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Natural Areas, Regions, and Two Centuries of Environmental Change on the Great Plains

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A careful reading of recent issues of the *Natural Areas Journal*, the publication of the Natural Areas Association, will leave you with the conclusion that humans are not a part of natural areas. When humans do appear, it is either as disturbing agents, disrupting the naturalness through, for example, the introduction of exotic plants and animals, or as managers, enhancing the naturalness through, for example, prescribed burning. This is an explicit and purposeful exclusion: "We can probably all agree," wrote the editor of the journal in 2004, "that 'natural' places are areas where human actions have minimally changed the communities and processes that occur there."[1] In fact, the stated mission of the Natural Areas Association is specifically "to benefit and protect natural areas by minimizing the human impact."[2]

So by this definition, natural areas are places, often quite small places, that are held out of time, protected remnants of plant and animal communities that were once more widely distributed but have since been removed. This is, of course, an unimpeachable goal—the preservation of natural heritage and biological diversity.

Historical geographers, on the other hand, are more interested in the process of removal—the ever-changing identification and use of resources, the modification of vegetation cover, the shaping of human landscapes over time, and so on. This entails adopting a much broader view of nature and natural areas, one that features human agency as a factor of environmental change. This has long been a central motif in geography, and now contributors to the *Natural Areas Journal* are also advocating it. Robertson and Hull, for example, promote

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"a view of nature that embraces humans as active and integral components of the ecosystem," and Trombulak and McGory Klyza argue that natural history and human history are "fundamentally related parts of a single, more comprehensive history."[3] Such dynamic views would seem to be at odds with the Natural Areas Association's mission to keep humans and nature apart, but they are really about two very different objectives: ensuring preservation on the one hand, and tracing environmental change on the other.

When humans are introduced into the picture, brought back into nature, the expanded scope of natural areas becomes more like the geographer's conception of regions—portions of the earth's surface that are "seen to be" distinctive ("seen to be," for there is much subjectivity in the recognition of regions) because they have a particular stamp, the product of interactions between humans and the remainder of the natural environment over time. The Great Plains has been recognized as such a region since the nineteenth century, though often under different names (Great American Desert, for example, or Pastoral Region) and with many different boundaries.

Boundary details aside, the Great Plains region is generally defined as extending from the Prairie Provinces of Canada to the Rio Grande, and from the Rocky Mountains to the Missouri River.[4] That is the setting for this study, which seeks to trace selective but significant environmental changes that have taken place in the region over the last two centuries. Some of these changes have been caused by human actions; others have been inflicted upon humans by a nature that affords them no special immunity. The story starts with the environmental impact of the fur trade during the early nineteenth century, moves into the extended period of pioneer settlement from 1854 to 1930, emphasizing vegetation change and drought, then brings other ecological themes, including water use, through to the present. The previous twelve millennia (at least) of human occupancy of the Plains are excluded here only because that is more ground than can be covered in a single essay. In its final stages the story reconnects with the concept of natural areas as protected places.

Fur Trade and Environment

For the first half of the nineteenth century, and even later in some places, fur traders were the dominant European American presence in the Great Plains. They came into the region from different directions: the French and then the British from the east and northeast following the northern shore of Lake Superior from Montreal and the broken lines of rivers and lakes from Hudson Bay; and the Spanish, French, and, after the Louisiana Purchase of 1803, Americans from the southeast, toiling up the Missouri River from St. Louis to the Northern Plains.

In the last quarter of the eighteenth century, the Hudson's Bay Company and the rival Northwest Company (they would eventually unite in 1821) built trading posts along the North Saskatchewan River as far west as contemporary Alberta and in the Qu'Appelle and Red River valleys in what is now Manitoba. South of the forty-ninth parallel, the American Fur Company established a virtual monopoly by the late 1820s, with trading posts along the Missouri River and its major tributaries serving all the Indian nations of the northern Great Plains. The British and American systems overlapped, especially competing for the trade at the Mandan villages (in present-day North Dakota) in the late eighteenth and early nineteenth centuries, but the British traders pulled back after 1818 when the forty-ninth parallel was recognized as the international boundary. The boundary zone remained an area of competition, with each side vying for the allegiance of trading Indians like the Assiniboine and Blackfeet, who moved their business back and forth to suit their own interests.[5]

The Great Plains south of contemporary Nebraska was never as important in the fur trade as the northern reaches of the region: there were fewer beaver, furs were thinner in the warm southern climates, and, in the absence

of navigable rivers, bison robes were difficult to transport. Instead, the salient ecological factor on the southern Great Plains in the early nineteenth century was the amassing of vast horse herds, especially by the Comanche. The competition for forage between horses and bison, as well as the feasible diffusion of diseases from horses to bison, led to a marked decline in the size of the bison herds by the 1830s.[6] Also salient were ongoing changes in the physical environment itself, separate from humans. Dendrochronology reveals a severe period of drought around 1820 centered on the panhandles of Texas and Oklahoma, the same area that became the Dust Bowl in the 1930s.[7] No wonder Stephen Long, who explored parts of those High Plains in 1820, labeled them the Great American Desert.

Bison dominated the Great Plains fur trade to the south of the forty-ninth parallel. The bulky robes were quickly and easily transported down the Missouri River from the trading posts to St. Louis. North of the boundary, beaver and other small furs, which were abundant in the Parkland Belt (which arcs around the prairies to the north), were emphasized because canoe transportation on rivers with multiple portages was not economic for the heavier bison robes. But bison were killed in large numbers in the prairies to provision the trading posts to the north with fresh meat, pemmican, and grease, so that the wide spectrum of wildlife taken for furs and food was quite similar in both the Canadian and American sectors.

With their low reproduction rates and concentrated colonies, beaver were quickly stripped from the streams of the Great Plains by trapping methods that did not discriminate between young and old, male and female. As early as the 1820s, beaver had been almost trapped out on the prairies of Manitoba and Saskatchewan, although disease epidemics may also have played a role.[8] The Hudson's Bay Company did introduce conservation policies after 1821, rotating trapping grounds to allow the beaver colonies time to recover, but this first conservation effort by European Americans on the Great Plains did not stem the depletion.[9] The outcome was similar on the American Plains, where there was not even a pretense of conservation. Records from the trading posts on the lower reaches of the Missouri River show that beaver had become a relatively insignificant item of trade by the 1820s. Even on the upper Missouri, according to Edwin Denig, a trader at Fort Union from 1833 to 1856, they had become "very rare" by the 1830s.[10] So even before the market price for beaver pelts plummeted in the late 1830s, when silk took over in the manufacture of top hats, the beaver trade in much of the Plains had atrophied because of resource scarcity.

