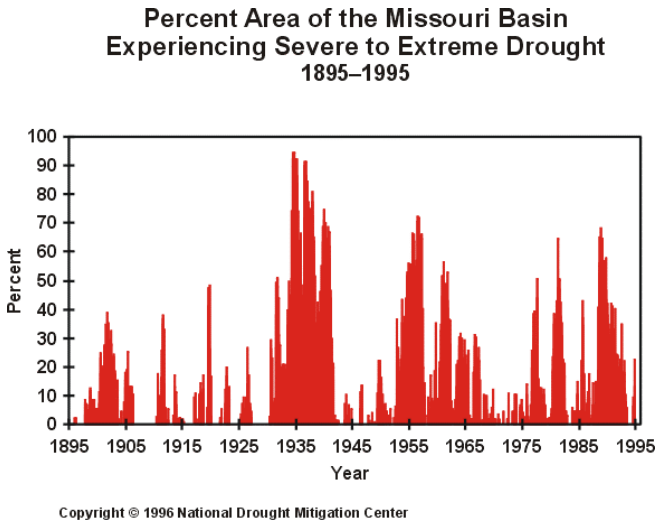


Figure 27. Drought cycles in the Missouri River Basin. National Drought Mitigatiion Center, Lincoln, NE.

Herbivory, fire and recurring drought are dominant processes driving NGP adaptation and evolution. Conservation landscapes and landscape networks should be designed that accommodate these processes on meaningful scales, recognizing the variability inherent in them. For example, approximately every 20 years, severe to extreme drought impacts over 50% of the Missouri River Basin[203] (Figure 24).

[203] National Drought Mitigation Center. No date. Historical graphs of the Palmer Drought Index. NDMC, Lincoln, NE. http://www.drought.unl.edu/whatis/palmer/missouri.gif

Most prairie species are adapted to this regime, but severe droughts could temporally eliminate wetlands or other local habitats that would take time to recover. A conservation landscape of even several million acres is unlikely to be large enough to buffer these regional scale processes, but with a regionally well-distributed network of landscapes, it would be more likely that one or more landscapes would experience less severe drought than others. Even within landscapes, however, larger areas support a wider range of habitat conditions than those found at a single small site, and would therefore be more resilient to this kind of disturbance.

Fire

Fire is one of the natural forces maintaining the species composition and ecological processes of northern grasslands.[204] Lightning-set fires are common—fire return intervals on the Great Plains were on the order of 2-25 years.[205] Much of the NGP burned frequently, over large areas, for weeks or months until weather or natural fire breaks (e.g., rivers, prairie dog colonies) extinguished them. Most lightning-set fires in the NGP occur during summer and early fall. Higgins estimated a frequency of six lightning fires/yr/10,000 sq km in grasslands in eastern North Dakota, 25/yr/10,000 sq km in western

[204] Higgins, K.F., A.D. Kruse and J.L. Piehl. 1989. Prescribed Burning Guidelines in the Northern Great Plains. U.S.F.W.S., Coop. Ext. Service, S.D. State Univ., U.S. Dept. Agric. EC 760. Jamestown, ND: Northern Prairie Wildl. Res. Center, http://www.npsc.nbs.gov/resource/tools/burning/intro.htm.

[205] Wright, H.A. and A.W. Bailey. 1980. Fire ecology and prescribed burning in the Great Plains - a research review. USDA For Serv Tech Rep INT-77. 60 pp.

North Dakota, and 92/yr/10,000 sq km in pine-savanna lands in northwestern South Dakota and southeastern Montana.[206] Native Americans' use of fire was probably to aid a hunter-gatherer lifestyle, to drive game and to procure food, shelter, and clothing. These fires, like lightning-set fires, played an important role in the evolutionary process and development of the grassland biome of the NGP by favoring fire-tolerant species and species adapted to utilizing the flush of nutrients released after fire.[207]

Most of the recent prescribed fires in the NGP have been used either for native prairie restoration or for wildlife habitat management. USFWS refuge and wetlands managers prescribe burns to reduce vegetative litter, to control noxious weeds, or to improve the height and density of plant cover (dense nesting cover for wildlife).[208]

Grazing

Historically, bison had a major impact on NGP grasslands. There are numerous historic references to vegetation that was cropped so intensively by bison over large areas that little forage was left to support livestock,[209] but that grazing intensity was spatially patchy.[210] This patchy grazing pattern created a heterogeneous mosaic of habitat types, from intensively cropped to nearly decadent stands of grass. These ungrazed stands are more susceptible to fire. Following fire, bison would selectively graze these newly opened stands, where rapidly regrowing plants provided more nutritious feed, allowing heavily grazed areas to recover.[211] These grazing patterns, combined with the bison's strong preference for grasses over forbs, affects plant species composition and, ultimately, animal distributions.[212] While modern livestock herds can be managed to mimic this movement pattern in a spatially restricted area, the scale at which these grazing patterns occurred historically was undoubtedly extensive.

Drought

Recurring drought may be one of the more important, though less tangible, disturbance processes shaping NGP ecosystems and biodiversity. The NGP typically experiences great fluctuations in precipitation. In fact, paleoclimate data show that a pattern of periodic, albeit random, drought events has

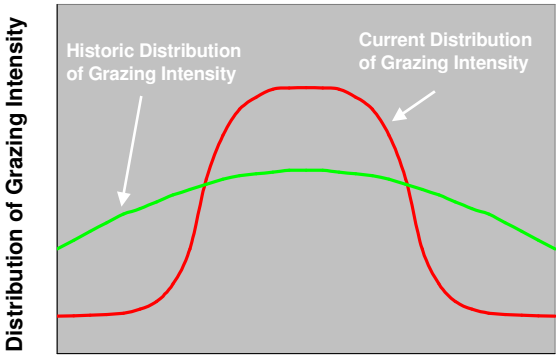


Figure 28. Grazing Intensity
Under a patchy mosaic of grazing intensity, the distribution of lightly grazed and intensively grazed patches is greater than what is currently the management practice over much of the Northern Great Plains...uniform utilization of grasses which are neither grazed too intensively or are left unutilized. The result for species dependent on the ends of the spectrum are a loss of appropriate habitat.

[206] Higgins, K.F. 1984. Lightning fires in North Dakota grasslands and in pine-savanna lands of South Dakota and Montana. Journal of Range Management 37:100-103.
[207] Higgins et al. 1989, note 204 *supra.*
[208] Wright and Bailey 1980, note 205 *supra*.
[209] Hart, R.H. 2001. Where the buffalo roamed—or did they? Great Plains Res. 11:83-102.
[210] Truett et al. 2001, note 8 *supra*.
[211] Id.
[212] See, e.g., Ostlie et al. 1997, note 47 *supra*.

occurred throughout the past 10,000 years.[213] Moreover, there is evidence of droughts of much longer duration and severity than anything recorded in the 20th century.[214] Considerable shifts in vegetation cover and, to some extent, species composition occurred as a result of these periodic dry periods. Undoubtedly, movement of large vertebrates (especially grazers) was influenced by drought events. In turn, drought also affects the occurrence and magnitude of other ecological processes such as fire and insect outbreaks. Conservation/restoration planning clearly needs to consider drought as a regular disturbance factor which may increase in frequency, length, and severity as a result of global climate change.

Minimum Dynamic Area

The interplay between fire and grazing intensity creates a shifting mosaic of successional stages and physical attributes that need to be accounted for in assessing the size of a prairie conservation landscape. For example, about 300 lb/acre (336 kg/ha) of aboveground biomass in a blue grama/ needle and thread grassland is needed in order for a fire to burn.[215] Until fuels build to that level, which may take several years, natural fires are unlikely to start or carry far. The surge of nutrients available to plants immediately after a fire, which often attracts ungulates, in turn affects grazing patterns. Thus, landscapes need to be large enough to support a continuum of successional stages that leave patches of sufficient size to support area-limited species. Additional modeling will be needed to address this component, but it has been suggested that the minimum dynamic area where disturbance events are common or large must itself be large.[216] Thus, a herd of 5,000 bison that require 500,000 acres to meet their food needs, might require four or more times that area if a portion of the area needs to be left ungrazed in

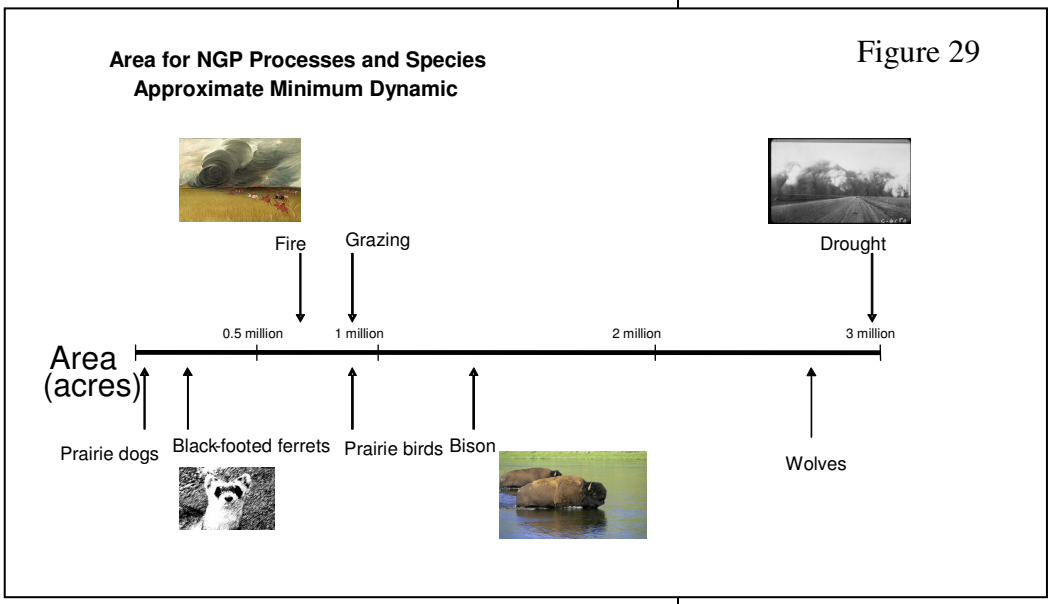


Figure 29

[213] Laird, K.R., S.C. Fritz, K.A. Maasch and B.F. Cumming. 1996. Greater drought intensity and frequency before A.D. 1200 in the Northern Great Plains. Nature 384:552-554; Woodhouse, C. and J.T. Overpeck. 1998. 2000 years of drought variability in the United States. Bull. Amer. Meteorological Soc. 79:2693-2714.

[214] Id.

[215] Knight, D.H. 1994. Mountains and Plains. Yale Univ. Press, New Haven.

[216] Poiani et al. 2000, note 159 *supra*.

order to build fuels for fire, and the desired rate of fire return is every four years. The minimum dynamic area for even modest restoration of bison and fire is thus 2 million acres (800,000 ha), given those parameters.

Another way to analyze the size of the minimum dynamic area needed for conservation is to look to the needs of the potentially widest-ranging species. Top predators, like the gray wolf and grizzly bear, would require substantial increases in prey biomass in order to reestablish in the NGP.[217] Based in part on current wolf recovery plans, Phillips[218] estimates that approximately 5,468 sq mi (3.5 million acres, 14,000 sq km) is the minimum size for biologically and socio-politically viable wolf restoration, and notes that populations of 20,000 bison and 10,000 elk or of 30,000 bison alone (readily supportable in many NGP areas of this size) would support a viable population of more than 500 wolves. Kunkel[219] concurs with these figures, but notes that "no single size, configuration, or suite of attributes exists for designing protected areas for large carnivores" and that "management should focus on maximizing reserve size and reducing persecution in reserve buffer zones."[220] Creating a viable population of grizzly bears in the NGP would probably require similarly large areas,[221] although the potential distribution of bears is likely tied to corridors along major rivers. Based on Botkin's[222] estimate, derived from reports from the Lewis and Clark expedition, the grizzly density along the Missouri River from Pierre, South Dakota, to Missoula, Montana, was 3.7 bear/100 square miles (= 15/1000 sq km). Kunkel suggests that 100 bears would need 7,000 square km of Missouri River-like habitat assuming food levels of the early 1800s.[223]

While bison can be maintained in populations much smaller than indicated here, and large carnivore predation and scavenging could possibly be accomplished with fewer numbers of animals maintained in viable populations outside of the ecoregion, the implication for establishing minimum dynamic area for the NGP is that conservation landscapes in the mixed grass prairies that are larger than .25 million acres (.1 million ha)–and more realistically 1-3 million acres (.4-1.2 million ha)—will be needed to ensure that a significant portion of ecosystem biodiversity and functionality will be retained.

Connectivity

To achieve an effective conservation landscape in the NGP, two dominant needs regarding connectivity are: 1) enabling local to regional-scale

[217] Although both species currently occur in grassland ecoregions adjacent to the NGP at low densities.
[218] Mike Phillips, pers. comm., Nov. 15, 2002
[219] Kyran Kunkel, pers. comm., Dec. 20, 2002
[220] Kunkel, K.E. 2003. Ecology, conservation, and restoration of large carnivores in western North America. *In* C.J. Zabel and R.G. Anthony editors. Mammal community dynamics in western coniferous forests of North America: management and conservation issues. Cambridge University Press, UK

[221] Woodroffe, R. and J. R. Ginsberg. 1998. Edge effects and the extinction of populations inside protected areas. Science 280:2126-2128: indicate minimum protected area for brown bears should be >3981 km^2.
[222] Botkin, D.B. 1996. Our Natural History: The Lessons of Lewis and Clark. Perigee Press.
[223] Kyran Kunkel, pers. comm., Dec. 20, 2002, citing: Mattson D J. and T Merrill. 2002. Extirpations of grizzly bears in the contiguous United States, 1850-2000. Conservation Biology 16:1123-1136.

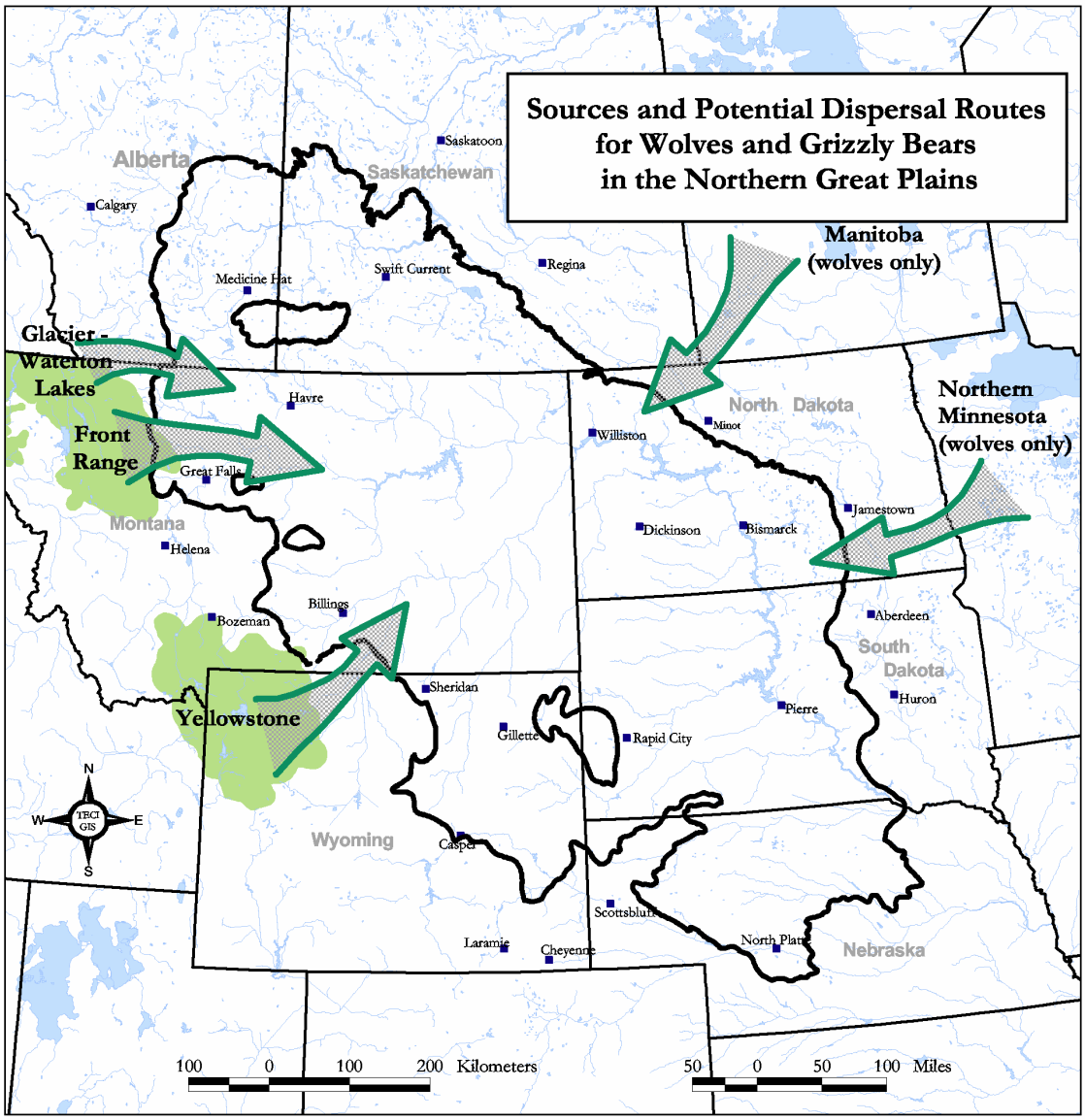
migrations of resident birds and mammals, migrant birds and invertebrates, and dispersal potential for plants, and 2) allowing adjustments in response to global climate change along elevation and latitudinal gradients.

Land use patterns have fragmented the habitats of many grassland species, whose populations may have been more or less continuous across wide swaths of prairie. Prairie dog colonies, for example, are highly fragmented.[224] In many places intact prairie is dissected by large areas of plowed land. Migration patterns of some species has been changed in response. Large ungulates like bison and elk likely shifted landscape use seasonally or in response to forage availability, although it is fairly well established that "long-range" migration (e.g. hundreds or thousands of miles) probably occurred rarely if at all.[225] Bison, for example, were so numerous that individual herds could not travel far before encountering other herds or the heavily grazed pastures of adjacent herds. Moreover, patterns of regional or local seasonal use are likely dependent on site-specific characteristics that the historic record does not reveal: for example, the amount of snow cover and summer moisture, which varies from year to year, might consistently favor grazing in some places.

Creating landscapes that can accommodate climate change in the NGP is equally challenging. There are few opportunities within the NGP for local accommodation, given that there are few elevational, climatic, or latitudinal gradients to exploit within this vast, largely flat, open space. A single landscape will probably not be enough to ensure the long-term security of NGP focal species and ecosystems if large, regional changes in climate occur. The best way to address this concern is to ensure that redundancy is provided in the conservation design, by having numerous landscapes that offer similar opportunities to conserve representative grassland species that are distributed widely throughout the ecoregion. Ideally, these would be "connected" by habitat that would permit movement among them, and to adjacent ecoregions.

[224] Lomolino, M.V. and G.A. Smith. 2003. Prairie dog towns as islands: applications of island biogeography and landscape ecology for conserving nonvolant terrestrial vertebrates. Global Ecology and Biogeography 12:275-286.
[225] Hart 2001, note 209 *supra*.

Figure 30. Potential Sources and Dispersal Routes of Large Predators.



SOURCES

Bader, M. 2000. Spatial needs of grizzly bears in the U.S. northern Rockies. Alliance for the Wild Rockies Special Report No. 10. Missoula, MT. 28 p.

Licht, D. S. and S. H. Fritts. Undated. Gray wolf (Canis lupus) occurrences in the Dakotas. U.S. Fish and Wildlife Service. Jamestown, ND.

LEGEND

Northern Great Plains Ecoregion boundary

Current U.S. grizzly bear distribution

WWF

Chapter 6: Restoration Opportunities: Seeds for Successful Conservation Action in the Northern Great Plains

Restorable Native Species Assemblages

Restoration of any large landscape presents enormous challenges. Many landscapes are so degraded that the costs of restoration seem insurmountable. In the tallgrass prairie, for example, the U.S. Forest Service has proposed the creation of the 16,000 acre (6,500 ha) Midewin National Tallgrass Prairie to cost approximately $300 million (US) over the next 15 years.[226] Costs of this sort would be daunting at the scale of restoration discussed above. Moreover, technically achieving full restoration of the entire mixed grass species suite in many cases might prove problematic.

Fortunately many grasslands within the NGP remain untilled. Today's untilled grasslands were probably spared the plow because they occur in sites that are relatively unproductive for crops or are on slopes too steep to plow.[227] Although they may not represent the best soils or potential productivity, these untilled areas nonetheless provide cost effective opportunities for large-scale restoration. We expect that, despite a variety of human-induced impacts, most are capable of recovery under proper management. For example, many plant species in the NGP evolved under heavy grazing. Early explorers record what would be described as severely overgrazed conditions today.[228] We therefore assume that much of the native untilled mixed grass prairie that remains is restorable simply by returning to a grazing regime that mimics to the extent possible "aboriginal" conditions, at little or no cost.

We focus on the opportunities for large-scale conservation presented by untilled grasslands, but also recognize that conserving viable examples of all habitat types may require restoration of tilled areas. For those areas that would need to be restored to grassland or planted to native species, active restoration is feasible although expensive. Current estimates for reseeding, preparation, labor, and materials for mixed grass prairie replanting ranges from $100–300 (US)/acre ($250-750/ha).[229] Still, this is a viable alternative where speeding up the natural recolonization process is desired.

Populations of most at-risk species in the prairies would likely improve with more attention to improving their specific habitat requirements. Ferruginous hawks, burrowing owls and mountain plover would likely benefit from expanded populations of burrowing mammals. Sage grouse in the Canadian portion of the range would likely benefit from management that increased silver sage habitats.

[226] U.S. Forest Service. 2002. Midewin Prairie Plan. http://www.fs.fed.us/mntp/plan/index.htm

[227] See, e.g., Knight 1994, note 215 *supra*.

[228] Truett et al. 2001, note 8 *supra*.

[229] Pat Fargey, Parks Canada, Grasslands National Park, Climax, Saskatchewan; Brian Martin, The Nature Conservancy, Helena, MT.

Expanding extirpated focal species populations presents other challenges, but none that are particularly costly or insurmountable. For example, methods to translocate prairie dogs are well known.[230] Bison have been successfully returned to many prairie environments[231] and thus, given sufficient space, restoration of large, genetically robust bison herds to the prairie should be relatively straightforward. Moreover, costs are modest—many functionally extirpated species like bison and prairie dogs have source populations from which to derive founder stock. Source populations of grizzly bears and wolves are nearby in the Rocky Mountain front; the long-distance dispersal ability of wolves also makes populations from forested regions of Alberta and Minnesota potential sources. Other species, like black-footed ferrets and piping plovers, may have significant costs associated with specialized parts of their recovery (such as captive breeding facilities), but they also have many governmental and nongovernmental organizations involved in their management, which allows some sharing of the cost burden.

Favorable Land Tenure

Public Lands: Many regions of high conservation value in the NGP, such as the Thunder Basin in Wyoming, Little Missouri River in North Dakota, Montana Glaciated Plains, and the Oglala/Buffalo Gap region of Nebraska and South Dakota include substantial acreages of public lands. In the U.S., these are primarily lands of the BLM and of the U.S. Forest Service, the latter referred to as National Grasslands.

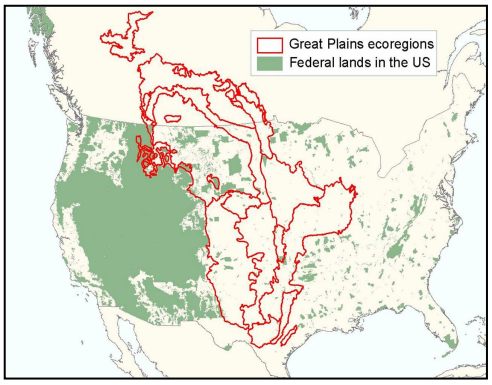


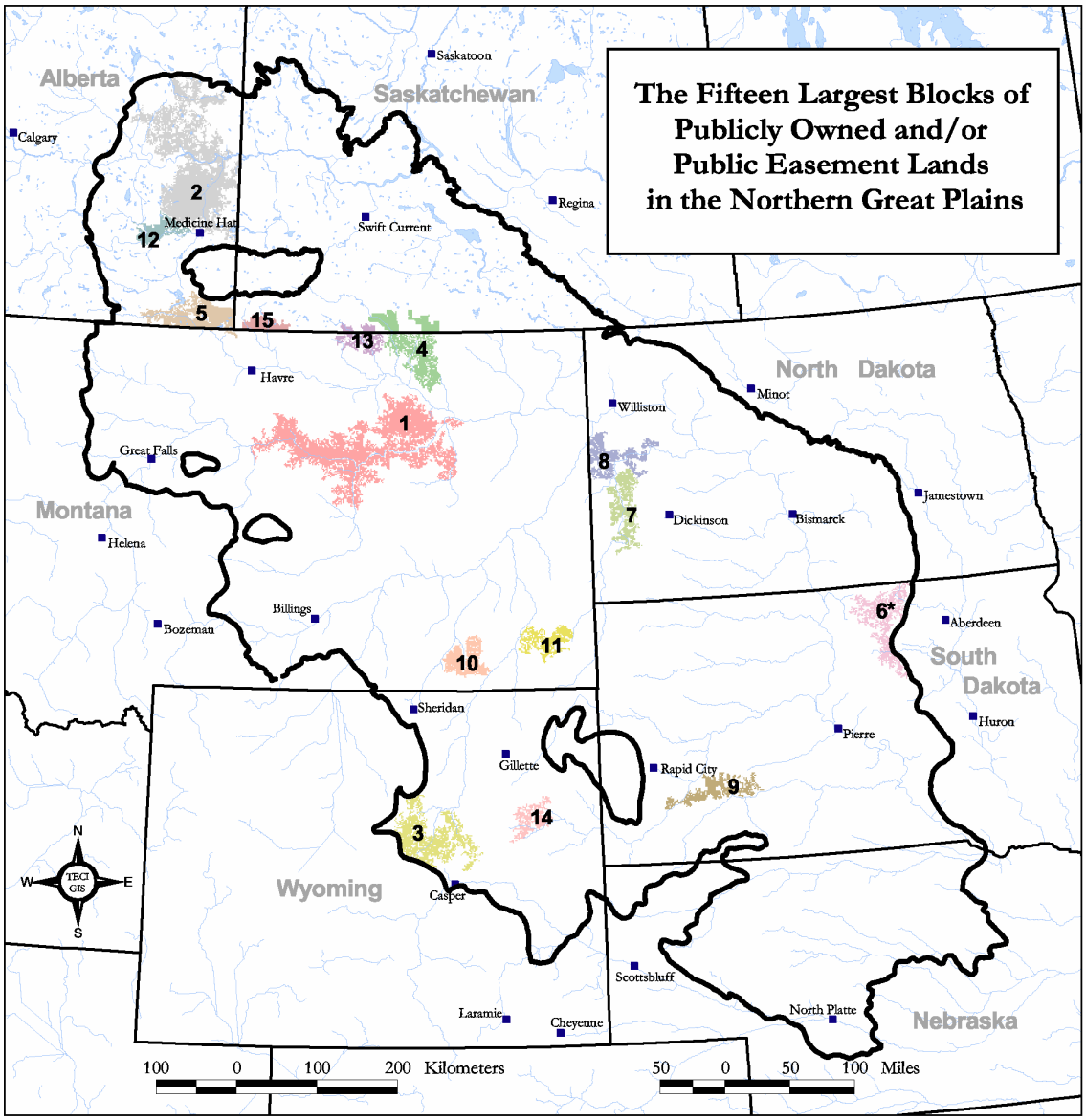
Figure 31. More public lands exist in the NGP ecoregion than in other Great Plains ecoregions

These public lands are often interspersed in a checkerboard pattern with private lands, and nearly all are leased by nearby landowners for grazing livestock. In Canada, various types of Crown Lands, grazing leases, and Community Pastures exist that also have varying levels of conservation management applied to them. The laws governing management of these lands varies in terms of its protection of biodiversity, but nearly all have some conservation management as part of their mandate. The opportunity afforded by public lands, apart from the fact that they overlap areas of high biodiversity value, is that they are generally untilled. These large blocks of public lands thus present unique opportunities for conservation in that they are under unified management and are often the most biologically intact regionally.

***Tribal Lands*:** Many Native American tribes are already managing large portions of their reservations in the U.S. for native species. Tribal governments have supported reintroductions of black-footed ferrets on the Ft. Belknap Reservation, MT, the Cheyenne River

[230] Truett, J.C., J.A.L.D. Dullum, R. Matchett, E. Owens, and D. Seery. 2001. Translocating prairie dogs: a review. Wildlife Society Bulletin 2001, 29:863-872.
[231] Berger and Cunningham 1994, note 192 *supra*.

Figure 32. Fifteen Largest Blocks of Public Land in the Northern Great Plains



SOURCES

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Saskatchewan Natural Heritage Program. 2000.
Alberta Natural Heritage Information Centre. Date unknown. Land ownership by quarter section.
U.S. Geological Survey. 2002. National Atlas of the U.S. - Federal land ownership.

LEGEND

Northern Great Plains Ecoregion boundary

Each contiguous block is colored uniquely and ranked by size from largest to smallest.

*Block 6 includes primarily US Fish and Wildlife Service easements, and includes little public ownership.

WWF

Sioux Reservation, SD, and the Rosebud Reservation, SD. Black-tailed prairie dogs are being augmented on the Cheyenne Reservation, MT. The Intertribal Bison Cooperative, a 51-member tribal organization, has a mission "to restore bison to Indian Nations in a manner that is compatible with their [its] spiritual and cultural beliefs and practices,"[232] and has instituted an ambitious herd development program occurring on 10 reservations within the ecoregion (Appendix H). The Blackfeet tribal government is reintroducing swift fox to the Blackfeet Reservation, MT. These ongoing efforts could be supported with improved conservation on adjacent non-Tribal lands.

New Emerging Public Attitudes

Many people working the land seem open to new ways of managing their land. The number of acres protected under conservation easements in the U.S. grew from 1.9 million acres to 6.2 million acres between 1990 and 2000, a 250% increase.[233] The potential for landowners to participate in conservation easements and other incentive programs for good conservation practices is growing.

Public awareness of and interest in prairie conservation appears to be growing as well, as evidenced by scores of recent newspaper and magazine articles covering the topic. This creates opportunities by both enhancing prospects for initiating policy change through elected officials and public agencies, and by the creation of a private-sector donor base for conservation work.

Many landowners are moving away from traditional livestock ranching models. Bison ranching in Saskatchewan, for example, grew from 175 farms to 562 farms from 1996 to 2001, a 221% increase.[234]

Declining Population

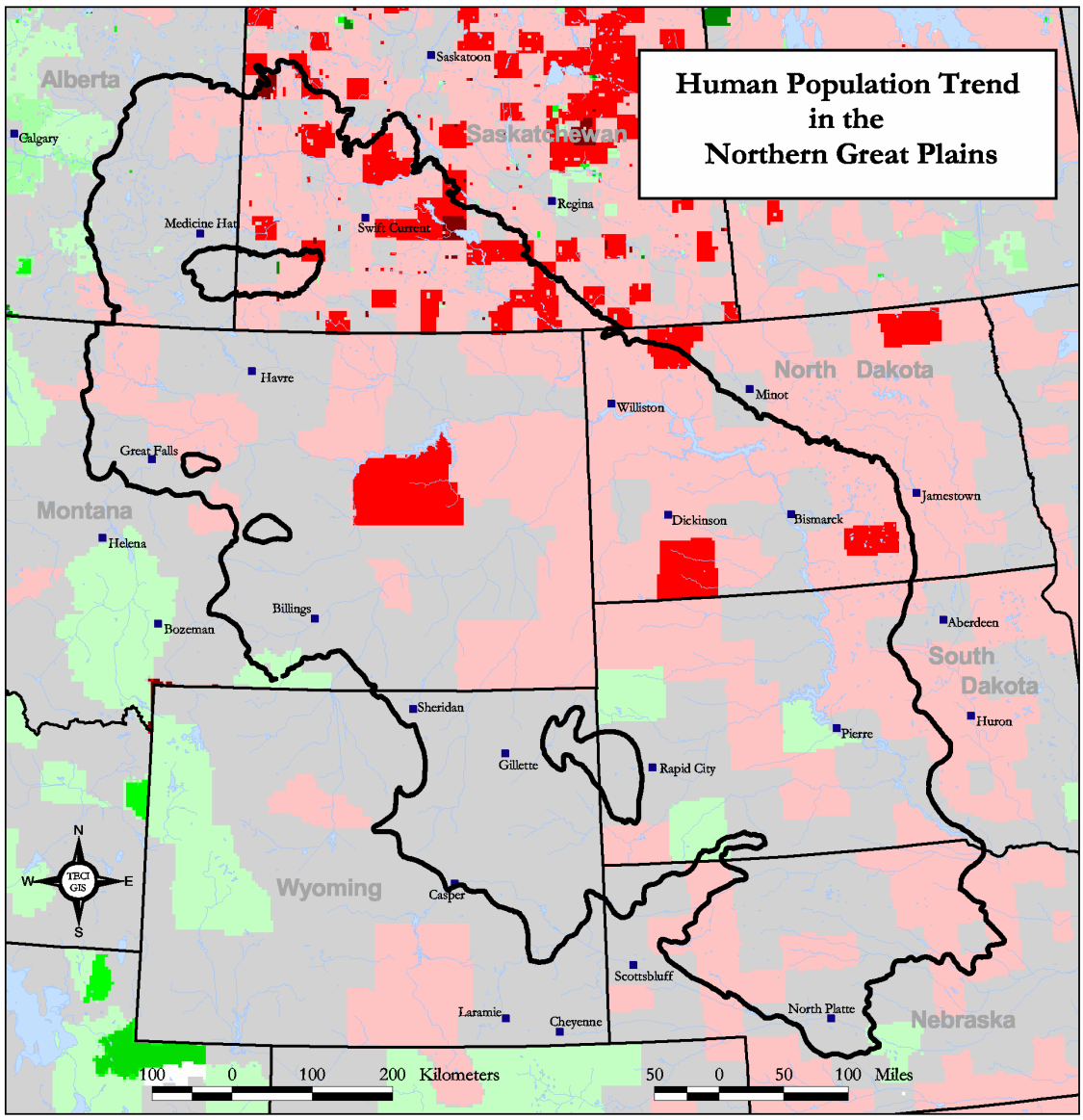
Stagnant economic conditions and limited employment opportunities are resulting in a continuing exodus of people from the plains. Agricultural subsidies affect land ownership in two major ways: (1) because a disproportionate share of subsidies goes to large operators, large operators are buying out small operators; and (2) subsidies result in inflated land values, thus making it even more difficult for young agriculturalists to get a start. South Dakota census data show a net emigration rate of 17.8% for farm family members in rural settings from 1990-95 (Higgins et al. 2002, note 84 *supra*). This trend is likely to continue to drive the numbers of people employed in agriculture in the NGP lower still.

[232] Intertribal Bison Cooperative, http://www.intertribalbison.org/main.asp?id=1.

[233] Land Trust Alliance. 2001. National Land Trust Census. http://www.lta.org/newsroom/census_summary_data.htm

[234] Statistics Canada. 2002. Census of Agriculture. http://www.statcan.ca/english/Pgdb/econ108i.htm

Figure 33. Human Population Trend in the Northern Great Plains



SOURCE

Center for International Earth Science Information Network, Columbia University; International Food Policy Research Institute; and World Resources Institute. 2000. Gridded Population of the World, Version 2.

