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"In Want of Nourishment for to Keep Them Alive":

Climate Fluctuations, Bison Scarcity, and the Smallpox Epidemic of 1780–82 on the Northern Great Plains

Abstract

Native American groups sustained appalling population losses when smallpox swept the northern Great Plains from 1780 to 1782. Although the epidemic struck the semisedentary villagers of the upper Missouri the hardest, it also ravaged migratory bison-hunting societies that were theoretically less prone to sustaining such heavy losses to Old World infectious diseases. This study asks why smallpox spread so widely among the migratory tribes and why it proved to be so virulent. Multiple lines of evidence suggest that climate fluctuations affected the productivity of the grasslands, affecting bison migration patterns and Native subsistence. Food shortages and resulting starvation facilitated the spread of smallpox and exacerbated the disease's effects on individuals and populations. This study highlights the environmental and cultural complexity of infectious disease epidemics.

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Introduction

The mid-nineteenth-century artist George Catlin once observed that smallpox was "the dread destroyer of the Indian race." Repeated epidemics produced a staggering death toll. Among those epidemics was one that swept the northern Great Plains of North America for eighteen months from 1780 to 1782, killing half or more of the region's Native population. The Mandans, Hidatsas, and Arikaras, who lived in semisedentary villages on the northern Plains, lost approximately 70 to 80 percent of their populations. The crowded, stationary nature of their large villages led to rapid smallpox diffusion and high human mortality. Yet, surprisingly, migratory peoples such as the Blackfeet, Assiniboine, Lakota Sioux, and Cree also sustained considerable losses in the 1780–82 epidemic, even though they lived in smaller, more scattered groups, which typically slowed disease transmission.[1]

This study endeavors to explain why smallpox spread so quickly among migratory Native groups during the 1780–82 epidemic and why it produced such high death rates. To understand the ravages of smallpox among the migratory societies, we need to consider those groups' intricate relationships with the northern Plains environment. Although trade and warfare spurred by the colonial expansion of European powers in North America had carried smallpox to the northern Plains in 1780, trade and warfare alone do not explain why smallpox spread so rapidly or why it proved so deadly. Nor does the lack of acquired immunity among northern Plains Natives entirely explain the disease's high death toll.[2] In this article, I use a variety of sources to argue that climate fluctuations in the years preceding the 1780 epidemic decreased bison populations, which in turn increased malnutrition among migratory groups, rendering them more vulnerable to smallpox. Close attention to the interrelationships among climate fluctuations, wildlife population demography, and food shortages can throw new light on the environmental and cultural factors affecting disease epidemics.

In 1787, Northwest Company trader David Thompson visited a Piegan Blackfoot band and learned from an old warrior, Saukamappee, about the ravages of the recent epidemic. The Piegan-adopted Cree Indian informed Thompson that during and immediately following the smallpox outbreak, his people could find no bison nearby for subsistence. The disappearance of the bison mystified Saukamappee. He addressed the development in spiritual terms, explaining that because the spirits had taken away Indians with sickness, it was only right that they also took away the animals since they would apparently be no longer needed. Saukamappee further observed that the game shortage increased his people's suffering, for they found it difficult to recover in the aftermath of the epidemic with little bison available for subsistence.[3]

In addressing the smallpox epidemic of 1780–82, several scholars refer to this scarcity of bison, but they have lacked concrete data on its cause. Some scholars have suggested that the game shortage was at least as much a perceived problem as it was one of reality. Other historians have asserted that rather than being depleted, "The bison sustained the nomads during the smallpox epidemic of 1780–82."[4] This study argues that, on the contrary, bison on the northern Great Plains were indeed scarce during the 1780–82 epidemic, and while food scarcity did not cause the smallpox outbreak, hunger contributed to its diffusion and virulence.

In addition to arguing that bison scarcity caused a nutritional crisis that intensified the 1780–82 smallpox epidemic, this study also asks *why* the northern Plains witnessed a scarcity of game at this time. Answering that question requires an examination of regional climate conditions preceding and during the epidemic. Climate fluctuations affected grassland ecology, which influenced bison population numbers, herd sizes, and migration patterns. These changes, in turn, affected the ability of Native groups to procure subsistence.[5]

Using contemporary observations and climate data from published tree-ring studies, I argue that the volatile nature of the northern Great Plains climate influenced both the bison shortage and the smallpox epidemic. While the northern Plains climate is always marked by variability, I argue that global climatic phenomena intensified Plains climate fluctuations in the years preceding the smallpox outbreak, with significant effects on bison movements and human hunger.