The massive bison herds were more resilient despite the practice of the Indians, who in seeking the thickest robes and tastiest meat took mainly the females and calves, thus diminishing reproductive capacity. Still, as a consequence of the additional culling for the fur trade, the herds had been reduced over much of what is now Nebraska by the 1830s. At the same time, they were being depleted from the north in the Canadian prairies as bison were taken for provisions.[11] It would be another four decades (and railroads, hide hunters, disease, military policy aimed at restricting Indians to reservations, and competition with horses and cattle for scarce winter forage) before this seemingly inexhaustible resource was nearly gone, leaving only 1,000 or so from the estimated 30 to 50 million that filled the Plains less than a century before.

Other changes in the physical environment brought about by the fur trade included depletion of woodlands along the Missouri River. Steamboats consumed up to thirty cords of wood every twenty-four running hours, with cedar and cottonwood, the preferred fuels, going first. But compared to later stages of occupancy, the fur trade barely scratched the surface of the Great Plains. The main bison depletion did not occur until the 1860s and 1870s, long after fur traders had been displaced by much larger settler populations, and beaver again proliferated along Plains streams after 1840 when there was no longer much market incentive to trap. Fur trapping and trading

remained an important frontier economic activity, but gradually trappers and traders retreated to the fringes of a larger Great Plains economy, where they remain today.

If humans are also included in the picture, however, the environmental impact of the fur trade was devastating. Native Americans were willing participants in the trade for sure, laborers in a global system where traders were middlemen and the markets were in Boston and New York, London and Leipzig. They were not pawns of the British and Americans but shrewd traders who used the exchange to enhance their circumstances. As Denig observed, "The nature of the barter for robes and other skins is such that the Indian receives what he considers an equivalent for his labor or he would not hunt."[12]

In the process, however, the fur trade brought disease, most seriously smallpox, which cut deadly paths through the Great Plains in the second half of the eighteenth century and first half of the nineteenth century. For example, in 1805 the French fur trader François-Antoine Larocque, on his way to the Bighorn Mountains, described the Crow as a "numerous people who were reduced to their present number by the ravage of the small Pox"; and in the terrible 1837-38 epidemic on the Northern Plains an estimated 17,200 Indians died.[13] Because of such death rates, and despite the immigration of European American trappers, traders, Indian agents, and missionaries, the total regional population must have declined over the course of the first half of the nineteenth century. The population curves of the Plains Indians went on a downward plunge that didn't reverse until the twentieth century, and into the space vacated by disease and the confinement of the Indians to reservations came waves of European Americans who reshaped the region in entirely new ways.

Resettling the Great Plains, 1854-1930

It is more difficult to generalize about environmental changes during this stage of Great Plains development because there were many more people on the scene, coming from diverse places, and there is much more information to distill. Moreover, the conditions of pioneering varied greatly from, for example, isolated pre-railroad times in eastern Nebraska in the late 1850s, when at best all that the settler had with which to break the tough prairie sod was an iron plow and a team of oxen, to twentieth-century frontiers in the Texas Panhandle and eastern Montana, where settlers arrived by railroad, worked their land with tractors, and hauled their grain to town in trucks. Many themes could be followed, including the introduction of cattle in large numbers after 1860 and the simultaneous virtual extinction of the bison, and the squaring off of the land through the survey system, which not only became the dominant reality of human geography on the Plains, but also channeled the movement of wildlife along the corridors of vegetation that fringed the gridded roads and fields. From the many possible themes, the two that are discussed here are vegetation change and the impact of drought, specifically the 1890s drought.

Although early settlers' accounts sometimes refer to a return of wooded vegetation in the early years of settlement, which was probably the result of a cessation of Indian burning and efforts to control fires started by lightning, rapid depletion of useful timber was the main outcome.[14] Typically, early settlers located their homes in river valleys where timber and water were available, but the local wood was quickly used for cabins, fences, furniture, implements, and fuel. For example, in eastern Nebraska in territorial days (1854-67), fully half the nucleated settlements had steam- or water-powered sawmills, which soon reduced the woodlands to a sparse, beadlike distribution mainly along the Platte and Missouri rivers.[15] Quickly, scarcity of timber became a constraint on the growth of settlement.

The advent of the railroad after 1864 substantially solved this problem. In effect, the pine forests of the Great Lakes were stripped to build settlements on the Great Plains. Soon, every town of any size had a lumberyard located near the tracks, often next to that other key

economic enterprise, the grain elevator. By 1870 settlers within reach of the railroad and with the necessary financial means had access to timber, though it wasn't local.

Settlers introduced trees as well as depleted them. Many eventually planted orchards, and commercial orchards were established, too. Kansas historian James Malin believed that most of the fruit trees didn't survive subsequent droughts and neglect.[16] Settlers were also encouraged to plant trees through cash incentives, bounties, and tax exemptions issued by state and federal governments that had bought into the prevailing theory that increased transpiration from trees would saturate the atmosphere and result in rainfall. Malin again played down the impact, arguing that, despite the incentives, many settlers planted no trees.[17] Most notoriously, the 1873 Timber Culture Act, which initially required settlers to plant forty acres of trees and nurture them for eight years in order to acquire free title to 160 acres, added little woodland to the Great Plains, the region it specifically targeted. The act was used mainly for the purpose of speculation, and in eventual acknowledgment of that, it was repealed in 1891.[18] The fact is, in the competition for space and investment between crops and trees, the former, offering hopes of quick profit, generally won.

The replacement of diverse tall- and mixed-grass prairie, and eventually a good deal of the shortgrass prairie, with relatively few introduced commercial grains was the most significant environmental change of the resettlement era. Introductions included alfalfa from the Mediterranean via Chile and California, sorghum from Africa and Asia by way of the eastern United States, and hard spring and winter wheat from Russia, most famously Turkey Red, which was transplanted to Kansas by Mennonites in 1874. Knowledge of this hardy, early maturing variety spread rapidly as a "folk phenomenon," passed on by word of mouth, and initially against the advice of agricultural experts who favored established varieties and millers who at first considered Turkey Red flour to be inferior.[19] With the spread of Turkey Red the number of varieties of wheat grown on the Great Plains decreased: by 1919-21, hard winter wheat, especially Turkey Red, Kharkov, and Kanred varieties, accounted for one-third of the wheat acreage in the United States. In particular, Turkey Red dominated the agricultural landscape of the Central Plains and was grown in every Great Plains state.[20] Compared to the approximately 100 varieties of grasses and forbs that graced every acre of the tallgrass prairie, this was clearly a drastic simplification of the ecosystem.

This metamorphosis was slow at first. It took great effort to clear land of timber and break the prairie sod with the rudimentary technology of the 1860s and 1870s. Besides, many of the settlers—especially the American settlers—were more committed to speculation and moving on at a profit than to long-term investment in a homestead.[21] Consequently, by 1870 only the easternmost counties in Kansas and Nebraska had more than 15 percent of their areas improved for agriculture.