LEGEND

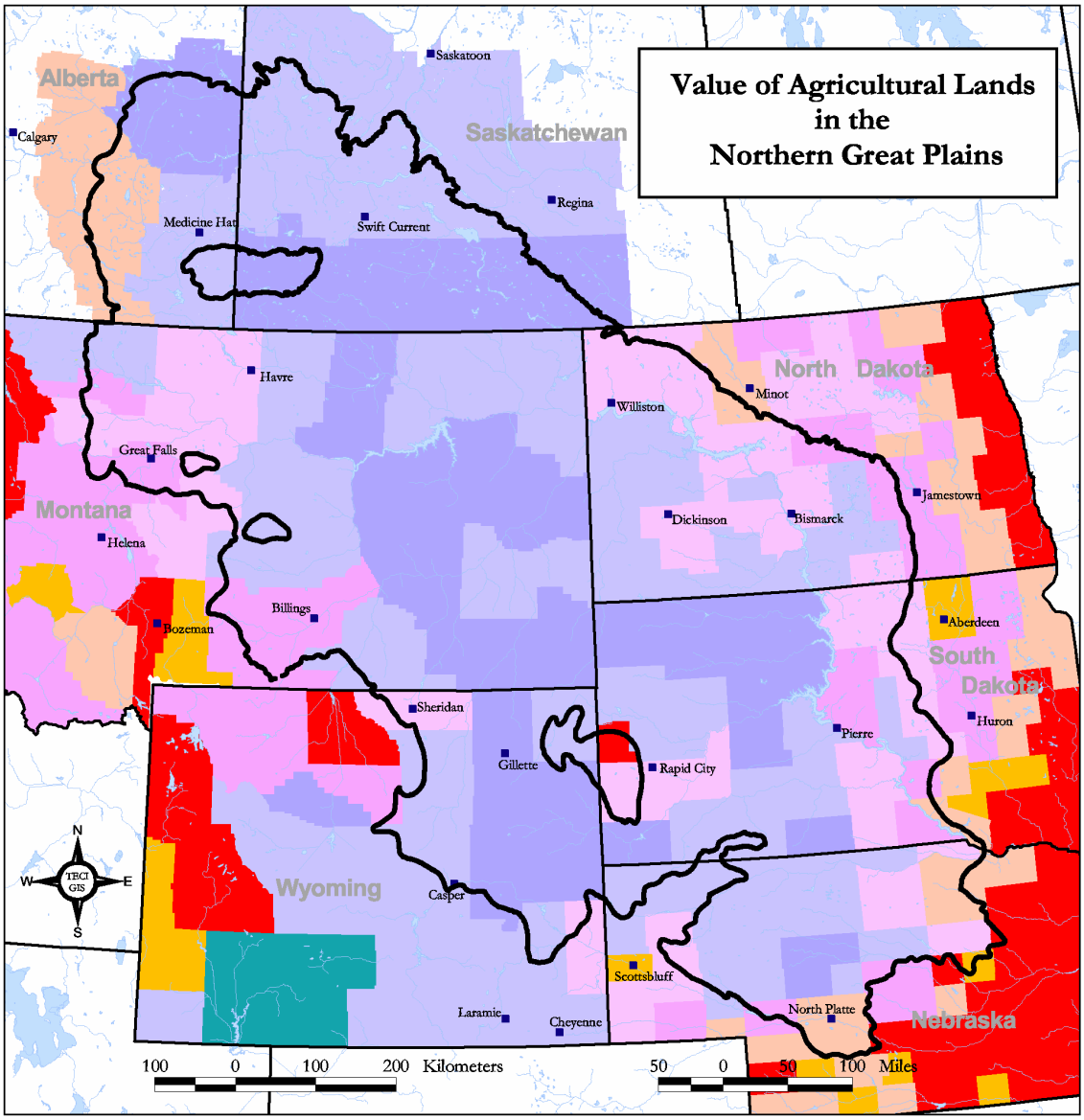
Northern Great Plains Ecoregion boundary

Percent change in human population (1990-1995):

- More than 20% decrease
- -20 - -11
- -10 - -1
- 0 - 10
- 11 - 20
- 21 - 30
- 31 - 40
- 41 - 50
- More than 50% increase

WWF

Figure 34. Agricultural Land Value in the Northern Great Plains



SOURCES

U.S. Department of Agriculture. 1997. Census of Agriculture.

Statistics Canada. 2001. Farm data, initial release, Tables 5.1 and 29.1.

LEGEND

Northern Great Plains Ecoregion boundary

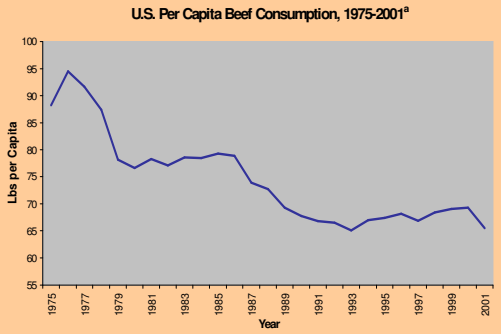
Average market value of an acre of agricultural land, 1996-1997 data adjusted to 2001 U.S. dollars:

- 50 - 100 dollars per acre
- 100 - 200
- 200 - 300
- 300 - 400
- 400 - 500
- 500 - 600
- 600 - 700
- 700+

WWF

A Need for Alternative Economies for NGP Communities

A troubled economy



Today, the economies of some of the most biologically intact areas in the NGP are in crisis, largely because of the decline of the agricultural economy throughout much of the ecoregion. While this overall economic trend is well known, two WWF studies have documented it in more detail for some areas of high conservation priority. For example, a review of six counties in Montana, Wyoming and South Dakota showed that from 1970-97 average annual county income from agriculture declined $22.2 million. Net farm income per county averaged negative $1.7 million in 1997 even with significant subsidies.

Prices for wheat and beef cattle, two of the mainstays of the economy west of the 100th meridian, have also been on a 30-year negative trend. While some producers may continue to remain profitable despite these declines, there is little prospect for improvement over the near term. Economic globalization and free-trade agreements can be expected to render NGP agriculture increasingly uncompetitive with other regions with better climate and market access that can produce these commodities more efficiently. The long-term outlook is that non-agricultural demand for land (ex-urban homesteads, subdivisions, recreational use) will in many areas probably begin to increasingly outcompete agricultural commodities for use of the land (see Connor et al. at pg. 109, note 85 *supra*.

The economic and demographic decline of the NGP has left many communities searching for new alternatives for reinvigorating themselves. Many realize that they must diversify their economic base to survive and thrive. In some cases, nearby prairie wildlife and wildlands are being touted as community assets and are being tapped by entrepreneurs. Two examples recently emerged from Montana's Plains. Ft. Benton, located at the west end of the new Upper Missouri River Breaks National Monument, is now developing a visitor center for the monument, an entrepreneur has restored an elegant old hotel, and outfitters are marketing river trips. Meanwhile, the town of Malta in northeast Montana is trying to attract ecotourists by staging a special three-day event based on wildlife watching at the nearby Bowdoin National Wildlife Refuge. Several studies in the intermountain West have demonstrated that counties with ready access to national parks, wilderness areas and other outdoor recreation opportunities, compared to those without these amenities, have substantially higher rates of population growth, higher income, growth in employment, and lower levels of unemployment.[235]

Sustained Demand for Recreational Opportunities

Demand for additional recreational opportunities in the United States continues to grow. Visitation to prairie parks like Badlands National Park is consistently strong — over 1 million visitors annually for the last 20 years. Rather than deterring economic growth, the presence of protected and roadless areas enhances local economies, and produces faster levels of economic growth (as measured by income and employment) in counties with protected areas than in counties without them.[236]

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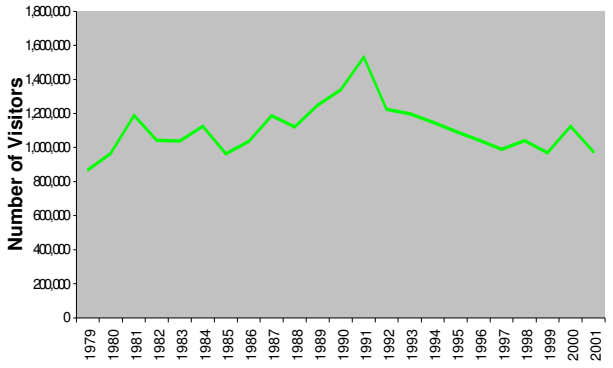
[235] Rudzitis and Johansen 1991, note 17 *supra*; Rasker, R., and A. Hackman. 1996. Economic development and the conservation of large carnivores. *Conservation Biology* 10:991-1002.

[236] Southwick Associates. 2000. *Historic Economic Performance of Oregon and Western Counties*

Figure 35 **Badlands National Park Visitation**



Source: U.S. National Park Service, Public Use Statistics Office, NPS Visitation Database Reports. http://www2.nature.nps.gov/stats/

Badlands National Park visitors generated $5.2 million in direct personal income for local residents and supported 438 tourism related jobs in 2000.[237] Harlingen, Texas, a gateway community to the Laguna Atascosa National Wildlife Refuge, hosts an annual migratory bird gala, which pumped $1.6 million into the local economy in 1995. More than 50 other communities across the country, many of them in the shadow of national parks or wildlife preserves, sponsor similar events to tap the economic potential of birdwatching. According to the U.S. Fish and Wildlife Service, McAllen, Texas (gateway to Santa Ana National Wildlife Refuge) received $14.4 million from birders, while Chincoteague, Virginia, Oak Harbor, Ohio, and Burns, Oregon respectively received $9.7, $5.6 and $4 million from birders who visited neighboring Chincoteague National Wildlife Refuge, Ottawa National Wildlife Refuge, and Malheur National Wildlife Refuge respectively.[238]

These numbers are not surprising when one considers that birdwatching is "one of the most popular and rapidly increasing nature tourism businesses in North America," and that it produced approximately $5.2 billion in revenues in 1996.[239] In Montana alone, wildlife watching produced $212 million in expenditures and sales and generated $82 million in job income in 1996.[240] Sixty-six million Americans participated in wildlife watching in 2001, including 18 million who took bird-watching trips.[241] Those traveling to observe wildlife spent $8.2 billion in trip-related expenditures.[242]

Expenditures for hunting in the United States increased from $14.2 billion in 1991, to $20.3 billion in 1996, to $20.6 billion in 2001, according to the U.S. Department of Interior.[243] Hunting

Associated with Roadless and Wilderness Areas, Southwick Associates, August 2000, p. 21.

[237] Propst, D., D. Stynes and Y. Sun. 2002. Economic impacts of Badlands National Park Visitor spending on the local economy, 2000. Deptartment of Park, Recreation and Tourism Resources, Michigan State University, East Lansing. http://www.prr.msu.edu/mgm2/badlands.pdf

[238] United States Department of Interior (1996) and Howe et al. (1997), as cited in "Wildlife Markets and Biodiversity Conservation in North America," Curtis H. Freese and David L. Trauger, Wildlife Society Bulletin, Vol. 28, No. 1 (Spring 2000), p. 48. The same revenue stats also found in *Balancing Nature and Commerce*, p. 29.

[239] United States Department of Interior (1996) and Howe et al. (1997), as cited in "Wildlife Markets and Biodiversity Conservation in North America," Curtis H. Freese and David L. Trauger, Wildlife Society Bulletin, Vol. 28, No. 1 (Spring 2000), p. 48.

[240] Caudill, J. and A. Laughland. 1998. 1996 National and State Economic Impacts of Wildlife Watching. USDI-Fish and Wildlife Service, Division of Economics, Arlington, VA.

[241] U.S. Department of Interior, U.S. Fish and Wildlife Service, U.S. Department of Commerce, and U.S. Census Bureau. 2002. www.census.gov/prod/2002pubs/FHW01.pdf

[242] Id.

[243] National Survey of Fishing, Hunting, and Wildlife-Associated Recreation, United States

expenditures in the 5 states in the NGP ecoregion totaled $885 million in 2001.[244] Moreover, hunting brought in 347,000 nonresidents to the 5 states in 2001—the highest percentage of nonresident hunters for all 50 states, including Alaska. As in the case of Badlands National Park, the local economic impact of a protected area where hunting is managed can be significant—visitor spending as a result of mostly hunting and fishing opportunities on the C.M. Russell National Wildlife Refuge in the 6-county area of the Refuge in 1995 was estimated as $3.5 million, including generation of 102 jobs.[245]

Economic and Other Incentives

Investments in Private Land conservation: The general inadequacy of public funding, combined in some cases with public aversion to and government policies against public agency purchase of private lands for conservation, has given increasing importance to land acquisition by nonprofit organizations. Ducks Unlimited, The Nature Conservancy, Nature Conservancy Canada, the Rocky Mountain Elk Foundation, and other nonprofit organizations have been directing financial resources into fee-simple acquisition and purchasing conservation easements from willing sellers on private lands in the NGP. Investment in interests in land from willing sellers in relatively intact ecosystems like the NGP has an advantage over rapidly developing areas because: 1) undeveloped areas have relatively fewer threats from fragmentation, human disturbance, pollution, and other threats, 2) survival of species is better than where rapidly increasing land prices demand more intensive use of the land, and 3) there are generally lower operating and restoration costs than in developed areas.[246]

In addition, land prices in the grasslands are relatively low, making large-scale investments in rights in land feasible. In constant U.S. dollars, farmland value in the mixed grass ecoregion actually declined 2% from 1978-1992—in real dollars, 54.4%.[247]

Availability and Participation in Government Programs: The U.S. federal government has targeted some $38.6 billion in farm and ranch conservation subsidies over the next decade (2002-2011).[248] The major shift in funding is away from retirement programs (such as the Conservation Reserve and Wetland Reserve Programs) and toward conservation on working land. The 2002 Farm Bill

Department of the Interior (1996), as cited in "Wildlife Markets and Biodiversity Conservation in North America," Curtis H. Freese and David L. Trauger, Wildlife Society Bulletin, Vol. 28, No. 1 (Spring 2000), p. 42; $16 billion and $23.3 billion, respectively, in 2001 dollars for 1991 and 1995: U.S. Dept. of Interior, Fish and Wildlife Service and U.S. Dept. of Commerce, U.S. Census Bureau, 2001 National Survey of Fishing, Hunting, and Wildlife-Associated Recreation. http://www.census.gov/prod/2002pubs/FHW01.pdf.

[244] U.S. Dept. Interior, Id.

[245] Laughland, A. and J. Caudill. 1997. Banking on Nature: The Economic Benefits to Local Communities of National Wildlife Refuge Visitation. U.S. Fish and Wildlife Service, Division of Economics, Washington, DC.

[246] Czech, B. 2002. A transdisciplinary approach to conservation land acquisition. Conservation Biology 16:1488-1497.

[247] Licht 1997, note 78 *supra* at pg. 129.

[248] U.S. Dept. of Agriculture. 2002. Economic Research Service, U.S.D.A. http://www.ers.usda.gov/Features/farmbill/analysis/conservationoverview.htm

expands authority for land retirement by a total of 4 million acres, an increase of nearly 11 percent over current authority. In addition, the Grassland Reserve Program (effective 2003) authorizes up to 2 million acres of grasslands to be enrolled under 10-30-year contracts (75% of grazing value) or 30-year or permanent easements. A total of $254 million will be available from 2003-2007 to fund this program.

Other federal agencies administer programs intended to deliver conservation results. The U.S. Fish and Wildlife Service administers the Landowner Incentive Program ($40 million annually) and $10 million in private stewardship grants to improve habitat for species at risk.[249]

Approximately 9.5 million acres (3.8 million ha) in the five states in the NGP ecoregion are currently enrolled in the U.S. Conservation Reserve Program (CRP; see Text Box).[250] In Saskatchewan, the Prairie Conservation Action Plan (PCAP) provides incentives for use of management practices consistent with grassland conservation and some funds are available for restoring cultivated land to grassland. Though many farmers and ranchers have already made significant progress as land stewards, more involvement would greatly enhance the chances for ecoregional recovery. Given proper financial and other incentives, including recognition of the benefits of large-scale ecological restoration, many landowners would probably make significant changes in their style of management. Participation of these progressive, conservation-oriented landowners is vital to the success of comprehensive ecological restoration.

Subsidies: Boon or bust?

Agriculture throughout much of the ecoregion continues to be heavily subsidized. North Dakota and Montana are the most agriculturally subsidized states in the U.S. as measured by relation to farm production, with direct federal payments of $0.27 and $0.24 respectively for each dollar of farm production.[251] South Dakota is fifth ($0.17) and Nebraska is eleventh ($0.12).[252] Farm subsidies for the five states of Montana, Wyoming, Nebraska and the Dakotas totaled nearly $16 billion during 1996-2001.[253] While appropriately directed subsidies could provide conservation opportunities, subsidies can have perverse economic results detrimental to conservation. For example, one study found that the CRP program had resulted in the destruction of 1.1 million acres of native prairie in Montana.[254] This was the result of retiring cropland into CRP, and then plowing untilled lands. Thus "sodbusting" occurs despite prohibitions against opening prairie simply to enroll it later in CRP. Because these CRP-enrolled lands are more depauperate biologically (many CRP lands contain 4-7 species of grasses and legumes while native prairie (in eastern South Dakota) contain around 80 species of plants[255]) they simply cannot replace the functional role of native grasslands. Species like Sprague's pipit and Baird's sparrow, for example, avoid these types of plantings.[256]

[249] U.S. Fish and Wildlife Service. Landowner incentives program. http://endangered.fws.gov/grants/private_stewardship.html

[250] U.S. Dept. of Agriculture, Farm Service Agency. 2002. CRP Monthly Summary. http://www.fsa.usda.gov/dafp/cepd/stats/Dec2002.pdf

[251] Environmental Defense. 2001. Food for Thought: The case for reforming farm programs. Environmental Defense, Washington DC, at Fig. 4.

[252] Id. Compare to major agricultural states such as California ($0.02) and Florida ($0.01).

[253] Environmental Working Group. 2003. Environmental Working Group Farm Subsidy Database: 1996-2001. http://www.ewg.org/farm/

[254] Knowles, C.J. 2001. The Conservation Reserve Program in Montana as a catalyst for loss of grassland biodiversity. FaunaWest Wildlife Consultants, Boulder, MT. Unpubl. Rept. to The Nature Conservancy. 21pp +.

[255] Higgins et al. 2002, note 107 *supra*.

[256] Id.

New Public-Private Partnerships

In addition to the growing work of the Prairie Pothole Joint Venture (PPJV), the Northern Great Plains Joint Venture (NGPJV) is being launched as a collective of public and private groups to restore prairie ecosystems for bird conservation. The PPJV is largely addressing conservation within the Missouri Coteau sub-ecoregion, with significant participation by Ducks Unlimited-US. The NGPJV region, which falls entirely within the Northern Great Plains Ecoregion, includes the area of Montana, the Dakotas, Wyoming, and the northwest corner of Nebraska between the Rocky Mountain Front and the Missouri River.

Meanwhile, the U.S. Bureau of Land Management and U.S. Forest Service have created many unique conservation opportunities over hundreds of thousands of acres of public land through development of National Reserves, National Preserves, National Monuments, National Conservation Areas and Cooperative Management and Protection Areas in the last decade.[257] Some of these conservation options could serve to heighten appreciation of publicly owned prairie lands.

Finally, national and international initiatives are underway to address continental and global grassland conservation. For example, the North American Council on Environmental Cooperation (CEC) is producing a framework for conservation of the central North American grasslands, including Canada, the U.S. and Mexico.[258]

[257] Forrest, S.C. 2002. Creating new opportunities for ecosystem restoration on public lands: an analysis of the potential for BLM lands. Public Land and Resources Law Review 23:21-75.

[258] Gauthier et al 2003, note 115, *supra.*

Chapter 7: The NGP Conservation Landscape

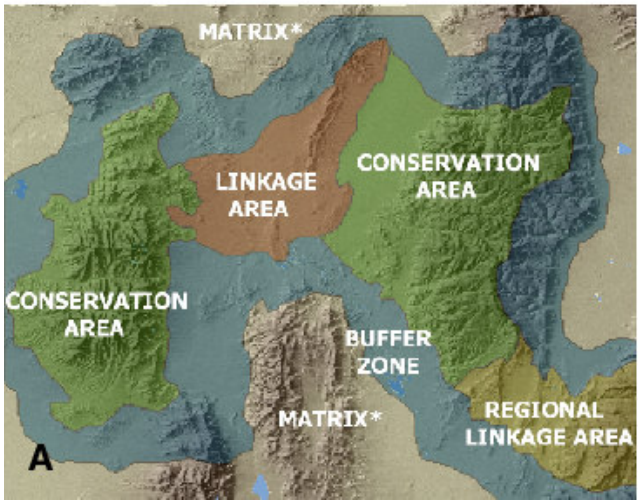


Figure 36. Hypothetical Reserve Network within a conservation network.

A conservation landscape is one designed to meet the ecological requirements of the biodiversity in a particular priority area. The design may include a mosaic of land uses ranging from conservation areas to low-impact land uses that act as buffers or corridors between protected areas, to areas of intense human use (e.g. cities or towns), where little biodiversity remains. This approach largely grew out of the reserve network concept,[259] which combines species conservation, land conservation, and resource management. Under this model, a set of core conservation reserves, surrounded by buffer zones managed under low-intensity land-use regimes, is managed to maximize ecological integrity (Figure 33). Linkage areas of sufficient size and shape as to permit dispersal of focal species connect conservation areas. Linkage areas may include a mosaic of human-converted landscapes and wild habitat. The portion of the landscape outside of the conservation areas, called the matrix, may consist of a mosaic of land uses that satisfy the needs of people while encouraging more natural levels of biodiversity.

Our primary goal in this assessment was to identify large-scale conservation areas that could serve as cores for building such a network—areas of at least one million acres to several million acres with high conservation value. This analysis builds on the work of The Nature Conservancy (TNC), which created a portfolio of high conservation value sites for the Northern Great Plains Steppe (using similar boundaries to the

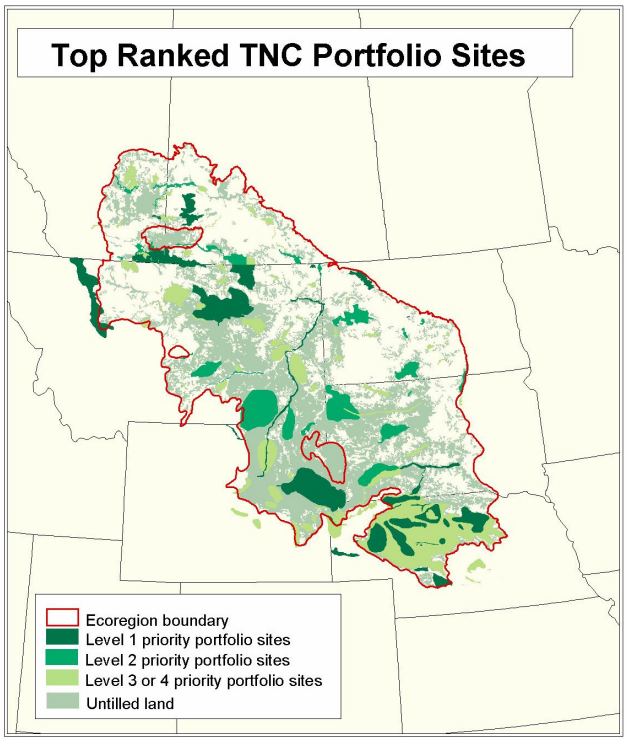


Figure 37. TNC Portfolio Sites.

[259] See, e.g., Noss, R.F., E. Dinerstein, B. Gilbert, M. Gilpin, G.J. Miller, J. Terborgh, and S. Trombulak. 1999. Core areas: where nature begins. *In* J. Terborgh and M. Soulé, eds., *Continental Conservation: Scientific Foundations of Regional Reserve Networks*, pp. 99-128. Island Press, Washington, D.C.

NGP Ecoregion) in 2000[260] and is currently working on an assessment of the Nebraska Sandhills.[261] The TNC assessments are based on data from state Natural Heritage programs, satellite imagery and field verification, expert workshops, and published literature.[262] TNC identified 116 portfolio sites in the Northern Great Plains Steppe and 82 in the Sandhills region (Figure 36).[263] Not surprisingly, because of the overlap in focal species we use and the data available to both planning efforts, several TNC sites fall within the large areas we identify.

While TNC developed its conservation plans to ensure representation of all distinct natural communities and to address concerns about species viability for its focal species, there was no explicit attempt to address restoration of large-scale ecological processes or extirpated keystone species like bison. Large conservation areas are needed to accomplish not only those objectives, but also to: (1) maintain large-scale ecological interactions and long-term evolutionary mechanisms; (2) maintain resilience in the face of large-scale disturbances and long-term change; (3) restore and maintain migration routes and movement corridors; and (4) restore ecologically significant components of the ecoregion. However, because a reserve design that includes large conservation cores will need to be complemented by a network of smaller reserves and non-reserve lands to meet particular conservation targets that occur outside of the large areas, the TNC analysis still provides an important basis for ecoregional conservation that this NGP Ecoregion assessment does not replace. The primary contribution of the current analysis is to complement TNC's work by identifying those landscapes where large core areas can be conserved.

IDENTIFYING AREAS FOR LARGE-SCALE RESTORATION:

Areas should have exceptional biodiversity value:

- As many biotic communities as possible should be represented among the suite of areas;
- Areas should include core populations of endemic species;
- Areas should afford opportunities to conserve or restore rare or threatened species; and
- Areas should be distributed to capture maximum biological variation across the ecoregion.

Areas should have high restoration potential:

- Areas should be practicably restorable from an economic, cultural, and legal standpoint;
- Areas should be sufficiently large and ecologically intact to support restoration of species and processes.

Our secondary goal was to identify relatively intact riparian systems or watersheds and areas with high biodiversity conservation importance due to the presence of Great Plains endemics, grassland obligates, and imperiled species, which also complemented TNC's analysis. Our analysis in this case is not scale-dependent in that our understanding of

[260] TNC 2000, note 27 *supra.*

[261] Hall, J., TNC, pers. comm.

[262] TNC's ERC team based its strategy for assembling the suite of priority areas (portfolio of conservation sites) on guidelines from The Nature Conservancy's publication: *Conservation by Design: A Framework for Success* (The Nature Conservancy 1996a).

[263] The sites identified by TNC range from 335 acres (135 ha) to 2.5 million acres (1.01 million ha), totalling about 30 million acres (12 million ha), or about 16% of the ecoregion. TNC 2000, note 27 *supra*.

aquatic species spatial needs is incomplete. We hope that by identifying watersheds that are relatively intact and aquatic reaches that are important for numerous focal species we will begin to focus some conservation attention on these areas.

With respect to connectivity, at the present time we lack sufficient knowledge regarding linkage requirements for NGP species to incorporate priorities for linkage zones into this analysis. Linkages between priority landscapes, however, will surely be important and will vary greatly among focal species. It is probably less important to provide physically connected landscapes within the ecoregion for passerine birds, for example, than for prairie dogs. Key migration and/or dispersal routes used by many species, particularly potentially wide-ranging predators and ungulates are unknown, and little work has been done to identify key connections to adjacent ecoregions. Regarding acquatics, the fragmentation effects of dams, reservoirs and dewatering probably vary significantly among fish species, but can be serious, as evidenced by the decline of the endangered pallid sturgeon.

Components of Suitable Large-scale Conservation Areas in the NGP

We had two objectives to meet in identifying large conservation areas: 1) that the areas contain high current biodiversity value, and 2) that the areas have high restoration potential. In order to accomplish this, we devised a decision-making model that enabled participating NPCN representatives to assign relative weights to criteria for satisfying both biodiversity and restoration objectives (Appendix L). Representatives assigned their own weights and these weights were averaged to determine a final NPCN consensus value for each criterion.

Restoration opportunities were divided into public and private sectors, as each of these requires slightly different criteria (Appendix L). The final outputs are maps representing those areas that best meet the combined goals of high current biodiversity and high restoration potential for private lands, for public lands, and for both types of land combined. Because riparian and wetland habitat values are largely linear (in the case of riparian habitat) or discrete (in the case of wetland habitat) we chose to examine these separately.

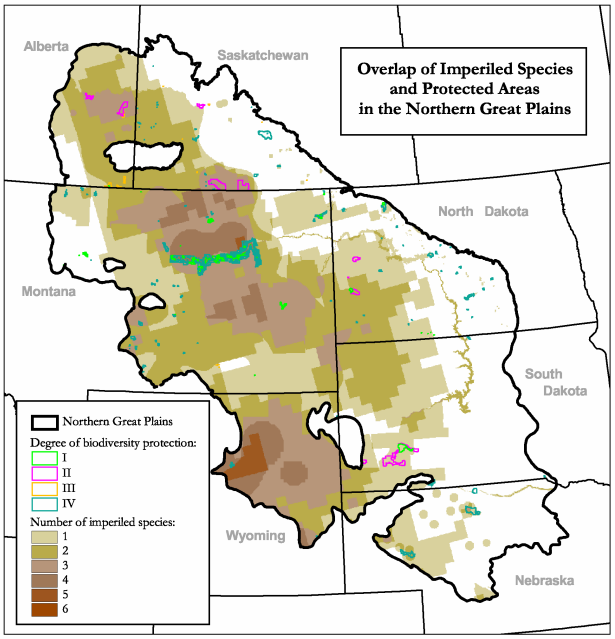


Figure 38. Overlap of Imperiled Species and Protected Areas in the Northern Great Plains.

Biodiversity Importance

Biodiversity importance was scored for each 1 sq km pixel in the ecoregion using the following criteria:

- *REPRESENTATIVE BIOTIC COMMUNITIES*

TNC's analysis recognized 323 natural community types, which TNC collapsed into 34 "ecological complexes,"— "*taxonomically-related associations and alliances, or easily identified (ecologically) assemblages of natural communities (e.g., riparian types) that could be incorporated in landscape-based conservation action*"[264]—in its Northern Great Plains Steppe plan (Table 3). Because representation of these complexes, as well as 19 animal and 21 primary plant focal species, was captured by TNC's portfolio design, we created one thematic map layer that included TNC's portfolio to represent important biodiversity value as well as to ensure to some degree that representative biotic communities were included in the model.

Another important data source for biodiversity importance was a 2002 WWF-Canada report detailing important conservation lands in southeast Alberta and southwest Saskatchewan, and adjacent U.S. lands.[265] This assessment produced 6 study blocks identified by high native vegetation cover (>63%) in contiguous blocks greater than 5000 km^2 with low road density <0.65 km of road/km^2. Results were based on finer filter analyses that looked to ecosystem diversity and rare and focal species occurrences as well as certain socioeconomic factors such as well-site occurrence, protected areas, and land ownership and population decline.[266]

Table 2: Ecological complexes represented by TNC's ecoregional analysis.

Community Type	***Number Represented***
Big sage	5
Basin big sage	1
Black sage	2
Birdsfoot sage	1
Mountain mahogany	3
Nuttall's saltbush	2
Greasewood	2
Silverberry	1
Creeping juniper	2
Tallgrass prairie	6
Prairie Sandreed	8
Western Wheatgrass	16
Thickspike Wheatgras	3
Needlegrass	23
Idaho fescue	2
Rough fescue	3
Bluebunch wheatgrass	11
Little bluestem	13

[264] TNC 2000, note 27 *supra*.

[265] Wallis, C. 2003. *Conservation Assessment-Northern Glaciated Plains of North America*. Report to World Wildlife Fund Canada. 87pp.

[266] Alberta Environmental Protection has also identified environmentally significant areas in the NGP portion of Alberta. Alberta Environmental Protection. 1997. *Environmentally Significant Areas of Alberta*. 3 Vols. Sweetgrass Consultants, Calgary. Available at: Alberta Community Development, http://www.cd.gov.ab.ca/preserving/parks/anhic/docs/esa_provincial_overview.pdf. The BLM's "Areas of Critical Environmental Concern" (ACECs) represent another class of "biologically important" areas in the NGP. These were not included in the model because we felt that for the most part the importance of these landscapes was captured in other criteria. Their recognition is likely to be important, however, in any future site-specific planning.

- *CORE POPULATIONS OF FOCAL BIRD SPECIES*
  We used concentrations of breeding densities for non-imperiled grassland-obligate birds (Appendix C2, Appendix L) to identify important breeding habitats for reasons discussed earlier.[267] The overlap of the highest breeding densities were used to represent "core" areas of high breeding biodiversity for grassland obligates.

- *CUMULATIVE DISTRIBUTIONS OF IMPERILED FOCAL SPECIES.* We mapped the distributions of critical habitats of all imperiled focal species (excluding black-footed ferrets) to identify areas where multiple imperiled species could be conserved (Figure 38).

- *SUITABLE HABITAT FOR PRAIRIE DOGS.* We utilized an existing analysis to identify areas suitable for prairie dog restoration[268] based on vegetation and slope in the prairie dog's historic range.

- *FOCAL AREAS FOR BLACK-FOOTED FERRET RECOVERY.* Black-footed ferret recovery areas are derived primarily from Proctor et al.[269] They include prairie dog habitat in blocks of over 5,000 acres (2020 ha) on public, tribal and private preserve lands, areas with current large concentrations of prairie dogs, ongoing ferret reintroduction efforts, areas managing toward ferret recovery, and areas proposed for ferret reintroduction.

- *KNOWN NATIVE PRAIRIE.* High quality data on the distribution of native prairie are limited to Alberta. We can refine future assessments and monitoring activities as more information is gathered on the distribution and condition of native prairies. Outside of Alberta, we used existing remotely sensed data for untilled grasslands as a surrogate for native prairie (Appendix L). In most areas we believe this is a good surrogate; most currently untilled grasslands have probably never been tilled. This received low weight among biological criteria because we recognize that some biological importance exists where grasslands have been tilled. A higher weight might exclude from consideration some areas that are biologically desirable (due to productivity or some intrinsic characteristic) even though they are tilled.

Other factors considered were: last known areas for bison, summer and/or winter precipitation, and dominance by C4 grasses. These criteria, however, did not weigh heavily according to NPCN member scoring in the final results of the model. These factors may be important at the site level in determining productivity, but productivity per se was not viewed to be as important as existing biotic integrity. We would have liked to include the distributions of wildlife diseases such as sylvatic plague, canine distemper, and chronic wasting disease as critieria. However, no reliable geographic data exist to help distinguish areas with a high incidence of these diseases.

We weighted these criteria—untilled grasslands, imperiled NGP species, focal bird species, prairie dog suitable

[267] See discussion, Chapter 5, *supra.*
[268] Proctor et al. in press, note 15 *supra*.
[269] Id.

habitat, and black-footed ferret recovery areas—according to relative values assigned by NPCN members. Then within the IDRISI decision-making environment[270] we produced a map representing relative biodiversity importance for each 1-km pixel within the NGP. Figure 36 indicates the distribution of the top 30% of all cells scored. This cutoff represents a compromise—while we want to concentrate on lands with the very highest biodiversity values, we needed enough suitable results in which optimum restoration opportunities over large expanses could be identified. Thirty percent gave us good discrimination (between high value and lesser value scores) and was fairly robust in that inclusion of a higher percentile of cell scores (e.g., 50%) did not result in "new" areas appearing, but rather greater aggregation within the general distribution as it appears in Figure 36. This map was used as a prerequisite for further analysis of restoration potential, because we wanted to focus on the most efficient and complementary areas first—those areas where we might capture the largest number of conservation targets.[271]

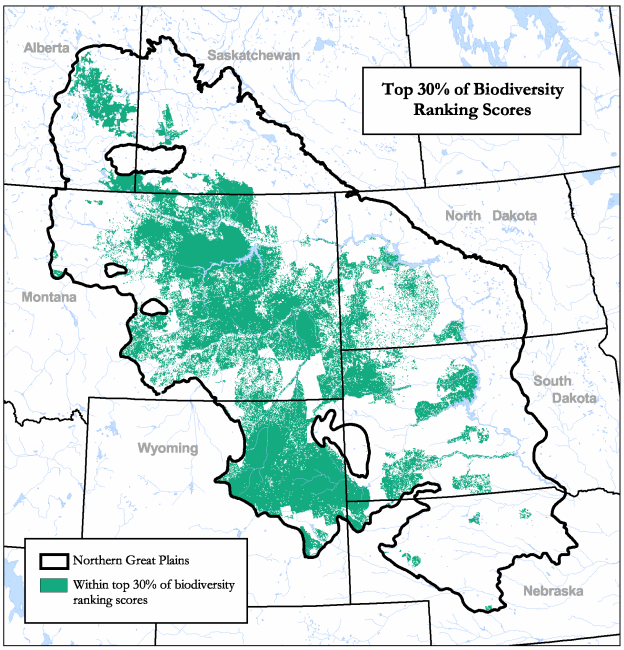


Figure 39. Top 30% of Biodiversity Ranking Scores by NPCN members.