Scholars exploring other regions have acknowledged that climate fluctuations, nutritional stress, and infectious diseases (including smallpox) often share a close relationship. Yet few studies have examined these relationships on the northern Great Plains. Linea Sundstrom's study of Lakota Sioux winter counts points out that "[p]oor nutrition and other stresses often set the stage for severe epidemics," but it does not link those famines to climate. Clyde D. Dollar, Michael K. Trimble, and R. G. Robertson provide evidence that local weather conditions helped to generate food shortages among the semisedentary villagers on the eve of the northern Plains smallpox epidemic of 1837–38. Focusing on Mandans, Hidatsas, and Arikaras, they show that an especially rainy and cool spring and summer in 1837 correlates with a bison shortage that "disrupted traditional hunting patterns and plunged the area into famine." Trimble argues that this food scarcity, coupled with Indians remaining inside their lodges because of the poor weather, produced higher rates of transmission and mortality than if milder weather conditions had prevailed. For the epidemic of 1780–82, however, no studies examine the correlations between regional climate patterns, grasslands ecology, bison migration, and smallpox.[6]

I support my hypothesis by presenting multiple lines of correlational evidence. Evidence that climate variations affected grasslands production does not exist; nor does historical evidence linking grasslands productivity to bison migration patterns. However, reported shortages of bison and Native hunger before and during the smallpox epidemic, along with recent research that indicates the years 1774 to 1782 witnessed considerable climatic variability, suggest a connection between those events. This study, therefore, examines the ecological relationships that lie between climatic events and human hunger in an effort to uncover the environmental dimensions of the 1780–82 smallpox epidemic. By intertwining insights from contemporary observations and scientific research, I can argue a suggested relationship between climate, grasslands production, bison migration, human subsistence, and epidemiological disaster.

This study has several parts. The first part outlines the ecological interrelationships between northern Plains Natives and their environment, highlighting the reliance of hunting societies on the bison population for subsistence and the annual migration cycle. I argue that seasonal climate changes during the average year influenced bison migration patterns. Native groups responded to these bison migration patterns by changing their own movements to minimize nutritional stress, but nevertheless seasonal food shortages frequently led to seasonal human hunger. Northern Plains Natives often endured significant food shortages, particularly during the winter.

The second part makes the case that even though climate variability was nothing unusual on the Great Plains, the 1780–82 smallpox epidemic was preceded by unusually variable climate. I use a variety of data sources to reconstruct climate conditions on the northern Plains on the eve of the 1780–82 smallpox epidemic. I then argue that erratic climate affected bison populations, which in turn increased rates of human malnutrition and starvation for northern Plains migratory tribes.[7]

The third part uses medical studies and historical works to highlight how malnutrition increased susceptibility to smallpox. The effects of nutritional stress within the context of the 1780–82 epidemic were threefold. First, general starvation, in the forms of undernourishment and malnourishment, fostered the spread of the *Variola* by both weakening Natives' immune systems and compelling them to search more widely for food than they might have usually done, thereby increasing contact between different groups and providing the pathogen with more opportunities to infect individuals. Second, nutritional stress amplified the destructive effects of the disease on the human body and made Indians more likely to perish as a result of smallpox infection. In short, starvation among Natives increased both their smallpox morbidity (illness) and mortality (death) rates. Finally, continued food shortages made it difficult for those who survived the epidemic to recover in its aftermath, causing prolonged suffering and an increased death toll among northern Plains Native societies.[8]

Ecological Interrelationships

In his classic history of the Great Plains, Walter Prescott Webb noted that, "The history of the Plains is the history of the grasslands." Indeed, as the following section highlights, all life on the Great Plains, animal and human, depended, in one way or another, on the grasses having a fruitful growing season. Climate patterns shaped the growth and nutritional value of grasses and forbs, which affected bison ecology and the subsistence of the peoples who depended on bison.[9]