The pace of environmental change accelerated with technological innovation: the lister, with its double plow and divided moldboard, in the 1880s; gasoline tractors by the First World War; and combines in the 1920s. Between 1880 and 1899, according to the Department of Agriculture's 1936 report on the condition of the western range, 104 million acres of tallgrass, mixed-grass, and shortgrass prairie on the Great Plains had been broken for crops.[22] And in only five years in the late 1920s, 5.3 million acres of shortgrass prairie on the Southern Plains were converted to crops, leaving soil exposed on a vast scale to the desiccating winds of the Dust Bowl era.[23]

Even where rangeland remained, conditions deteriorated because of overgrazing. A significant exception was the twelve million acres of pasture and hay meadows in the Nebraska Sandhills, where "conservative range use" had maintained grazing capacity: in 1936 the vegetation cover was essentially the same as when plant collections were first taken from 1839 to 1858. Elsewhere on the Great Plains as a whole in 1936, mainly as a result of overgrazing, the

capacity of the range to support stock had declined by more than one-half since the region was first opened to European American settlement. Areas with more than 51 percent forage depletion included much of Wyoming, western Kansas, eastern Colorado, western Oklahoma, and the panhandle of Texas.[24]

Of course, plant cover thinned and changed composition independently of humans as drought periodically struck the Plains. Human populations thinned, too, during such times, with the drought of the 1890s being particularly calamitous. Following the drought, depression, and biblical-like retributions of locust plagues during the 1870s, which stemmed migration to the Plains, settlers advanced rapidly westward in the good years of the 1880s, convinced by scientists, the railroads, and their own optimism that by planting trees and turning over the earth they were producing the abundant rainfall. They poured into western Kansas and Nebraska and into eastern Colorado, planting wheat and corn where previously there had been only grass. And they borrowed, using the bright future as collateral, so that when the rains stopped coming in 1889-90, then ceased again more drastically in 1893-96, which also coincided with a nationwide economic crisis, they were left with crops that withered in the heat and debts they couldn't pay.

Settlers who had recently believed in their capacity to change the climate now found themselves overpowered by the drought. According to the Nebraska State Board of Agriculture, 1894 was the "warmest and driest of any year" on record. Crops were a "total failure."[25] Drought struck the eastern and central Plains, too, also resulting in crop failure, but established farmers there had sufficient reserves to weather the hard times. In western Nebraska and Kansas, distressed communities first tried (at considerable cost) to secure the services of "Melbourne the Rain Wizard," who worked to produce precipitation by agitating the atmosphere with a mysterious noisy apparatus that he kept concealed in a tent. When this failed, many left, heading to the nearest town, trudging back east, or trying their chances in other parts of the west. Towns were abandoned, leaving perhaps a stone church, too heavy to carry away, and fire hydrants that stood as the only evidence of what had once been streets (Fig. 1). Everything else was appropriated to improve surviving farms and ranches. Many counties lost more than one-third of their populations from 1890 to 1900 (and this is counting settlers who filtered back in when adequate rains returned after 1896).[26] Some, like Perkins County in Nebraska and those in the southwestern corner of Kansas, lost more than half their populations. It was, in the words of geographer Harlan Barrows, the "first great crushing defeat" of the American farmer.[27]

The Nebraska and Kansas state legislatures raised emergency relief funds, and charity in the form of clothes and food flowed in from all over the United States. But unlike in the Dust Bowl of the 1930s, there were no government-sponsored photographers to record the distress, no payments for listing the land or other work programs, no low-interest federal loans to refinance farm mortgages. It was all too disillusioning, repudiating the heady optimism of the "rain belters," and altering, at least for a while, people's attitudes about where they stood in relation to the rest of the environment. There was talk of putting cropland back into grass in 1896, but such adjusted thinking was short-lived. After 1900, with good rainfall and decent prices, the crop farmers reasserted themselves, now using surface irrigation and dry farming as solutions. These were more realistic strategies than "rain follows the plow," but the cycle of boom and bust repeated itself in the 1920s and 1930s, and to an extent has done so ever since (though subsequently the busts have been mitigated by government support systems).

Through to the Present

The themes of vegetation change and periodic drought could be carried through to the present. For example, statistics from the Forest Service's ongoing Forest Inventory and

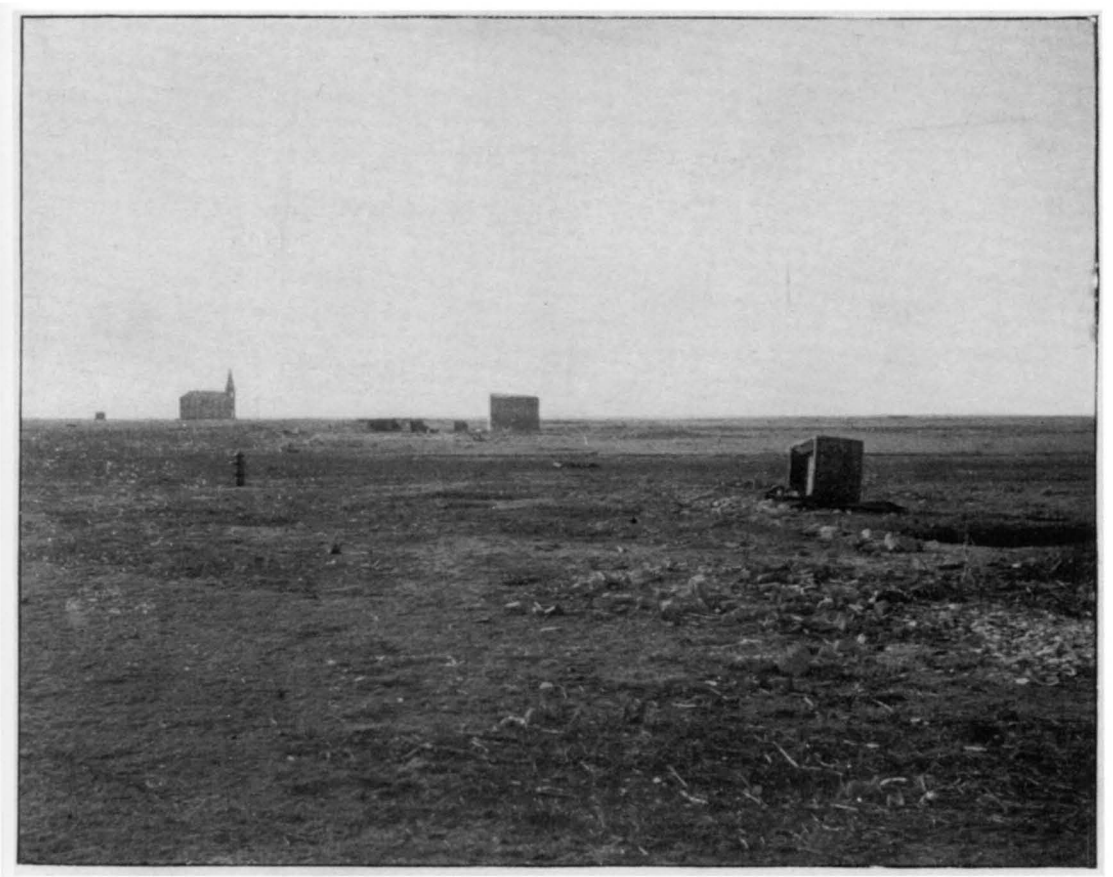

FIG. 1. *Abandoned town in western Kansas, 1890s.* Source: Willard D. Johnson, "The High Plains and Their Utilization," in *Twenty-First Annual Report of the United States Geological Survey to the Secretary of the Interior, 1899-1900, Part IV–Hydrography*, F. H. Newell, Chief of Division, plate CXXVIII, no. B. Washington, DC: U.S. Government Printing Office, 1901.