Restoration Potential

Restoration potential depends on both ecological and socioeconomic conditions. Areas that are relatively intact ecologically, such as untilled native prairie, will generally be easier to restore than areas that have been heavily degraded ecologically, such as wheat fields. "Restoration should focus on how to improve the viability and integrity of *existing* conservation targets" as opposed to the poorer second choice of starting from scratch.[272] Land tenure and associated land-use policies will strongly influence the cost and feasibility of converting lands from non-biodiversity uses to biodiversity conservation purposes. We assumed that lower costs and greater public support for restoration are more likely to prevail where the landscape is less modified

[270] IDRISI32 version 132.22. IDRISI is a professional-level GIS, Image Processing and Spatial Statistics analytical tool developed by Clark Labs at Clark University. http://www.clarklabs.org/AboutClarkLabs.asp?cat=1

[271] Capturing conservation "efficiency" is recognized as a key overarching principle in conservation planning: Groves, C. 2003. Drafting a Conservation Blueprint: A Practitioner's Guide to Planning for Biodiversity. Island Press, Washington, D.C.

[272] Id.

and fewer dollars have been capitalized into infrastructure.

Restoration on public lands
Each 1 km pixel of public land in the ecoregion was scored for restoration potential using, as a prerequisite, the top 30% of cells from the biodiversity importance layer, plus the following additional criteria:

- *MANAGEMENT OPPORTUNITY.* Some land ownership types are managed with biodiversity conservation as a high or their highest priority. For example, National Parks, Wildlife Refuges, and Ecological Reserves are typically charged with managing to preserve biodiversity. Thus, there is generally less cost in changing management emphasis as one moves along the continuum from private lands to quasi-public, to fully protected lands. In other words, there is additional benefit in working in those landscapes that have some or much protection already in place.

- *SUITABLE FOR BLACK-TAILED PRAIRIE DOGS*. Public lands are critical for black-tailed prairie dog ecosystem recovery because private landowners seldom have either the desire or enough land to allow large colonies to exist. Prairie dogs are also more likely recoverable on public lands, where there are legal mandates for their conservation.

- *ROAD DENSITY*. Roads are indicative of the level of infrastructure development (primarily resource development on public lands). Larger highways will curtail natural movement of wildlife. Furthermore, roads act as conduits for the establishment of invasive species.[273] We consider low road density as a fairly good indicator of the level of human infrastructure and ecological integrity.

- *UNTILLED LAND.* Untilled land provides an indicator not only of the biological value of a landscape, but also implies lower restoration costs of reintroducing native species. We viewed this as relatively unimportant on public lands as tillage is prohibited on most public lands.

- *PRESENCE OF PRODUCTIVE OIL AND GAS WELLS FOR THE US, OIL AND GAS POOLS FOR SASKATCHEWAN (NO DATA FOR ALBERTA).* There may be instances where intensive industrial use of the land conflicts with conservation objectives. Where possible, it is best to avoid situations where competing objectives might come into conflict with biodiversity concerns.

- *PRESENCE OF COAL DEPOSITS, INCLUDING COAL BED METHANE FIELDS (FOR THE SAME REASONS AS LISTED ABOVE).*

Restoration on private lands
Each 1 km pixel of private land[274] in the ecoregion was scored for restoration potential using, as a prerequisite, the top 30% of cells from the biodiversity importance layer, and including the following criteria:

[273] Gelbard and Belnap 2003, note 147 *supra*.
[274] Tribal lands were treated as private lands for this analysis. We recognize that certain tribal lands are "public" to Tribal members, but ownership data was not available for Tribal lands in the Dakotas and we deemed these lands would be better represented as private lands in the aggregate.

- *HUMAN POPULATION DENSITY.* We felt that fewer people imply fewer land-use conflicts, less human infrastructure, and greater opportunities for moving to conservation-driven management. This was relatively more important for restoration on private lands than all other factors except untilled, which we felt was the most important attribute from a restoration standpoint.

- *UNTILLED.* We viewed untilled private lands as very important because untilled grasslands still retain some of their original biotic integrity, will be less expensive to restore, and probably represent areas with fewer existing conflicts over potential use. They may be ecologically suitable for immediate reoccupancy by bison and/or prairie dogs, two of our keystone focal species.

- *AGRICULTURAL LAND VALUE*. Areas of low land value should have relatively high potential for restoration because less money is needed to purchase lands or easements for conservation purposes. Furthermore, high land values generally indicate greater socioeconomic demand for the land and therefore greater potential for land-use conflict. Unfortunately, the only data available to us were of coarse geographic resolution. Data at the county scale do not reflect local variations in price due to the remoteness of the property, the quality of the property, and so forth. Although we retained agricultural land value in the model, we gave it much less weight than most other factors due to the data's coarseness.

- *PROXIMITY TO PUBLIC LANDS*. From a leveraging standpoint, we considered proximity to public lands as beneficial because changing management of such private lands could connect and functionally enlarge existing public lands with favorable management regimes.

- *ROAD DENSITY.* Same as for public lands.

- *COAL/OIL/GAS DEVELOPMENT*. Same as for public lands.

- *AVERAGE AGE AND AVERAGE INCOME.* Age and income were considered by some to be of use in identifying private lands with restoration potential. Both old age and low average income may be indicative of the probability of future turnover of private land and its relative value. We included the data in the model, but weighted them lightly recognizing that their value was confounded by other variables that could affect land tenure.

Relative Restoration Potential for Public and Private Lands

The results of the restoration analysis are indicated by Figures 40 and 41. Areas shaded dark red have the highest relative restoration potential. Restoration potential on private lands appears to be heavily influenced by the intactness of grasslands, which in turn is likely a function of annual precipitation influencing agricultural development. The eastern part of the ecoregion generally has greater precipitation and thus more tilled land. Public lands restoration potential is influenced by

both how the lands were rated with respect to the IUCN protected area designation, and, particularly in the Powder River Basin and parts of the Little Missouri Grasslands, impacts from oil and gas development.

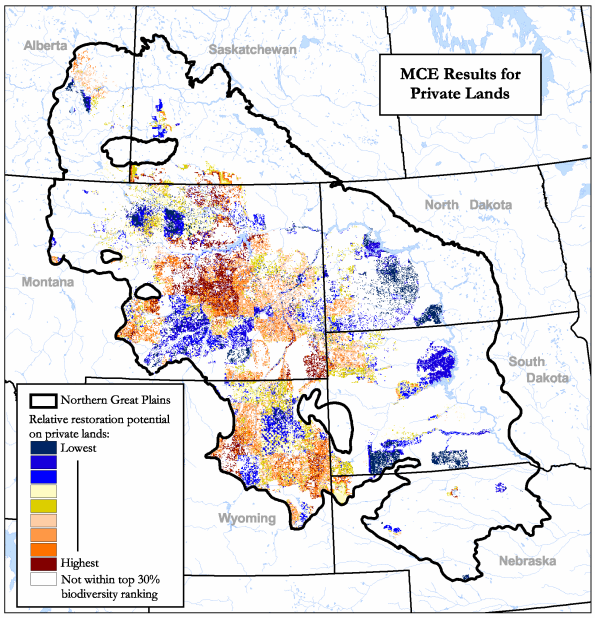


Figure 40. Best Restoration Potential for Private Lands.

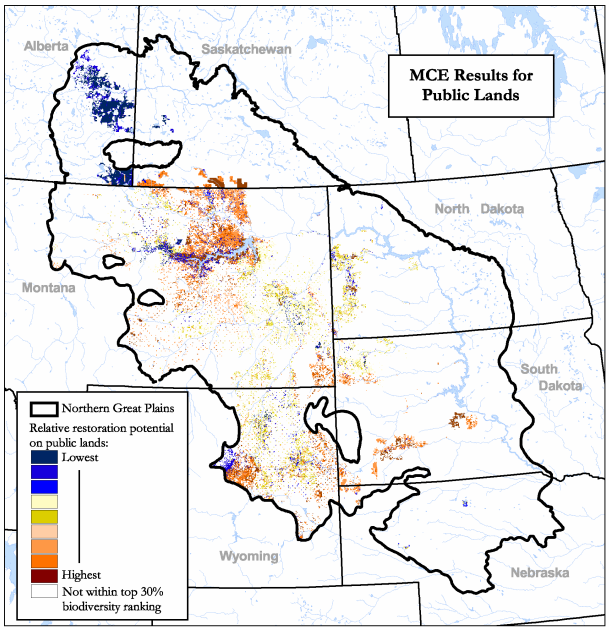


Figure 41. Best Restoration Potential for Public Lands.

Ten Potential Core Areas for Large Landscape Conservation

The highest scoring 50,000 cells for both public and private lands[275] are shown in Figure 39. Ten landscapes in the ecoregion appear to have outstanding opportunities for large-scale conservation based on this analysis:[276]

1. Sage Creek, AB/SW Pastures SK: This approximately 2-2.5 million acre (ca. 1 million ha) area includes primarily Canadian land straddling the Alberta/Saskatchewan border and part of Montana. It includes large ownership of Crown lands and Prairie Farm Rehabilitation Administration lands, and is an area that has been identified as having high biodiversity importance by TNC, WWF-Canada, and several other organizations.
2. Grasslands National Park, SK/ Bitter Creek, MT: This region of approximately 2-2.5 million acres (ca. 1 million ha) straddles the Canada-U.S. boundary. It includes Grasslands National Park on the Canadian side and the BLM's Bitter Creek Area of Critical Environmental Concern on the U.S. side. This area has been recognized by several organizations as having exceptional biodiversity significance.
3. Montana Glaciated Plains, MT: Approximately 2.5-3.5 million acres (1-1.4 million ha), this region is largely bracketed by the 1.1-million-

[275] 50,000 was chosen after a few iterations using different numbers of cells. 50,000 gave us the best ability to clearly distinguish separate large area concentrations across the ecoregion.
[276] We adopted site descriptors used by TNC 2000, note 27 *supra*, where appropriate.

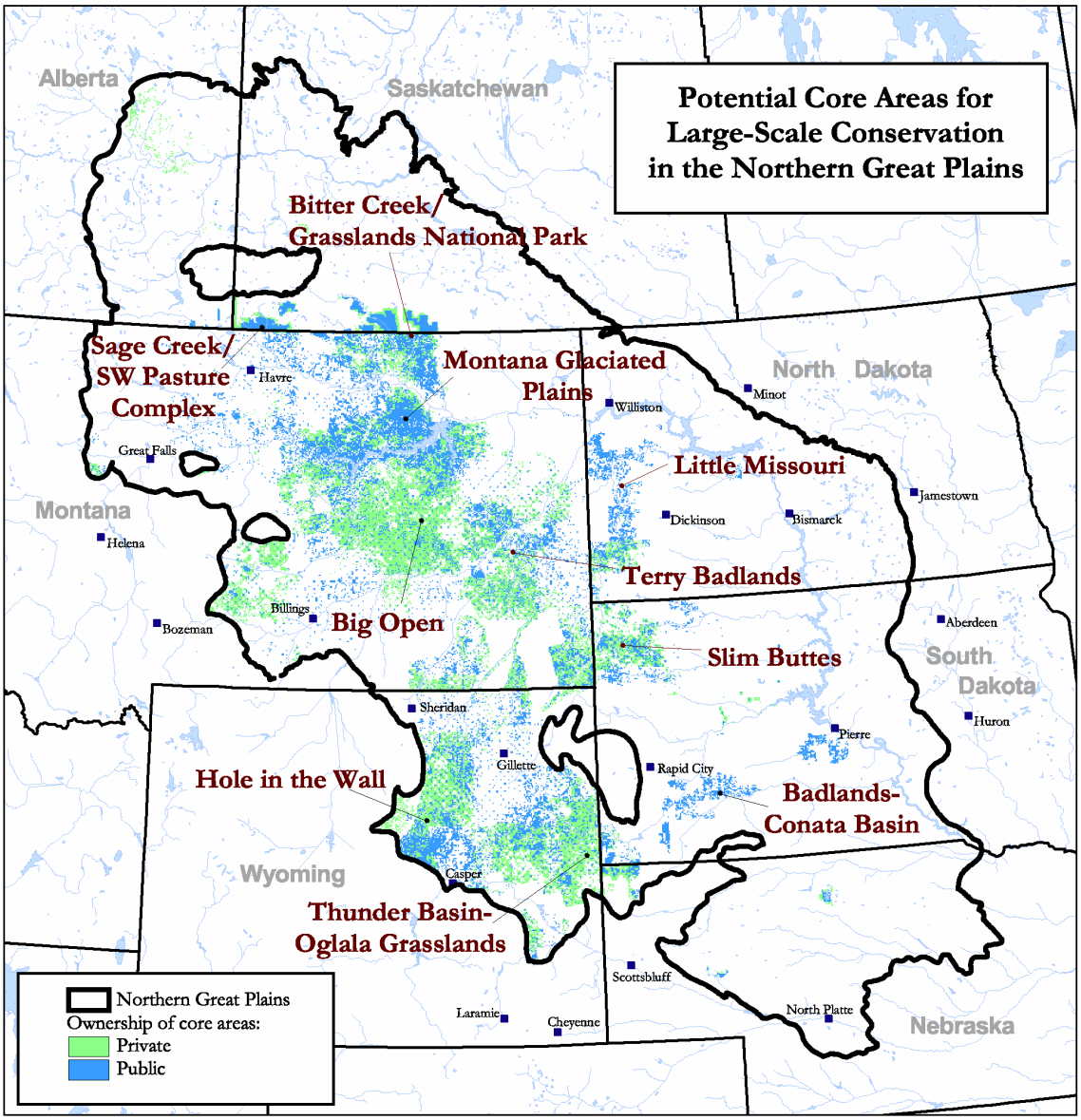
acre CMR Refuge on the south and by the Milk River on the north. It includes extensive prairie dog habitat, two reintroduction sites for black-footed ferrets, and significant populations of mountain plover and sage grouse.

4. Little Missouri Grasslands, ND. Anchored by Theodore Roosevelt National Park and the Little Missouri National Grasslands, this area contains the highest density of prairie dogs remaining in North Dakota and an existing public bison herd.
5. Terry Badlands, MT: Prairie dogs and intact grasslands.
6. Big Open, MT: Mostly composed of private lands, this area is one of the least populated areas in the ecoregion. It boasts largely untilled grasslands and high quality sage grouse populations.
7. Thunder Basin, WY/Oglala Grasslands, NE: Intact grasslands, significant prairie dog populations, significant potential for black-footed ferret reintroduction. Site priority is rated "very high" by TNC.
8. Slim Buttes, SD: Mostly intact grasslands, a mix of public and private lands.
9. Badlands/Conata Basin, SD: Mostly anchored by Badlands National Park and the Buffalo Gap National Grassland, the area contains the only successful black-footed ferret recovery site, numerous prairie dogs, and an existing public bison herd.
10. Hole in the Wall, WY: This area rated high due to significant mountain plover habitat, significant prairie dog acreage, relatively intact grasslands, and large contiguous acreage in BLM lands.

We did not affix "boundaries" to any of these landscapes, recognizing that a generalized model such as this serves primarily to locate opportunities that will have to be explored in greater detail at the site level. For example, the "Sage Creek" area of Alberta was not highlighted by this analysis, although it is generally acknowledged to be an important grassland landscape and ecologically linked to the "SW Pastures" area of Saskatchewan.[277] However, most of the sites encompass areas in excess of 2 million acres, approaching the size of areas (3 million acres or greater) discussed earlier[278] as likely necessary to capture the full range of biodiversity and ecological processes within the ecoregion and to restore keystone species like the bison and prairie dog.

[277] See, Wallis, note 265 *supra* and Alberta Environmental Protection, note 265 *supra*.
[278] See discussion, notes 154-210, *supra*.

Figure 42. Ten Potential Core Areas for Conservation Identified by NPCN based on Biodiversity Importance and Restorability



Important Aquatic/Riparian Areas

Typically, freshwater ecosystem planning involves a different approach than the "reserve design" applied to terrestrial landscapes. Often, the classification of distinct zoogeographic watersheds (Ecological Drainage Units) is used to identify ecological subunits of the landscape that may have unique biota or processes.[279] We have not attempted that here, noting that recent Glaciation in the upper Missouri has resulted in "no known endemic [endemic to the upper Missouri only] fish, mussel, crayfish, or aquatic herpetofauna species," although the prairie potholes "may harbor endemic species of aquatic invertebrates and plants."[280]

For the present, our preliminary assessment roughly approximates recommendations by Moyle and Yoshiyama[281] to identify clusters of species in need of conservation, although a better result would be obtained by also identifying clusters with high densities of these species as well as high densities of endemics or other native fish.[282] We present data on the distribution of several key aquatic focal species, recognizing that a more thorough understanding of the ecological context for their conservation may be difficult to express spatially and that conserving their habitats presents special problems of scale and connectivity. For example, habitat quality for nesting birds and fish in much of the main stem Missouri River may be affected by the controlled release of stored water hundreds of miles away. We also lack information on habitat suitability for some extirpated species, like river otter, that could better inform restoration opportunities for reaches of some prairie streams. In addition, we would like to identify relatively intact watersheds within the ecoregion as potential conservation areas.

Given the limitations described above, we used the following criteria to identify rivers and streams with high conservation value:

- *IMPERILED AQUATIC/RIPARIAN SPECIES CONCENTRATIONS.* A number of aquatic or limnic species occurring in the NGP are considered at risk or are listed as species threatened, endangered or of concern. We included distributions for several fish species (pallid sturgeon, sturgeon chub, sicklefin chub, shovelnose sturgeon, pearl dace, finescale dace, finescale x redbelly dace and western silvery minnow) and two bird species (Interior tern and Piping plover).

- *WETLAND/RIPARIAN BIRDS.* We used highest concentrations of breeding densities for non-imperiled grassland-obligate birds that specialize in aquatic habitats

[279] Higgins, J. 2003. Maintaining the Ebbs and Flows of the Landscape: Conservation Planning for Freshwater Ecosystems. Pp 291-318, *in* Groves, C, *Drafting a Conservation Blueprint*, Island Press, Washington, D.C.

[280] Abell et al, note 95 *supra*.

[281] Moyle, P.B., and R.M. Yoshiyama. 1994. Protection of aquatic biodiversity in California: A five-tiered approach. Fisheries 19:6-18.

[282] Patton, T.M. 1997. Distribution and status of fishes in the Missouri River Drainage in Wyoming: Implications for identifying conservation areas. Ph.D. Dissertation, University of Wyoming, Laramie. 173 pp.

(Appendix C2, Appendix L) to indicate critical areas for their conservation. The overlap of these layers thus represents "core" areas of high biodiversity for wetland breeding bird that are grassland obligates across the ecoregion.

- *DEGREE OF AGRICULTURAL RUNOFF.* This factor provides an assessment of watershed quality based on potential pesticide runoff, potential nitrogen runoff, and potential sediment loading (Figure 42). Areas with comparatively low levels of runoff may be more intact.

- *HYDROLOGICAL MODIFICATION.* Fewer dams reflect fewer conflicts in providing natural flow regimes and greater opportunities to effect positive changes to riparian systems (Figure 43).

This preliminary assessment identified a number of exceptional wetland/riparian areas with important conservation value:

High imperiled aquatic species richness
Looking at wetland/riparian focal species cumulative habitat overlap, high imperiled species richness occurs in the Yellowstone River drainage from its confluence with Missouri River upstream to the vicinity of Forsyth, MT, the Missouri River below the Ft. Peck dam to the tailwater of the Garrison Dam (Lake Sakakwea) in North Dakota, the Missouri above Ft. Peck Reservoir, and the lower Powder River, Wyoming and Montana (Figure 40).

Areas of wetland/riparian breeding bird density
The largest area of wetland/riparian breeding bird density occurs in the Missouri Coteau of southcentral North Dakota (Figure 41). TNC has identified four portfolio sites in this area, and there are two existing National Wildlife Refuges (Long Lake and Slade). While the importance of the entire Coteau for aquatic birds is evident, other areas in the northwest portion of the ecoregion appear to be important centers of breeding bird density, such as the area around the Bow and Red Deer Rivers, AB, and the Upper Musselshell, MT.

Relatively intact watersheds
The relatively least impaired watersheds—those with both low hydrologic modification and low agricultural runoff potential—include the Whitewater/Frenchman watersheds of northcentral Montana (no data available for Canada), Rosebud Creek, MT, the lower and upper Powder River watershed in Wyoming and Montana, the upper Moreau River watershed in South Dakota, the upper Milk River watershed, Montana (no data for Canada), and the tributaries of the Cheyenne River, Wyoming. At least 2 of these (Powder River and Rosebud Creek) are in rapidly industrializing coal and coal-bed methane extraction areas, where the potential for future impacts on watershed integrity are high.

A comparison of several expert-identified aquatic riverine conservation areas are shown in Table 3. Among the areas that score consistently high in terms of biotic diversity, watershed integrity in no specific order are the Yellowstone/Missouri Confluence, MT/ND, the Powder River WY/MT, the

Upper Missouri, MT, Frenchmans River, SK/MT, Milk River, AB/MT, the Upper Niobrara, WY/NB, the Cheyenne River, WY/SD, and the Little Missouri, WY/ND. These nine areas contain exceptional opportunities for aquatic conservation. We combined those aquatic systems that ranked "high" according to TNC, scored in the top 5% of streams evaluated in Wyoming by Patton, ranked low in flow impairment and agricultural pollution by U.S. EPA, and contained 2 or more target species as "high value" aquatic systems in the NGP ecoregion. In addition, a nationwide survey of watersheds of ecological conservation importance has identified the upper and middle White River in South Dakota as critical.[283] The 24 streams that met one or more of these criteria are shown in Figure 47, along with existing protected status.

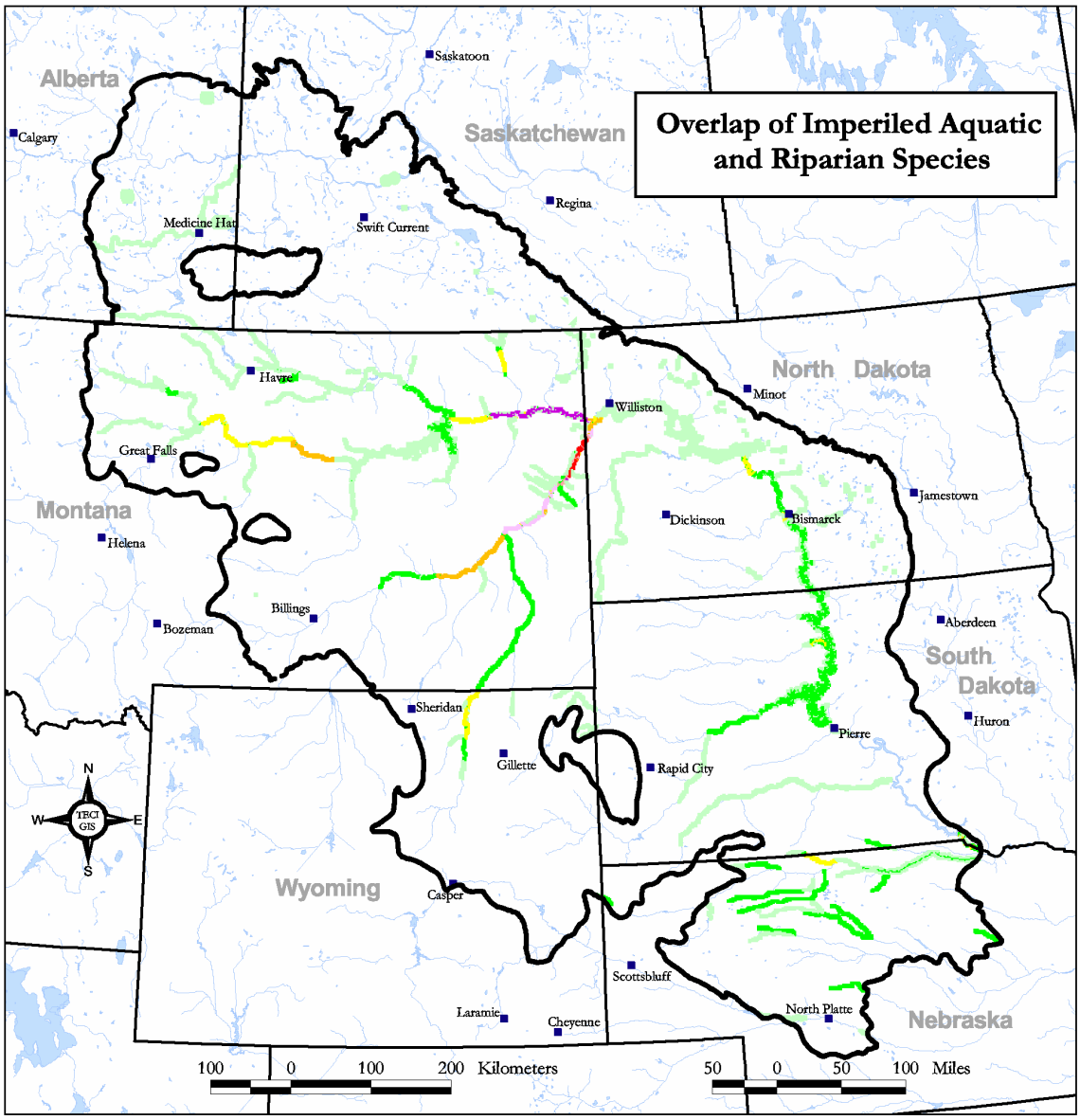
Table 3. Comparison of Expert-Identified High-Quality Riverine Aquatic Communities and NPCN Attributes

	TNC Biodiversity Rating	Top-ranked Wyoming Streams[1]	Intact Watershed	Imperiled Species Richness (0-8)
Milk River, AB	Very High		Not rated	1
Upper Milk River, MT	None		High	1
Red Deer/S. Saskatchewan River, AB/SK	High		Not rated	1
Frenchman River, SK	High		Not rated	0
Frenchman River, MT	None		High	0
Yellowstone River, MT	Very High			6
Missouri Confluence, MT/ND	Very High			8
Upper Missouri River, MT	High			4
West Fork Poplar River, MT	Low			3
Rosebud Creek MT	None		High	0
Beaver Creek ND	Low			2
Little Missouri River, ND	High			1
Little Missouri River, WY	Not rated	X		1
Cheyenne River, SD/WY	High			2
High Bank Creek SD	High			0
Moreau River SD	Low		High	0
White/Little White SD/NE	Very High			1
Upper Powder River, WY	Very High	X	High	0
Lower Powder River, WY/MT	Very High		High	3
S. Fork Powder River, WY	Not rated	X	High	1
Upper Niobrara River, WY/NE	High	X		0
Little Powder River, WY	High	X		1
Van Tassel Creek, WY	Not rated	X		0
Crazy Woman Creek, WY	Not rated	X		

[1] Patton, note 255 *supra*.

[283] Master, L.L., S.R. Flock and B.A. Stein, Eds. 1998 Rivers of Life: Critical Watersheds for Protecting Freshwater Biodiversity. The Nature Conservancy, Arlington, VA. Accessible at www.natureserve.org/publications/riversOflife.jsp.

Figure 43. Overlap of Imperiled Aquatic and Riparian Species



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Univ. of North Dakota. Undated. Fishes of N. Dakota.

LEGEND

Northern Great Plains Ecoregion boundary

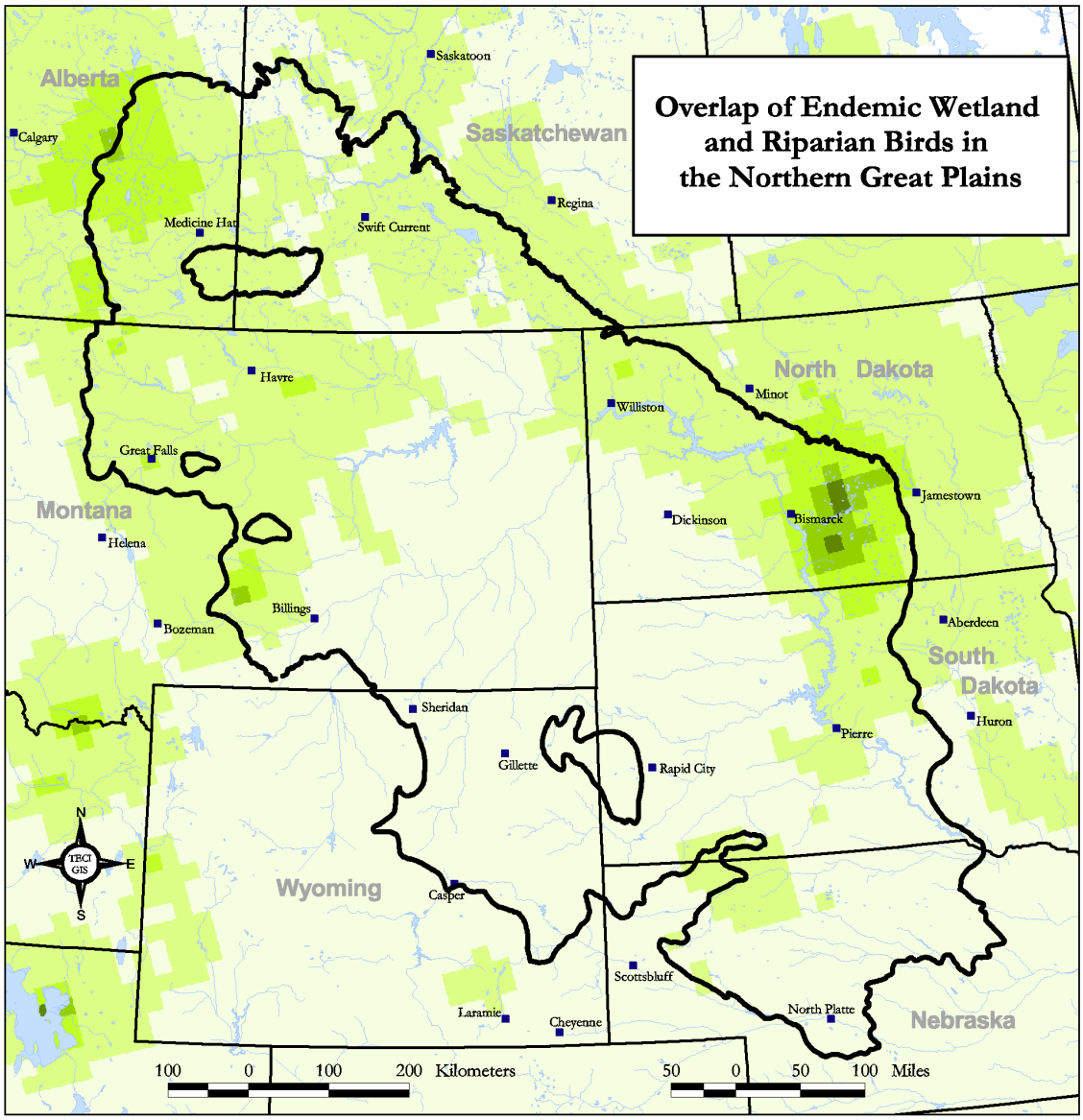
Number of imperiled fish and aquatic/riparian bird species present:

1
2
3
4
5
6
7
8

Imperiled aquatic/riparian species include: pallid sturgeon, sturgeon chub, sicklefin chub, shovelnose sturgeon, pearl dace, finescale dace, finscale x. redbelly dace, western silvery minnow, piping plover and interior least tern.

WWF

Figure 44. Overlap of Endemic Wetland and Rriparian Birds in the Northern Great Plains



SOURCES

Sauer, J. R., J. E. Hines, and J. Fallon. 2002. The North American Breeding Bird Survey, Results and Analysis, 1966 - 1996.

WWF and TECI GIS reclassified breeding bird survey data to a scale of 1-10 across the range of each species, then added all scores.

Riparian/wetland endemics include marbled godwit, Wilson's phalarope, Frankin's gull, and American white pelican.

LEGEND

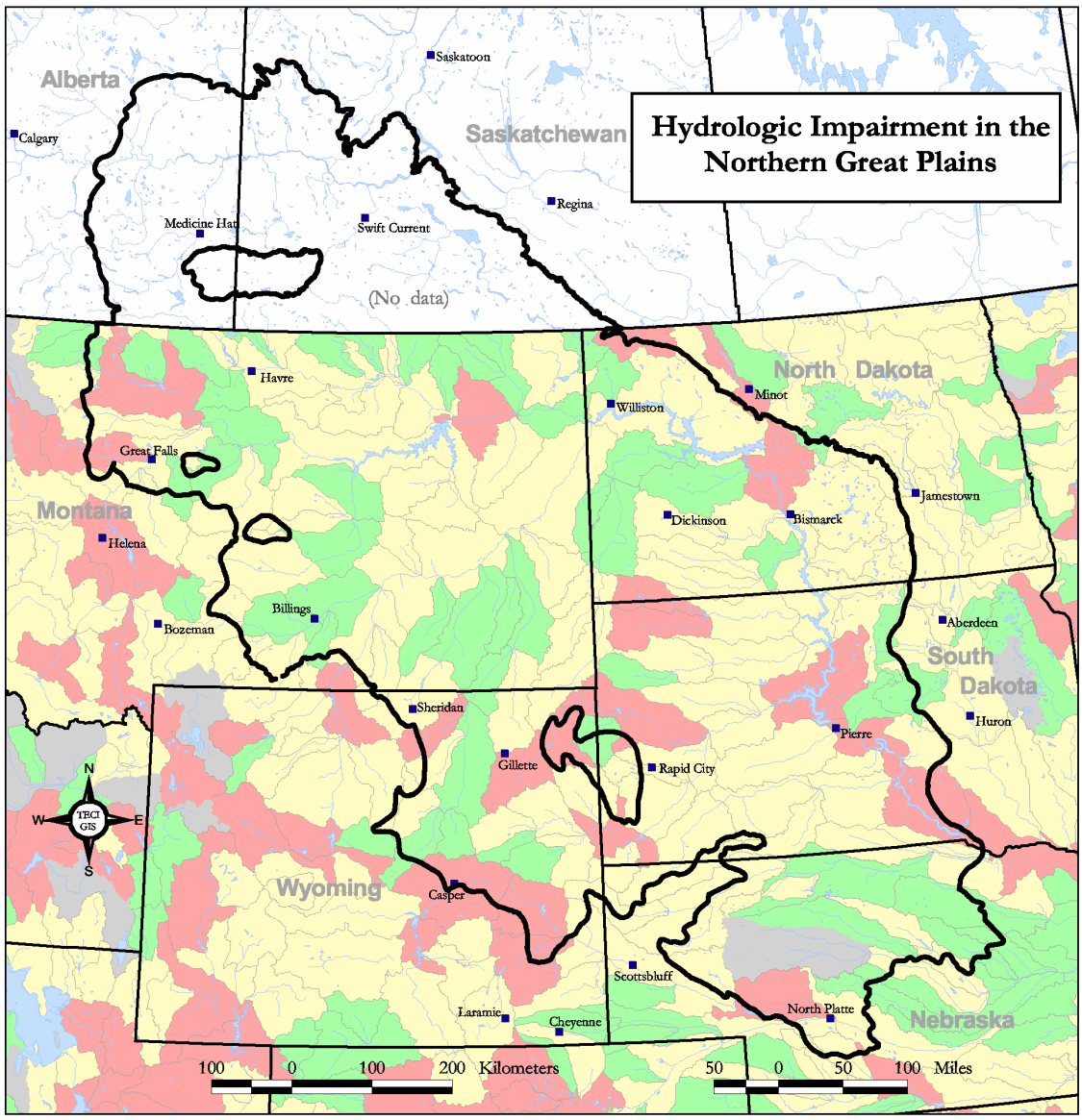
Northern Great Plains Ecoregion boundary

Relative amount of overlap of breeding distributions of bird species that are both riparian/wetland obligates and Great Plains endemics (maximum possible value = 40):

- 0 - 3
- 4 - 7
- 8 - 11
- 12 - 15
- 16 - 19

WWF

Figure 45. Hydrologic Impairment in the Northern Great Plains



SOURCE

U.S. Environmental Protection Agency. 1995. Index of watershed indicators; hydrologic modification caused by dams, 1995-1996. EPA Environmental Information Mangement System.