Early Euroamerican visitors to the Great Plains recognized that the region's climate was quite different from that of lands elsewhere in North America. In particular, Pierre-Antoine Tabeau, a French trader who traversed the Missouri during the first decade of the nineteenth century, noted that "rains are very rare" on the Plains. That was true, depending on the time of year. On the Great Plains, most of a year's precipitation falls during the spring, between April and June. The rest of the year is generally dry, with the least precipitation in November and December. In this dry subhumid to semiarid environment, only a few species were able to survive and dominate the landscape, such as grama and buffalo grasses. Those grasses, with their ability to alter their growth patterns in response to prevailing precipitation patterns, to become dormant and thereby minimize energy use and production, were the bedrock of ungulate subsistence. The quantity and quality of forage production was intimately linked to precipitation patterns, so changes in climate could and did affect the nutritional intake of the bison.[10]

Local precipitation and temperature patterns influenced the plant communities that covered the Plains. Species adapted to particular climate conditions tended to dominate various grassland "zones." On the northern Plains, two general subregions existed, the mesic (moist) grasslands that lay generally to the north of the xeric (dry) grasslands. Each zone was dominated by grass species that reached their productive peaks at different times of the year. Cool-season grasses in the northern reaches of the Plains began growing early in the spring but reached their nutritional peak late in the year. In contrast, the warm-season grasses to the south started growing later but reached their productive peak earlier than the cool-season grasses. Better adapted to drier conditions, the short grasses of the xeric regions fared better than their mesic counterparts during droughts by becoming dormant and thus conserving some of their energy.[11]

The fact that each grassland zone began growing at different times of the year and reached their respective nutritional peaks at different times influenced bison migration patterns, as well as herd sizes and their spatial distribution. Bison pursued the best available forage, so their migration patterns were closely related to the nutritional productivity of parts of the grasslands or the lack thereof. The productivity of a particular part of the grasslands determined the number of grazing animals that it could support; during drier times, bison out of necessity diffused into smaller groups; during wetter times, they could congregate in larger groups. Although, as we will see, climatic variations sometimes caused changes in bison migration patterns, their movement typically followed the changing of the seasons and therefore the relative productivity of the different grassland zones.[12]

During the spring months, the early growth of cool-season grasses led bison to diffuse in small groups throughout prairies dominated by these species. As summer arrived and, with it, warmer temperatures, short grasses deeper into the Plains, in the dry subregion, began growing again, pulling bison to areas rich in their favorite grasses, such as blue grama and buffalo grass. The high nutritional output of the short grasses on the heels of the wet months enabled bison to gather in large herds. Heavy grazing, accompanied by the rapid depletion of the warm-season grasses' nutritional value during the hot and dry late summer months, drew the bison back toward the cool-season grasslands during the fall. Here they diffused into smaller groups as the availability and nutritional quality of forage declined.

In the winter, with the Plains covered with snow, many bison herds turned to stream and river valleys. Riparian areas provided shelter against the elements, as well as forage such as cottonwood bark, twigs, and rosebuds. Other herds migrated to the parklands on the northern and western reaches of the Plains, where they fed on fescue grasses that retained their nutritional value into winter. Small scattered groups were the norm during winter, although sizable herds sometimes gathered in large areas that afforded them adequate food and shelter from the elements. With grasses offering minimal nutritional value during the winter months, many bison starved to death each year while remaining animals lost weight and nutritional value as their bodies utilized their fat reserves to stay alive.[13]

Northern Great Plains Native groups who relied on the bison adopted a distinct annual migration cycle that mirrored that of the buffalo. In the spring, hunters diffused into small groups along with the bison. The summer congregations of large bison herds, however, allowed Native groups to gather for communal hunts. When fall drew bison back toward the cool-season grasslands and splintered into smaller groups, Indians also dispersed and, when possible, procured stores of provisions for the approaching winter because the boom-and-bust nature of bison availability during the coming season encouraged such stockpiling.