Analysis show a general downward trend in the amount of forest in Great Plains states (North Dakota, with a recent small increase, is an exception).[28] Much of the 18,500 miles of layered shelterbelts that were planted by the Forest Service from 1935 to 1942 have either died or were bulldozed out in the "fence row to fence row" farming frenzy of the 1970s to permit the widest possible swing of pivot irrigation systems. But the Forest Service statistics refer only to potential commercial timber. What they don't reveal is that trees have "moved from fields to yards" in rural, exurban, and urban areas, where they have been planted as windbreaks or for ornamentation.[29] Taking such plantings into account, along with new colonization by eastern red cedar, thanks to fire suppression, and some protection of wooded floodplains, it is likely that there are more trees on the Great Plains now than at any other time since the start of European American settlement. Moreover, many of the deliberate plantings are exotics, so the diversity of trees and shrubs is greater than in the past (Figs. 2 and 3).

Rather than continue with this theme, however, or with the almost perennial possibility of drought (which occurs somewhere on the Plains almost every year), attention is now turned to the use of the High Plains Aquifer as an example

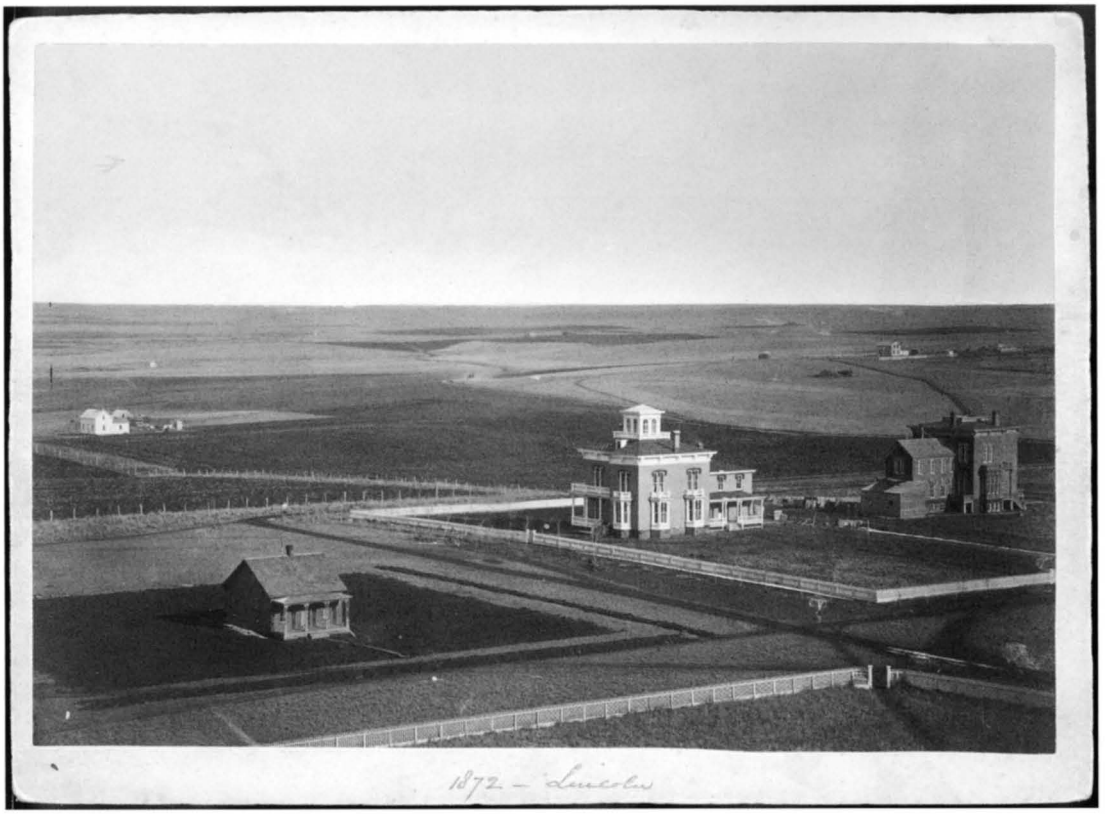

FIG. 2. *View of the Kennard House and surroundings, ca. 1872, Lincoln, Nebraska.* Courtesy Nebraska State Historical Society Photograph Collections.

of the literally deepening impact of humans on the physical ecosystems of the region.

The High Plains Aquifer, which in 2000 consisted of about 2,980 million acre feet of water (the subterranean equivalent of Lake Huron), underlies 173,000 square miles of the Great Plains from South Dakota to West Texas. The aquifer was, and still is, thickest and nearest the surface in Nebraska and thinnest and most remote from the surface in its southern extremities. The water is held between the grains of sands and gravels, especially those associated with the Tertiary Ogallala Formation. This is essentially fossil water, an endowment from streams that were once fed by snowmelt in the Rocky Mountains and that subsequently were captured and diverted by rivers such as the Pecos before they reached the Plains. Now the replenishment of the aquifer—about one inch a year from precipitation—cannot keep up with the extraction for irrigation, which accounts for 94 percent of the usage.[30] Before the 1940s the aquifer lay there, known in detail from at least the time of Willard Johnson's 1901-2 geological report but untapped, after the soil the Great Plains' prime national endowment for human use.[31]

Native Americans of the High Plains traditionally used surface water from rivers like the Platte and Arkansas, which carried year-round supplies, and from lesser streams that held water in parts of their reaches for at least some of the year. Even intermittent creeks often had accessible water not far beneath the surface of their sandy beds. Water was also periodically