LEGEND

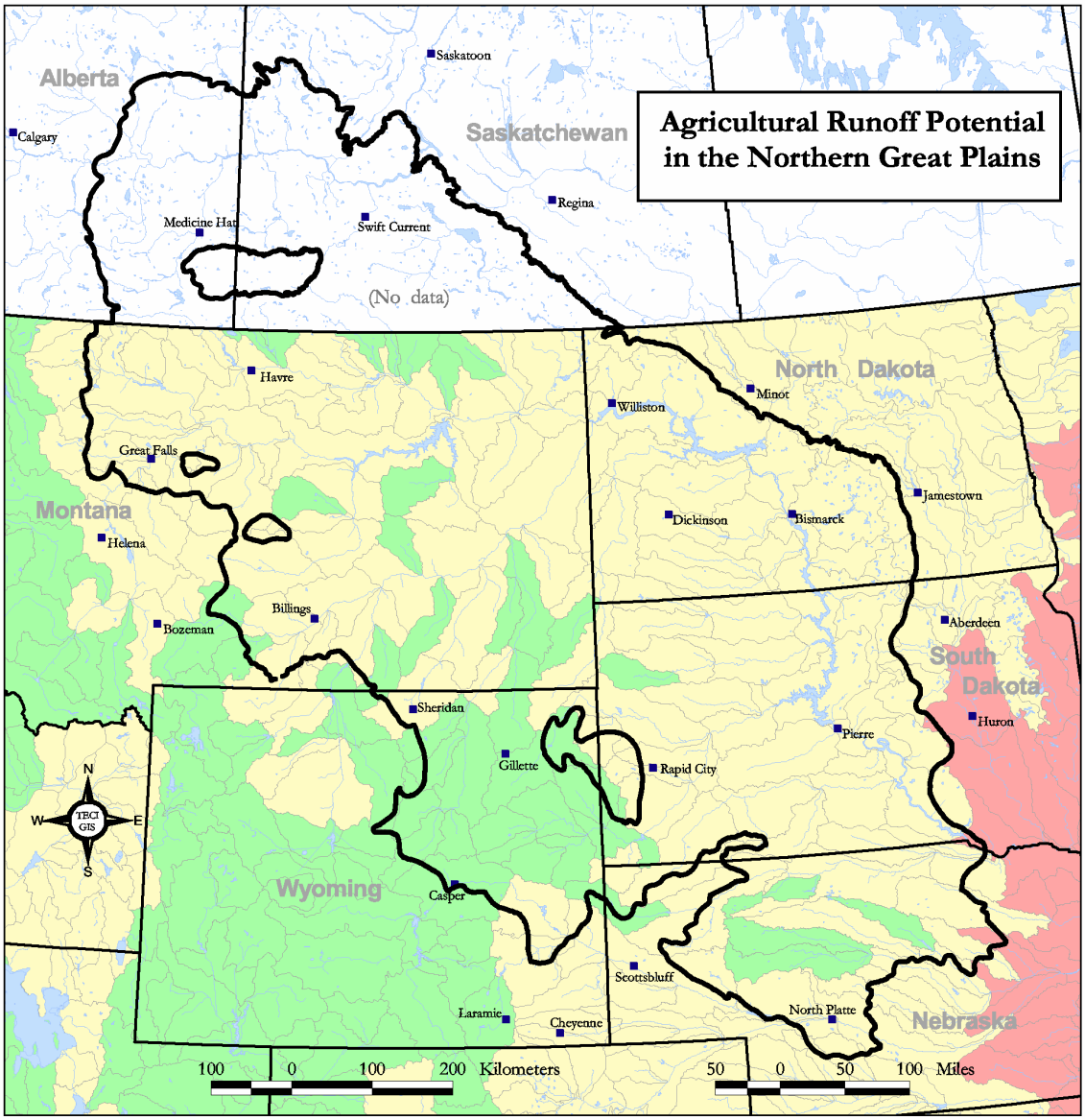
Northern Great Plains Ecoregion boundary

Hydrologic impairment:

- Low volumes of impounded water
- Moderate volumes of impounded water
- High volumes of impounded water
- Insufficient data

WWF

Figure 46. Agricultural Runoff in the Northern Great Plains



SOURCE

U.S. Environmental Protection Agency. 1995. Index of watershed indicators; index of agricultural runoff potential (based upon nitrogen, sediment and pesticide, 1990-1995. EPA Environmental Information Mangement System.

LEGEND

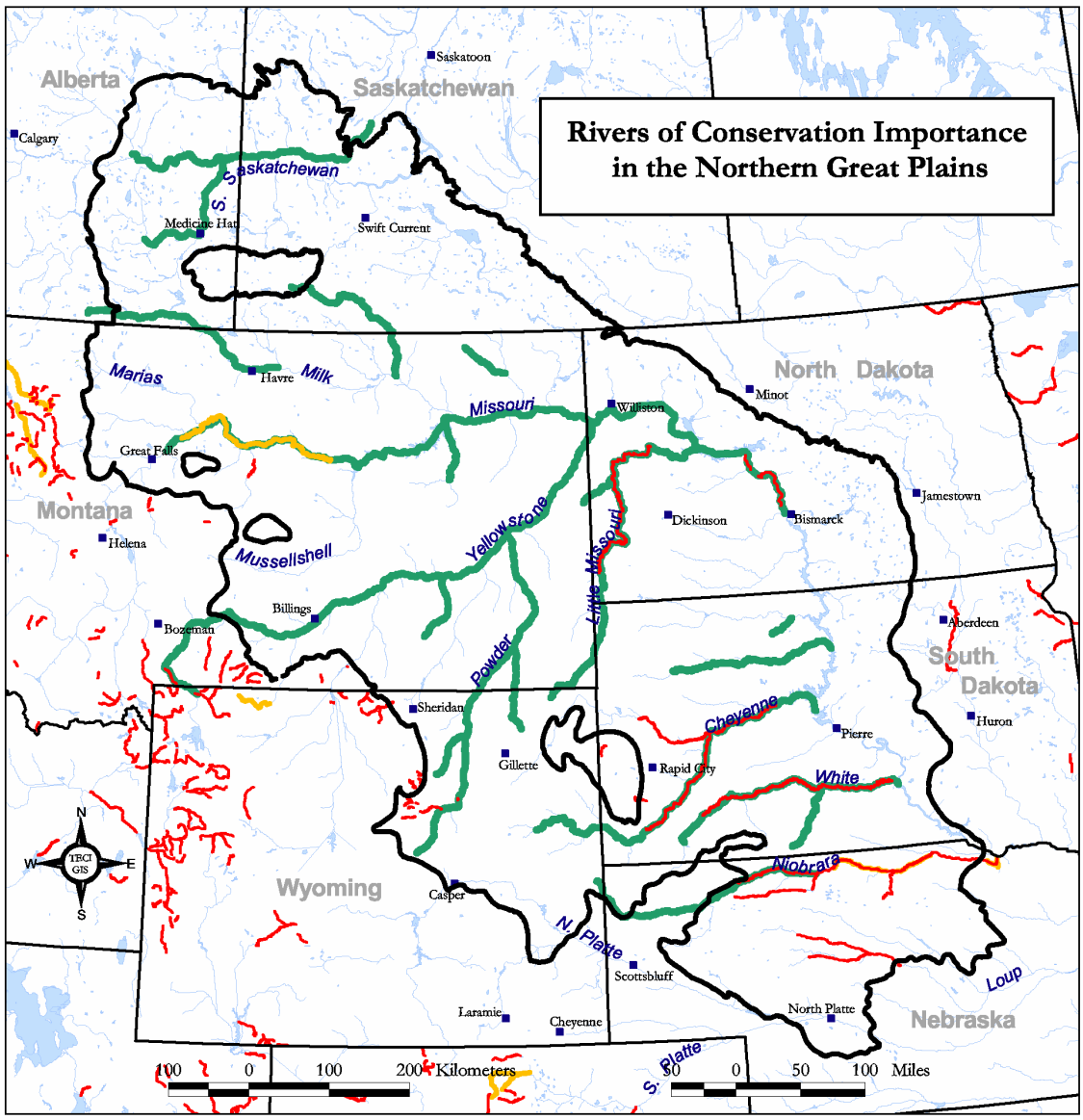
Northern Great Plains Ecoregion boundary

Hydrologic impairment:

- Low level of potential impact
- Moderate level of potential impact
- High level of potential impact

WWF

Figure 47. Rivers of Conservation Importance in the Northern Great Plains



SOURCES

U.S. Department of Interior, National Park Service. 2002. National Wild and Scenic Rivers System. Http://www.nps.gov/rivers.

U.S. Department of Interior, National Park Service. 1996. Nationwide Rivers Inventory.

(Rivers and streams with exceptional opportunities for aquatic conservation were chosen as part of the NPCN assessment.)

LEGEND

Northern Great Plains Ecoregion boundary

Exceptional opportunities for aquatic conservation

Designated Wild, Scenic or Recreational Rivers

Potential Wild, Scenic or Recreational Rivers

WWF

Evaluating the NGP Conservation Landscape: A Template for Ecoregional Recovery and Restoration.

Each of the ten large terrestrial conservation areas identified by our analysis could contribute significantly to meeting large-scale conservation needs. The size and proximity of some large areas, particularly along a generally north-south axis, indicate opportunities for linkages. All ten sites contain suitable prairie dog habitat of more than 200,000 acres (80,000 ha) and all are presumably suitable for bison.

These ten large terrestrial areas can also cover a substantial part, but by no means all, of the representation needs for subecoregions (see Chapter 2), ecological complexes, and focal species. A review of Appendix M shows that the ten large areas cover two of the four grassland subecoregions in the NGP, 18 of 32 ecological complexes, and habitats for 17 of our 22 focal species.[284] The Bitter Creek/Grasslands National Park area alone includes 8 (25%) of the 32 ecological complexes; this area and the Montana Glaciated Plains include 13 of 32 complexes; and these two areas and the Little Missouri Grasslands cover 16 (50%) of the 32 complexes. However, there is little redundancy among the 10 large areas—9 ecological complexes are represented in only one of the 10 large areas, suggesting a need to duplicate representation elsewhere.

For focal species, the Montana Glaciated Plains alone includes over half of the 22 key focal species habitats we identified; this area and the Little Missouri include 15 (62%); and these two areas and the Slim Buttes and Bitter Creek/Grasslands National Park or Sage Creek AB/SW Pastures include 17 (71%). Four focal species are covered by only one large area, and the four riparian/wetland focal bird species are totally excluded except for the marbled godwit in one large area.

Four of the large areas are within the Northwest Glaciated Plains subecoregion and six are within the Missouri Plateau subecoregion. No large areas were identified within the Missouri Coteau or Nebraska Sandhills—these subecoregions appear to have relatively fewer opportunities for large-scale restoration and may be better served by a system of smaller reserves or other ongoing conservation strategies. TNC's soon-to-be-completed biodiversity assessments for these subecoregions, as well as sites in the Coteau identified by Ducks Unlimited, should provide a more complete description of site needs and priorities for these subecoregions in the future.

In terms of meeting representation targets (subecoregions, ecological complexes and focal species), the Montana Glaciated Plains, Bitter Creek/Grasslands National Park, and Little Missouri Grasslands emerge as the most important large conservation areas. However, ensuring a broad geographic scope of coverage and the need for redundancy suggests that these northern sites be complemented by one or two of the large areas in the

[284] Not captured are habitats for the Dakota skipper, American Burying beetle, blowout penstemon, American white pelican, Franklin's gull, McCown's longspur, long-billed curlew, and Wilson's phalarope.

South Dakota-Wyoming-Nebraska tri-state region.

The large-scale sites identified by our analysis offer an interesting complement and contrast to TNC's portfolio (Figure 43). Seven of the 10 sites (Montana Glaciated Plains, Bitter Creek, SW Pastures, Terry Badlands, Badlands National Park, Thunder Basin/Oglala, Slim Buttes) are quite similar in location and extent to the areas previously identified by TNC. Although the inclusion of TNC's expert-defined areas in the biodiversity layer explains some of this correlation, that criterion was not strongly weighted by NPCN, and in theory would not have necessarily contributed substantially to the high ranking of those cells, absent other important features expressed through other criteria. Three areas (Little Missouri, Big Open, and Hole in the Wall) were not identified by TNC. Hole in the Wall in particular appears to have exceptional biodiversity importance, although this area has apparently received little conservation recognition to date.

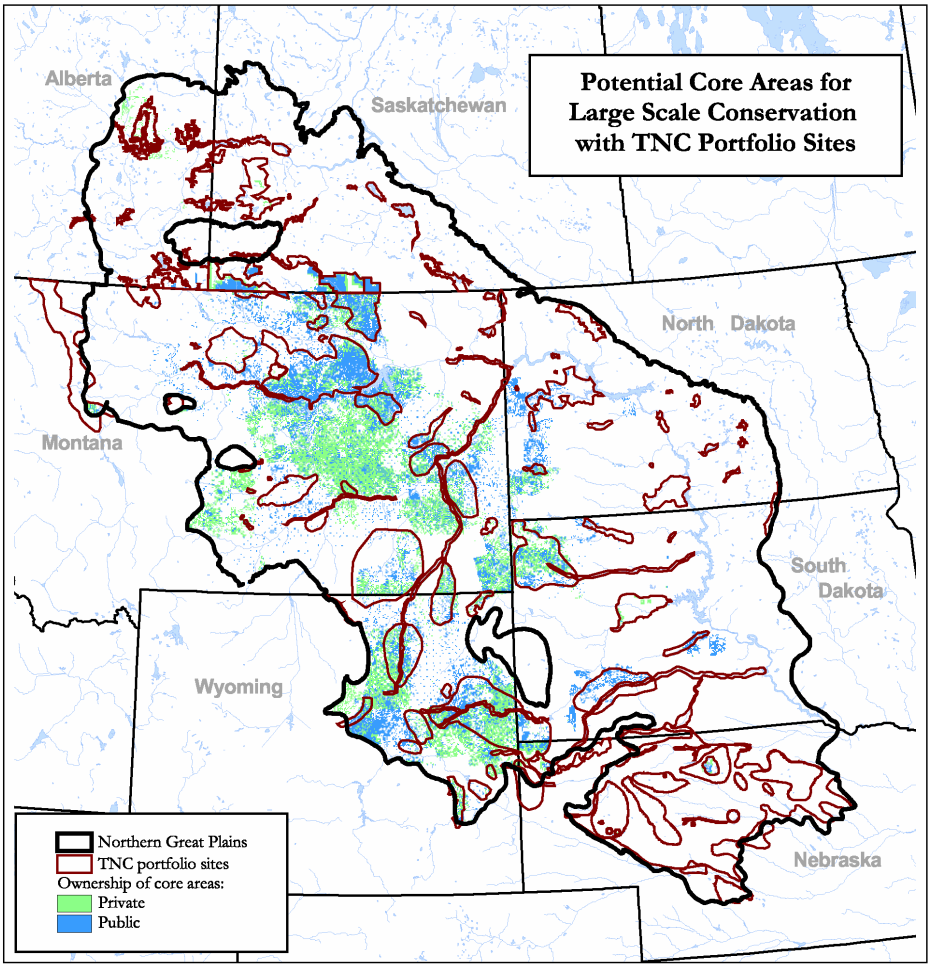


Figure 48. Comparison of Large Conservation Areas with TNC Portfolio Sites.

We believe that Tribal lands are key areas for conservation and restoration in the NGP. However, with the exception of lands adjacent to or within the Badlands National Park complex, Tribal lands did not score well in this analysis, despite the fact that some tribal lands (Ft. Belknap, Standing Rock, Cheyenne River Sioux, Pine Ridge, Rosebud Sioux) had relatively high biodiversity importance scores (Figure 49). Further analysis indicated several possible reasons for this based on the criteria used in the model: 1) Tribal lands had some of the highest relative population densities in the ecoregion by census tract. Population density was one of the more strongly weighted criteria in terms of restoration potential, with higher population densities receiving lower scores; 2) Criteria agreed upon by NPCN gave higher value to lands adjacent to public lands. This resulted in lower valued cells within tribal boundaries than in many other private lands. While few, if any, tribal jurisdictions could accommodate conservation areas on the scale of 3 million acres by themselves, opportunities where management of lands outside of reservation boundaries could be brought into line with tribal management, thereby creating functionally contiguous landscapes, should be further explored. Additional work will be needed to determine where management of non-Tribal lands will best complement ongoing conservation efforts on Tribal and First Nation lands.

Current protected area coverage in the Northern Great Plains is thin with respect to the large landscapes we have identified. Covering less than 2% of the

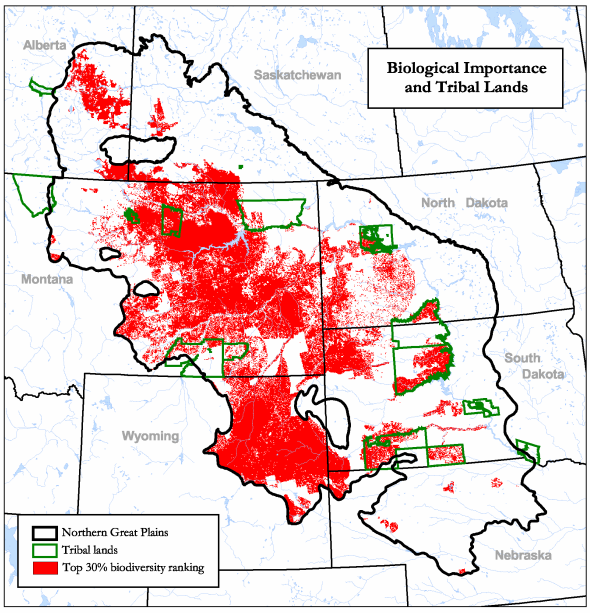


Figure 49. Biological Importance and Tribal Lands

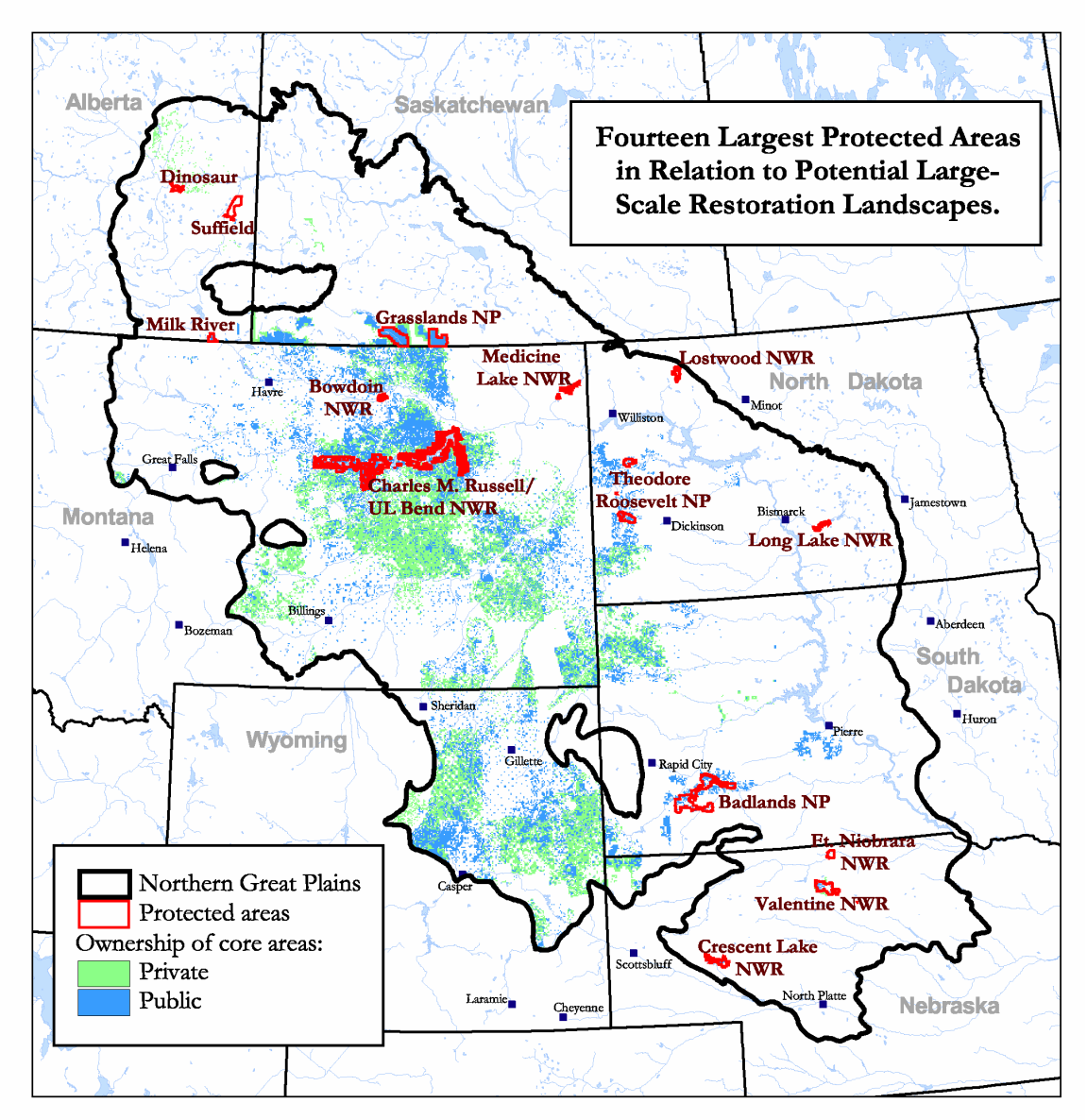
ecoregion, this system, however, provides an important starting point. For example, 18 of our 22 focal species, and 22 of TNC's 32 ecological complexes (not including Suffield for which data are unavailable), are included in at least one of the ten largest protected areas in the NGP (Appendix N).

A brief review of these ten largest protected areas also highlights several problems. The five smallest average 39,394 acres (15,943 ha) (range: 22,300 – 70,447 acres; 9,025 – 28,510 ha)—large enough for contributing significantly to key conservation elements but limited in terms of restoring large-scale processes and large mammals or prairie dog complexes. Configuration and fragmentation also present problems among these areas. The largest, the Charles M. Russell National Wildlife Refuge, is highly oblong with grassland habitats forming a long, narrow fringe around it borders, with a nearly 200,000-

acre (81,000-ha) reservoir largely dividing it in half, and with approximately 80% of its land subject to livestock grazing. Similarly, Badlands National Park, Grasslands National Park and Theodore Roosevelt National Park are fragmented into separate geographic units. Thus the largest protected areas have high edge to area ratios, complicating boundary issues for managing biodiversity within them.

As suggested by the analysis here, restoring and managing for biodiversity three or four of the large-scale areas we identified (8-15 million acres; 3.2-6 million ha) would at least triple the land area devoted to conservation lands and would substantially improve biotic integrity of the ecoregion. This would still fall short of bringing the percentage of land in conservation in the North America's temperate grasslands generally, and the NGP specifically, into line with the amount of land protected in other biomes (Figure 1), but it would be a significant step toward conserving species that need large landscapes and ecological processes that operate at large scales.

Figure 50. Ten Largest Protected Areas in Relation to Potential Large-Scale Restoration Landscapes.



Chapter 8: The Future of the Northern Great Plains

This plan is a first attempt by NPCN to identify opportunities for large-scale conservation within the NGP ecoregion. It provides a starting point for further investigation, more detailed site planning, and development of implementation strategies. The most important product of this assessment is that numerous opportunities still exist to conserve landscapes in the NGP at scales appropriate to the ecological dynamics of the ecoregion. Our conservation goals should therefore aim beyond retaining fragments of prairie that often represent little more than museum pieces of our natural heritage. Rather, beginning with the few very special places we have identified, we can begin to restore North America's grasslands on a scale meaningful for long-term conservation.

We believe that restoring and conserving the prairie's remarkable ecosystems and wildlife will add economic diversity to and help capture the full socioeconomic potential of the ecoregion.[285] Several studies have demonstrated that communities located near natural areas offering diverse outdoor recreational activities are more robust economically than communities that are not. The NGP still has a substantial amount of intact grassland under a variety of land ownership and management regimes. Large-area complexes of public lands, tribal lands, and non-tribal ranching and agricultural lands exist that can be linked and cooperatively managed to provide the ecological conditions necessary to support native species. These places might provide the nuclei and serve as examples for improving biotic health throughout the ecoregion.
Restoration of these lands will necessarily be a multi-staged process. Over the short term, the resources needed to proceed with restoration at all scales throughout the ecoregion are unlikely to become available. We will require realistic time frames—decades—to accomplish these goals. However, the window of opportunity is wide open.

The conditions and opportunities described above suggest that a multi-pronged strategy is needed to accomplish broad-scale, long-term conservation in the NGP. A combination of drought, faltering of NGP agricultural commodities in the global market, and declining income are rapidly changing human demographic patterns. Thus, socioeconomic transformation is already underway. The question is not whether the landscape will change throughout the region, but how it will change. We can begin by rebuilding the biotic integrity of the grasslands while creating a more diversified and sustainable economic base for the region.

Comprehensive biodiversity conservation in the NGP requires that we address the conservation needs of species, habitats, and ecological and evolutionary processes at multiple scales, from local to ecoregion-wide to linkages among ecoregions. This assessment identified 10 terrestrial

[285] See Licht, D. 1997, note 76 *supra*, for a discussion of the economic implications of developing prairie reserves.

areas, ranging in size from 1.9 million acres (700,000 ha) to 3.9 million acres (1.6 million ha) with good potential for large-scale restoration. Each of these is sufficiently large and ecologically intact to serve as an important anchor in a system of reserves or conservation areas. Probably at least four of them, totalling 10-15 million acres (4-6 million ha) and 6-8% of the NGP ecoregion, will be needed as anchors in an ecoregion-wide system. TNC identified sites ranging from very small to very large totaling about 30 million acres (12 million ha)—around 17% of the NGP ecoregion--with considerable overlap with the ten large areas we identified. Assembling a strategy for restoring and conserving the biodiversity of these high-priority areas, and of the twenty-three aquatic areas of special importance also identified, will require further analysis, but we can begin immediately to work toward improving the biotic health of the ecoregion by:

- **Increasing conservation lands ecoregionally.** The need to increase lands managed primarily for biodiversity conservation in the ecoregion is acute. The current 1.5% coverage of existing traditional protected areas is woefully inadequate. Expanding the lands in conservation can be accomplished through a variety of instruments, including voluntary landowner agreements, easements, and acquisition, as well as through the creation of traditional protected areas such as parks and refuges. The scale and form of such conservation areas depend on how the rest of the ecoregion's landscape is managed. Stopping tillage of native prairie and implementing livestock grazing practices that help restore and maintain biodiversity will limit the land area that needs to be managed primarily for conservation purposes. Approaches that incorporate private lands management in non-traditional land uses that result in biodiversity protection should be explored. By 2020, we should expand existing coverage of conservation lands to10-15% (17-27 million acres, 7-11 million ha) of the ecoregion, including two or more areas of several million acres each. This will likely be far short of the coverage needed, but will be a significant step in restoring grassland biodiversity.

- **Promoting ecologically sustainable management:** Management of both the agricultural and nonagricultural portions of the landscape should strive to: (a) prevent further loss of native prairie; (b) limit the spread of nonnative plant and animal species that are destructive to native biodiversity, and (c) lead to widespread adoption of grazing practices that restore and maintain native prairie habitats and species diversity. Given the current state of grasslands health, it is prudent to adopt immediately a policy of "no net loss" of native grasslands to cropland or resource development, particularly in those areas that have been identified as critical for conservation of the ecoregion's plants and animals. We should seek to stabilize the amount of area impacted by

invasive nonnative plant and animal species that are destructive to native biodiversity within the next 5 years. And over the next decade, we should make substantial progress in adopting grazing practices on both public and private lands that are compatible with restoring and maintaining native prairie habitats and species diversity.

- **Restoring populations of native species and securing their long-term viability.** By 2050 in the NGP there should be: (a) at least two populations of 10,000 wild bison each under natural or near-natural conditions; (b) at least 500,000 acres of prairie dog towns within large complexes supporting viable populations of black-footed ferrets; and (c) stable (with latitude for natural fluctuations) or increasing populations of all grassland-dependent birds. For the most part, if we adopt appropriate management and increase conservation protection, the prairie and prairie streams, often with modest management investments, will restore themselves across very large landscapes.

- **Ensuring that flows in the Missouri River system and its significant tributaries, including the Milk, Cheyenne, and White Rivers, can support the full complement of aquatic and riparian species.** Beginning immediately, there should be no new construction of dams on major rivers and streams in the NGP. By 2025 or sooner where dictated by conservation needs, near-natural flows should be restored in all identified priority streams and rivers in the ecoregion. By 2025, the spread of nonnative aquatic and riparian species should be stabilized or reversed within the identified priority streams and rivers.

Much work remains to be done to translate this vision into on-the-ground conservation action. With this assessment as a foundation, we need to make the case to supporters, the public, and decision-makers that conserving NGP biodiversity has a significant local, regional and global impact. Our urgent challenge is to find ways to invest local communities in conservation in ways that support their own economic and social well-being. We will work with federal, state and provincial institutions, citizen's groups, community leaders, and others that recognize the importance of these conservation landscapes. We will need to provide leadership to develop a national policy framework in the U.S. and Canada to address overarching issues of the NGP that are of concern to the people within the ecoregion and to the U.S. and Canadian publics generally. Strategies for addressing all of these components must be put in place, and soon, if we are to be successful in restoring NGP biodiversity.

We can restore and retain a remarkable part of the natural heritage valued by people across North America if we are successful in accomplishing these tasks. We have an opportunity to restore a link in the chain from the past to a future and

inspire people across North America and around the world that large-scale restoration of the native ecosystems and wildlife of the Northern Great Plains is possible.

APPENDIX A: DESCRIPTION OF PRIORITY SITES[1]

Name: Sage Creek, AB/ SW Pastures SK

Location:

Primarily Canadian land straddling the Alberta/Saskatchewan border & Montana

Approximate Size:

772k ha = 1.9 million acres total

Other Designations:

Large ownership of Crown lands and Prairie Farm Rehabilitation Administration lands
This area was ranked high biodiversity importance by TNC, WWF-Canada, and several other organizations. The Nature Conservancy ranks this as a medium in threat urgency due to agricultural conversion, poor grazing management, and ground squirrel control. This site contains 2 of the total TNC Ecological Complex Representations. Wetland-Alkali/ saline and Riparian- shrub are present in this area.

Planning Status: Alberta Environmental Protection Environmentally Significant Areas, Transboundary Working Group, The Nature Conservancy Sage Creek/Southwest Pastures Complex

Ownership (ha):

State/Provincial	49,561	122,468
Federal BLM:	184,335	455,491
Private:	519,108	1,282,744
Other Federal:	19,037	47,041
TOTAL:	772,041 ha	1,907,744 ac

Outstanding biological features:

Species of biological concern:

Sprague's pipit, interior tern sage grouse, swift fox

Focal species:

Ferruginous hawk, baird's sparrow, chestnut collared longspur

Area occupied by prairie dogs: 0 acres

Conservation status:

Percent (area) "untilled": 80%

Percent (area) in IUCN protected classes I and II: 0.2%

Name: Grasslands National Park, SK/ Bitter Creek, MT

Location:

Grasslands National Park-Canadian side

BLM's Bitter Creek Area Critical Environmental Concern on U.S. side

Approximate Size:

1.1 million ha = 2.7 million acres total

Other Designations:

The nature conservancy ranks the Grasslands area a low threat urgency rank due to loss of fire regime, exotic species, and recreational use. TNC ranks the Bitter Creek section a medium in threat urgency due to exotic species, conversion for cropland, and loss of fire regime. This area includes 8 of the 32 ecological complexes. For example, Wooded-draw deciduous, Riparian-herbaceous, and badlands all occur in this area.

Planning Status:

Ownership (ha):

Federal BLM:	238,720	589,890
Tribal:	12,659	31,281
State/Provincial:	109,143	269,698
Other Federal:	91,381	225,807
Private:	648,101	1,601,492
TOTAL:	1,100,422 ha	2,718,168 ac

Outstanding biological features:

Species of biological concern:

Interior tern, sage grouse, Sprague's pipit, Swift fox, Prairie dog

Focal species:

Baird's sparrow, Chestnut collared longspur, Lark bunting

Area occupied by prairie dogs: 1,814 acres

Conservation status:

Percent (area) "untilled": 74%

Percent (area) in IUCN protected classes I and II: 8.3%

Name: Montana Glaciated Plains, MT

Location:

This area is bracketed by the 1.1-million-acre CMR Refuge on the south and by the Milk River on the north.

Approximate Size:

1.4 million ha = 3.5 million acres

Other Designations:

This area includes extensive prairie dog habitat, two reintroduction sites for black-footed ferrets, and significant populations of mountain plover and sage grouse. This area covers 11 of TNC's 22 focal species habitats. The TNC Ecological Complex Representation includes coniferous, Riparian-cottonwood, and Big sage.

Planning Status:

Ownership (ha):

Federal BLM:	517,952	1,279,887
Tribal:	116,188	287,107
U.S. Fish and Wildlife Service:	206,797	511,007
State:	78,317	193,525
Private:	514,201	1,270,618
Local Government:	33	82
Private Preserves:	12,600	31,135
TOTAL:	1,446,088 ha	3,573,361 ac

Outstanding biological features:

Species of biological concern:

Mountain plover, piping plover, sage grouse, black-footed ferret, swift fox, and prairie dog

Focal species:

Ferruginous hawk, chestnut collared longspur, and lark bunting

Area occupied by prairie dogs: 36,622 acres

Conservation status:

Percent (area) "untilled": 77%

Percent (area) in IUCN protected classes I and II: 3.8%

Name: Little Missouri Grasslands, ND

Location:

Anchored by Theodore Roosevelt National Park and the Little Missouri National Grasslands

Approximate Size:

1.56 million ha = 3.86 million acres

Other Designations:

This area contains the highest density of prairie dogs remaining in North Dakota and an existing public bison herd.

Planning Status:

Ownership:

Federal BLM:	7,289	18,011
U.S. National Park Service:	28,230	69,758
U.S. Fish and Wildlife Service:	851	2,103
U.S. Forest Service:	360,278	890,266
State:	52,145	128,853
Private:	1,115,096	2,755,462
TOTAL:	1,563,890 ha	3,864,453 ac

Outstanding biological features:

Species of biological concern:

Interior (least) tern, sage grouse, prairie dog

Focal species:

Baird's sparrow, chestnut collared longspur, lark bunting

Area occupied by prairie dogs: 2,852

Conservation status:

Percent (area) "untilled": 63%

Percent (area) in IUCN protected classes I and II: 1.9%

Name: Terry Badlands, MT

Location:

South Eastern Montana

Approximate Size:

981k ha = 2.4 million acres

Other Designations:

Contains large populations of prairie dogs and intact grasslands.

Planning Status:

Ownership:

U.S. Forest Service:	12,299	30,390
U.S. Fish and Wildlife Service:	37	91
State:	375,695	928,363
Private:	593,879	1,467,507
Department of Defense:	33	82
TOTAL:	981,943 ha	2,426,433 ac

Outstanding biological features:

Species of biological concern:

Swift fox, sage grouse, prairie dog

Focal species:

Ferruginous hawk, chestnut collared longspur, lark bunting

Area occupied by prairie dogs: 2,670

Conservation status:

Percent (area) “untilled”: 82%

Percent (area) in IUCN protected classes I and II: 0.6%

Name: Big Open, MT
Location: Central/east central Montana
Approximate Size:
906k ha = 2.2 million acres
Other Designations:
Mostly composed of private lands, this area is one of the least populated areas in the ecoregion. It boasts largely untilled grasslands and high quality sage grouse populations.
Planning Status:
Ownership (ha):

Federal BLM:	103,215	255,050
U.S. Fish and Wildlife Service:	1,581	3,907
State:	52,876	130,660
Private:	748,500	1,849,584
TOTAL:	906,171 ha	2,239,201 ac

Outstanding biological features:
Species of biological concern:
Sage grouse, swift fox, prairie dog
Focal species:
Chestnut collared longspur, lark bunting
Area occupied by prairie dogs: 2,860

Conservation status:
Percent (area) "untilled": 80%
Percent (area) in IUCN protected classes I and II: 0%

Name: Thunder Basin, WY/ Oglala Grasslands, NE:
Location: East central Wyoming
Approximate Size:

1.6 million ha = 3.95 million acres

Other Designations:

This area boasts intact grasslands, significant prairie dog populations, and significant potential for black-footed ferret reintroduction. Site priority is rated "very high" by TNC.