The arrival of the harsh winter months on the northern Plains usually proved challenging for bison-hunting Natives, whether or not the fall hunts had been fruitful. Cold, snow, and resulting shortages of forage killed many of the Natives' horses each winter and left the others in a weakened state of health. This made travel and hunting difficult for Natives. Therefore, Natives who migrated with the bison established camps near typical buffalo wintering grounds and remained stationary for approximately five months, from November into April. Once in camp, they relied on nearby herds and, when game became scarce, turned to their supplies of meat procured during the fall, which they usually exhausted before winter's end. As winter wore on and bison became lean as they utilized their fat stores, hunters had to kill greater numbers of them to satisfy their dietary needs. Bison availability was a perpetual uncertainty during the cold months, as Hudson's Bay Company trader Matthew Cocking discovered when he visited Assiniboines and Blackfeet during the winter of 1772–73. Northern Great Plains Indians therefore eagerly awaited the arrival of spring, for warmer temperatures and rainfall promised the end of their hunger.[14]

This annual cycle developed during the course of the eighteenth century as northern Plains Native groups integrated equestrianism into their cultures and became increasingly reliant on the bison herds for their dietary needs. A few groups, such as the Crows, mostly abandoned semisedentary agricultural production in favor of migratory bison hunting. The growth of equestrianism was much less pronounced than it was on the southern Plains because of ecological limitations that hindered the survival and usefulness of horses north of the Platte River (especially above the Missouri). Nevertheless, northern Plains Natives applied increasing pressure to the bison population. Many Native bison hunters continued to utilize the "pound" method of bison hunting, but they added horses to the process to make it a more efficient system. So while horses were not absolutely essential for northern Plains hunters, they offered a considerable advantage for use in the chase. The combination of horse availability and bison subsistence also drew Natives to the northern Plains from elsewhere: the migrations of the western Sioux and the tribes of the Blackfoot Confederacy serve as excellent examples. This mounting pressure on the bison herds not only affected herd sizes and their composition but also their migration patterns. Moreover, the addition of horses (even in relatively modest numbers compared to the south) altered the complexion of the grasslands by introducing more grazing animals to the ecosystems. Finally, a growing reliance on the bison encouraged Natives to use fires to flush the animals into areas where the hunters could better harvest them. While this practice fostered new rich grass growth, it also allowed for less nutritious grass species to spread and take the place of grasses preferred by the bison. In short, the intrusion of human predators and competing grazers challenged the bison's access to reliable, abundant sources of forage.[15]

Despite the ecological changes that the eighteenth century brought to the grasslands, northern Plains bison hunters nevertheless depended on predictable annual bison migration cycles for their subsistence. Utilizing the bison as a primary source of food, however, meant that phenomena that affected the game could also affect their human hunters. In addition to the pressures introduced by their hunting patterns and horse grazing, the erratic nature of the northern Plains climate sometimes affected forage productivity, thereby also potentially influencing bison migration patterns and disrupting the hunting efforts of Indians who depended on the animal's predictability. When the rains failed, as they did on the northern Plains for at least nine years between 1752 and 1786, bison, which naturally pursued the most plentiful and nutritious forage, may have abandoned their typical seasonal grazing grounds in favor of areas less affected by dry conditions. However, when a winter season lasted particularly long or began particularly early, bison likely forsook the open Plains as they sought refuge from the elements. Likewise, an especially wet summer probably altered bison migration patterns by enabling the ungulates to feed on grasses that typically withered earlier in the season. Such developments compelled bison-hunting Natives to alter their own migration patterns or else face hunger.[16]

Droughts were the most significant form of climate variability on the northern Plains, for people at any rate. Droughts were erratic yet prevalent phenomena on the northern Plains. A well-known North Dakota tree-ring study from the 1940s (Table 1) highlights the variable nature of the northern Plains climate in the eighteenth century, as well as the frequency of dry years.

Short-grass prairies had evolved to respond to frequent droughts. During droughts, annual forbs and grasses decrease considerably, but perennial grasses persist by reducing aboveground growth, which helps maintain energy stores in root systems. These evolutionary strategies mean that the forage yield of a prairie—the amount of aboveground plant matter that could sustain grazers—decreases significantly during droughts. Nutrient quality of the forage may also decrease. When the quantity and quality of forage declines, so does the carrying capacity of the grasslands, which poses serious challenges for the grazing animals.[17]

Bison herds respond in a number of ways to drought: older individuals are more likely to die while the fertility of cows and survival of young decrease. Since droughts reduce the availability of annual plants, thereby making perennial plants more readily available, bison reproduction can suffer. Bison obtain necessary nutrients from

Table 1: Wet and dry years on the North Dakota Plains over an eighty-year span during the eighteenth century