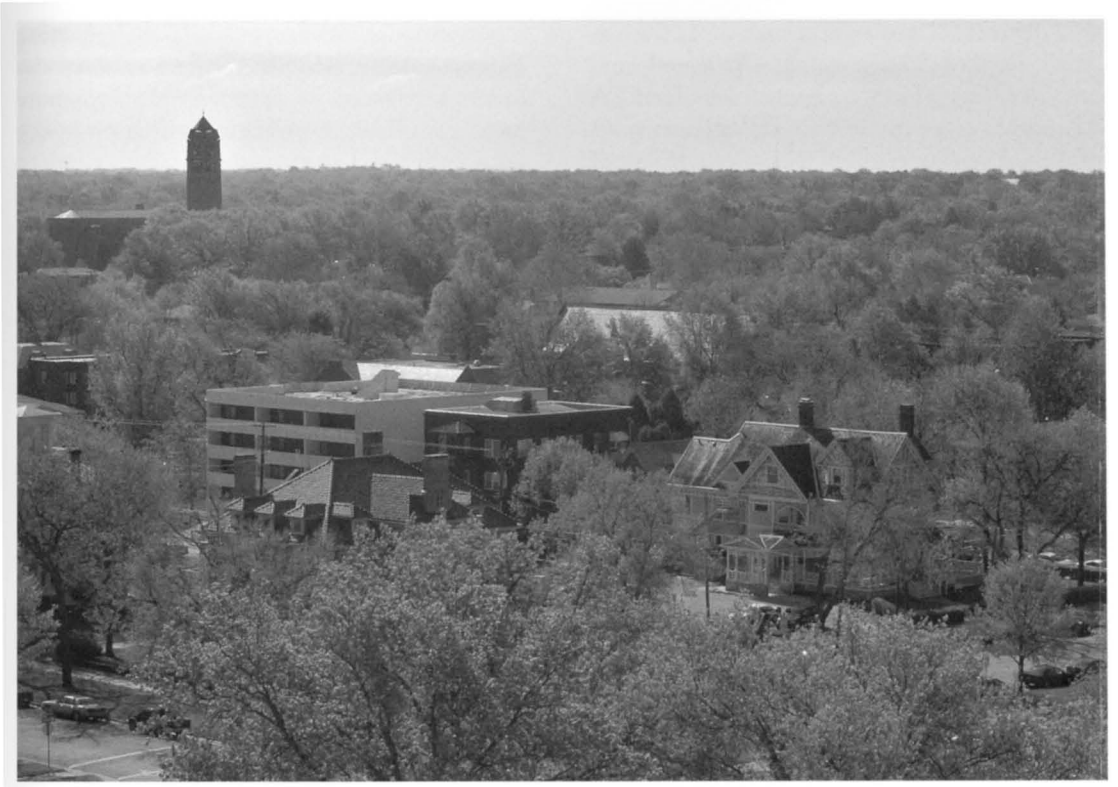

FIG. 3. *Lincoln, Nebraska. 2005.* Photograph taken from approximately same position as figure 2. Courtesy *Lincoln Journal Star.*

available in the innumerable depressions that pock the landscape of the High Plains. A final source of water—the most reliable—came from springs located along the margins of valleys and breaks where permeable sands, marls, and gravels overlie impermeable materials such as bedrock, causing underground water from the High Plains Aquifer to discharge. The anthropologist Waldo Wedel concluded that even pre-horse pedestrian Indians could have occupied the High Plains for much of the year by using these water sources.[32]

These sources would not suffice, however, for the more numerous European Americans who moved into the area in the 1870s and 1880s with plans for intensified land use. Settlers dug wells by hand, shoring up the sandy sections with boards, hoping to hit water within fifty feet, but often excavating down through geological time beyond 100 feet before the water table was tapped. Windmills, coming into common use in the 1880s, made it easier to bring the water to the surface, but their pumping reach was limited to about thirty feet, and the water they delivered could barely irrigate ten acres. These limitations led Willard Johnson to conclude that the High Plains was essentially "nonirrigable."[33] Even in 1940 the High Plains Aquifer remained a reserve for the future rather than a resource available for immediate use.

This situation changed dramatically in the 1940s with the innovation of new drilling and pump technology that permitted water to be extracted from a depth of 300 feet and distributed via gravity flood irrigation or, after

1970, by center pivots at a rate of 1,000 gallons a minute. The amount of irrigated land on the Great Plains increased rapidly from 2.1 million acres in 1949 to 13.7 million acres in 1980.[34] Sustained by this water, parts of the Plains—most dramatically southwestern Kansas—became outliers of the midwestern Corn Belt, with industrialized farming that begins with corn and soybeans and ends up as packaged beef and pork. As a result, by 2000 the aquifer had diminished by about 200 million cubic feet, or six percent of the stored drainable water.[35]

A six percent decrease over fifty years would seem to be tolerable, but it is the geographic variation in depletion that tells the real story. Nebraska actually experienced a 4 million acre feet increase in stored drainable water from 1950 to 2000, the result of seepage from canals and return of irrigation flow. On the plains of Texas, however, over the same period the stored drainable water declined by 124 million acre feet, leaving a saturated thickness (the distance between the top of the water table and the base of the aquifer) of less than fifty feet over extensive areas. When you consider that at least thirty feet of saturated thickness is needed to successfully operate a large-capacity well, it becomes clear that irrigation in much of West Texas has a limited future. Moreover, the depth of this falling water table in the Texas Panhandle and adjacent New Mexico is now more than 300 feet (compared to less than twenty-five feet in the Platte, Republican, and Arkansas valleys and parts of the Nebraska Sandhills), and the deeper the well the higher the energy costs to raise the water to the surface.[36] Yet another complication is recent evidence showing that serious pesticide pollution of the aquifer is taking place more rapidly than was previously thought.[37]

Although pronouncements of the death of the High Plains Aquifer, starting as early as the 1940s, have proven to be premature, it is hard to dispute Opie's conclusion that "[p]umping the Ogallala remains an unrepeatable and irreversible experiment in continuous depletion."[38] Spatially, the depletion is occurring in a general south-to-north direction, reflecting in large part the time that has passed since the onset of irrigation in a given locale. At a more local scale there is often great variation in the accessibility of the groundwater, giving rise to oases of development and population growth where the water is available and large depopulated expanses where it is not.[39]

Adjustments have been made, especially in the crisis areas of the Southern Plains. Colorado, New Mexico, Oklahoma, Texas, and parts of Kansas formally acknowledge the depletion and have variously imposed restrictions on the installation of new wells, the spacing of wells, and the amount of water withdrawn, while improved delivery methods such as irrigation scheduling and low-pressure overhead sprinkling have rationalized consumption rates. Significantly, however, every farmer Opie spoke to in the course of his study "acknowledged that the end of widespread irrigation is inevitable."[40] Indeed, western Kansas's groundwater districts have long had a policy of "planned depletion."[41]

If, then, the irrigation era proves to be for large parts of the High Plains only a spectacular interlude, what will replace it? Predictions are almost sure to be wrong, of course. Witness the influential 1936 report of the Great Plains Committee, entitled *The Future of the Great Plains*, which concluded that "[i]rrigation at best can cause only minor changes in the economic life of the Great Plains" just as technological innovations brought the High Plains Aquifer within reach.[42] That report, coming in the midst of a drought that had forced a temporary realism on Plains settlers, recommended the retirement of marginal arable land back into grass and the purchase of rangeland by the federal government to "promote its best use."[43] More than 11 million acres were bought this way, with 3.8 million acres becoming National Grasslands. But outside such regulated areas, land was seeded back into wheat as soon as rainfall allowed, because wheat offered the farmer the best chance for a profit.