Planning Status:
Ownership (ha):

Federal BLM:	56,110	138,651
Tribal:	57,512	142,115
U.S. Forest Service:	269,054	664,847
State:	71,747	177,291
Private:	1,144,791	2,828,840
Department of Defense:	353	872
Other Federal:	486	1201
TOTAL:	1,600,054 ha	3,953,817 ac

Outstanding biological features:

Species of biological concern:

Mountain plover, swift fox, prairie dog

Focal species:

Lark bunting

Area occupied by prairie dogs: 76,410 acres (1999 pre-plague survey)

Conservation status:

Percent (area) "untilled": 92%
Percent (area) in IUCN protected classes I and II: 0%

Name: Slim Buttes, SD
Location: Northwest SD
Approximate Size:
947k ha = 2.3 million acres
Other Designations:
This area is made up of mostly intact grasslands, blending a mix of public and private lands.
Planning Status:
Ownership (ha):

Federal BLM:	21,528	53,195
U.S. Forest Service:	28,797	71,159
State:	135,368	334,502
Private:	761,341	1,881,315
TOTAL:	947,034 ha	2,340,171 ac

Outstanding biological features:
Species of biological concern:
Piping plover, sage grouse
Focal species:
Ferruginous hawk, lark bunting
Area occupied by prairie dogs: 0 acres

Conservation status:
Percent (area) "untilled": 83%
Percent (area) in IUCN protected classes I and II: 0%

Name: Badlands/Conata Basin, SD:

Location:

Anchored by Badlands National Park and the Buffalo Gap National Grassland

Approximate Size:

1.15 million ha = 2.8 million acres

Other Designations:

The area contains the only successful black-footed ferret recovery site, numerous prairie dogs, and an existing public bison herd.

Planning Status:

Ownership:

Federal BLM:	1,071	2,647
U.S. Forest Service:	148,822	367,747
Tribal:	363,349	897,855
National Park Service/ Parks Canada:	59,789	147,742
State/ Provincial:	11,312	27,953
Private:	560,960	1,386,162
Private Preserves:	236	583
Other Federal:	45	112
TOTAL:	1,145,585 ha	2,830,801 ac

Outstanding biological features:

Species of biological concern:

Black-footed ferret. Swift fox, prairie dog

Focal species:

Lark bunting

Area occupied by prairie dogs: 18,159 acres

Conservation status:

Percent (area) “untilled”: 80%

Percent (area) in IUCN protected classes I and II: 8.5%

Name: Hole in the Wall, WY
Location: Central/east central Wyoming
Approximate Size:
1.09 Million ha = 2.7 million acres
Other Designations: This area rated high due to significant mountain plover habitat, significant prairie dog acreage, relatively intact grasslands, and large contiguous acreage in BLM lands.
Planning Status:

Ownership (ha):

Federal BLM:	352,028	869,880
Tribal:	3,784	9,350
U.S. Forest Service:	71	175
State/ Provincial:	112,870	278,908
Private:	623,404	1,540,465
TOTAL:	1,092,157 ha	2,698,779 ac

Outstanding biological features:
Species of biological concern:
Mountain plover, swift fox, prairie dog
Focal species:
Lark bunting
Area occupied by prairie dogs: 33,548 acres

Conservation status:
Percent (area) "untilled": 97%
Percent (area) in IUCN protected classes I and II: 0%

[1] An artificial boundary was inscribed around each core area to enable analysis. Therefore, values of ownership, untilled lands and IUCN protected classes are not precise and should serve as estimates.

Appendix B. STATUS OF KEY PRAIRIE PLANTS OF THE NORTHERN GREAT PLAINS ECOREGION

		Global Rank (TNC)[1]	Great Plains Endemic[2]	ESA listed/ petitioned	BLM Sensitive/ Watch	USFS Sensitive	Montana Species of Concern[3]	Nebraska Species of Concern[7]	Wyoming Species of Concern[4]	COSEWIC Listing[9]	Alberta tracking list[5]	Saskatchewan species at risk[6]
Blowout penstemon	*Penstemon haydenii*	G1	X	**E**			N/A	X	N/A	N/A	N/A	N/A
Barr's milkvetch	*Astragalus barrii*	G3	X	former C2	Sensitive	X	X	X	X	N/A	N/A	N/A
Dakota wild buckwheat	*Eriogonum visheri*	G3	X	former C2	Watch		X	N/A	N/A	N/A	N/A	N/A
Hayden's yellow-cress	*Rorippa calycina*	G3	X		MT-Watch		X	X	X			
Wyoming dodder	*Cuscuta plattensis*	G1?	X				N/A	N/A	X	N/A	N/A	N/A
Smooth goosefoot	*Chenopodium subglabrum*	G3	no		MT-Watch		X	X		concern	X	
Sidesaddle (Secund) bladderpod	*Lesquerella arenosa* var. *argillosa*	G5T3	X		WY-Sensitive			X	X			
Prairie moonwort (Field grape fern)	*Botrychium campestre*	G3	no			X	X (outside)		X		X	X
Great Plains bladderpod	*Lesquerella arenosa var. arenosa*	G5	X					X				
Golden stickleaf	*Mentzelia pumila*	G4	?		Watch		X					
Ute ladies' tresses	*Spiranthes diluvialis*	G2	no	**T**			X (outside)	N/A	X		N/A	
Chaffweed	*Centunculus minimus*	G5	no		MT-Watch		X	X	X			
Hot Spring phacelia	*Phacelia thermalis*	G3			Watch		X					
Joe-pye weed	*Eupatorium maculatum*	G5			Watch		X				X	
Andean prairie-clover	*Dalea cylindriceps*	G3	no					X	X			
Slender mouse-ear cress	*Halimolobus virgata*	G4								T	X	X
Great Plains stickseed	*Lappula cenchrusoides*	G2G3	X					X				
Western prairie fringed orchid[10]	*Platanthera praeclara*			T				X				
Wyoming sullivantia	*Sullivantia hapemanii var. hapemanii*	G3			MT-Watch		X					
Plains phlox	*Phlox andicola*	G4			MT-Watch		X					
Upright pinweed	*Lechea tenuifolia*	G3						X				
Porter's sagebrush	*Artemesia porteri*	G2		WY-Sensitive								
Small-flowered sand verbena	*Tripterocalyx micanthus*	G5								T		
Tiny cryptanthe	*Cryptantha minima*	G5								E		
Western spiderwort	*Tradescantia occidentalis*	G5								T		
Soapweed (Yucca)	*Yucca glauca*	G5								T		
Western blue-flag	*Iris missouriensis*	G5								T		
Hairy (silky) prairie clover	*Dalea villosa var. villosa*	G5							X	T		E
Tall wooly heads	*Psilocarpus elatior*	G4								concern		
Hare-footed locoweed	*Oxytropis lagopus*	G4G5								concern		

[1] G1 Critically imperiled globally because of extreme rarity or because of some factor(s) making it especially vulnerable to extinction (typically 5 or fewer occurrences or very few remaining individuals or acres).
G2 Imperiled globally because of rarity or because of some factor(s) making it very vulnerable to extinction throughout its range (6 to 20 occurrences or few remaining individuals or acres).
G3 Either very rare and local throughout its range or found locally (even abundantly at some of its locations) in a restricted range (e.g., a single western state, a physiographic region in the East) or because of other factors making it vulnerable to extinction throughout its range (21 to 100 occurrences).
G4 Widespread, abundant, and apparently secure globally, though it may be quite rare in parts of its range, especially at the periphery. Thus, the element is of long-term concern (usually more than 100 occurrences).
G5 Demonstrably widespread, abundant, and secure globally, though it may be quite rare in parts of its range, especially at the periphery.

[2] Ostlie, W. R., R. E. Schneider, J. M. Aldrich, T. M. Faust, R. L. B. McKim and S. J. Chaplin. 1997. The status of biodiversity in the Great Plains. The Nature Conservancy, Arlington, VA. USA. 326 pp. + XII.
[3] Carlson, J. 2001. Coordinator, Montana Animal Species of Concern Committee. Montana Animal Species of Concern. Montana Natural Heritage Program and Montana Fish, Wildlife and Parks, Helena, MT. 12pp.
[4] Fertig, W. and G. Beauvais. 1999. Wyoming Plant and Animal Species of Special Concern. Wyoming Natural Diversity Database, Laramie, Wyoming. Unpublished report.
[5] Alberta Natural Heritage Information Center. 2000. At: http://www.cd.gov.ab.ca/preserving/parks/anhic/fishtrak.asp
[6] Saskatchewan Conservation Data Center. 2002. Interim list, species at risk requiring special management consideration. At: http://www.biodiversity.sk.ca/docs/SARlistforindustry.htm
[7] Nebraska Natural Heritage Program. 1996. Nebraska species of concern. At: www.natureserve.org/nhp/us/ne/elements.html
[9] COSEWIC. 2002. Canadian Species at Risk, May 2002. Committee on the Status of Endangered Wildlife in Canada. 34 pp. www.cosewic.gc.ca
[10] Occurs in Loup and Garfield Co.'s, NB. Proposed Title Transfer Middle Loup Division Nebraska Final Environmental Assessment September 2002. http://www.gp.usbr.gov/nepa/middle_loup_EA/contents.htm

Appendix C1. Checklist of Birds of the NGP Ecoregion

Species	Scientific Name	Geographic Affinity	Ecological Affinity	NGP Status	Sand Hills Status [1]	Bowdoin Refuge[2]	Thunder Basin[3]
Grebes							
Common loon	*Gavia immer*	Northern	Limnic	Breeding	Migrant	no	Resident
Pacific loon	*Gavia pacifica*		Limnic	Accidental			Accidental
Pied-billed grebe	*Podilymbus podiceps*	Pandemic	Limnic	Breeding	Breeds	Breeding	Breeding
Horned grebe	*Podiceps auritus*	Northern	Limnic	Breeding	Migrant	Breeding	Breeding
Red-necked grebe	*Podiceps grisegena*	Northern	Limnic	Migrant	Migrant	Accidental	no
Eared grebe	*Podiceps nigricollis*	Western	Limnic	Breeding	Breeds	Breeding	Breeding
Western grebe	*Aechmophorus occidentalis*	Western	Limnic	Breeding	Breeds	Breeding	Breeding
Clark's grebe	*Aechmophorus clarkii*	--	Limnic	Accidental	Accidental	Breeding	no
Pelicans							
American white pelican	Pelecanus erythrorhynchos	Western	Limnic	Breeding	Migrant	Breeding	Resident
Brown pelican	Pelecanus occidentalis	--	Limnic	Accidental	Accidental	no	no
Double-crested cormorant	*Phalacrocorax auritus*	Pandemic	Limnic	Breeding	Breeds	Breeding	Resident
Herons							
American bittern	Botaurus lentiginosus	Eastern	Limnic	Breeding	Breeds	Breeding	Breeding
Least bittern	Ixobrychus exilis	Eastern	Limnic	Accidental	Breeds	no	no
Great blue heron	Ardea herodias	Pandemic	Limnic	Breeding	Breeds	Breeding	Breeding
Great egret	Casmerodius albus	Pandemic	Limnic	Accidental	Migrant	no	no
Snowy egret	Egretta thula	Pandemic	Limnic	Migrant	Migrant	Migrant	no
Little blue heron	Egretta caerulea	Eastern	Limnic	Accidental	Migrant	no	no
Cattle egret	Bubulcus ibis	Eastern	Limnic	Accidental	Breeds	Accidental	no
Green-backed heron	Butorides striatus	Eastern	Limnic	Accidental	Possibly Breeds	Accidental	Migrant

Species	Scientific Name	Geographic Affinity	Ecological Affinity	NGP Status	Sand Hills Status [1]	Bowdoin Refuge[2]	Thunder Basin[3]
Black-crowned night-heron	Nycticorax nycticorax	Pandemic	Limnic	Breeding	Breeds	Breeding	Breeding
Yello-crowned Night-heron	Nyctanassa violacea		Limnic	Accidental		no	no
White-faced ibis	Plegadis chihi	Western	Limnic	Breeding	Breeds	Breeding	Resident
Swans, Geese, Ducks							
Tundra swan	Cygnus columbianus	--	--	Migrant	Migrant	Migrant	no
Trumpeter swan	Cygnus buccinator	Western	Limnic	Breeding	Breeds	no	no
Greater white-fronted goose	Anser albifrons	--	--	Migrant	Migrant	Accidental	Migrant
Snow goose	Chen caerulescens	--	--	Migrant	Migrant	Accidental	Migrant
Ross' goose	Chen rossii	--	--	Migrant	Migrant	Accidental	no
Canada goose	Branta canadensis	Pandemic	Limnic	Breeding	Breeds	Breeding	Breeding
Wood duck	Aix sponsa	Eastern	Limnic	Breeding	Breeds	Migrant	no
Green-winged teal	Anas crecca	Pandemic	Limnic	Breeding	Breeds	Breeding	Breeding
American black duck	Anas rubripes	Eastern	Limnic	Accidental	Accidental	Accidental	no
Mallard	Anas platyrhynchos	Pandemic	Limnic	Breeding	Breeds	Breeding	Breeding
Northern pintail	Anas acuta	Pandemic	Limnic	Breeding	Breeds	Breeding	Breeding
Blue-winged teal	Anas discors	Pandemic	Limnic	Breeding	Breeds	Breeding	Resident
Cinnamon teal	Anas cyanoptera	Western	Limnic	Breeding	Breeds	Breeding	Breeding
Northern shoveler	Anas clypeata	Pandemic	Limnic	Breeding	Breeds	Breeding	Breeding
Gargeney	Anas querquedula			Accidental	No	no	no
Gadwall	Anas strepera	Western	Limnic	Breeding	Breeds	Breeding	Resident
Eurasian wigeon	Anas penelope	--	--	Accidental	Accidental	no	no
American wigeon	Anas americana	Western	Limnic	Breeding	Breeds	Breeding	no
Canvasback	Aythya valisineria	Western	Limnic	Breeding	Breeds	Breeding	Breeding
Redhead	Aythya americana	Western	Limnic	Breeding	Breeds	Breeding	no
Ring-necked duck	Aythya collaris	Northern	Limnic	Migrant	Migrant	Migrant	Migrant
Greater scaup	Aythya marila	--	--	Accidental	Migrant	no	Migrant
Lesser scaup	Aythya affinis	Western	Limnic	Breeding	Breeds	Breeding	Breeding
Long-tailed duck	Clangula hyemalis	--	--	Accidental	Accidental	Accidental	no

White-winged scoter	Melanitta fusca	Northern	Limnic	Accidental	Accidental	Accidental	no
Species	Scientific Name	Geographic Affinity	Ecological Affinity	NGP Status	Sand Hills Status 1	Bowdoin Refuge2	Thunder Basin3
Surf scoter	Melanitta perspicillata	--	--	Accidental	Accidental	Accidental	no
Black scoter	Melanitta nigra			Accidental		no	no
Common goldeneye	Bucephala clangula	Northern	Limnic	Breeding	Migrant	Breeding	Breeding
Barrow's goldeneye	Bucephala islandica	--	--	Accidental	Accidental	Accidental	no
Bufflehead	Bucephala albeola	Northern	Limnic	Migrant	Migrant	Migrant	Migrant
Hooded merganser	Lophodytes cucullatus	Eastern	Limnic	Migrant	Migrant	Migrant	Migrant
Common merganser	Mergus merganser	Northern	Limnic	Winter	Migrant	Migrant	Resident
Red-breasted merganser	Mergus serrator	--	--	Migrant	Accidental	Accidental	Accidental
Ruddy duck	Oxyura jamaicensis	Western	Limnic	Breeding	Breeds	Breeding	Breeding
Raptors							
Turkey vulture	*Cathartes aura*	Pandemic	Broad	Breeding	Breeds	no	Breeding
Osprey	*Pandion haliaetus*	Pandemic	Limnic	Breeding	Migrant	Accidental	Accidental
Black-shouldered kite	*Elanus caeruleus*	--	--		Accidental	no	no
Bald eagle	*Haliaeetus leucocephalus*	Northern	Broad	Breeding	Migrant	Resident	Breeding
Northern harrier	*Circus cyaneus*	Pandemic	Grassland	Breeding	Breeds	Breeding	Breeding
Sharp-shinned hawk	*Accipiter striatus*	Pandemic	Woodland	Breeding	Breeds	Accidental	Breeding
Cooper's hawk	*Accipiter cooperii*	Pandemic	Woodland	Breeding	Possibly Breeds	Accidental	Breeding
Northern goshawk	*Accipiter gentilis*	Northern	Woodland	Winter	Migrant	Winter	Breeding
Red-shouldered hawk	*Buteo lineatus*	Eastern	Woodland	No	Accidental	no	no
Broad-winged hawk	*Buteo platypterus*	Eastern	Woodland	Migrant	Migrant	Migrant	no
Swainson's hawk	*Buteo swainsoni*	Western	Grassland	Breeding	Breeds	Breeding	Breeding
Red-tailed hawk	*Buteo jamaicensis*	Pandemic	Broad	Breeding	Breeds	Accidental	Breeding
Ferruginous hawk	*Buteo regalis*	Western	Grassland	Breeding	Breeds	Breeding	Breeding
Rough-legged hawk	*Buteo lagopus*	--	Broad	Winter	Winter	Winter	Breeding
Golden eagle	*Aquila chrysaetos*	Western	Broad	Breeding	Possibly Breeds	Resident	Breeding
American kestrel	*Falco sparverius*	Eastern	Woodland	Breeding	Breeds	Breeding	Breeding
Merlin	*Falco columbarius*	Northern	Woodland	Breeding	Migrant	Accidental	Migrant

Species	Scientific Name	Geographic Affinity	Ecological Affinity	NGP Status	Sand Hills Status [1]	Bowdoin Refuge[2]	Thunder Basin[3]
Peregrine falcon	*Falco peregrinus*	Pandemic	Misc.	Migrant	Migrant	Migrant	Migrant
Gyrfalcon	*Falco rusticolus*	--	--	Accidental	Winter	Accidental	Winter
Prairie falcon	*Falco mexicanus*	Western	Grassland	Breeding	Possibly Breeds	Accidental	Breeding
Upland game							
Gray partridge	*Perdix perdix*	--	Introduced	Breeding	Possibly Breeds	Breeding	Resident
Chukar	*Alectoris chukar*			Accidental			Resident
Ring-necked pheasant	*Phasianus colchicus*	--	Introduced	Breeding	Breeds	Breeding	no
Greater prairie-chicken	*Tympanuchus cupido*	Endemic	Grassland	No	Breeds	no	no
Ruffed grouse	*Bonasa umbellus*			Breeding		no	no
Sharp-tailed grouse	*Tympanuchus phasianellus*	Northern	Grassland	Breeding	Breeds	Breeding	Breeding
Greater sage grouse	*Centrocercus urophasianus*		Shrub	Breeding	No	Breeding	Breeding
Wild turkey	*Meleagris gallopavo*	Pandemic	Woodland	Breeding	Breeds	no	Breeding
Northern bobwhite	*Colinus virginianus*	Eastern	Shrub	No	Breeds	no	no
Rails, Cranes							
Yellow rail	*Coturnicops noveboracensis*	Northern	Limnic	Breeding	Possibly Breeds	no	no
Black rail	*Laterallus jamaicensis*	Eastern	Limnic	No	Accidental	no	no
Virginia rail	*Rallus limicola*	Pandemic	Limnic	Breeding	Breeds	Breeding	Breeding
Sora	*Porzana carolina*	Pandemic	Limnic	Breeding	Breeds	Breeding	Breeding
Common moorhen	*Gallinula chloropus*	Eastern	Limnic	No	Possibly Breeds	no	no
American coot	*Fulica americana*	Pandemic	Limnic	Breeding	Breeds	Breeding	Breeding
Sandhill crane	*Grus canadensis*	Northern	Limnic	Breeding	Migrant	Migrant	Breeding
Whooping crane	*Grus americana*	Northern	Limnic	Migrant	Migrant	no	no

Species	Scientific Name	Geographic Affinity	Ecological Affinity	NGP Status	Sand Hills Status [1]	Bowdoin Refuge[2]	Thunder Basin[3]
Shorebirds							
Black-bellied plover	*Pluvialis squatarola*	--	--	Migrant	Migrant	Migrant	Migrant
American golden-plover	*Pluvialis dominica*	--	--	Migrant	Migrant	Accidental	no
Semipalmated plover	*Charadrius semipalmatus*	--	--	Migrant	Migrant	Accidental	Migrant
Piping plover	*Charadrius melodus*	Pandemic	Limnic	Breeding	Breeds	Breeding	no
Mountain plover	*Charadrius montanus*			Breeding	No	Accidental	Breeding
Killdeer	*Charadrius vociferus*	Pandemic	Limnic	Breeding	Breeds	Breeding	Breeding
Black-necked stilt	*Himantopus mexicanus*	Western	Limnic	Breeding	Breeds	Breeding	no
American avocet	*Recurvirostra americana*	Western	Limnic	Breeding	Breeds	Breeding	Breeding
Greater yellowlegs	*Tringa melanoleuca*	--	--	Migrant	Migrant	Migrant	Migrant
Lesser yellowlegs	*Tringa flavipes*	--	--	Migrant	Migrant	Accidental	Migrant
Solitary sandpiper	*Tringa solitaria*	--	--	Migrant	Migrant	Migrant	Migrant
Willet	*Catoptrophorus semipalmatus*	Pandemic	Limnic	Breeding	Breeds	Breeding	Breeding
Spotted sandpiper	*Actitis macularia*	Pandemic	Limnic	Breeding	Breeds	Breeding	Breeding
Upland sandpiper	*Bartramia longicauda*	Endemic	Grassland	Breeding	Breeds	Breeding	Breeding
Whimbrel	*Numenius phaeopus*	--	--	Accidental	Accidental	Accidental	no
Long-billed curlew	*Numenius americanus*	Endemic	Grassland	Breeding	Breeds	Breeding	Breeding
Hudsonian godwit	*Limosa haemastica*	--	--	Migrant	Migrant	Accidental	
Marbled godwit	*Limosa fedoa*	Endemic	Grassland	Breeding	Migrant	Breeding	Breeding
Ruddy turnstone	*Arenaria interpres*			Accidental		Accidental	no
Red knot	*Calidris canutus*	--	--	Migrant	Migrant	Accidental	no
Sanderling	*Calidris alba*	--	--	Migrant	Migrant	Migrant	no
Semipalmated sandpiper	*Calidris pusilla*	--	--	Migrant	Migrant	Migrant	no
Western sandpiper	*Calidris mauri*	--	--	Migrant	Migrant	Migrant	Migrant
Least sandpiper	*Calidris minutilla*	--	--	Migrant	Migrant		Migrant
White-rumped sandpiper	*Calidris fuscicollis*	--	--	Migrant	Migrant	Accidental	no
Baird's sandpiper	*Calidris bairdii*	--	--	Migrant	Migrant	Migrant	Migrant

Species	Scientific Name	Geographic Affinity	Ecological Affinity	NGP Status	Sand Hills Status [1]	Bowdoin Refuge[2]	Thunder Basin[3]
Pectoral sandpiper	*Calidris melanotos*	--	--	Migrant	Migrant	Migrant	Migrant
Dunlin	*Calidris alpina*	--	--	Migrant	Migrant	Accidental	no
Stilt sandpiper	*Calidris himantopus*	--	--	Migrant	Migrant	Migrant	Migrant
Short-billed dowitcher	*Limnodromus griseus*	--	--	Migrant	Migrant	Accidental	Accidental
Long-billed dowitcher	*Limnodromus scolopaceus*	--	--	Migrant	Migrant	Migrant	Migrant
Buff-breasted sandpiper	*Tryngites subruficollis*			Migrant		no	no
Common snipe	*Gallinago gallinago*	Northern	Limnic	Breeding	Breeds	Breeding	Breeding
American woodcock	*Scolopax minor*	Northern	Shrub	No	Possibly Breeds	no	no
Wilson's phalarope	*Phalaropus tricolor*	Endemic	Limnic	Breeding	Breeds	Breeding	Breeding
Red phalarope	*Phalaropus fulicaria*			Accidental		Accidental	no
Red-necked phalarope	*Phalaropus lobatus*</td>	--	--	Migrant	Migrant	Migrant	Migrant
Franklin's gull	*Larus pipixcan*	Endemic	Limnic	Breeding	Migrant	Breeding	Resident
Bonaparte's gull	*Larus philadelphia*	--	--	Migrant	Migrant	Migrant	Migrant
Ring-billed gull	*Larus delawarensis*	Western	Limnic	Breeding	Migrant	Breeding	Migrant
California gull	*Larus californicus*	Western	Limnic	Breeding	Migrant	Breeding	Breeding
Herring gull	*Larus argentatus*	--	--	Migrant	Migrant	Migrant	Migrant
Glaucous gull	*Larus hyperboreus*	--	--	Accidental	Accidental	no	no
Sabine's gull	*Xema sabini*	--	--	Accidental	Accidental	Accidental	no
Black-legged kittiwake	*Rissa tridactyla*			Accidental		no	no
Caspian tern	*Sterna caspia*	Pandemic	Limnic	Migrant	Migrant	Breeding	no
Common tern	*Sterna hirundo*	Pandemic	Limnic	Breeding	Migrant	Breeding	Migrant
Forster's tern	*Sterna forsteri*	Pandemic	Limnic	Breeding	Breeds	Accidental	Breeding
Least tern	*Sterna antillarum*	Pandemic	Limnic	Breeding	Breeds	no	no
Black tern	*Chlidonias niger*	Pandemic	Limnic	Breeding	Breeds	Breeding	Breeding
Doves							
Rock dove	*Columba livia*	--	Introduced	Breeding	Breeds	Resident	Resident
Mourning dove	*Zenaida macroura*	Pandemic	Woodland	Breeding	Breeds	Breeding	Breeding
Band-tailed pigeon	*Columba fasciata*			Accidental		no	no

Species	Scientific Name	Geographic Affinity	Ecological Affinity	NGP Status	Sand Hills Status [1]	Bowdoin Refuge[2]	Thunder Basin[3]
Cuckoos							
Black-billed cuckoo	*Coccyzus erythropthalmus*	Eastern	Woodland	Breeding	Breeds	Breeding	no
Yellow-billed cuckoo	*Coccyzus americanus*	Pandemic	Woodland	Breeding	Breeds	Accidental	Migrant
Owls							
Common barn-owl	*Tyto alba*	Pandemic	Misc.	Breeding	Breeds	no	Resident
Eastern screech-owl	*Otus asio*	Eastern	Woodland	Breeding	Breeds	Breeding	Breeding
Great horned owl	*Bubo virginianus*	Pandemic	Woodland	Breeding	Breeds	Breeding	Breeding
Snowy owl	*Nyctea scandiaca*	--	--	Winter	Winter	Winter	Winter
Burrowing owl	*Athene cunicularia*	Western	Grassland	Breeding	Breeds	Breeding	Breeding
Barred owl	*Strix varia*	Eastern	Woodland	No	Possibly Breeds	no	no
Long-eared owl	*Asio otus*	Pandemic	Woodland	Breeding	Breeds	Breeding	Breeding
Short-eared owl	*Asio flammeus*	Pandemic	Grassland	Breeding	Breeds	Breeding	Breeding
Northern saw-whet owl	*Aegolius acadicus*	Northern	Woodland	Accidental	Breeds	Accidental	Breeding
Goatsuckers, swifts							
Common nighthawk	*Chordeils minor*	Pandemic	Misc.	Breeding	Breeds	Breeding	Breeding
Common poorwill	*Phalaenoptilus nuttallii*	Western	Grassland	Breeding	Breeds	no	Breeding
Whip-poor-will	*Caprimulgus vociferus*	Eastern	Woodland	No	Possibly Breeds	no	no
Chimney swift	*Chaetura pelagica*	Eastern	Woodland	Breeding	Breeds	no	no
White-throated swift	*Aeronautes saxatalis*			Breeding		no	Breeding
Hummingbirds							
Ruby-throated hummingbird	*Archilochus colubris*	Eastern	Woodland	Breeding	Migrant	Breeding	Breeding

Species	Scientific Name	Geographic Affinity	Ecological Affinity	NGP Status	Sand Hills Status [1]	Bowdoin Refuge[2]	Thunder Basin[3]
Kingfishers, woodpeckers							
Belted kingfisher	*Ceryle alcyon*	Pandemic	Limnic	Breeding	Breeds	Resident	Breeding
Red-headed woodpecker	*Melanerpes erythrocephalus*	Eastern	Woodland	Breeding	Breeds	Breeding	Breeding
Lewis's woodpecker	*Melanerpes uropygialis*		Woodland	Migrant		no	Migrant
Red-bellied woodpecker	*Melanerpes carolinus*	Eastern	Woodland	Accidental	Possibly Breeds	no	no
Red-naped sapsucker	*Sphyrpicus nuchalis*		Woodland	Accidental	No	no	no
Yellow-bellied sapsucker	*Sphyrapicus varius*	Northern	Woodland	Migrant	Migrant	Migrant	Resident
Downy woodpecker	*Picoides pubescens*	Pandemic	Woodland	Breeding	Breeds	Breeding	Breeding
Hairy woodpecker	*Picoides villosus*	Pandemic	Woodland	Breeding	Breeds	Breeding	Breeding
Northern flicker	*Colaptes auratus*	Pandemic	Woodland	Breeding	Breeds	Breeding	Breeding
Flycatchers							
Olive-sided flycatcher	*Contopus borealis*	Northern	Woodland	Migrant	Migrant	no	Breeding
Western wood-pewee	*Contopus sordidulus*	Western	Woodland	Breeding	Breeds	Resident	Breeding
Eastern wood-pewee	*Contopus virens*	Eastern	Woodland	No	Breeds	no	no
Cordilleran flycatcher	*Empidonax occidentalis*			Breeding		no	Breeding
Yellow-bellied flycatcher	*Empidonax flaviventris*	--	--	No	Migrant	no	no
Alder flycatcher	*Empidonax alnorum*	--	--	Migrant	Migrant	Accidental	no
Willow flycatcher	*Empidonax traillii*	Pandemic	Woodland	Breeding	Possibly Breeds	Breeding	Resident
Least flycatcher	*Empidonax minimus*	Eastern	Woodland	Breeding	Migrant	Breeding	Resident
Hammond's flycatcher	*Empidonax hammondii*			Accidental			Accidental
Dusky flycatcher	*Empidonax oberhoseri*			Breeding		no	Breeding
Eastern phoebe	*Sayornis phoebe*	Eastern	Woodland	Breeding	Breeds	no	no
Say's phoebe	*Sayornis saya*	Western	Woodland	Breeding	Breeds	Breeding	Breeding
Ash-throated flycatcher	*Myiarchus cinerascens*			Breeding			Breeding
Great crested flycatcher	*Myiarchus crinitus*	Eastern	Woodland	Accidental	Breeds	no	no

Species	Scientific Name	Geographic Affinity	Ecological Affinity	NGP Status	Sand Hills Status [1]	Bowdoin Refuge[2]	Thunder Basin[3]
Cassin's kingbird	*Tyrannus vociferans*	Western	Woodland	No	Possibly Breeds	no	Resident
Western kingbird	*Tyrannus verticalis*	Western	Woodland	Breeding	Breeds	Breeding	Breeding
Eastern kingbird	*Tyrannus tyrannus*	Eastern	Woodland	Breeding	Breeds	Breeding	Breeding
Scissor-tailed flycatcher	*Tyrannus forficatus*	Southern	Woodland	No	Accidental	no	no
Larks, swallows							
Horned lark	*Eremophila alpestris*	Pandemic	Grassland	Breeding	Breeds	Breeding	Breeding
Purple martin	*Progne subis*	Pandemic	Misc.	Accidental	Possibly Breeds	no	no
Tree swallow	*Tachycineta bicolor*	Northern	Misc.	Breeding	Breeds	Breeding	Breeding
Violet-green swallow	*Tachycineta thalassina*	Western	Misc.	Breeding	Migrant	no	Breeding
Northern rough-winged swallow	*Stelgidopteryx serripennis*	Pandemic	Misc.	Breeding	Breeds	Breeding	Breeding
Bank swallow	*Riparia riparia*	Pandemic	Misc.	Breeding	Possibly Breeds	Breeding	Breeding
Cliff swallow	*Hirundo pyrrhonota*	Pandemic	Misc.	Breeding	Breeds	Breeding	Breeding
Barn swallow	*Hirundo rustica*	Pandemic	Mixc.	Breeding	Breeds	Breeding	Breeding
Jays, Crows							
Gray jay	*Perisoreus canadensis*	Northern	Woodland	Accidental	Accidental		no
Steller's jay	*Cyanocitta stelleri*	--	--	Accidental	Accidental		Resident
Blue jay	*Cyanocitta cristata*	Eastern	Woodland	Breeding	Breeds	Resident	Breeding
Pinyon jay	*Gymnorhinus cuanocephalus*	Western	Woodland	Breeding	Accidental	no	Resident
Clark's nutcracker	*Nucifraga columbiana*	--	--	Resident	Accidental	no	Resident
American magpie	*Pica pica*	Western	Woodland	Breeding	Breeds	Breeding	Breeding
Common raven	*Corvus corax*			Breeding		no	Breeding
American crow	*Corvus brachyrhynchos*	Pandemic	Woodland	Breeding	Breeds	Resident	Breeding

Species	Scientific Name	Geographic Affinity	Ecological Affinity	NGP Status	Sand Hills Status [1]	Bowdoin Refuge[2]	Thunder Basin[3]
Chickadees, creepers							
Black-capped chickadee	*Poecile atricapilla*	Pandemic	Woodland	Breeding	Breeds	Breeding	Breeding
Mountain chickadee	*Poecile gambeli*			Winter		Winter	no
Tufted titmouse	*Baeolophus bicolor*	Eastern	Woodland	No	Accidental	no	no
Red-breasted nuthatch	*Sitta canadensis*	Western	Woodland	Breeding	Breeds	Accidental	Breeding
White-breasted nuthatch	*Sitta carolinensis*	Pandemic	Woodland	Breeding	Breeds	no	Breeding
Pygmy nuthatch	*Sitta pygmaea*			Breeding			Resident
Brown creeper	*Certhia americana*	Northern	Woodland	Breeding	Breeds	Accidental	no
Wrens							
Rock wren	*Salpinctes obsoletus*	Western	Xeric Scrub	Breeding	Breeds	Accidental	Breeding
Bewick's wren	*Thryomanes bewickii*	Eastern	Woodland	Accidental	Accidental	no	Accidental
Canyon wren	*Catherpes mexicanus*		Canyon	Breeding		no	no
House wren	*Troglodytes aedon*	Pandemic	Woodland	Breeding	Breeds	Breeding	Breeding
Winter wren	*Troglodytes troglodytes*	Northern	Woodland	Migrant	Migrant	Accidental	no
Sedge wren	*Cistothorus platensis*	Eastern	Limnic	Accidental	Possibly Breeds	no	no
Marsh wren	*Cistothorus palustris*	Pandemic	Limnic	Breeding	Breeds	Breeding	no
Thrushes							
Golden-crowned kinglet	*Regulus satrapa*	Northern	Woodland	Migrant	Migrant	Winter	no
Ruby-crowned kinglet	*Regulus calendula*	Northern	Woodland	Migrant	Migrant	Accidental	Resident
Eastern bluebird	*Siala sialis*	Eastern	Woodland	Breeding	Breeds	no	Breeding
Mountain bluebird	*Siala currucoides*	Western	Woodland	Breeding	Possibly Breeds	Accidental	Breeding
Townsend's solitaire	*Myadestes townsendi*	Western	Woodland	Resident	Migrant	Accidental	Breeding
Veery	*Catharus fuscescens*	Northern	Woodland	Breeding	Migrant	Accidental	Breeding
Gray-cheeked thrush	*Catharus minimus*	--	--	Migrant	Migrant	Accidental	Migrant
Swainson's thrush	*Catharus ustulatus*	Northern	Woodland	Migrant	Migrant	Migrant	Breeding

Species	Scientific Name	Geographic Affinity	Ecological Affinity	NGP Status	Sand Hills Status [1]	Bowdoin Refuge[2]	Thunder Basin[3]
Hermit thrush	*Catharus guttatus*	Northern	Woodland	Migrant	Migrant	Migrant	no
Wood thrush	*Hylocichla mustelina*	Eastern	Woodland	Accidental	Possibly Breeds	Accidental	no
American robin	*Turdus migratorius*	Pandemic	Woodland	Breeding	Breeds	Breeding	Breeding
Varied thrush	*Ixoreus naevius*	--	--	Accidental	Accidental	Accidental	no
Thrashers							
Gray catbird	*Dumetella carolinensis*	Eastern	Woodland	Breeding	Breeds	Accidental	Breeding
Northern mockingbird	*Mimus polyglottos*	Eastern	Woodland	Accidental	Breeds	Accidental	Accidental
Sage thrasher	*Oreoscoptes montanus*	Western	Xeric Scrub	Breeding	Accidental	no	Breeding
Brown thrasher	*Toxostoma rufum*	Eastern	Woodland	Breeding	Breeds	Breeding	Breeding
American pipit	*Anthus rubescens*			Migrant		Resident	Resident
Spragues pipit	*Anthus spragueii*			Breeding	No	Breeding	Breeding
Waxwings, Shrikes							
Bohemian waxwing	*Bombycilla garrulus*	--	--	Winter	Accidental	Winter	Winter
Cedar waxwing	*Bombycilla cedrorum*	Pandemic	Woodland	Breeding	Possibly Breeds	Breeding	Breeding
Northern shrike	*Lanius excubitor*	--	--	Winter	Winter	Winter	Winter
Loggerhead shrike	*Lanius ludovicianus*	Pandemic	Woodland	Breeding	Breeds	Breeding	Breeding
European starling	*Sturnus vulgaris*	--	Introduced	Breeding	Breeds	Breeding	Breeding
Vireos							
Bell's vireo	*Vireo bellii*	Eastern	Woodland	Breeding	Breeds	no	
Yellow-throated vireo	*Vireo flavifrons*	Eastern	Woodland	Accidental	Possibly Breeds	no	
Warbling vireo	*Vireo gilvus*	Pandemic	Woodland	Breeding	Breeds	Accidental	Breeding
Philadelphia vireo	*Vireo philadelphicus*	Northern	Woodland	No	Migrant	no	no
Red-eyed vireo	*Vireo olivaceus*	Eastern	Woodland	Breeding	Breeds	Resident	Breeding
Plumbeous vireo	*Vireo plumbeus*			Breeding		no	Breeding
Blue-headed vireo	*Vireo solitarius*			Migrant		no	no