Years	Precipitation
1707–20	Dry
1720–23	Wet
1723–28	Average
1728–35	Dry
1735–38	Wet
1738–40	Dry
1740–44	Wet
1744–52	Dry
1752–86	Variable

Source: Data from George F. Will, *Tree Ring Studies in North Dakota* (Fargo: North Dakota Agricultural College, 1946).
Note: While fluctuations between periods of consecutive wet or dry years were common between 1707 and 1752, the period of 1752–86 witnessed particularly variable precipitation, with ten wet years, nine dry years, and four average years.

both annuals and perennials, but the former fosters better reproduction. Herds shift their migration patterns during droughts as well, sometimes moving to areas with better forage quality and sometimes breaking into smaller groups to alleviate pressure on grazing areas. General deprivations of essential forage and nutrients, however, could weaken and even kill off some bison.[18]

On the northern Plains, as Table 1 demonstrates, several dry years often alternated with several years of above-average rainfall. By the late eighteenth century, many northern Plains tribes had enough familiarity with the climatic variability of the grasslands to be able to predict the bison's reaction to such periods of environmental stress. Consulting their most experienced and skilled hunters, they shifted their movements to track the bison. Nonetheless, dry spells probably generated significant nutritional stress for Natives, for they endured food scarcities while feeding on animals that were themselves nutritionally impoverished.[19]

Droughts also had a more indirect effect on the bison hunters. As some groups, such as the Crows and western Sioux, during the eighteenth century adopted equestrian bison hunting and moved away from agricultural production, they engaged in considerable trade with horticultural societies such as the Mandans and Arikaras to acquire their produce in exchange for meats and hides. When droughts struck and reduced crop production, the semisedentary villagers often had little surplus to trade, and the hunters suffered from an imbalanced diet. At the same time, climatic phenomena that made bison hard to come by influenced the hunters' trading power. When drought and other climatic events occurred, they highlighted the fragility of a system of mutual dependence; specialization rendered Native groups vulnerable to environmental changes.[20]

While drought had the most pronounced effects on grasslands, slighter changes in temperature and precipitation could also affect the nutritional value of the grasslands and their grazing capacity. Mild winters changed bison migration patterns because warmer temperatures and decreased snowfall made it unnecessary for buffalo to seek shelter and forage in the parklands. Ironically, these mild winters could cause even greater hardship for Plains Natives than a typical winter season: bison that remained on the high plains instead of moving down into riparian areas could remain out of the reach of the Indians, whose horses were less adapted than bison to survive and travel on the open plains in the cold. Relatively wetter conditions during a given season, year, or stretch of years influenced the productive patterns of the grasslands and could also alter the parts of the Plains in which bison concentrated.[21] Subtle and dramatic shifts in climate patterns affected the grasslands, the bison that grazed them, and the human societies that followed the herds. By entwining their survival more tightly with bison, northern Plains hunters increased their vulnerability to environmental shifts.

Climate Fluctuations and Food

While climate on the northern Plains is marked by variability, I argue that during the decade preceding the 1780–82 epidemic, climate conditions were particularly variable. This period of marked climate fluctuations, I contend, made conditions ripe for the spread of smallpox throughout the northern Great Plains and enabled such an outbreak to be especially catastrophic. To support this argument, I use what historical ecologists call "multiple lines of evidence."[22] Since one cannot "prove" through experimentation or historical documentation that climate fluctuations contributed to the virulence of the 1780–82 smallpox epidemic, I use several different types of evidence alongside one another to make inferences about causality as it relates to climate variability, bison migration and populations, Native malnutrition, and smallpox virulence. In particular, the following pages employ a blend of historical documentation and climatic reconstruction data to suggest connections between environmental and epidemiological events.

Climate data come from a variety of scales. Regional scale data are derived from climatological data based on global climate processes and regional tree ring–based Palmer Drought Severity Indices (PDSIs), highlighting conditions throughout the northern Plains. Local climate data come from archival sources and winter counts. Written accounts by fur traders on the Plains and parklands of modern-day Canada give local evidence for climate extremes, and

Lakota Sioux winter counts provide insight into the climatic situation on the far northern Plains of the modern-day United States (see figure 1).