Genetically altered grains or, at the other end of the experimental spectrum, the biodi-

verse perennial grain agriculture advocated by the Land Institute in Salina, Kansas, could feasibly stabilize farming in the semiarid parts of the Great Plains, but it's hard to see how extensive wheat farming, or ranching, with their limited labor requirements, could restore a thick rural population. And without that population, small towns will continue to dwindle for want of customers in their schools, shops, and bars, and will fall into the ranks of that most numerous type of Plains towns, the ghost town.

Nor would other prospects, promising though they are for the economy, restore a full fabric of Plains life such as that which prevailed during the pioneer settlement era. Massive reserves of coal and oil underlie the Great Plains, but these export industries would not return substantial numbers of people to the region, except locally during boom times. The harnessing of wind energy (and other forms of solar energy) does promise much for the Great Plains: ten of the leading twelve states in terms of wind energy potential are in the region, with North Dakota (which has an amazing average annual wind speed of sixteen to eighteen miles an hour) at the top.[44] Long-distance high-voltage transmission lines would have to be constructed to transport the electricity, farmers could earn extra income from leasing land for wind turbines and from royalty payments, and there would probably be multiplier effects in the local manufacture of wind turbines, blades, and other components. But to date the wind energy industry employs only a few thousand people nationally, so even though economic and environmental benefits would accrue from additional development, there likely would be little population added to the Great Plains in the process.

Then there is the potential for development of the majestic Plains environment. Vast areas of grasslands could be stocked for safari-like tourism: people could experience the unparalleled spectacle of the migrating sandhill cranes, whooping cranes, and waterfowl through the central Platte valley, the calming silence of an empty road unfurling ahead to the horizon, and the sparkling clarity of the skies at night, a sight that is obscured in more urbanized places. All these attractions will bring people to the Plains, and perhaps some, freed in their locational choices by the Internet and pulled by the low cost of living, will decide to stay. But in the foreseeable future it is unlikely that they would outnumber the Plains residents, especially the young, who leave.

Contemporary Natural Areas of the Great Plains

One way to categorize the natural areas (in the broadest sense, with humans included) of the contemporary Great Plains is to move from the most humanized to the least humanized places: from urban areas, through heavily cropped areas, rangeland, and finally to natural areas in the restricted sense of protected places where human impact is expressly minimalized (Fig. 4).

Metropolitan statistical areas, according to the Census Bureau, are urban areas with more than 50,000 inhabitants, including those in the surrounding home county.[45] On the Plains, the metropolitan statistical areas lie mainly at the margins to the west and especially to the east. Only Bismarck, Rapid City, Lubbock, Amarillo, Midland, Odessa, San Angelo, and Abilene are entirely in the heart of the region. They make up a small proportion of the area of the Great Plains but are home to a considerable proportion of the region's population: 34 percent in South Dakota, 46 percent in Kansas, 53 percent in Nebraska, and 58 percent in North Dakota. Without exception, Plains metropolitan statistical areas are growing in both population and areal extent.[46]

At the risk of overgeneralization, a few statements can be made concerning the environments of these highly humanized places. Shaped more by external economic and social forces (not least by automobile) than by local conditions, Plains urban areas don't differ markedly in form, landscapes, or even functions from one part of the region to another. They don't, for example, express the local geology in their

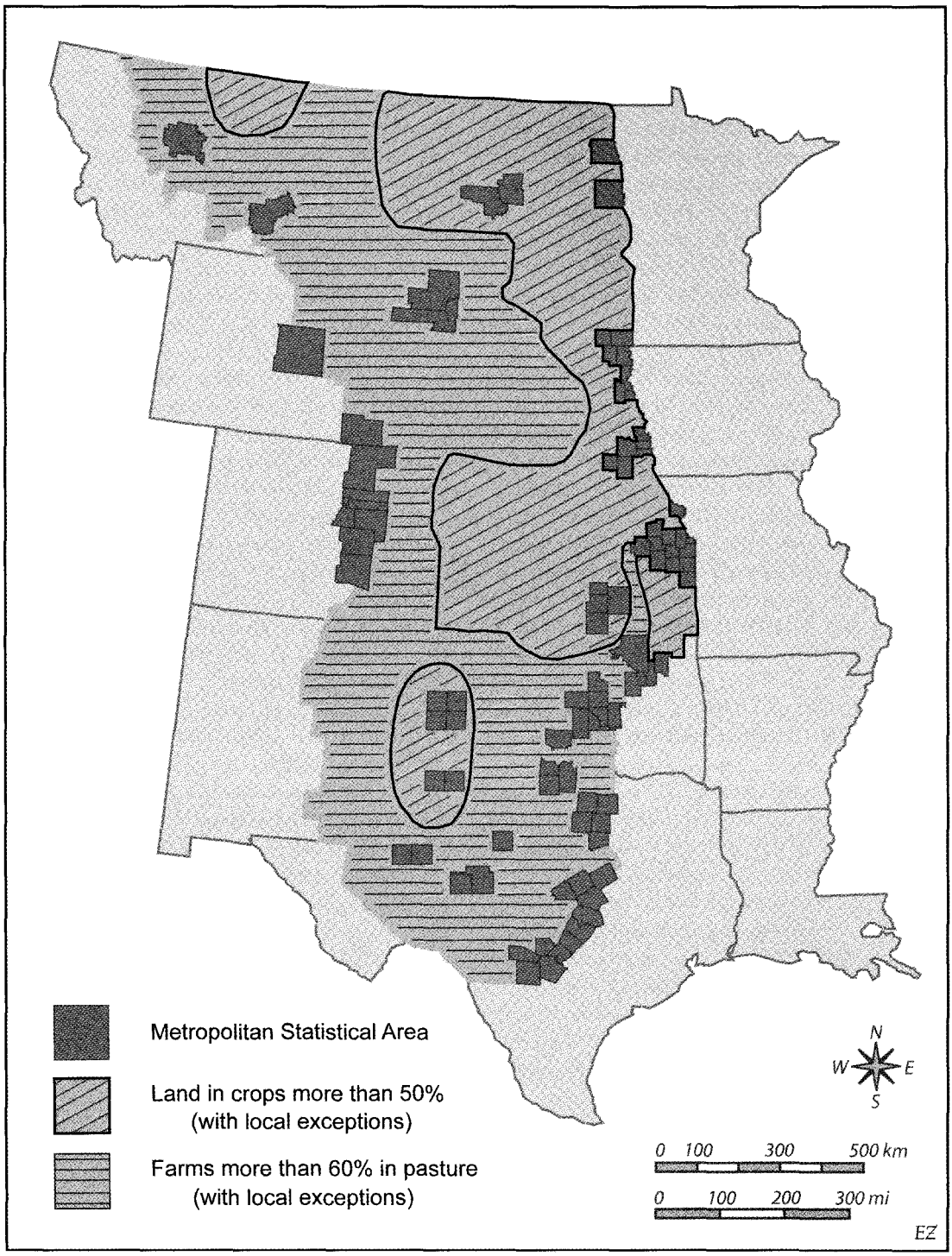

FIG. 4. *Natural areas of the United States Great Plains.*

buildings to any great extent and indeed never did, and because of heating and air conditioning it is no longer a necessity to adapt buildings to the local climates. With minor exceptions, architecture is also similar and standardized. As Murphy writes, "[T]he architectural story of the Great Plains after European American immigration was about an architecture that just happened to be built on the Plains."[47] Not only did it not grow out of specific locales within the region, but it also does not differ substantially from architecture elsewhere in the United States.