Species	Scientific Name	Geographic Affinity	Ecological Affinity	NGP Status	Sand Hills Status [1]	Bowdoin Refuge[2]	Thunder Basin[3]
Warblers							
Blue-winged warbler	*Vermivora pinus*	Eastern	Woodland	Accidental	Accidental	no	no
Brewster's hybrid	*Vermivora pinus x V. chrysoptera*	--	--	No	Accidental	no	no
Tennessee warbler	*Vermivora peregrina*	Northern	Woodland	Breeding	Migrant	Accidental	no
Orange-crowned warbler	Vermivora celata	--	--	Migrant	Migrant	Migrant	Breeding
Nashville warbler	*Vermivora ruficapilla*	Northern	Woodland	Migrant	Migrant	no	no
Northern parula	*Parula americana*	Eastern	Woodland	Accidental	Possibly Breeds	no	no
Yellow warbler	*Dendroica petechia*	Pandemic	Woodland	Breeding	Breeds	Breeding	Breeding
Chestnut-sided warbler	*Dendroica pensylvanica*			Migrant		no	no
Magnolia warbler	*Dendroica magnolia*	Northern	Woodland	Migrant	Migrant	no	no
Cape May warbler	*Dendroica tigrina*			Accidental		Accidental	no
Black-throated blue warbler	*Dendroica caerulescens*	Eastern	Woodland	Accidental	Accidental	no	no
Yellow-rumped warbler	*Dendroica coronata*	Northern	Woodland	Breeding	Migrant	Resident	Resident
Black-throated gray warbler	*Dendroica nigrescens*	--	--	No	Accidental	no	no
Townsend's warbler	*Dendroica townsendi*	--	--	Accidental	Accidental	Accidental	Accidental
Black-throated green warbler	*Dendroica virens*	Eastern	Woodland	Migrant	Migrant	no	no
Blackburnian warbler	*Dendroica fusca*	Northern	Woodlan	Migrant	Migrant	Accidental	no
Yellow-throated warbler	*Dendroica domina*	Eastern	Woodland	No	Possibly Breeds	no	no
Prairie warbler	*Dendroica discolor*	Eastern	Woodland	No	Accidental	no	no
Palm warbler	*Dendroica palmarum*	Northern	Woodland	Migrant	Migrant	Accidental	no
Bay-breasted warbler	*Dendroica castanea*	Northern	Woodland	Migrant	Migrant	no	no
Blackpoll warbler	*Dendroica striata*	--	--	Migrant	Migrant	Migrant	Migrant
Black-and-white warbler	*Dendroica varia*	Eastern	Woodland	Breeding	Possibly Breeds	no	Migrant

Cerulean warbler	*Dendroica cerulea*	Eastern	Woodland	No	Possibly Breeds	no	
Species	*Scientific Name*	Geographic Affinity	Ecological Affinity	NGP Status	Sand Hills Status 1	Bowdoin Refuge2	Thunder Basin3
American redstart	*Setophaga ruticilla*	Eastern	Woodland	Breeding	Breeds	Migrant	Breeding
Worm-eating warbler	*Helmitheros vermivorus*	Eastern		Accidental	Accidental	no	no
Ovenbird	*Seiurus aurocapillus*	Eastern	Woodland	Breeding	Breeds	Migrant	Breeding
Northern waterthrush	*Seiurus noveboracensis*	Northern	Woodland	Migrant	Migrant	Migrant	Migrant
Kentucky warbler	*Oporornis formosus*	Eastern	Woodland	No	Possibly Breeds	no	no
Mourning warbler	*Oporonis philadelphia*			Accidental		Accidental	no
Connecticut warbler	*Oporornis agilis*	--	--	No	Migrant	no	no
Macgillivray's warbler	*Oporornis tolmiei*	Western	Woodland	Breeding	Migrant	Migrant	Breeding
Common yellowthroat	*Geothlypis trichas*	Pandemic	Limnic	Breeding	Breeds	Breeding	Breeding
Wilson's warbler	*Wilsonia pusilla*	--	--	Migrant	Migrant	Migrant	Breeding
Canada warbler	*Wilsonia canadensis*	Northern	Woodland	Migrant	Migrant	no	no
Yellow-breasted chat	*Icteria virens*	Pandemic	Woodland	Breeding	Breeds	Migrant	Breeding
Tanagers							
Summer tanager	*Piranga rubra*	Eastern	Woodland	No	Accidental	no	no
Scarlet tanager	*Piranga olivacea*	Eastern	Woodland	Breeding	Breeds	no	no
Western tanager	*Piranga ludoviciana*	Western	Woodland	Breeding	Migrant	Migrant	Breeding
Northern cardinal	*Cardinalis cardinalis*	Eastern	Woodland	Accidental	Possibly Breeds	no	no

Species	Scientific Name	Geographic Affinity	Ecological Affinity	NGP Status	Sand Hills Status [1]	Bowdoin Refuge[2]	Thunder Basin[3]
Grosbeaks, sparrows							
Rose-breasted grosbeak	*Pheucticus ludovicianus*	Eastern	Woodland	Breeding	Possibly Breeds	Migrant	Breeding
Black-headed grosbeak	*Pheucticus melanocephalus*	Western	Woodland	Breeding	Breeds	Accidental	Breeding
Blue grosbeak	*Guiraca caerulea*	Southern	Woodland	Breeding	Breeds	Accidental	no
Lazuli bunting	*Passerina amoena*	Western	Woodland	Breeding	Possibly Breeds	Accidental	Breeding
Indigo bunting	*Passerina cyanea*	Eastern	Woodland	Accidental	Breeds	no	no
Dickcissel	*Spiza americana*	Endemic	Grassland	Breeding	Breeds	no	no
Spotted towhee	*Pipilo maculatus*			Breeding		no	no
Green-tailed towhee	*Pipilo chlorurus*	Western	Xeric Scrub	Accidental	Accidental	no	no
Rufous-sided towhee	*Pipilo erythrophthalmus*	Pandemic	Woodland	Breeding	Breeds	Breeding	Breeding
Cassin's sparrow	*Aimophila cassinii*	Endemic	Grassland	No	Accidental	no	no
Sage sparrow	*Amphispiza belli*			Breeding		no	Breeding
American tree sparrow	*Spizella arborea*	--	--	Winter	Winter	Winter	Winter
Chipping sparrow	*Spizella passerina*	Pandemic	Woodland	Breeding	Breeds	Breeding	Breeding
Clay-colored sparrow	*Spizella pallida*	Endemic	Grassland	Breeding	Migrant	Breeding	Breeding
Brewer's sparrow	*Spizella breweri*	Western	Xeric Scrub	Breeding	Accidental	Breeding	Breeding
Field sparrow	*Spizella pusilla*	Eastern	Grassland	Breeding	Breeds	no	no
Vesper sparrow	*Pooecetes grammacus*	Pandemic	Grassland	Breeding	Breeds	Breeding	Breeding
Lark sparrow	*Chondestes grammacus*	Western	Grassland	Breeding	Breeds	Breeding	Breeding
Lark bunting	*Calamospiza melanocorys*	Endemic	Grassland	Breeding	Breeds	Breeding	Breeding
Savannah sparrow	*Passerculus sandwichensis*	Pandemic	Grassland	Breeding	Breeds	Breeding	Breeding
Baird's sparrow	*Ammodramus bairdii*	Endemic	Grassland	Breeding	Migrant	Breeding	Breeding
Grasshopper sparrow	*Ammodramus savannarum*	Pandemic	Grassland	Breeding	Breeds	Breeding	Breeding
Le conte's sparrow	*Ammodramus leconteii*	Endemic	Grassland	Breeding	Migrant	Accidental	no

Nelson's sharp-tailed sparrow	*Ammodramus nelsoni*			Breeding		no	no
Species	Scientific Name	Geographic Affinity	Ecological Affinity	NGP Status	Sand Hills Status [1]	Bowdoin Refuge[2]	Thunder Basin[3]
Fox sparrow	*Passerella iliaca*	--	--	Migrant	Migrant	Migrant	no
Song sparrow	*Melospiza melodia*	Pandemic	Woodland	Breeding	Breeds	Breeding	Breeding
Lincoln's sparrow	*Melospiza lincolnii*	--	--	Migrant	Migrant	Migrant	Migrant
Swamp sparrow	*Melospiza georgiana*	Northern	Limnic	Breeding	Breeds	no	no
White-throated sparrow	*Zonotrichia albicollis*	Northern	Woodland	Migrant	Migrant	Migrant	Migrant
White-crowned sparrow	*Zonotrichia leucophrys*	--	--	Breeding	Migrant	Migrant	Resident
Harris' sparrow	*Zonotrichia querula*	--	--	Migrant	Winter	Winter	Winter
Dark-eyed junco	*Junco hyemalis*	Northern	Woodland	Winter	Winter	Winter	Resident
Mccown's longspur	*Calcarius mccownii*	Endemic	Grassland	Breeding	Migrant	Breeding	Breeding
Smith's longspur	*Calcarius pictus*			Migrant		no	no
Lapland longspur	*Calcarius lapponicus*	--	--	Winter	Winter	Winter	Winter
Chestnut-collared longspur	*Calcarius ornatus*	Endemic	Grassland	Breeding	Breeds	Breeding	Breeding
Snow bunting	*Plectrophenax nivalis*	--	--	Winter	Winter	Winter	Winter
Meadowlarks, Blackbirds							
Bobolink	*Dolichonyx oryzivorus*	Pandemic	Grassland	Breeding	Breeds	Resident	Breeding
Red-winged blackbird	*Agelaius phoeniceus*	Pandemic	Limnic	Breeding	Breeds	Breeding	Breeding
Eastern meadowlark	*Sturnella magna*	Eastern	Grassland	Accidental	Breeds	no	no
Western meadowlark	*Sturnella neglecta*	Western	Grassland	Breeding	Breeds	Breeding	Breeding
Yellow-headed blackbird	*Xanthocephalus xanthocephalus*	Western	Limnic	Breeding	Breeds	Breeding	Breeding
Rusty blackbird	*Euphagus carolinus*	--	--	Migrant	Migrant	Accidental	
Brewer's blackbird	*Euphagus cyanocephalus*	Western	Grassland	Breeding	Breeds	Breeding	Breeding
Common grackle	*Quiscalus quiscula*	Eastern	Woodland	Breeding	Breeds	Breeding	Breeding
Brown-headed cowbird	*Molothrus ater*	Pandemic	Woodland	Breeding	Breeds	Breeding	Breeding
Bullock's oriole	*Icterus bullockii*			Breeding		Breeding	no
Baltimore oriole	*Icterus galbula*			Breeding		no	no
Orchard oriole	*Icterus spurius*	Eastern	Woodland	Breeding	Breeds	Accidental	Breeding

Species	Scientific Name	Geographic Affinity	Ecological Affinity	NGP Status	Sand Hills Status [1]	Bowdoin Refuge[2]	Thunder Basin[3]
Finches							
Pine grosbeak	*Pinicola enucleator*			Accidental		Accidental	
Gray-crowned rosy-finch	*Leucosticte tephrocotis*			Winter			Resident
Purple finch	*Carpodacus purpureus*	Northern	Woodland	No	Migrant	no	Winter
Cassin's finch	*Carpodacus cassinii*	--	--	Accidental	Accidental	Accidental	no
House finch	*Carpodacus mexicanus*			Breeding		Accidental	Breeding
Red crossbill	*Loxia curvirostra*	Northern	Woodland	Breeding	Migrant	Accidental	Breeding
White-winged crossbill	*Loxia leucoptera*	Northern	Accidental	Winter	Accidental	no	no
Common redpoll	*Carduelis flammea*	--	--	Winter	Winter	Winter	Winter
Hoary redpoll	*Carduelis hornemanni*			Accidental		Accidental	no
Pine siskin	*Carduelis pinus*	Northern	Woodland	Winter	Breeds	Resident	Breeding
Lesser goldfinch	*Carduelis psaltria*			Accidental			Accidental
American goldfinch	*Carduelis tristis*	Pandemic	Woodland	Breeding	Breeds	Breeding	Breeding
Evening grosbeak	*Coccothraustes vespertinus*	Northern	Woodland	Winter	Winter	Winter	Breeding
House sparrow	*Passer domesticus*	--	Introduced	Breeding	Breeds	Breeding	Breeding

* Common and scientific names following American Ornithologists' Union Checklist of North American Birds, 6th edition, 1983, and supplements; Sibley, D.A. 2000. The Sibley Guide to Birds. Alfred A. Knopf, New York. "Migrant" pertains to spring and fall occurrence, "breeds" and "possibly breeds" to summer.

[1] Labedz, T.E. 1998. Birds. In, An Atlas of the Sandhills. A. Bleed and C. Flowerday, eds. Conservation and Survey Division, Institute of Agric. and Nat. Res., Univ. Nebr., Lincoln. http://csd.unl.edu/csd/illustrations/ra5a/mammals.html.

[2] Department of the Interior, U.S. Fish and Wildlife Service. 1992. Bowdoin National Wildlife Refuge Birds, Malta, Montana. Department of the Interior, U.S. Fish and Wildlife Service. Jamestown, ND: Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/othrdata/chekbird/r6/bowdoin.htm

[3] Von Ahlefeldt, J., T. Byer, P. McLaughlin. 1992. Thunder Basin National Grassland checklist of birds. Medicine Bow National Forest. Jamestown, ND: Norhtern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/othrdata/chekbird/r6/thunder.htm.

Appendix C2. STATUS OF KEY PRAIRIE BIRDS, NORTHERN GREAT PLAINS ECOREGION

	Occurs NGP	Occurs Sandhills	Great Plains endemic[5]	Grassland obligates[4]	TNC[7] "Unlucky 13"	ESA list/ petition	COSEWIC Listing[9]	Montana PIF priority I and II[2]	Wyoming PIF priority I and II[3]	West River PIF priority I	Central mixed-grass PIF priority I	BLM Sensitive	Montana Species Concern[1]	BBS declining (1980-2001)[6]	USFWS Cons Concern[9]
mountain plover	X		X	X	X		E	I	I	N/A	N/A	MT	X	non-sig	X
Baird's sparrow	X		X	X	X			I	I	I	N/A	MT, WY	X	X	X
Sprague's pipit	X		X	X	X		T	I	N/A	N/A	N/A		X	X	X
long-billed curlew	X	X	X	X	X		concern	II	I	I	I	MT, WY		X	X
lark bunting	X	X	X	X	X			II	II	I				X	X
chestnut-collared longspur	X		X	X	X			II	II	I	N/A			X	X
McCown's longspur	X		X	X	X			II	I	I	N/A			non-sig	X
Ferruginous hawk	X	X	X	X	X		concern	II	I	N/A	N/A	MT, WY			X
marbled godwit	X		X	X				II						non-sig	X
Wilson's phalarope	X	X	X						I					non-sig	X
Franklin's gull	X		X						I				X		
burrowing owl	X	X		X	X			I	I			MT, WY	X	non-sig	X
Interior (least) tern	X	X				E		I					X	ND	X
piping plover	X					E	E	I					X	ND	ESA
greater sage grouse	X					P	E	I	I			WY		X	X
loggerhead shrike	X	X					T	II	II			MT, WY		X	X
sage thrasher	X						E	?	?	?	?	WY		?	
dickcissel	X	X		X					II		I	MT	X	non-sig	X
Swainson's hawk	X	X		X					I		I			X	X
American white pelican	X	X							II				X	non-sig	
northern harrier	X	X		X										non-sig	X
sharp-tailed grouse	X	X		X										non-sig	GAME
upland sandpiper	X	X		X					I					X	X
short-eared owl	X			X			concern		I					non-sig	X
horned lark	X	X		X										X	X
western meadowlark	X	X		X										X	
grasshopper sparrow	X	X		X					II					X	X
lark sparrow	X	X							II					X	
Brewer's sparrow	X	X						II				WY		X	X
bobolink	X	X		X					II					X	no
greater prairie chicken	no	X		X	X		EXT				I			non-sig	GAME
Bell's vireo	no	X									I			X	X
savannah sparrow	X	no		X										X	
vesper sparrow	X	X							II					non-sig	no
red-headed woodpecker	X						concern							?	X
yellow rail	X						concern							?	X
Prairie falcon	X	X													X

[1] Carlson, J. 2001. Coordinator, Montana Animal Species of Concern Committee. Montana Animal Species of Concern. Montana Natural Heritage Program and Montana Fish, Wildlife and Parks, Helena,

[2] Casey, D. 2000. Partners in Flight Draft Bird Conservation Plan Montana. American Bird Conservancy, Helena, MT.

[3] Cerovski, A., M. Gorges, T. Byer, K. Duffy, and D. Felley, eds. 2001. Wyoming Bird Conservation Plan, Version 1.0. Wyoming Partners In Flight. Wyoming Game and Fish Dept., Lander, WY.

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Appendix D1. CHECKLIST OF MAMMALS OF THE NGP

Name	Scientific Name	Affinity[1]	Sand Hills[2]	CMR Refuge[3]
Marsupials				
Opossum	*Didelphis virginiana*	L	x	
Insectivores				
Masked shrew	*Sorex cinereus*	L	x	x
Hayden's shrew	*Sorex haydeni*			x
Merriam's shrew	*Sorex merriami*			x
Montana shrew	*Sorex monticolus*			x
Vagrant shrew	*Sorex vagrans*			
Short-tailed shrew	*Blarina brevicauda*	L	x	
Least shrew	*Cryptotis parva*		x	
Eastern mole	*Scalopus aquaticus*		x	
Bats				
California myotis	*Myotis californicus*			x
Western small-footed myotis	*Myotis ciliolabrum*			x
Keen's bat	*Myotis keeni*	L	x	
Small-footed bat	*Myotis leibi*	L	x	
Little brown myotis	*Myotis lucifugus*			x
Long-eared myotis	*Myotis evotis*			x
Fringed myotis	*Myotis thysanodes*			
Long-legged myotis	*Myotis volans*			x
Yuma myotis	*Myotis yumanensis*			
Silver-haired bat	*Lasionycteris noctivagans*	L	x	x
Big brown bat	*Eptesicus fuscus*	L	x	x
Red bat	*Lasiurus borealis*	L	x	
Hoary bat	*Lasiurus cinereus*	P	x	x
Townsend's big-eared bat	*Corynorhinus townsendii*			x
Brazilian free-tailed bat	*Tadarida brasiliensis*		x*	
Rabbits				
Desert cottontail	*Sylvilagus auduboni*		x	x
Eastern cottontail	*Sylvilagus floridanus*		x	
Mountain cottontail	*Sylvilagus nuttallii*			x
Black-tailed jackrabbit	*Lepus californicus*		x	
White-tailed jackrabbit	*Lepus townsendii*	G	x	x
Squirrels				
Least chipmunk	*Tamias minimus*			x
Yellow-bellied marmot	*Marmota flaviventris*	P		x
Richardson's ground squirrel	*Spermophilus richardsoni*	G		x

Name	Scientific Name	Affinity[1]	Sand Hills[2]	CMR Refuge[3]
Franklin's ground squirrel	*Spermophilus franklini*	G	x	
Golden-mantled ground squirrel	*Spermophilus lateralis*			x
Spotted ground squirrel	*Spermophilus spilosoma*		x	
Thirteen-lined ground squirrel	*Spermophilus tridecemlineatus*	G	x	x
Black-tailed prairie dog	*Cynomys ludovicianus*	G	x	x
Fox squirrel	*Sciurus niger*	L	x	
Red squirrel	*Tamiasciurus hudsonicus*	W		
Gophers				
Northern pocket gopher	*Thomomys talpoides*			x
Plains pocket gopher	*Geomys bursarius*	G	x	
Mice, rats and voles				
Olive-backed pocket mouse	*Perognathus fasciatus*	G		x
Plains pocket mouse	*Perognathus flavescens*	G	x	
Silky pocket mouse	*Perognathus flavus*		x	
Hispid pocket mouse	*Perognathus hispidus*	G	x	
Ord's kangaroo rat	*Dipodomys ordi*		x	
Western harvest mouse	*Reithrodontomys megalotis*		x	x
Plains harvest mouse	*Reithrodontomys montanus*	G	x	
White-footed mouse	*Peromyscus leucopus*	P	x	x
Deer mouse	*Peromyscus maniculatus*	P	x	x
Northern grasshopper mouse	*Onychomys leucogaster*	G	x	x
Bushytail woodrat	*Neotoma cinerea*	W		x
Eastern wood rat	*Neotoma floridana*		x*	
Gapper's red-backed mouse	*Clethrionomys gapperi*	N		
Prairie vole	*Microtus ochrogaster*	G	x	x
Longtail vole	*Microtus longicaudus*			x
Mountain vole	*Microtus montanus*			x
Meadow vole	*Microtus pennsylvanicus*	N	x	x
Sagebrush vole	*Lemmiscus curtatus*			x
Muskrat	*Ondatra zibethicus*	L	x	x
Southern bog lemming	*Synaptomys cooperi*	L	x*	
Norway rat	*Rattus norvegicus*	I	x	
House mouse	*Mus musculus*	I	x	x
Meadow jumping mouse	*Zapus hudsonicus*	N	x	
Preble's jumping mouse	*Zapus hudsonicus preblei*	L		
Western jumping mouse	*Zapus princeps*			x
Beaver				
Beaver	*Castor canadensis*	L	x	x

Name	Scientific Name	Affinity[1]	Sand Hills[2]	CMR Refuge[3]
Porcupine				
Porcupine	*Erethizon dorsatum*	P	x	x

Carnivores				
Coyote	*Canis latrans*	P	x	x
Gray wolf	*Canis lupus*	P		
Swift fox	*Vulpes velox*	G	x	x
Red fox	*Vulpes vulpes*	P	x	x
Gray fox	*Urocyon cinereoargenteus*	S	x	
Black bear	*Ursus americanus*	W		x
Grizzly bear	*Ursus horribilis*	P		
Raccoon	*Procyon lotor*	P	x	x
Long-tailed weasel	*Mustela frenata*	P	x	x
Short-tail weasel	*Mustela erminea*	P		x
Least weasel	*Mustela nivalis*	N	x	x
Black-footed ferret	*Mustela nigripes*	G		x
Mink	*Mustela vison*	L	x	x
Badger	*Taxidea taxus*	P	x	x
River otter	*Lutra canadensis*	L		x
Eastern spotted skunk	*Spilogale putorius*	G	x	
Western spotted skunk	*Spilogale gracilis*			
Striped skunk	*Mephitis mephitis*	P	x	x
Mountain lion	*Felis concolor*	P		x
Bobcat	*Lynx rufus*	P	x	x
Artiodactyls				
Elk	*Cervus canadensis*	P	x	x
Mule deer	*Odocoileus hemionus*	P	x	x
White-tailed deer	*Odocoileus virginianus*	P	x	x
Moose	*Alces alces*	N		x
Pronghorn	*Antilocapra americana*	G	x	x
Big horn sheep	*Ovis canadensis*	S		x
Bison	*Bison bison*	G	x	

[1] **P** = Widespread
W = Woodland
G = Grassland or steppe
N = Northern or boreal
L = Wetland or riparian forest
L = Wetland or riparian forest

* Species marginally occurring in the Sand Hills

[2] Freeman, P. 1998. Mammals. In, An Atlas of the Sandhills. A. Bleed and C. Flowerday, eds. Conservation and Survey Division, Institute of Agric. and Nat. Res., Univ. Nebr., Lincoln. http://csd.unl.edu/csd/illustrations/ra5a/mammals.html

[3] U.S. Dept. of Interior, U.S. Fish and Wildlife Service. Mammals of the Charles M. Russell National Wildlife Refuge. Charles M. Russell Nat. Wildl. Refuge. Unpaginated.

Appendix D2. STATUS OF KEY PRAIRIE MAMMALS OF THE NORTHERN GREAT PLAINS ECOREGION

	Occurs NHP	Occurs Sandhills	Prairie endemic[1]	ESA listed/ petitioned	BLM Sensitive[7]	Montana Species of Concern[2]	South Dakota Listed Species[4]	Nebraska Species of Concern[8]	Wyoming Species of Concern[3]	COSEWIC Listing[9]	Alberta tracking list[5]	Saskatchewan species at risk[6]
black-footed ferret	X	EXT	X	X	MT	X	X	X	X	extirpated	N/A	EXT
black-tailed prairie dog	X	X	X	X	MT	X	sc		X	concern	N/A	X
swift fox	X	EXT	X		MT, WY	X	X	X	X	endangered	X	X
eastern spotted skunk	X	X	X		MT	N/A		X	X	N/A	N/A	N/A
bison (free ranging)	X	EXT	X			X			X			
plains pocket mouse	X	X	X			N/A			X	N/A	N/A	N/A
olive-backed pocket mouse	X	X	X					X			X	
hispid pocket mouse	X	X	X			X			X			
plains harvest mouse	X	X	X						X			
northern grasshopper mouse	X	X	X								X	
prairie vole	X	X	X								X	
Franklin's ground squirrel	X	X	X									
Richardson's ground squirrel	X	no	X									
Thirteen-lined ground squirrel	X	X	X									
plains pocket gopher	X	X	X									
pronghorn	X	X	X									
white-tailed jackrabbit	X	X	X									
grizzly bear	EXT	EXT		X		X			X	ext		
gray wolf	EXT	EXT		X	MT	X			X	ext		
Preble's meadow jumping mouse	marginal	no		X		N/A	N/A	N/A	X	N/A	N/A	N/A
Merriam's shrew	X	no			MT	X	N/A	X		N/A	N/A	N/A
spotted bat	X	no			MT, WY	X			X			
Townsend's big-eared bat	X	no			MT, WY	X		X	X			
meadow jumping mouse	X	X			MT	X						
mountain lion	X	EXT					X	X				
western spotted skunk	X	no				X						
long-eared myotis	X	no			WY			N/A	X		X	
fringed myotis	X	no			WY	X		X	X			
silky pocket mouse	X	X						X	X			
river otter	X	EXT					X					
spotted ground squirrel	?	X							X			
wolverine	EXT	EXT								X		
Ord's kangaroo rat	X	X								X		

[1] Knoph, F.L. and F.B. Samson. 1997. Conservation of grassland vertebrates. Ecol. Stud. 125:273-289.

[2] Carlson, J. 2001. Coordinator, Montana Animal Species of Concern Committee. Montana Animal Species of Concern. Montana Natural Heritage Program and Montana Fish, Wildlife and Parks, Helena, MT. 12pp.; U.S. BLM. 2002. BLM Wyoming Sensitive Species Policy and List.

[3] Fertig, W. and G. Beauvais. 1999. Wyoming Plant and Animal Species of Special Concern. Wyoming Natural Diversity Database, Laramie, Wyoming. Unpublished report.

[4] South Dakota Codified Laws, Chapter 41:10:02 et seq. (2001) at http://legis.state.sd.us/rules/rules/4110.htm#41:10:03:01

[5] Alberta Natural Heritage Information Center. 2000. At: http://www.cd.gov.ab.ca/preserving/parks/anhic/fishtrak.asp

[6] Saskatchewan Conservation Data Center. 2002. Interim list, species at risk requiring special management consideration. At: http://www.biodiversity.sk.ca/docs/SARlistforindustry.htm

[7] Sidle, J. 1998. Matrix of "Listed" species in the Great Plains of North America and their occurrence on National Grasslands. U.S.D.A. Forest Service, Chadron, NB. At: www.fs.fed.us/r2/nebraska/gpng

[8] Nebraska Natural Heritage Program. 1996. Nebraska species of concern. At: www.natureserve.org/nhp/us/ne/elements.html

[9] COSEWIC. 2002. Canadian Species at Risk, May 2002. Committee on the Status of Endangered Wildlife in Canada. 34 pp. www.cosewic.gc.ca

Appendix E1. CHECKLIST OF NGP FISH.										
Name	Scientific Name	SD	ND	MT (CMR)	MT (State)	WY (Powder R)[2]	WY (State)	NB[1]	SK	AB
Sturgeon - Acipenseridae										
pallid sturgeon	*Scaphirhynchus albus*	E	E	E	E					
shovelnose sturgeon	*Scaphirhynchus platorynchus*	x	x	x	x	x	x			
Paddlefish - Polyodontidae										
paddlefish	*Polyodon spathula*	SC	SC	x	x	x	x			
Gar - Lepisosteidae										
shortnose gar	*Lepisosteus platostomus*	x	x	x	x			x		
Herring - Clupeidae										
gizzard shad	*Dorosoma cepedianum*						Int	x		
Mooneyes - Hiodontidae										
goldeye	*Hiodon alosoides*	x	x	x	x	x	x	x		
Minnows - Cyprinidae										
central stoneroller	*Campostoma anomalum*		x				x	x		
lake chub	*Couesius plumbeus*	x	x	x	x		x	x		
grass carp	*Ctenopharyngodon idella*	Int	Int			x	Int			
red shiner	*Cyprinella lutrensis*	x	x				x	x		
spotfin shiner	*Cyprinella spiloptera*		x							
common carp	*Cyprinus carpio*	Int	Int	Int	x	Int	Int	Int		
western silvery minnow	*Hybognathus argyritis*		x	x	x	x	x	x		
brassy minnow	*Hybognathus hankinsoni*	x	x	x	x	x	x	x		
Mississippi silvery minnow	*Hybognathus nuchalis*	x	x							
plains minnow	*Hybognathus placitus*	x	x	x	x	x	x	x		
speckled chub	*Hybopsis aestivalis*							x		
flathead chub	*Hybopsis gracilis*			x		x	x	x		
silver chub	*Hybopsis storeriana*							x		
sturgeon chub	*Macrhybopsis gelida*	x	x		x	x	x			
sicklefin chub	*Macrhybopsis meeki*	x	x		x					
pearl dace	*Margariscus margarita*	x	x				x	SC		

Name	Scientific Name	SD	ND	MT (CMR)	MT (State)	WY (Powder R)[2]	WY (State)	NB[1]	SK	AB
hornyhead chub	*Nocomis biguttatus*	x	x				x	SC		
golden shiner	*Notemigonus crysoleucas*	x	x			x	Int	x		
pugnose shiner	*Notropis anogenus*		x							
emerald shiner	*Notropis atherinoides*	x	x	x			Int	x		
river shiner	*Notropis blennius*	x	x					x		
common shiner	*Notropis cornutus*	x	x				x	x		
bigmouth shiner	*Notropis dorsalis*	x	x					x		
Topeka shiner	*Notropis topeka*							x		
blackchin shiner	*Notropis heterodon*	x								
blacknose shiner	*Notropis heterolepsis*	x	x					x		
spottail shiner	*Notropis hudsonius*	x	x	x			Int			
red shiner	*Notropis lutrensis*							x		
rosyface shiner	*Notropis rubellus*	x	x							
silverband shiner	*Notropis shumardi*	?								
sand shiner	*Notropis stramineus*	x	x	x		x	x	x		
suckermouth minnow	*Phenacobius mirabilis*	?						x		
northern redbelly dace	*Phoxinus eos*	x	x	x				x		
redbelly x finescale hybrid	*Phoxinus eos x neogaeus*			x						
finescale dace	*Phoxinus neogaeus*	x	x				x	x		
bluntnose minnow	*Pimephales notatus*	x	x					x		
fathead minnow	*Pimephales promelas*	x	x	x		x	x	x		
flathead chub	*Platygobio gracilis*	x	x							
blacknose dace	*Rhinichthys atratulus*	x	x					x		
longnose dace	*Rhinichthys cataractae*	x	x	x		x	x	x		
rudd	*Scardinius erythrophthalmus*	?								
creek chub	*Semotilus atromaculatus*	x	x	x		x	x	x		
Suckers - Catostomidae										
highfin carpsucker	*Carpiodes velifer*							x		
river carpsucker	*Carpiodes carpio*	x	x	x		x	x	x		
quillback	*Carpiodes cyprinus*						x	x		
longnose sucker	*Catostomus catostomus*	x	x	x		x	x	x		

Name	Scientific Name	SD	ND	MT (CMR)	MT (State)	WY (Powder R)[2]	WY (State)	NB[1]	SK	AB
white sucker	*Catostomus commersoni*	x	x	x		x	x	x		
mountain sucker	*Catostomus platyrhynchus*			x		x	x			
blue sucker	*Cycleptus elongatus*	x	x	x						
smallmouth buffalo	*Ictiobus bubalus*	x	x	x		x	x	x		
bigmouth buffalo	*Ictiobus cyprinellus*	x	x	x				x		
shorthead redhorse	*Morostoma macrolepidotum*	x	x	x		x	x	x		
Catfish - Ictaluridae										
black bullhead	*Ameiurus melas*	x	x	Int		x	x	x		
yellow bullhead	*Ameiurus natalis*					Int	x	x		
brown bullhead	*Ameiurus nebulosus*	x	x							
blue catfish	*Ictalurus furcatus*	x								
channel catfish	*Ictalurus punctatus*	x	x	x		x	x	x		
slender madtom	*Noturus exilis*	x								
stonecat	*Noturus flavus*	x	x	x		x	x	x		
tadpole madtom	*Noturus gyrinus*	x	x					x		
flathead catfish	*Pylodictus olivaris*							x		
Pike - Esocidae										
grass pickerel	*Esox americanus*							x		
northern pike	*Esox lucius*	x	x	x		x	Int	x		
Mudminnows - Umbridae										
central mudminnow	*Umbra limi*	x	x							
Trout - Salmonidae										
lake herring (cisco)	*Coregonus artedi*	Int	Int							
cutthroat trout	*Oncorhynchus clarki*	Int								
rainbow trout	*Oncorhynchus mykiss*	Int	Int	x				Int		
brown trout	*Salmo trutta*	Int	Int	Int				Int		
brook trout	*Salvelinus fontinalis*	Int					Int	Int		
lake trout	*Salvelinus namaycush*			x						
chinook salmon	*Oncorhynchus tshawytscha*			Int						

Name	Scientific Name	SD	ND	MT (CMR)	MT (State)	WY (Powder R)[2]	WY (State)	NB[1]	SK	AB
Trout-perch - Percopsidae										
trout-perch	*Percopsis omiscomaycus*	x	x							
Codfish - Gadidae										
burbot	*Lota lota*	x	x	x		x	x	x		
Killifish - Fundulidae										
banded killifish	*Fundulus diaphanus*	x	x							
plains topminnow	*Fundulus sciadicus*	x					x	x		
plains killifish	*Fundulus zebrinus*	x		Int			x	x		
Sticklebacks - Gasterosteidae										
brook stickleback	*Culaea inconstans*	x	x	x		x	x	x		
Sea bass - Serranidae										
white bass	*Morone chrysops*	Int	Int					x		
Sunfish - Centrarchidae										
rock bass	*Ambloplites rupestris*					Int	Int			
green sunfish	*Lepomis cyanellus*	x	x	Int		Int	Int	x		
pumpkinseed	*Lepomis gibbosus*	x	x				Int	x		
orangespotted sunfish	*Lepomis humilis*	x	x					x		
orangespotted/ pumpkinseed	*L. humilis x L. gibbosus*		x							
bluegill	*Lepomis macrochirus*	x	x	Int			Int	Int		
bluegill/green sunfish hybrid	*L. macrochirus x L. cyanellus*	x								
smallmouth bass	*Micropterus dolomieu*	Int	Int	Int		Int	Int	Int		
largemouth bass	*Micropterus salmoides*	x	Int	Int			Int	Int		
white crappie	*Pomoxis annularis*	x	x	Int			Int	x		
black crappie	*Pomoxis nigromaculatus*	x	x	Int			Int	x		

Name	Scientific Name	SD	ND	MT (CMR)	MT (State)	WY (Powder R)[2]	WY (State)	NB[1]	SK	AB
Perch - Percidae										
Iowa darter	*Etheostoma exile*	x	x	x			x	x		
johnny darter	*Etheostoma nigrum*	x	x				x	x		
orangethroat darter	*Etheostoma spectablile*						x	x		
yellow perch	*Perca flavescens*	x	x	Int			Int	x		
blackside darter	*Percina maculata*	x	x					Extinct		
sauger	*Stizostedion canadense*	x	x	x		x	x	x		
Walleye	*Stizostedion vitreum*	x	x	Int		Int	Int	x		
saugeye	*S. canadense x S. vitreum*	x	x							
Drums – Sciaenidae										
freshwater drum	*Aplodinotus grunniens*	x	x	x			Int	x		
Sculpin – Cottidae										
mottled sculpin	*Cottus bairdi*			x		x	x			x
E = Endangered										
SC = Species of Concern										
Int = Introduced										
x = present										

[1] Hrabik, R.A. 1998. Fishes. In, An Atlas of the Sandhills. A. Bleed and C. Flowerday, eds. Conservation and Survey Division, Institute of Agric. and Nat. Res., Univ. Nebr., Lincoln. http://csd.unl.edu/csd/illustrations/ra5a/mammals.html

[2] Hubert, W.S. 1993. The Powder River: A relatively pristine stream on the Great Plains. Pp. 387-395 in Proc. Of the symposium on restoration planning for the rivers of the Mississippi River ecosystem. L.W. Hesse, C.B. Stalnaker, and N.G. Benson, eds. Biological Rept. 19, U.S. Dept. of Interior, National Biological Survey, Washington, D.C.

Appendix E2. STATUS OF KEY PRAIRIE FISHES OF THE NORTHERN GREAT PLAINS ECOREGION

	Occurs NHP	Occurs Sandhills	Prairie endemic[1]	ESA listed/ petitioned	BLM Sensitive	Montana Species of Concern[2]	South Dakota Listed Species[4]	Nebraska Species of Concern	Wyoming Species of Concern[3]	COSEWIC Listing[9]	Alberta tracking list[5]	Saskatchewan species at risk[6]
pallid sturgeon	X	no	X	X	MT	X	X	X	N/A		N/A	N/A
sturgeon chub	X	no	X		MT	X	X	X	X		N/A	N/A
sicklefin chub	X	no	X		MT	X	X	X	N/A		N/A	N/A
pearl dace	X	X			MT	X	X	X	X			
finescale dace	X	?			MT	N/A	X	X	X		X	
blue sucker	X	no			MT	X		X				
paddlefish	X	no			MT	X		X				
shortnose gar	X	no			MT	X						
plains topminnow	X		X		MT			X				
western silvery minnow	X	X	X						X	T	X	
blacknose shiner	X		X				X	X				
trout-perch	X					X	X	X				
northern redbelly dace	X				MT		X	X				
Topeka shiner	no	X		X				X				
hornyhead chub	X							X	X			
sauger	X					X					X	
finescale x redbelly dace	X	no				X						
banded killifish	X						X					
longnose sucker	X						X					
shovelnose sturgeon	X	X							X			
suckermouth minnow	X								X			
bigmouth buffalo	X	X								concern		X
brassy minnow	X	X						X				
orangethroat darter	?							X	X			
Iowa darter	X							X				
Johnny darter	X							X				
brook stickleback	?							X				
highfin carpsucker	?							X				
lake chub	X							X				
river shiner	?							X				
plains killifish	X	X										
mottled sculpin	?	no									X	
shortjaw cisco										X		
chestnut lamprey										X		

[1] Knoph, F.L. and F.B. Samson. 1997. Conservation of grassland vertebrates. Ecol. Stud. 125:273-289.

2 Carlson, J. 2001. Coordinator, Montana Animal Species of Concern Committee. Montana Animal Species of Concern. Montana Natural Heritage Program and Montana Fish, Wildlife and Parks, Helena, MT. 12pp.

[3] Fertig, W. and G. Beauvais. 1999. Wyoming Plant and Animal Species of Special Concern. Wyoming Natural Diversity Database, Laramie, Wyoming. Unpublished report.

[4] South Dakota Codified Laws, Chapter 41:10:02 et seq. (2001) at http://legis.state.sd.us/rules/rules/4110.htm#41:10:03:01

[5] Alberta Natural Heritage Information Center. 2000. At: http://www.cd.gov.ab.ca/preserving/parks/anhic/fishtrak.asp

[6] Saskatchewan Conservation Data Center. 2002. Interim list, species at risk requiring special management consideration. At: http://www.biodiversity.sk.ca/docs/SARlistforindustry.htm

[7] Sidle, J. 1998. Matrix of "Listed" species in the Great Plains of North America and their occurrence on National Grasslands. U.S.D.A. Forest Service, Chadron, NB. At: www.fs.fed.us/r2/nebraska/gpng

[8] Nebraska Natural Heritage Program. 1996. Nebraska species of concern. At: www.natureserve.org/nhp/us/ne/elements.html

[9] COSEWIC. 2002. Canadian Species at Risk, May 2002. Committee on the Status of Endangered Wildlife in Canada. 34 pp. www.cosewic.gc.ca

Appendix F1. CHECKLIST OF REPTILES AND AMPHIBIANS OF THE NGP

Name	Scientific Name	Sand Hills[1]	SD[3]	ND[4]	AB[5]	WY[6]	MT
Amphibians							
Northern leopard frog	*Rana pipiens*	x	X	x	x	x	
Bullfrog	*Rana catesbeiana*	x	X			x	
Plains leopard frog	*Rana blairi*		X				
Wood frog	*Rana sylvatica*				x		
Western striped chorus frog	*Pseudacris triseriata*	x	X	x	x	x	
Boreal chorus frog	*Pseudacris maculata*			x	x	x	
Blanchard's (northern) cricket frog	*Acris crepitans*	x	X				
Great plains toad	*Bufo cognatus*	x	X	x	x		
Canadian (Dakota) toad	*Bufo hemiophrys*			x	x		
Rocky mountain toad	*Bufo woodhousii*	x	X	x		x	
Plains spadefoot toad	*Spea bombifrons*	x	X	x	x	x	
Great basin spadefoot	*Spea intermontana*					x	
Tiger salamander	*Ambystoma tigrinum*	x	X	x	x	x	
Turtles							
Snapping turtle	*Chelydra serpentina*	x		x	x	x	
False map turtle	*Graptemys pseudogeographica*			x			
Smooth softshell	*Apalone mutica*			x			
Yellow mud turtle	*Kinosternon flavescens*	x					
Ornate box turtle	*Terrapene ornata*	x				x	
Painted turtle	*Chrysemys picta*	x		x	x	x	
Blanding's turtle	*Emydoidea blandingii*	x					
Name	*Scientific Name*	*Sand Hills1*	*SD3*	*ND4*	*AB5*	*WY6*	*MT*
Spiny softshell turtle	*Trionyx spiniferus*	x				x	
Lizards							
Lesser earless lizard	*Holbrookia maculata*	x					
Northern prairie lizard	*Sceloporus undulatus*	x				x	
Red-lipped prairie lizard	*Sceloporus undulatus erythrocheilus*					x	
Sagebrush lizard	*Sceloporus graciosus*			x		x	
Eastern short-horned lizard	*Phrynosoma douglassi*			x	x	x	
Six-lined racerunner	*Cnemidophorus sexlineatus*	x					

Prairie skink*	*Eumeces septentrionalis*	*x**					
Many-lined skink	*Eumeces multivirgatus*	*x*					

Snakes

Common or northern watersnake	*Nerodia sipedon*	*x*					
Black Hills redbelly	*Storeria occipitomaculata*					*x*	
Wandering gartersnake	*Thamnopsis elegans vagrans*				*x*	*x*	
Plains gartersnake	*Thamnophis radix*	*x*		*x*	*x*	*x*	
Common or red-sided gartersnake	*Thamnophis sirtalis*	*x*		*x*	*x*	*x*	
Smooth green snake	*Opheodrys vernalis*			*x*		*x*	
Western hognose snake	*Heterodon nasicus*	*x*		*x*	*x*	*x*	

Name	Scientific Name	Sand Hills[1]	SD[3]	ND[4]	AB[5]	WY[6]	MT
Blue or green racer	*Coluber constrictor*	*x*		*x*	*x*	*x*	
Glossy snake	*Arizona elegans*	*x*					
Bull snake	*Pituophis catenifer*	*x*		*x*	*x*	*x*	
Milk snake	*Lampropeltis triangulum*	*x*				*x*	
Prairie rattlesnake	*Crotalus viridis*	*x*		*x*	*x*	*x*	

[1]Freeman, P. 1998. Amphibians and Reptiles. *In*, An Atlas of the Sandhills. A. Bleed and C. Flowerday, eds. Conservation and Survey Division, Institute of Agric. and Nat. Res., Univ. Nebr., Lincoln. http://csd.unl.edu/csd/illustrations/ra5a/mammals.html

[2] U.S.G.S. Northern Prairie Wildlife Research Center. Checklist of amphibian species and identification guide. http://www.npwrc.usgs.gov/narcam/idguide/index.htm

[3] Fisher, T.D., D.C. Backlund, K.F. Higgins and D.E. Naugle. 1999. Field guide to South Dakota amphibians. SDAES Bull. 733, SD State Univ., Brookings. 52 pp.

[4] Hoberg, T. and C. Gause. 1992. Reptiles and amphibians of North Dakota. North Dakota Outdoors 55(1):7-19. Jamestown, ND: Northern Prairie Wildlife Research Center Home Page. http://www.npwrc.usgs.gov/resource/distr/herps/amrepnd/amrepnd.htm

[5] Bergman, K. 1999. TARAS - Reptiles of Alberta. The Alberta Reptile and Amphibian Society. http://www.kingsnake.ca/TARAS/contents/herps.htm

[6] Wyoming Geographic Information Science Center, Species Atlas. http://www.sdvc.uwyo.edu/wbn/atlas/

* Species marginal to the Sand Hills.

Appendix F2. STATUS OF KEY PRAIRIE HERPTILES OF THE NORTHERN GREAT PLAINS ECOREGION

	Occurs NHP	Occurs Sandhills	Prairie endemic[1]	ESA listed/ petitioned	BLM Sensitive[7]	Montana Species of Concern[2]	South Dakota Listed Species[4]	Nebraska Species of Concern[8]	Wyoming Species of Concern[3]	COSEWIC Listing[9]	Alberta tracking list[5]	Saskatchewan species at risk[6]
Great Plains toad	X	X				X				concern	X	X
Northern leopard frog	X	X			X	X			X	concern	X	X
Plains spadefoot	X	X	X									
Canadian toad	X	no			X						X	
Ornate box turtle	X	X	X			N/A			X		N/A	N/A
Spiny softshell	X	X			X	X						
Snapping turtle	X	X			X	X						
Blanding's turtle	no	X					X				N/A	N/A
False map turtle	X	no					X				N/A	N/A
Yellow mud turtle	no	X						X			N/A	N/A
Painted turtle	X	X									X	
Sagebrush lizard (S. graciousus)	X	no				X		X				
Short-horned lizard	X	no			X			X		concern		
Northern prairie lizard	X	X							X			
Northern earless lizard	X	X							X			
Northern many lined skink	X	X							X			
Plains garter snake	X	X	X								X	
Western (plains) hognose snake	X	X				X					X	
Milk snake	X	X				X			X			
Smooth green snake	X	no				X		X	X			
Redbelly snake	X	no						X	X			
Red-sided garter snake	X	X									X	
Glossy snake	no	X						X				
Plains blackhead snake	X	no						X				
Western terrestrial garter snake	X	no									X	
Racer	X	X								concern		

[1] Knoph, F.L. and F.B. Samson. 1997. Conservation of grassland vertebrates. Ecol. Stud. 125:273-289.

2 Carlson, J. 2001. Coordinator, Montana Animal Species of Concern Committee. Montana Animal Species of Concern. Montana Natural Heritage Program and Montana Fish, Wildlife and Parks, Helena, MT. 12pp.

[3] Fertig, W. and G. Beauvais. 1999. Wyoming Plant and Animal Species of Special Concern. Wyoming Natural Diversity Database, Laramie, Wyoming. Unpublished report.

[4] South Dakota Codified Laws, Chapter 41:10:02 et seq. (2001) at http://legis.state.sd.us/rules/rules/4110.htm#41:10:03:01

[5] Alberta Natural Heritage Information Center. 2000. At: http://www.cd.gov.ab.ca/preserving/parks/anhic/fishtrak.asp

[6] Saskatchewan Conservation Data Center. 2002. Interim list, species at risk requiring special management consideration. At: http://www.biodiversity.sk.ca/docs/SARlistforindustry.htm

[7] Sidle, J. 1998. Matrix of "Listed" species in the Great Plains of North America and their occurrence on National Grasslands. U.S.D.A. Forest Service, Chadron, NB. At: www.fs.fed.us/r2/nebraska/gpng

[8] Nebraska Natural Heritage Program. 1996. Nebraska species of concern. At: www.natureserve.org/nhp/us/ne/elements.html

[9] COSEWIC. 2002. Canadian Species at Risk, May 2002. Committee on the Status of Endangered Wildlife in Canada. 34 pp. www.cosewic.gc.ca

Appendix G1. Confirmed Occurrence Records for Odonata of the U.S. Portion of Northern Great Plains Ecoregion

Source: Kondratieff, Boris C. (coordinator). 2000. Dragonflies and Damselflies (Odonata) of the United States. Jamestown, ND: Northern Prairie Wildlife Research Center Home Page: **http://www.npwrc.usgs.gov/resource/distr/insects/dfly/dflyusa.htm** (Version 26JUN2002).

No? = Confirmed records exist for county overlapping NGP in subject state, though since only part of the county is within the NGP it's not certain the species inhabits the NGP. None of the species labeled No? are considered in the total number of species.

SUMMARY

FAMILY	NUMBER OF SPECIES
Calopterygidae	**3**
Lestidae	**7**
Coenagrionidae	**28**
Aeshnidae	**10**
Gomphidae	**10**
Corduliidae	**5**
Libellulidae	**29**

Calopterygidae: 3 species

American Rubyspot *(Hetaerina americana)*
River Jewelwing *(Calopteryx aequabilis)*
Ebony Jewelwing *(Calopteryx maculata)*

Lestidae: 7 species

Spotted Spreadwing *(Lestes congener)*
Common Spreadwing *(Lestes disjunctus)*
Emerald Spreadwing *(Lestes dryas)*
Sweetflag Spreadwing *(Lestes forcipatus)*
Lyre-tipped Spreadwing *(Lestes unguiculatus)*
Great Spreadwing *(Archilestes grandis)*
Slender Spreadwing *(Lestes rectangularis)*

Coenagrionidae: 28 species

Western Red Damsel *(Amphiagrion abbreviatum)*
Variable Dancer *(Argia fumipennis)*
Prairie Bluet *(Coenagrion angulatum)*
Taiga Bluet *(Coenagrion resolutum)*
River Bluet *(Enallagma anna)*
Rainbow Bluet *(Enallagma antennatum)*

Boreal Bluet *(Enallagma boreale)*
Tule Bluet *(Enallagma carunculatum)*
Familiar Bluet *(Enallagma civile)*
Northern Bluet *(Enallagma cyathigerum)*
Marsh Bluet *(Enallagma ebrium)*
Hagen's Bluet *(Enallagma hageni)*
Arroyo Bluet *(Enallagma praevarum)*
Pacific Forktail *(Ischnura cervula)*
Western Forktail *(Ischnura perparva)*
Eastern Forktail *(Ischnura verticalis)*
Alkali Bluet *(Enallagma clausum)*
Plains Forktail *(Ischnura damula)*
Paiute Dancer *(Argia Alberta)*
Emma's Dancer *(Argia emma)*
Kiowa Dancer *(Argia immunda)*
Sooty Dancer *(Argia lugens)*
Springwater Dancer *(Argia plana)*
Vivid Dancer *(Argia vivida)*
Sedge Sprite *(Nehalennia irene)*
Blue-fronted Dancer *(Argia apicalis)*
Powdered Dancer *(Argia moesta)*—No?Nebraska
Blue-ringed Dancer *(Argia sedula)*
Double-striped Bluet *(Enallagma basidens)*

Aeshnidae: 10 species
Variable Darner *(Aeshna interrupta)*
Common Green Darner *(Anax junius)*
Lance-tipped Darner *(Aeshna constricta)*
Shadow Darner *(Aeshna umbrosa)*
California Darner *(Aeshna californica)*
Blue-eyed Darner *(Aeshna multicolor)*
Paddle-tailed Darner *(Aeshna palmata)*
Canada Darner *(Aeshna canadensis)*
Shadow Darner *(Aeshna umbrosa)*
Fawn Darner *(Boyeria vinosa)*

Gomphidae: 10 species

Plains Clubtail *(Gomphus externus)*
Horned Clubtail *(Arigomphus cornutus)*
Pronghorn Clubtail *(Gomphus graslinellus)*
Eastern Ringtail *(Erpetogomphus designatus)*
Pale Snaketail *(Ophiogomphus severus)*

Brimstone Clubtail *(Stylurus intricatus)*
Great Basin Snaketail *(Ophiogomphus morrisoni)*
Common Sanddragon *(Progomphus obscurus)*
Riverine Clubtail *(Stylurus amnicola)*
Elusive Clubtail *(Stylurus notatus)*

Corduliidae: 5 species

Plains Emerald *(Somatochlora ensigera)*
Stripe-winged Baskettail *(Epitheca costalis)*
Common Baskettail *(Epitheca cynosura)*
Ocellated Emerald *(Somatochlora minor)*
Prince Baskettail *(Epitheca princeps)*

Libellulidae: 29 species

Western Meadowhawk *(Sympetrum occidentale)*
Striped Meadowhawk *(Sympetrum pallipes)*
Eastern Pondhawk *(Erythemis simplicicollis)*
Pale-faced Clubskimmer *(Brechmorhoga mendax)*
Hudsonian Whiteface *(Leucorrhinia hudsonica)*
Boreal Whiteface *(Leucorrhinia borealis)*--No? Wyoming
Red-veined Meadowhawk *(Sympetrum madidum)*
Dot-tailed Whiteface *(Leucorrhinia intacta)*
Eight-spotted Skimmer *(Libellula forensis)*
Widow Skimmer *(Libellula luctuosa)*
Common Whitetail *(Libellula lydia)*
Twelve-spotted Skimmer *(Libellula pulchella)*
Four-spotted Skimmer *(Libellula quadrimaculata)*
Flame Skimmer *(Libellula saturata)*
Blue Dasher *(Pachydiplax longipennis)*
Eastern Amberwing *(Perithemis tenera)*
Variegated Meadowhawk *(Sympetrum corruptum)*
Saffron-winged Meadowhawk *(Sympetrum costiferum)*
Black Meadowhawk *(Sympetrum danae)*
Cherry-faced Meadowhawk *(Sympetrum internum)*
White-faced Meadowhawk *(Sympetrum obtrusum)*
Striped Meadowhawk *(Sympetrum pallipes)*
Ruby Meadowhawk *(Sympetrum rubicundulum)*
Black Saddlebags *(Tramea lacerata)*
Red-mantled Saddlebags *(Tramea onusta)*
Calico Pennant *(Celithemis elisa)*
Halloween Pennant *(Celithemis eponina)*
Wandering Glider *(Pantala flavescens)*
Spot-winged Glider *(Pantala hymenaea)*
Blue-faced Meadowhawk *(Sympetrum ambiguum)*

Appendix G2. Confirmed Occurrence Records for Butterflies of the U.S. Portion of Northern Great Plains Ecoregion

Source: Opler, P.A., R.E. Stanford, and H. Pavulaan (coordination and editing). 2002. Butterflies of North America. Northern Prairie Wildlife Research Center, U.S. Geological Survey web site:
http://www.npwrc.usgs.gov/resource/distr/lepid/bflyusa/bflyusa.htm

Yes? = Good chance of confirmed record in NGP of subject state based on confirmed county records and description of range and habitat.
No? = Though confirmed record exists in county overlapping NGP in subject state, description of range and habitat indicates unlikely that confirmed record is in NGP.
SH = Confirmed and unequivocal record in Sandhills Ecoregion only.

Summary

Family	Number species
Swallowtails (Papilionidae)	14
Whites and Sulphurs (Pieridae)	25
Gossamer Wing Butterflies (Lycaenidae)	47
Metalmarks (Riodinidae)	1
Brush-footed Butterflies (Nymphalidae)	77
Skippers (Hesperiidae)	56
TOTAL	220

A. Swallowtails

Parnassians (Subfamily Parnassiinae)

Rocky Mountain Parnassian *(Parnassius smintheus)*

Swallowtails (Subfamily Papilioninae)

Pipevine Swallowtail *(Battus philenor)*
Black Swallowtail *(Papilio polyxenes)*
Old World Swallowtail *(Papilio machaon)*
Anise Swallowtail *(Papilio zelicaon)*
Indra Swallowtail *(Papilio indra)*
Giant Swallowtail *(Papilio cresphontes)*
Eastern Tiger Swallowtail *(Papilio glaucus)*
Canadian Tiger Swallowtail *(Papilio canadensis)*
Western Tiger Swallowtail *(Papilio rutulus)*
Two-tailed Swallowtail *(Papilio multicaudata)*
Pale Swallowtail *(Papilio eurymedon)*
Spicebush Swallowtail *(Papilio troilus)*
Palamedes Swallowtail *(Papilio palamedes)* SH

B. Whites and Sulphurs

Whites (Subfamily Pierinae) 11 species

Pine White *(Neophasia menapia)*
Becker's White *(Pontia beckerii)*
Spring White *(Pontia sisymbrii)*
Checkered White *(Pontia protodice)*
Western White *(Pontia occidentalis)*
Margined White *(Pieris marginalis)*
Cabbage White *(Pieris rapae)*
Large Marble *(Euchloe ausonides)*
Olympia Marble *(Euchloe olympia)*
Stella Orangetip *(Anthocharis stella)*
Southern Rocky Mountain Orangetip *(Anthocharis julia)*

Sulphurs (Subfamily Coliadinae) 14 species

Clouded Sulphur *(Colias philodice)*
Orange Sulphur *(Colias eurytheme)*
Christina Sulphur *(Colias christina)*
Western Sulphur *(Colias occidentalis)*
Christina Sulphur *(Colias christina)*
Queen Alexandra's Sulphur *(Colias alexandra)*
Pelidne Sulphur *(Colias pelidne)*
Pink-edged Sulphur *(Colias interior)*
Southern Dogface *(Zerene cesonia)*
Cloudless Sulphur *(Phoebis sennae)*
Dainty Sulphur *(Nathalis iole)*
Mexican Yellow *(Eurema mexicana)*
Little Yellow *(Eurema lisa)*
Sleepy Orange *(Eurema nicippe)*

C. Gossamer-wing Butterflies

Coppers (Subfamily Lycaeninae) 10 species

American Copper *(Lycaena phlaeas)*
Lustrous Copper *(Lycaena cupreus)*
Gray Copper *(Lycaena dione)*
Edith's Copper *(Lycaena editha)*
Bronze Copper *(Lycaena hyllus)*
Ruddy Copper *(Lycaena rubidus)*
Blue Copper *(Lycaena heteronea)*
Purplish Copper *(Lycaena helloides)*
Lilac-bordered Copper *(Lycaena nivalis)*
Mariposa Copper *(Lycaena mariposa)*

Hairstreaks (Subfamily Theclinae) 20 species

Coral Hairstreak *(Satyrium titus)*
Behr's Hairstreak *(Satyrium behrii)* W, Yes?

Sooty Hairstreak *(Satyrium fuliginosum)*
Acadian Hairstreak *(Satyrium acadica)*
Edwards' Hairstreak *(Satyrium edwardsii)*
California Hairstreak *(Satyrium californica)* W, Yes?
Sylvan Hairstreak *(Satyrium sylvinus)* W, Yes?
Banded Hairstreak *(Satyrium calanus)*
Striped Hairstreak *(Satyrium liparops)*
Hedgerow Hairstreak *(Satyrium saepium)* M NO? W Yes?
Western Green Hairstreak *(Callophrys affinis)*
Sheridan's Green Hairstreak *(Callophrys sheridani)*
Brown Elfin *(Callophrys augustinus)*
Moss' Elfin *(Callophrys mossii)*
Hoary Elfin *(Callophrys polios)*
Western Pine Elfin *(Callophrys eryphon)*
Thicket Hairstreak *(Callophrys spinetorum)*
Juniper Hairstreak *(Callophrys gryneus)*
Gray Hairstreak *(Strymon melinus)*
Leda Ministreak *(Ministrymon leda)*SH yes?

Blues (Subfamily Polyommatinae) 17 species
Western Pygmy-Blue *(Brephidium exile)*
Marine Blue *(Leptotes marina)*SH
Reakirt's Blue *(Hemiargus isola)*
Eastern Tailed-Blue *(Everes comyntas)*
Western Tailed-Blue *(Everes amyntula)*
Spring Azure *(Celastrina "ladon")*
Summer Azure *(Celastrina neglecta)*
Rocky Mountain Dotted-Blue *(Euphilotes ancilla)*
Rita Dotted-Blue *(Euphilotes rita)* W Yes?
Arrowhead Blue *(Glaucopsyche piasus)*
Silvery Blue *(Glaucopsyche lygdamus)*
Melissa Blue *(Lycaeides melissa)*
Greenish Blue *(Plebeius saepiolus)*
Boisduval's Blue *(Plebeius icarioides)*
Shasta Blue *(Plebeius shasta)*
Lupine Blue *(Plebeius lupini)*
Arctic Blue *(Agriades glandon)*

D. Metalmarks

Mormon Metalmark *(Apodemia mormo)*

E. Brush-footed Butterflies

Snouts (Subfamily Libytheinae)
American Snout *(Libytheana carinenta)*

Heliconians and Fritillaries (Subfamily Heliconiinae)

Gulf Fritillary *(Agraulis vanillae)*
Zebra Heliconian *(Heliconius charithonius)* SH No?
Variegated Fritillary *(Euptoieta claudia)*
Great Spangled Fritillary *(Speyeria cybele)*
Aphrodite Fritillary *(Speyeria aphrodite)*
Regal Fritillary *(Speyeria idalia)*
Edwards' Fritillary *(Speyeria edwardsii)*
Coronis Fritillary *(Speyeria coronis)*
Zerene Fritillary *(Speyeria zerene)*
Callippe Fritillary *(Speyeria callippe)*
Atlantis Fritillary *(Speyeria atlantis)*
Great Basin Fritillary *(Speyeria egleis)*
Northwestern Fritillary *(Speyeria hesperis)*
Hydaspe Fritillary *(Speyeria hydaspe)*
Mormon Fritillary *(Speyeria mormonia)*
Silver-bordered Fritillary *(Boloria selene)*
Meadow Fritillary *(Boloria bellona)*
Pacific Fritillary *(Boloria epithore)*
Alberta Fritillary *(Boloria alberta)*
Arctic Fritillary *(Boloria chariclea)*

True Brush-foots (Subfamily Nymphalinae) 34 species
Dotted Checkerspot *(Poladryas minuta)*
Fulvia Checkerspot *(Thessalia fulvia)*SH
Gorgone Checkerspot *(Chlosyne gorgone)*
Silvery Checkerspot *(Chlosyne nycteis)*
Northern Checkerspot *(Chlosyne palla)*
Sagebrush Checkerspot *(Chlosyne acastus)*
Texan Crescent *(Phyciodes texana)*
Phaon Crescent *(Phyciodes phaon)* SH, NE NGP?
Pearl Crescent *(Phyciodes tharos)*
Northern Crescent *(Phyciodes cocyta)*
Tawny Crescent *(Phyciodes batesii)*
Field Crescent *(Phyciodes pratensis)*
Painted Crescent *(Phyciodes picta)*SH
Pale Crescent *(Phyciodes pallida)*
Mylitta Crescent *(Phyciodes mylitta)*
Gillette's Checkerspot *(Euphydryas gillettii)*
Variable Checkerspot *(Euphydryas chalcedona)*
Baltimore *(Euphydryas phaeton)* SH
Question Mark *(Polygonia interrogationis)*
Edith's Checkerspot *(Euphydryas editha)*
Eastern Comma *(Polygonia comma)*
Satyr Comma *(Polygonia satyrus)*
Green Comma *(Polygonia faunus)*
Hoary Comma *(Polygonia gracilis)*

Gray Comma *(Polygonia progne)*
Compton Tortoiseshell *(Nymphalis vaualbum)*
California Tortoiseshell *(Nymphalis californica)*
Mourning Cloak *(Nymphalis antiopa)*
Milbert's Tortoiseshell *(Nymphalis milberti)*
American Lady *(Vanessa virginiensis)*
Painted Lady *(Vanessa cardui)*
West Coast Lady *(Vanessa annabella)*
Red Admiral *(Vanessa atalanta)*
Common Buckeye *(Junonia coenia)*

Admirals and Relatives (Subfamily Limenitidinae) 5 species
Red-spotted Purple *(Limenitis arthemis)*
'Astyanax' Red-spotted Purple *(Limenitis arthemis astyanax)*
White Admiral *(Limenitis arthemis arthemis)*
Viceroy *(Limenitis archippus)*
Weidemeyer's Admiral *(Limenitis weidemeyerii)*

Leafwings (Subfamily Charaxinae) 1 species
Goatweed Leafwing *(Anaea andria)*

Emperors (Subfamily Apaturinae) 2 species
Hackberry Emperor *(Asterocampa celtis)*
Tawny Emperor *(Asterocampa clyton)*NE NGP Yes?

Satyrs (Subfamily Satyrinae) 14 species
Northern Pearly Eye *(Enodia anthedon)*
Eyed Brown *(Satyrodes eurydice)*
Little Wood Satyr *(Megisto cymela)*
Common Ringlet *(Coenonympha tullia)*
Common Wood Nymph *(Cercyonis pegala)*
Mead's Wood Nymph *(Cercyonis meadii)*
Great Basin Wood Nymph *(Cercyonis sthenele)*
Small Wood Nymph *(Cercyonis oetus)*
Common Alpine *(Erebia epipsodea)*
Ridings' Satyr *(Neominois ridingsii)*
Wyoming Satyr *(Neominois wyomingo)*
Chryxus Arctic *(Oeneis chryxus)*
Uhler's Arctic *(Oeneis uhleri)*
Alberta Arctic *(Oeneis alberta)*

Monarchs (Subfamily Danainae)
Monarch *(Danaus plexippus)*
Queen *(Danaus gilippus)*SH

F. Skippers

Spread-wing Skippers (Subfamily Pyrginae)

Silver-spotted Skipper *(Epargyreus clarus)*
Northern Cloudywing *(Thorybes pylades)*
Southern Cloudywing *(Thorybes bathyllus)*SH
Hayhurst's Scallopwing *(Staphylus hayhurstii)*SH
Dreamy Duskywing *(Erynnis icelus)*
Juvenal's Duskywing *(Erynnis juvenalis)*
Horace's Duskywing *(Erynnis horatius)*SH, NE NGP Yes?
Afranius Duskywing *(Erynnis afranius)*
Mottled Duskywing *(Erynnis martialis)*
Wild Indigo Duskywing *(Erynnis baptisiae)*SH, NE NGP Yes?
Persius Duskywing *(Erynnis persius)*
Two-banded Checkered-Skipper *(Pyrgus ruralis)*
Small Checkered-Skipper *(Pyrgus scriptura)*
Common Checkered-Skipper *(Pyrgus communis)*
Common Sootywing *(Pholisora catullus)*
Mohave Sootywing *(Hesperopsis libya)*

Grass Skippers (Subfamily Hesperiinae) 38 species

Arctic Skipper *(Carterocephalus palaemon)*
Least Skipper *(Ancyloxypha numitor)*
Garita Skipperling *(Oarisma garita)*
Fiery Skipper *(Hylephila phyleus)*
European Skipper *(Thymelicus lineola)* M NO? Nonnative
Uncas Skipper *(Hesperia uncas)*
Juba Skipper *(Hesperia juba)*
Western Branded Skipper *(Hesperia colorado)*
Ottoe Skipper *(Hesperia ottoe)*
Leonard's Skipper *(Hesperia leonardus)*
Pahaska Skipper *(Hesperia pahaska)*
Dakota Skipper *(Hesperia dacotae)*
Green Skipper *(Hesperia viridis)*W Yes? NE NGP Yes?, SH Yes?
Plains Skipper *(Hesperia assiniboia)*
Nevada Skipper *(Hesperia nevada)*
Peck's Skipper *(Polites peckius)*
Rhesus Skipper *(Polites rhesus)*
Sandhill Skipper *(Polites sabuleti)* W No?
Draco Skipper *(Polites draco)*
Tawny-edged Skipper *(Polites themistocles)*
Crossline Skipper *(Polites origenes)*
Long Dash *(Polites mystic)*
Northern Broken-Dash *(Wallengrenia egeremet)* SH
Little Glassywing *(Pompeius verna)* SH
Sonora Skipper *(Polites sonora)* W NO?
Sachem *(Atalopedes campestris)*

Arogos Skipper *(Atrytone arogos)*
Delaware Skipper *(Anatrytone logan)*
Woodland Skipper *(Ochlodes sylvanoides)*
Hobomok Skipper *(Poanes hobomok)*
Zabulon Skipper *(Poanes zabulon)*
Taxiles Skipper *(Poanes taxiles)*
Broad-winged Skipper *(Poanes viator)* SH
Dun Skipper *(Euphyes vestris)*
Dion Skipper *(Euphyes dion)* SH Yes?
Two-spotted Skipper *(Euphyes bimacula)* SH, NE NGP Yes?
Dusted Skipper *(Atrytonopsis hianna)*
Simius Roadside-Skipper *("Amblyscirtes" simius)*
Oslar's Roadside-Skipper *(Amblyscirtes oslari)*
Common Roadside-Skipper *(Amblyscirtes vialis)*
Eufala Skipper *(Lerodea eufala)* SH

Giant-Skippers (Subfamily Megathyminae)

Yucca Giant-Skipper *(Megathymus yuccae)* SH
Strecker's Giant-Skipper *(Megathymus streckeri)*

Appendix G3. Grasshoppers of the NGP					
Name	**Scientific Name**	**ND[1]**	**SD[1]**	**WY[2]**	**N[2]**
Plains lubber grasshopper	*Brachystola magna*	X	X		
Prairie bird-locust	*Schistocerca emarginata*	X	X		
Rainbow grasshopper	*Dactylotum bicolor* Charpentier	X	O		
Snakeweed grasshopper	*Hesperotettix viridis* (Thomas)	X	X	X	
Marshelder grasshopper	*Hesperotettix speciosus*	O	X		
Russian-thistle grasshopper	*Aeoloplides turnbulli* (Thomas)	X	X		
Cudweed/ Sage grasshopper	*Hyphchlora alba* (Dodge)	X	X		
Large-headed grasshopper	*Phoetaliotes nebrascensis* (Thomas)	X	X		
Two-striped grasshopper	*Melanoplus bivittatus* (Say)	X	X	X	
Differential grasshopper	*Melanoplus differentialis* (Thomas)	X	X		
Dawson grasshopper	*Melanoplus dawsoni* (Scudder)	X	X		
Gladston grasshopper	*Melanoplus gladstoni* Scudder	X	X	X	
Red-legged grasshopper	*Melanoplus femurrubrum* (DeGeer)	X	X		
Northern grasshopper	*Melanoplus borealis* (Fieber)	X	X		
Migratory grasshopper	*Melanoplus sanguinipes* (Fabricius)	X	X	X	X
Rocky mountain locust	*Melanoplus spretus* (Walsh)	O			
Brunner spur-throated grasshopper	*Melanoplus bruneri* Scudder	O	X		
Little spur-throated grasshopper	*Melanoplus infantilis* Scudder	X	X	X	X
Lakin grasshopper	*Melanoplus lakinus* Scudder		X		
Flabellate grasshopper	*Melanoplus occidentalis* (Thomas)		X	X	
Huckleberry grasshopper	*Melanoplus fasciatus* (Walker)		X		
Pasture grasshopper	*Melanoplus confusus* Scudder	X	X	X	
Keeler grasshopper	*Melanoplus keeleri* (Thomas)	X	X	X	
Federal grasshopper	*Melanoplus foedus* Scudder	X	X	X	
Packard grasshopper	*Melanoplus packardii* Scudder	X	X		
Narrow-winged grasshopper	*Melanoplus angustipennis* (Dodge)	X	X		
Yellowish grasshopper	*Melanoplus flavidus* Scudder	X	X		
Sagebrush grasshopper	*Melanoplus bowditchi* Scudder	X	X		
Two-striped toothpick (slant-face) grasshopper	*Mermiria bivittata* (Serville)	X	X		
Painted toothpick grasshopper	*Mermiria picta* (F. Walker)		X		
Short-winged toothpick grasshopper	*Pseudopomala brachyptera* (Scudder)	X	X		
Green fool grasshopper	*Acrolophitus hirtipes* (Say)	X	X		
Sprinkled grasshopper	*Chloealtis conspersa* (Harris)	X	X		
Cow grasshopper	*Chloealtis abdominalis* (Thomas)		X		
Meadow grasshopper	*Chorthippus curtipennis* (Harris)	X	X		
Brunner slant-faced grasshopper	*Stenobothrus brunneus* (Thomas)	X	O		
Club-horned grasshopper	*Aeropedellus clavatus* (Thomas)	X	X	X	X
Four-spotted grasshopper	*Phlibostroma quadrimaculatus* (Thomas)	X	X	X	X
Velvet-striped grasshopper	*Eritettix simplex* (Scudder)	X	X	X	
Obscure grasshopper	*Opeia obscura* (Thomas)	X	X	X	X
Striped grasshopper	*Amphitornus coloradus* (Thomas)	X	X	X	X