The human populations of these urban areas are more diverse than those of the surrounding countryside, with more young people and greater ethnic variety. They are distinctive physical environments as well.[48] Because of the absorptive qualities of the buildings, the variegated texture of the urban terrain, and the heat generated from the cities themselves, they are heat islands, considerably warmer than the rural areas. Their paved surfaces speed up the hydrological cycle, and increased runoff can lead to flash floods and soil erosion. They are sources of air pollution (think of Denver in the 1970s, before emissions control) which is exported widely. They retain little of the local original vegetation, yet because of introductions into parks and gardens from around the world, they contain a greater variety of plant species than the encircling countryside; in addition to deliberate introductions, pioneer species in the early stages of plant succession take hold in the neglected areas of the city, such as demolished sites and industrial lands, adding to the vegetative diversity. There are fewer species of wildlife compared to the original local occurrence, but there are, for example, more birds than in the rural areas. They have their own particularly rich ecosystems, such as sewage lagoons with abundant nutrients that support a diverse assemblage of plants and wildlife. And finally, at the fringes of the urban areas, highways lined by the same franchise businesses found everywhere (which again blurs any specific place identity) strike out into heavily cropped farmland that is quickly accruing value as real estate.

Over much of the central Great Plains and the eastern parts of the northern Great Plains, as well as in an outlier in the Texas Panhandle, more that 50 percent of the total land area is in crops (Fig. 4).[49] In parts of eastern Nebraska and eastern North Dakota, that figure rises to more than 75 percent. These areas are as humanized as a city block. Agricultural intensification, as in Weld County, Colorado, where corn production has increased 500 percent since 1940, means that space is used to produce only for human consumption, with drastic effects on biodiversity.[50] Where once there was the abundant variety of the tallgrass prairie, there are now expansive stands not only of a crop (corn, wheat, soybeans, sorghum) but of only a few genetic varieties of that single crop. Simplification of the ecosystem and insecticides have eliminated many insect species (the Red River Valley of the North, eastern Nebraska, southwest Kansas, and the Texas Panhandle stand out on the national map showing acres of crops treated for insect control), and an analysis of breeding bird populations from 1966 to 1993 shows that twenty-four of twenty-eight monitored species have seen population declines, again largely as a result of agricultural intensification.[51] The associated elimination of woodland and windbreaks at the perimeter of the fields reduces wildlife refuge space and truncates dispersal corridors, as well as adding monotony to this manufactured environment. Massive inputs of nitrogen fertilizer (only the Midwest rivals the cropped areas of the Great Plains in the amount of acres on which commercial fertilizer is used) substitute for soil nutrients that have long since been depleted, but only an estimated 40 to 60 percent of the nitrogen is taken up by the crops, the remainder being lost as trace gases into the atmosphere or as a nitrate solution leaching into surface water or groundwater. These are rural areas for sure, and they can be beautiful (a sunset over a russet sorghum field, for example, or the bright green of the winter wheat showing through the snow), but they are certainly not natural in the sense of being untouched by humans.

The human population of the cropland areas is diminishing, which marks another reduction

in biodiversity. Each successive agricultural census reveals that there are fewer farms; that they are increasing in size; and that, with mechanization, they need fewer people to operate them. As the farm population dwindles, towns lose their service functions, ending up perhaps with only the one that started it all, the grain elevator. Many counties in the eastern parts of the region reached their maximum populations in the 1880s; those in the north and west, settled later, tended to peak in the 1920s. The minority of rural counties now experiencing population growth are within commuting distance of urban places, or in transportation corridors such as the Platte Valley. Young people especially can find little to sustain themselves in these highly successful (in terms of agricultural output) but depopulating areas; young women may find the situation particularly difficult because once the teaching jobs are filled and the beautician's shop staffed, there are even fewer opportunities than for young men, who might still be able to find work in the agricultural economy.[52] Plains women don't do agricultural work in great numbers in the heavily cropped areas of the Plains, where they operate only 3 to 4 percent of farms, compared to almost 9 percent nationally.[53]

The same demographic spasm is occurring in the rangeland areas of the western Great Plains, from eastern Montana to eastern New Mexico and including the Nebraska Sandhills. This is ranch country, where, according to the 1997 *Atlas of American Agriculture*, more than 80 percent of the land in farms is pastureland and more than 70 percent of agricultural products sold come from cattle and calves (Fig. 4).[54] Dryland wheat cuts into the rangeland in years of good rainfall and high prices, only to withdraw again when conditions deteriorate. Compared to the eastern Great Plains, the human presence has always been sparse in ranch country, and it's getting sparser by the year: witness the signposts, which are more often to single ranches than to towns.

In Garfield County in eastern Montana, for example, a county that occupies 5,000 square miles of windswept rangeland interspersed with blocks of dryland wheat, the maximum population was reached in 1916, the year drought brought the initial settlement boom to a disillusioning end. The peak decennial census year was 1920, when 5,368 residents were counted; then there was only decline, decade by decade, to a total of 1,218 in 2000. Over this same time period, the number of farms fell from 1,530 to 268, while the average size of farms increased from 571 acres to 8,141 acres.[55] Jonathan Raban, traveling in eastern Montana in the 1990s, described the scene as a graveyard of skeletal towns and abandoned farms, the latter sometimes revealed only by a durable juniper-post fence line, wagon ruts across the range that are exposed only as indentations in a light covering of snow, or perhaps a patch of emerald green marking the old pig pen, still fertilizing.[56]

Time has taken a greater toll on the human landscapes of range country than on the range itself. According to Knopf, compared to the tall- and mixed-grass prairies of the eastern Plains, the shortgrass prairie of the western Plains is "merely fragmented rather than obliterated."[57] The statistics vary from source to source, but it seems that the shortgrass prairie in Wyoming is still about 80 percent intact, though Texas and Saskatchewan have suffered much greater losses.[58] Indeed, Flores reveals that only 3 percent of the native prairie remains in Lubbock County, Texas.[59]

But in Lubbock County, shortgrass prairie has been removed for cropland because of the High Plains Aquifer. Elsewhere, grazing is the main impact, and the shortgrass prairie had evolved defensive mechanisms against grazing (including short stature) to withstand the impact of the bison and other herbivores long before cattle were introduced. Still, excessive grazing and other stresses have created open sites that invite colonization by exotics or undesirable native plants; in Texas, for example, where the shortgrasses have not been plowed up for croplands, honey mesquite has spread widely, captured the available moisture, and left the surviving grasses "patchy and unproductive."[60]