Name	Scientific Name	ND[1]	SD[1]	WY[2]	N[2]
Spotted-winged grasshopper	*Cordillacris occipitalis* (Thomas)	X	X	X	X
Crenulate-winged grasshopper	*Cordillacris crenulata* (Bruner)	O	X	X	
Brown-spotted grasshopper	*Psoloessa delicatula* (Scudder)	X	X	X	X
White-whiskered grasshopper	*Ageneotettix deorum* Scudder	X	X	X	X
Big-headed / Elliott grasshopper	*Aulocara elliotti* (Thomas)	X	X	X	X
White-crossed grasshopper	*Aulocara femoratum* (Scudder)	X	X	X	X
Ebony grasshopper	*Boopedon nubilum* (Say)	X	X	X	
Chromatic pasture grasshopper	*Orphulella pelidna* (Burmeister)	X	X		
Showy pasture grasshopper	*Orphulella speciosa* (Scudder)	X	X		
Northern sedge grasshopper	*Stethophyma gracile* (Scudder)		X		
Speckle-winged grasshopper	*Arphia conspersa* Scudder	X	X		
Red-winged grasshopper	*Arphia pseudonietana* (Thomas)	X	X	X	
Green-striped grasshopper	*Chortophaga viridifasciata* (DeGeer)	X	X		
Dusky/ Western clouded grasshopper	*Encoptolophus costalis* Scudder	X	X		X
Wrinkled grasshopper	*Hippiscus ocelote* (Saussure)	X	X		
Coral-winged grasshopper	*Pardalophora apiculata* (Harris)		X		
Haldeman grasshopper	*Pardalophora haldemani* (Scudder)	X	X		
Red-shanked grasshopper	*Xanthippus corallipes* (Haldeman)	X	X	X	
Powerful range grasshopper	*Cratypedes neglectus* (Thomas)	X			
Three-banded grasshopper	*Hadrotettix trifasciatus* (Say)	X	X	X	
Clear-winged grasshopper	*Camnula pellucida* (Scudder)	X	X	X	X
Mottled sand grasshopper	*Spharagemon collare* (Scudder)	X	X		
Boll grasshopper	*Spharagemon bolli* Scudder		X		
Orange-legged/Barren-ground grasshopper	*Spharagemon equale* (Say)	X	X	X	
Campestral grasshopper	*Spharagemon campestris* (McNeill)	X	X		
Carolina locust	*Dissosteira carolina* (Linnaeus)	X	X		
High plains grasshopper	*Dissosteira longipennis* (Thomas)		X		
Toothed slender (field) grasshopper	*Trimerotropis agrestis* (McNeill)	X	X		
Broad-banded grasshopper	*Trimerotropis latifasciata* Scudder	X	X		
Milk-vetch grasshopper	*Trimerotropis pistrinaria* Saussure	X	X		
Stripe-legged/ Band-faced grasshopper	*Trimerotropis cincta* (Thomas)	X	X		
Geyser grasshopper	*Trimerotropis diversellus* Hebard	X	X		
Great basin/ Azure-winged grasshopper	*Trimerotropis sparsa* (Thomas)	X	O		
Slender grasshopper	*Trimerotropis gracilis* (McNeill)	X	X		
Wrangler grasshopper	*Circotettix rabula* Rehn & Hebard	X	X		
Snapper grasshopper	*Circotettix carlineanus* (Thomas)	X	X		
Long-horned/ Flat-horned grasshopper	*Psinidia fenestralis* (Serville)				
Kiowa (range) grasshopper	*Trachyrachys kiowa* (Thomas)	X	X	X	
Blue-legged/ Spotted grasshopper	*Metator pardalinus* (Saussure)	X	X	X	
Platte range grasshopper	*Mestobregma plattei* (Thomas)		X	X	
Hayden grasshopper	*Derotmema haydeni* (Thomas)	X	X		

[1]http://www.ndsu.nodak.edu/entomology/hopper/orthoptera_index.htm

[2]http://www.sidney.ars.usda.gov/grasshopper/ID_Tools/F_Guide/populate.htm

Note: N represents Northern mixedgrass prairie; X denotes specimen of species has been collected and preserved; O denotes published literature record

Appendix H. PLAINS BISON HERD SUMMARY: Herds within historic bison range, Conservation Herds within the NGP Ecoregion (Bold), and Tribal Herds within the NGP Ecoregion.

	Reserve Size (ac)[1]	No. animals[13]	Stocking rate (Ac/bison)	Management: Round-up period and Culling type[13]
Public Bison Herds				
Badlands NP, SD	64,000 [7]	750	85	Random, opportunistic culling
Crescent Lake NWR, NB (proposed) [4]	45,849	0	N/A	N/A
Custer State Park, SD	72,000	1100	65	Annual: Sales & Hunted by age, fertility, weight
Ft. Niobrara NWR, NB	19,000	350	54	Annual: sales by age, weight, health, reproductive success
Wind Cave NP, SD	28,500	375	76	Annual: culled by age
T.Roosevelt NP, ND	70,466	600	117	Round-up and culling by age every 3 yrs
Ft. Robinson State Park, NE[5]	9000[13]	500	18	Annual: culled by age, appearance
Hot Springs State Park, WY	800	11	73	Annual: sales by age, calves, temperment
Yellowtone/Grand Teton NP, WY	2,200,000	4700	468	Free/Hunted
Bear River State Park, WY	60	8	8	Annual: calves auctioned
Natl Bison Range, MT	18,500	400	46	Annual: random culling by age, health
Tallgrass Prairie NP, KS (proposed)	10,894	0	N/A	N/A
Wichita Mtns NWR, OK	58,200	565	103	Annual: sales by age, injured, random calves
Sully's Hill NGP, ND	1,380	37	37	Culled by age
Wood Buffalo NP, Can	2,220,000 [2]	5000	201	Hunted
Henry's Mtns, UT [3]	384,000	270	1422	Culled randomly through hunting permits
Antelope Is. State Park, UT	28,022	600	47	Annual: sales and hunted by age
Elk Island NP, AB	48,000	800 [12]	60	Annual: sales by age
Waterton Lakes NP, AB	500	27	19	Round-up every 2 yrs, random opportunistic culling
Prince Albert National Park, SK	173,000	310	558	Free Ranging/no culling
Primrose Lake Air Weapons Range*	2,500,000	100	25000	Free Ranging/no culling

Blue Mounds State Park, MN[13]	640	56	11	Annual: sales & hunting by age
Caprock Canyons State Park, TX[13]	331	40	8	No culling
Daniels Park, CO[13]	800	26	31	Annual: sales by age
Fermilab National Accelerator, IL[13]	69	32	2	Annual: calves sold
Finney Game Refuge[13]	3,672	120	31	Annual: sales by age, condition
Genesee Park[13]	500	26	19	Annual: sales by age
Konza Prairie Biological Station[13]	2,480	275	9	Annual: sales by age, favor newly introduced bulls to change breeding dominance
Land Between the Lakes National Recreation Area[13]	882	130	7	Annual: sales, calves, injured, animals that calve late
Maxwell Wildlife Refuge[13]	2,251	230	10	Annual: sales, animals that calve early in spring
Neal Smith National Wildlife Refuge[13]	702	35	20	Annual: culled for genetics, appearance
Prairie State Park, MO[13]	3,865	76	51	Annual: sales by age
Sandhill Wildlife Area, WI[13] *	249	15	17	Annual: exchange & donations by age
Wildcat Hills State Recreation Area, NE[13]	360	10	36	Every 2 years: sales and slaughter, calves, old bulls, age
Buffalo Pound Provincial Park, SK[13]	474	33	14	Annual: sales, all calves and by age
Riding Mountain National Park[13]	1,235	33	37	Annual sales: by age
Wainwright (Western Area Training Centre), AB[13]	160	16	10	Annual: sales, to avoid inbreeding.

The Nature Conservancy[1]				
Cross Ranch, ND	6,000	75	80	Annual, sales by age, health, appearance
Ordway Preserve, SD	3,500	160	22	Annual, sales by age
Niobrara Valley, NB	7,500	250	30	Annual, sales and hunted by age
Tallgrass Prairie, OK	39,000	3,300 (goal)	12	Annual, sales to mimic historic predation

Medano Zapata Ranch, CO*	47,000	1100	43	Annual, sales by age
Clymer Meadow Preserve, TX[13]	1,200	320	4	N/A
Smoky Valley Ranch, KS[13]	3,113	45	69	criteria under development
Intertribal[6]				
Northern Cheyenne, Lame Deer, MT [3]	135,000	30-100	1350	Hunted
Cheyenne River Sioux, Eagle Butte, SD[8]	30,000	2500	12	Hunted
Crow Creek Sioux, Ft. Thompson, SD	4,000	200-650	9	Annual Auction
Ft. Belknap Assiniboine/Gros Ventre, MT	ND			
Ft. Peck, Poplar, MT	7,350	100	73	
Lower Brule Sioux, Lower Brule, SD	6,000	400	15	Hunted
Rosebud Sioux, Rosebud, SD[11]	1,163	160	7	
Standing Rock Sioux, Ft. Yates, ND[11]	6,200	300	20	
Mandan, Kidatsa, Arikara, New Town, ND		200		
Blackfeet Nation, Browning, MT				
Crow Tribe, Crow Agency, MT[10]	22,000	1500	14	
Yankton Sioux Tribe, Marty, SD[11]	520	78	7	
Other tribal				
Oglala Sioux Tribe, Pine Ridge, SD[11]	31,000	1030	30	

[1] Callenbach, Ernest. 1996. Bring back the buffalo! Univ. of Calif. Press, Berkeley. 303pp. (Unless otherwise noted)

[2] L.N. Carbyn, S.M. Oosenbrug and D.W. Anions. 1993. Wolves, bison and the Dynamics Related to the Peace-Athabasca Delta in Canada's Wood Buffalo National Park. Canadian Circumpolar Research Series No. 4, Univ. Alberta, Edmonton. 270pp. At 3, 5.

[3] Knowles, C.J. 2001. Suitability of Montana Wildlands for Bison Reintroduction. Unpubl. Rept to Mt. Fish, Wildlife and Parks, Helena, MT. 31pp. At 22-23.

[4] U.S. Fish and Wildlife Service. 2002. Notice of Availability. 67 Fed. Reg. 21711-21712, May 1, 2002.

[5] Berger, J. and C. Cunningham. 1994. Bison: Mating and Conservation in Small Populations. Columbia Univ. Press, New York, NY.

[6] Intertribal Bison Cooperative, http://www.intertribalbison.org/main.asp?id=1.

[7] Sage Creek Wilderness Area of the Park only. See: http://www.nps.gov/badl/exp/home.htm

[8] Cheyenne River Sioux Tribe: http://www.crstgfp.com/bufhunts.htm

[10] Crow Tribe: http://www.intertribalbison.org/tribes.asp?map=9&tribe=8

[11] Archambeau, R. 2002. Tribal Conservation Report. Unpubl. Rept. to Conservation Alliance of the Great Plains.

[12] 450 Plains bison, 350 wood bison

[13] Boyd, Delaney P. "Conservation of North American Bison: Status and Recommendations," Thesis, University of Calgary, April 2003.

* Located at the margin of the historic bison range

Appendix I. Definitions of the IUCN protected area management categories

Source: IUCN. 1994. *1993 United Nations List of National Parks and Protected Areas*. Prepared by World Conservation Monitoring Centre and the IUCN Commission on National Parks and Protected Areas. World Conservation Union (IUCN), Gland, Switzerland and Cambridge, UK. Xlvi + 315 pp.

Category	Definition
Ia	**Strict Nature Reserve: protected area managed mainly for science** Area of land and/or sea possessing some outstanding or representative ecosystems, geological or physiological features and/or species, available primarily for scientific research and/or environmental monitoring
Ib	**Wilderness Area: protected area managed mainly for wilderness protection** Large area of unmodified or slightly modified land, and/or sea, retaining its natural character and influence, without permanent or significant habitation, which is protected and managed so as to preserve its natural condition.
II	**National Park: protected area managed mainly for ecosystem protection and recreation** Natural area of land and/or sea, designated to (a) protect the ecological integrity of one or more ecosystems for present and future generations, (b) exclude exploitation or occupation inimical to the purposes of designation of the area and (c) provide a foundation for spiritual, scientific, educational, recreational and visitor opportunities, all of which must be environmentally and culturally compatible.
III	**National Monument: protected area managed mainly for conservation of specific natural features** Area containing one, or more, specific natural or natural/cultural feature which is of outstanding or unique value because of its inherent rarity, representative or aesthetic qualities of cultural significance.
IV	**Habitat/Species Management Area: protected area managed mainly for conservation through management intervention** Area of land and/or sea subject to active intervention for management purposes so as to ensure the maintenance of habitats and/or to meet the requirements of specific species.
V	**Protected Landscape/Seascape: protected area managed mainly for landcape/seascape conservation and recreation** Area of land, with coast and sea as appropriate, where the interaction of people and nature over time has produced an area of distinct character with significant aesthetic, ecological and/or cultural value, and often with high biological diversity. Safeguarding the integrity of this traditional interaction is vital to the protection, maintenance and evolution of such an area.
VI	**Managed Resource Protected Area: protected area managed mainly for the sustainable use of natural ecosystems** Area containing predominantly unmodified natural systems, managed to ensure long term protection and maintenance of biological diversity, while providing at the same time a sustainable flow of natural products and services to meet community needs.

The 2000 version of the WWF/Conservation Biology Institute protected areas database was used as a source of IUCN category status for protected areas in the U.S. (http://www.consbio.org/cbi/what/pad.htm). Additional BLM and state lands added to update the WWF/CBI data were assigned IUCN cat. VI (nominal protection). Private preserves were added and assigned IUCN cat. IV. A crosswalk table for IUCN & GAP, including examples, can be found at: http://www.wri.org/wri/pdf/gfw_namerica_methods.pdf.

In Saskatchewan, the public lands data layer provided by TNC had IUCN category information included. PFRA community pastures were assigned IUCN cat. VI.

For Alberta, there was no WWF/CBI data or Heritage data, so these were assigned IUCN category to protected areas and generic crown lands according to the references above and using a description found at the Alberta Community Development website, www.cd.gov.ab.ca/preserving/parks/index.asp

Appendix J. Extent of protection of the world's major biomes.

Biome	Protected Areas			% Biome
	Area (km²)	Number	Extent (km²)	Protected
1. Tropical humid forests	10,513,210.00	1,030.00	922,453.00	8.77%
2. Subtropical/temperate rain forests/woodlands	3,930,979.00	977.00	404,497.00	10.29%
3. Temperate needle-leaf forests/woodlands	15,682,817.00	1,492.00	897,375.00	5.72%
4. Tropical dry forests/woodlands	17,312,538.00	1,290.00	1,224,556.00	7.07%
5. Temperate broad-leaf forests	11,216,659.00	3,905.00	403,298.00	3.60%
6. Evergreen sclerophyllous forests	3,757,144.00	1,469.00	164,883.00	4.39%
7. Warm deserts/semi-deserts	24,279,843.00	605.00	1,173,025.00	4.83%
8. Cold-winter deserts	9,250,252.00	290.00	546,168.00	5.90%
9. Tundra communities	22,017,390.00	171.00	1,845,188.00	8.38%
10. Tropical grasslands/savannas	4,264,832.00	100.00	316,465.00	7.42%
11. Temperate grasslands	8,976,591.00	495.00	88,127.00	0.98%
12. Mixed mountain systems	10,633,145.00	2,766.00	967,130.00	9.10%
13. Mixed island systems	3,252,563.00	1,980.00	530,676.00	16.32%
14. Lake systems	517,695.00	66.00	5,814.00	1.12%
TOTAL	**145,605,658.00**	**16,636.00**	**9,489,655.00**	**6.52%**

Source: Green, M. and J. Paine. 1997. Paper presented at IUCN World Commission on Protected Areas Symposium on Protected Areas in the 21st Century: From Islands to Networks Albany, Australia, 24-29th November 1997. Authors note that "...this analysis under-represents the protection of biomes by about 30% because only 16,6636 (55%) of the 30,350 protected areas have been classified. Their total area is nearly 9.5 million sq. km, which represents just over 70% of the global protected areas network."

APPENDIX K. MODEL DESCRIPTION: GENERATING THE LARGE AREAS MAP

Based on available GIS information, layers were created for all potentially relevant criteria to identify important "biodiversity hotspots." The following criteria were assumed to either contribute to or detract from selecting an area for consideration as a large conservation area, but did not exclude an area from consideration:

Important Biological Areas

Conserving or Restoring Endangered Species:

Bff focal areas: suitable black-tailed prairie dog habitat in blocks of over 5,000 acres on public, tribal and private preserve lands within black-footed ferret focal areas. Includes areas with current large concentrations of prairie dogs and current BFF reintroduction efforts on the ground, areas managing toward ferret recovery, and areas proposed for ferret reintroduction by J. Proctor et al. Suitability = 20

Imperiled focal species: - revised layer that includes federally protected or candidate species in the U.S. or Canada: blowout penstemon, Dakota skipper, American burying beetle (new data), Sprague's pipit concentrations (entire range, BBS data), loggerhead shrike concentrations (entire range, BBS data), mountain plover concentrations, swift fox range, greater sage grouse concentrations, sage thrasher, piping plover breeding habitat, interior least tern breeding habitat. Presence of one or more of these species = 20

Imperiled focal species-cumulative: the overlap of areas of high concentrations of imperiled focal species above, e.g., areas where numerous species overlap to areas where no species overlap (alternative to above).

Core Populations of Endemic Species

Endemic/obligate birds that are not imperiled: portions of the ecoregion where the highest number of endemic bird species overlap occurs. Overlap of birds that are both great plains endemics and grassland obligates (see below); range of values from 10-20, with 20 = greatest amount of overlap; based on BBS (breeding bird survey) data only:

Baird's sparrow
long-billed curlew
lark bunting
chestnut-collared longspur
McCown's longspur
Ferruginous hawk

Btpd suitability: habitat suitable for black-tailed prairie dog, based upon slope and vegetation only; Proctor et al., in press. Suitability = 20

Expert areas: TNC portfolio sites ranked very high priority = 20, high/medium = 15 and low = 12;
Also, study area boundaries and high value landscapes from Cliff Wallis' study commissioned by WWF-Canada. 12 = initial study block boundaries, 20 = high value landscapes identified within the study areas.

Untilled: tilled/untilled from US NLCD National Land Cover Data
www.usgs.landcover.gov/nationallandcover.html and Canadian PFRA (Prairie Farm Rehabilitation Administration data

5 = tilled, 10 = forests, water, transitional, barren, etc., 20 = untilled grassland, wetlands and shrublands

Last areas for bison: Map illustrating the Extermination of the American Bison, W.T. Hornaday, 1889.

Dispersal areas: areas of potential dispersal for grizzly and wolf. Wolf distribution from US Fish and Wildlife Service Gray Wolf Recovery Status Reports, grizzly distribution from Bader, Mike, 2000, Distribution of grizzly bears in the U.S. Northern Rockies. Northwest Science 74:4.

Precipitation: From the Sustainable Development Department, Food and Agriculture Organization of the United Nations http://www.fao.org/WAICENT/FAOINFO/SUSTDEV/EIdirect/climate/EIsp0002.htm

a) **avg. summer precipitation**
b) **avg. winter precipitation**
c) **avg. overall precipitation**

Predominance of C4 grasses: C4 and C3 dominant areas according to the Simple Biosphere 2 Model (SiB2), an AHVRR-derived classfication. http://edcdaac.usgs.gov/glcc/nadoc2_0.html. (Sellers, P.J. et al. 1996)

Data for Private Lands

Private lands only (includes Tribal lands): Lands not included in the CBI/WWF Protected Areas database. www.consbio.org/cbi/what/pad_2001.htm

Top 30% of all lands within ecoregion based on biological importance results from model

Human pop: human population density, projected 2000 population using 1990-1995 data, by tract
Range of equal area values from 0-20 (20 = zero people/sq km, 0 = downtown Billings)

Road density: derived using a 1 sq mi moving window. data contains range of values from 0-20 (20 = more than approx. 900 m from the nearest road)

Ag land value: average value of an acre of agricultural land (adjusted to US dollars, 2001) -
equal area classification from 0-20, with median $250 = 10

Coal deposits: presence of coal deposits, including coal bed methane fields

UsSk oilgas: presence of productive oil and gas wells for the US; oil and gas pools for Sask.; no data for Alberta.

Untilled: tilled/untilled from US NLCD and Canadian PFRA data
5 = tilled, 10 = forests, water, transitional, barren, etc., 20 = untilled grassland, wetlands and shrublands

Proximity to public lands: 10 = 5 km, 12 = 4 km, 14 = 3 km, 16 = 2 km, 18 = 1 km, 20 = adjacent

Avg. age: US 2000 census by tract, Canada by census unit. 10 will represent avg. age, 20 will represent oldest age in dataset.

Avg. income: US 2000census by tract, Canada by census unit 10 will represent avg. ann. income, 20 will represent highest income in dataset.

Data for Public Lands

Publicly managed lands only: managed areas according to the www.consbio.org/cbi/what/pad_2001.htm and the National Atlas of the U.S. (http://www.nationalatlas.gov/atlasftp.html).

Top 30% of all lands within ecoregion based on biological importance

Degree of protection: IUCN ranking 10 = unranked, 11 = VI, 12 = V, 14 = IV, 16 = III, 18 = II, 20 = I
Ia and b

Strict Nature Reserve: Protected Area managed mainly for science or
Wilderness Area: Protected Area managed mainly for wilderness protection
II
National Park: Protected Area managed mainly for ecosystem conservation and recreation
III
Natural Monument: Protected Area managed for conservation of specific natural features
IV
Habitat/Species Management Area: Protected Area managed mainly for conservation through management intervention
V
Protected Landscape/Seascape: Protected Area managed mainly for landscape/seascape conservation and recreation
VI
Managed Resource Protected Areas: Protected Area managed mainly for the sustainable use of natural ecosystems

Prairie dog suitable: Proctor et al., in press. Suitability = 20

Road density: derived using a 1 sq mi moving window data contains range of values from 0-20 (20 = more than approx. 900 m from the nearest road)

UsSk oilgas: presence of productive oil and gas wells for the US; oil and gas pools for Sask.; no data for Alberta.

Coal deposits: presence of coal deposits, including coal bed methane fields

Untilled: tilled/untilled from US NLCD and Canadian PFRA data
5 = tilled, 10 = forests, water, transitional, barren, etc., 20 = untilled grassland, wetlands and shrublands

Data for Aquatic Areas of Importance

Aquatic_risk fish: - revised layer that now includes overlap of pallid sturgeon, sturgeon chub, sicklefin chub, piping plover, interior least tern, shovelnose sturgeon, pearl dace, finescale dace, finescale x redbelly dace and western silvery minnow. 10=0 spp. present, 11=1 present, 12=2 present, 13=3 present, 14=4 present, 15=5 present, 16=6 present, 18=7 present, 20=8 (maximum) present. No place has more than 8 present.

Aquatic risk birds: Interior (least) tern -riparian and lake ---(U.S. FWS critical habitat)
piping plover - riparian ---(U.S. FWS critical habitat)

Riparian birds: overlap of riparian/wetland bird species; range of values from 10-15; BBS data only
marbled godwit -
Wilson's phalarope - wetland
Franklin's gull - lake
American white pelican - open water

Expert areas: TNC aquatic portfolio areas

Agricultural runoff :A composite indicator was constructed by ranking watersheds for each of the three components -- potential pesticide runoff, potential nitrogen runoff, and potential in-stream sediment loads -- and then summing the rankings for each watershed. This procedure weighted each of the three components equally. U.S. EPA data.

Hydrologic modification: This index shows the relative dam storage capacities in watersheds, which provides a picture of the relative degree of modification of hydrologic conditions in a watershed.

All data layers were resampled to 1 X 1 km resolution for the MCE Exercise.

Data layers and constraints were then weighted according to their relative importance. Because assigning weights for a given criterion is somewhat subjective and may vary widely among individuals or organizations, we used an Analytical Hierarchy Process (AHP), [286] a weighting method which breaks down the information into simple pairwise comparisons in which only two criteria are considered at a time. Instead of one individual or group assigning the weights, we derived them using collective NPCN input. Relative weights were assigned on a 9-point continuous scale. In developing the weights, participating NPCN members compare every possible pairing and enter the ratings into a pairwise-comparison matrix; these are then computed into a "best fit" set of weights (see attached matrix for final weights). Finally, values in the layers are all combined using a weighted average to produce a continuous map of suitability masked by the specified constraints.

To complete the assessment, first the biological factors were evaluated to come up with biologic suitability for large area restoration. Then, socio-economic factors relevant to restoration were evaluated together with the biological suitability layer functioning as a prerequisite or condition. The final image represents a measure of the top 50,000 pixels most suitable for large area conservation. These are then grouped into spatial clusters. Large areas (2 million acres) of "consensus pixels" represented the final recommendation for large area conservation.[287]

[286] Saaty, T.L., (1990). Multicriteria Decision Making – The Analytical Hierarchy Process. Volume I, AHP Series,, McGraw Hill, New York, NY

[287] Buckley, J.J. 1984. The multiple judge, multiple criteria ranking problem: a fuzzy set approach. Fuzzy Set and Systems. 13: 25-37;Carver, S.J., 1991. Integrating Multi-Criteria Evaluation with Geographical Information Systems, International Journal of Geographical Information Systems 5(3): 321-339;Eastman, J.R., Kyem, P.A.K., Toledano, J. and Jin, W., 1993. GIS and Decision Making, Explorations in Geographic Information System Technology, 4, UNITAR, Geneva; The Resources Agency, First Draft Report on the Methodology to Identify State Conservation Priorities, California Continuing Resources Investment Strategy Project (CCRISP), April 2, 2001. http://legacy.ca.gov/pub_docs/CCRISP_Methodology.pdf

APPENDIX K, CON'T: Pairwise Weights Used in the MCE Analysis

Table 1: Pairwise Weights Assigned by NPCN to Criteria Used in the MCE Analysis

	Black-footed ferret focal areas	Overlap imperiled focal species	Endemic obligate birds	Habitat suitable for black tailed prairie dog	Important areas identified by experts	Untilled lands identified by satellite	Last areas for wild bison	Precipitation (total avg. for summer)	Precipitation (total avg. for winter)	C4 dominant grasses
Black-footed ferret focal areas	1									
Overlap imperiled focal species	2	1								
Endemic obligate birds	3	1/2	1							
Habitat suitable for black tailed prairie dog	2	1/3	1	1						
Important areas identified by experts	1	1/4	1/3	3	1					
Untilled lands identified by satellite	1	1/7	1/5	1/2	1/6	1				
Last areas for wild bison	1/8	1/9	1/9	1/9	1/9	1/9	1			
Precipitation (total avg. for summer)	1/4	1/6	1/5	1/5	1/5	1/5	1/9	1		
Precipitation (total avg. for winter)	1/8	1/9	1/9	1/9	1/9	1/9	1/9	1/9	1	
C4 dominant grasses	1/5	1/6	1/5	1/4	1/6	1/4	1/9	1/3	1/9	1

Table 2: Pairwise Weights Assigned by NPCN to Criteria for Identifying Private Land with High Potential for Restoration

	Human population density	Road density	Agricultural land value	Presence of coal deposits	Presence of oil and gas deposits	Untilled lands identified by satellite	Proximity to public lands	Median age (2000 Census)	Median income (2000 Census)
Human population density	1								
Road density	1/2	1							
Agricultural land value	1/8	1/8	1						
Presence of coal deposits	1/4	1/4	1/2	1					
Presence of oil and gas deposits	1/3	1/3	1/2	3	1				
Untilled lands identified by satellite	2	1	8	4	3	1			
Proximity to public lands	1/2	1/2	4	5	1/2	1/3	1		
Median age (2000 Census)	1/9	1/9	1/8	1/8	1/8	1/9	1/9	1	
Median income (2000 Census)	1/4	1/5	1/6	1/3	1/4	1/3	1/3	1/8	1

Table 3: Pairwise Weights Assigned by NPCN to Criteria for Identifying Public Land with High Potential for Restoration

	degree of protection	Habitat suitable for black tailed prairie dog	Road density	Presence of oil and gas deposits	Presence of coal deposits	Untilled lands identified by satellite
degree of protection	1					
Habitat suitable for black tailed prairie dog	1/3	1				
Road density	1/2	1	1			
Presence of oil and gas deposits	1/5	1/2	1/4	1		
Presence of coal deposits	1/6	1/3	1/4	1/2	1	
Untilled lands identified by satellite	1/4	1/2	1/3	3	5	1

Table 4: Biological Areas **Eigenvector of weights**	
Black-footed ferret focal areas	0.10
Overlap of imperiled focal species	0.24
Endemic obligate birds	0.18
Habitat suitable for black-tailed prairie dogs	0.12
Important areas identified by experts	0.16
Untilled lands identified by satellite	0.09
Last areas for wild bison	0.05
Precipitation (total avg. for summer)	0.03
Precipitation (total avg. for winter)	0.02
C4 dominant grasses	0.02

Table 5: Private Lands **Eigenvector of weights**	
Human population density	0.20
Road density	0.19
Agricultural land value	0.07
Presence of coal deposits	0.05
Presence of oil and gas deposits	0.09
Untilled lands identified by satellite	0.22
Proximity to public lands	0.11
Median age (2000 Census)	0.03
Mediam income (2000 Census)	0.02

Table 6: Public Lands **Eigenvector of weights**	
Degree of biodiversity protection	0.38
Habitat suitable for black-tailed prairie dogs	0.16
Road density	0.22
Presence of oil and gas deposits	0.06
Presence of coal deposits	0.04
Untilled lands identified by satellite	0.13

Appendix L. Representation of NGP focal species and ecological complexes in the 10 largest terrestrial landscapes

	Focal species	Montana Glaciated Plains	Bitter Creek MT/ Grasslands National Park SK	Sage Creek AB/ SW Pastures SK	Little Missouri Grasslands ND	Thunder Basin WY/ Oglala Grasslands NE	Badlands/Conata Basin SD	Slim Buttes SD	Hole in the Wall/ Bighorn Front WY	Big Open MT	Terry Badlands MT
Imperiled bird species (breeding at moderate to high densities)	Mountain plover	Y				Y			Y		
	Sprague's pipit		Y	Y							
	Loggerhead shrike							Y			
	Piping plover	Y									
	Interior (least) tern				Y						
	Sage grouse	Y	Y	Y	Y			Y		Y	Y
Endemic Birds that are also Grassland Obligates (breeding at moderate to high densities)	Ferruginous hawk	Y		Y				Y			Y
	Long-billed curlew										
	Baird's sparrow		Y	Y	Y						
	Chestnut collared longspur	Y	Y	Y	Y			Y		Y	Y
	Lark bunting	Y	Y		Y	Y	Y	Y	Y	Y	Y
	McCown's longspur										
Endemic Birds also Riparian/wetland dependent (breeding at moderate to high densities)	Wilson's phalarope										
	Franklin's Gull										
	American white pelican										
	Marbled godwit	Y									
Imperiled mammals	Black-footed ferret	Y					Y				
	Swift fox	Y	Y	Y		Y	Y		Y	Y	Y
	Prairie dog	Y	Y		Y	Y	Y		Y	Y	Y
Prairie dog complex > 13,000 ac (for PD associates)		Y	Y		Y	Y	Y		Y	Y	Y
Prairie dog suitable habitat> 200,000 ac (10% landscape)		Y	Y	Y	Y	Y	Y	Y	Y	Y	Y
Imperiled plants	Blowout penstemon										
Imperiled invertebrates	Dakota skipper				Y						
	American burying beetle										
TNC Ecological Complex Representation	Wetland-pothole									No data	
	Wetland-Lake									No data	
	Wetland-Alkali/ saline			Y						No data	
	Wetland-fen									No data	
	Wetland-Playa									No data	
	Wooded draw-deciduous		Y				Y			No data	
	Wooded draw-deciduous/ coniferous	Y			Y	Y				No data	
	Wooded draw-shrub									No data	
	Riparian-herbaceous		Y							No data	
	Riparian-shrub			Y	Y					No data	
	Riparian-cottonwood	Y								No data	
	Riparian-deciduous/ coniferous				Y					No data	
	Sandhills									No data	
	Badlands		Y		Y	Y	Y			No data	Y
	Big sage	Y								No data	
	Basin big sage									No data	

Appendix M. Representation of NGP focal species and ecological complexes in the 10 largest protected areas.

		CM Russell NWR, MT	Suffield National Wildlife Area AB	Badlands NP, SD	Grasslands National Park, SK	Valentine NWR, NE	Theodore Roosevelt NP, ND	Crescent Lake NWR, NE	Medicine Lake NWR, MT	Lostwood NWR, ND	Long Lake NWR, ND
	Focal species										
Imperiled bird species (breeding at moderate to high densities)	Mountain plover	Y									
	Sprague's pipit		Y		Y						
	Loggerhead shrike										
	Piping plover	Y							Y	Y	Y
	Interior (least) tern										
	Sage grouse	Y			Y						
Endemic Birds that are also Grassland Obligates (breeding at moderate to high densities)	Ferruginous hawk	Y									Y
	Long-billed curlew		Y								
	Baird's sparrow		Y		Y				Y	Y	
	Chestnut collared longspur	Y	Y		Y		Y			Y	Y
	Lark bunting	Y		Y			Y				
	McCown's longspur										
Endemic Birds also Riparian/wetland dependent (breeding at moderate to high densities)	Wilson's phalarope										Y
	Franklin's Gull										
	American white pelican										Y
	Marbled godwit		Y								Y
Imperiled mammals	Black-footed ferret	Y		Y							
	Swift fox	Y	Y	Y	Y						
	Prairie dog	Y		Y	Y		Y				
Prairie dog complex > 13,000 ac (for PD associates)		Y		Y	Y		Y				
Prairie dog suitable habitat> 200,000 ac (10% landscape)											
Imperiled plants	Blowout penstemon					?		Y			
Imperiled invertebrates	Dakota skipper									Y	
	Burying beetle					Y					
TNC Ecological Complex Representation	Wetland-pothole		No data						Y	Y	
	Wetland-Lake		No data			Y		Y		Y	Y
	Wetland-Alkali/ saline		No data					Y		Y	
	Wetland-fen		No data			Y				Y	
	Wetland-Playa		No data								
	Wooded draw-deciduous		No data	Y	Y						
	Wooded draw-deciduous/ coniferous	Y	No data				Y			Y	
	Wooded draw-shrub		No data								
	Riparian-herbaceous		No data		Y						
	Riparian-shrub		No data				Y				
	Riparian-cottonwood	Y	No data								
	Riparian-deciduous/ coniferous		No data				Y				
	Sandhills		No data						Y		Y
	Badlands		No data	Y	Y		Y				
	Big sage	Y	No data								
	Basin big sage		No data								
	Black sage		No data								
	Birdsfoot sage		No data								

[i] Based on a 1.5 km separation distance. See, Lockhart, note 175, *supra* Matchett, R., note 176 *supra*.