Disturbance of the shortgrass prairie through oil, coal, and gas development, though relatively

localized, is particularly traumatic, and it's only going to increase: the forecast is that over the next twenty years an additional 50,000-120,000 coal-bed methane wells will be drilled in the Powder River Basin of Wyoming, along with all the repercussions: draining of aquifers, polluted streams and creeks, access roads, power lines, compressor stations, and wastewater pits.[61] Also, as Ian Frazier so vividly explained, where the land is strip-mined, geology, prairie, and history are "scrambled" into "waste heaps," undoing in a moment the gradual accumulations of millennia.[62]

On the Great Plains, shortgrass prairie is where most of the final types of natural areas discussed here—protected reserves of relatively unaltered ecosystems—are located. There are many categories of such protected areas and many degrees of human exclusion. Rather than discussing all the categories and giving examples of each, which Zinser has already done in great detail, a few generalizations are offered.[63]

The first generalization, given by Flores in 1996, is that "the Great Plains as a whole remains pathetically protected ecologically."[64] In actuality, this generalization is more applicable to some categories of protection than to others. The Great Plains has thirty units of the U.S. National Park System, for example, but only four National Parks proper: Badlands National Park, Theodore Roosevelt National Park, Carlsbad Caverns National Park, and Wind Cave National Park are in the U.S. portion of the Plains and three (Riding Mountain National Park, Grasslands National Park, and Elk Island National Park) are in the Canadian section. Together the American parks amount to only 0.6 percent of the national system, which is a measure of what Flores calls the "perceived aesthetic deficiencies" of the Great Plains.[65] Other components of the National Park System, including National Monuments such as Wyoming's Devils Tower and the Tallgrass Prairie National Preserve in the Kansas Flint Hills, the only unit in the entire system that aims to protect that almost vanished ecosystem, are scattered across the region.

These are not, of course, places from which humans are excluded—approximately 1 million visitors stop by (generally only briefly) Badlands National Park each year, and you can take a bus tour of the Tallgrass Prairie National Preserve. But there are considerable areas within the National Parks, for example, that are designated as units of the National Wilderness Preservation System, serving as islands of original vegetation and sheltered sanctuaries for Plains wildlife.

Not surprisingly, National Forests are few and far between in the Great Plains: only three are fully within the region, two of them, improbably, in Nebraska. Wild and Scenic Rivers are also poorly represented, not because, as Hass explains, Plains rivers lack scenic qualities but because so much of this fertile land is owned and farmed.[66] Only relatively short sections of Plains rivers, two on the Missouri and one along the Niobrara, are protected in this manner, with human access and use restricted to various degrees, and as of 2005 none of the Prairie Provinces' rivers has merited inclusion in the Canadian Heritage River System.

By contrast, the Great Plains stands out on the maps of National Grasslands and National Wildlife Refuges. All but three of the United States' nineteen National Grasslands are in the Plains. Run by the Forest Service, they are mainly leased for grazing but are also used for recreation, wildlife management, and watershed protection. Grazing is regulated, but paradoxically, according to the World Wildlife Fund, such uniform grazing results in a homogeneous grassland that actually reduces biodiversity, because some species—grassland birds, for example—favor lightly grazed niches while others are attracted to heavily grazed areas.[67] There are 110 National Wildlife Refuges in the American Great Plains, amounting to 22 percent of the national total, though only 2 percent of the acreage. North Dakota alone has sixty-two such refuges. These places are managed mainly as water-based wildlife habitat, with hunting, trapping, fishing, logging, and even farming permitted. They are not, therefore, protected areas as defined by the Natural

Areas Association, but they do constitute, to use Zinser's words, "the most comprehensive wildlife resource management program in the world."[68]

In addition to these federally managed and conserved areas on the Plains are numerous parcels of land that are protected by private organizations such as the Nature Conservancy. Through acquisitions, conservation easements, and land exchanges between government agencies and private landowners, the Conservancy works to preserve native species and protect biodiversity. More than 56,800 acres of tallgrass, mixed-grass, and shortgrass prairies in Kansas have been shielded in this way, and in South Dakota and Wyoming 45,000 acres in and around the Black Hills have similarly been set aside from development.[69] Even more quietly, many individual farmers throughout the Plains have diversified their crop and livestock operations, reducing their reliance on chemical pesticides, planting buffer strips around streams, using cover crops to reduce erosion, and in general pursuing good long-term management techniques that they hope will yield profits while promoting sustainability. These are not natural areas in the sense of human exclusion, but they are indeed enhanced natural areas in their beneficial merger of human interest and environmental health. Through such individual actions, as well as through the efforts of governmental and private organizations, and despite the prevailing forces of development, it may well be that the Great Plains are not now as "pathetically protected ecologically" as they were when Flores was writing a decade ago.

Conclusion: Retrospect and Prospect

Looking back over two centuries, it can perhaps be seen that the fur trade was simply a resource grab, that the resettlement era was characterized by agricultural practices that eventually consumed the stored richness of the soil, and that intensified agricultural practices in the second half of the twentieth century extended that depletion to the water of the High Plains Aquifer. It can also be seen that a corner was turned in the 1930s, initially by force of necessity, and that conservation, preservation, and protection of Great Plains environments have since grown in scope. The amount of land set aside for such purposes, however, is still considerably less than the area of grasslands that has continued to be plowed up for new cropland—which, for example, increased by 28 percent in the Canadian Prairie Provinces from 1971 to 1996, and by 5 to 10 percent on privately owned land in north-central Montana from 1982 to 1997.[70]

All the beneficial adjustments that are made in securing the occupancy and environmental health of the Great Plains could turn out to be less important in the long run, however, than external influences that reach into the region and propel development in one direction or another. In the agricultural economy, Plains grain farmers may see falling profit margins and increased price volatility as a result of growing competition from farmers in Brazil, Argentina, and the Ukraine, and the government price supports that now sustain them will certainly face retraction. Then there is the ominous, human-induced reality of global warming. Temperatures over the central and northern Great Plains have risen 2 degrees Fahrenheit (1 degree Celsius) over the last century, with increases of 5.5°F (3°C) occurring over parts of Montana, South Dakota, and North Dakota. Over the same period, annual precipitation declined by 10 percent in the eastern portions of Montana, Wyoming, and Colorado, and in North Dakota.

The national assessment of potential climate change, completed in 2001, predicts that the Great Plains will continue to experience this warming, and that precipitation in the western parts of the region will decrease. Furthermore, even where precipitation gains are expected, as in the eastern Plains, increased evaporation from the higher temperatures will produce net soil moisture losses.[71] Among the implications are a warmer and longer growing season, a concomitant in-migration of invasive species, more frequent high-intensity rain events in the Southern Plains leading to flooding and heavier

soil erosion, increased competition for water, and heightened stress on farmers and ranchers as they struggle to adjust to the changing circumstances. Whatever the accuracy of these specific predictions (some of the models contradict each other), the proven climate trends so far are convincing evidence that humans live within nature as both agents and victims of change. And the scale of the change is such that no region, and no protected areas within regions, will be immune to the consequences: the human impact is now everywhere.

NOTES

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