The Little Ice Age and La Niña both influenced climate fluctuations on the northern Plains during the late eighteenth century. The Little Ice Age led to cooler temperatures across the globe from the fourteenth century through the mid-nineteenth. During this time, the northern Plains witnessed more variation in annual temperature and precipitation averages than during the periods before or after the Little Ice Age.[23]

La Niña events also influenced the northern Plains. A phenomenon known as La Niña teleconnections exists in which Pacific Ocean

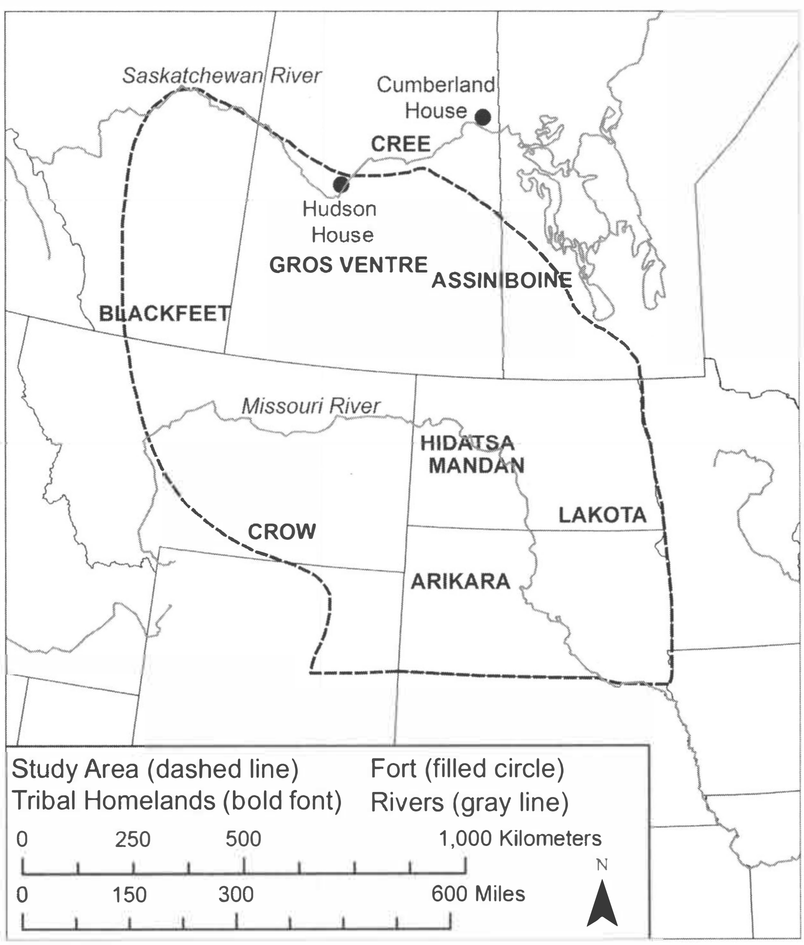

Figure 1. The northern Great Plains and approximate homelands of regional Native American tribes, 1780. Credit: Prepared by Christine Nycz, School of Natural Resources, University of Nebraska-Lincoln, 2011.

current activity produces climatic and weather anomalies in distant areas. Although the study of La Niña activity remains in its infancy compared to that of El Niño, there appear to be some links between La Niña events and northern Plains climate. During the first three months of a La Niña year, the region generally receives greater precipitation and colder temperatures than usual. The remainder of that year witnesses less precipitation than the annual regional average, and the summer months will be hotter than usual. Recent research shows that the incidence of La Niña events, which had been few during the 1760s, increased during the 1770s and 1780s. Most significantly, a protracted La Niña event lasting more than three years, with the potential to cause considerable climate and weather changes, occurred between 1778 and 1780.[24]

Tree-ring studies provide an important lens through which to examine the climate trends that defined the northern Great Plains of the late eighteenth century. Derived primarily from tree-ring studies, PDSI plots map precipitation patterns throughout much of North America in a given year showing if areas experienced above or below-average precipitation. In the following maps (see figures 2, 3 and 4), negative numbers on the plots refer to years with below-average precipitation (specific to a given area), with lower numbers signifying greater deficiencies. Positive figures indicate above-average precipitation, with higher numbers indicating greater surpluses. This study considers two separate PDSI plot studies. One presents reconstructions for the entirety of the North America; the other covers only the continental United States. However, this study relies much more heavily on the latter for a pair of reasons. First, the general North America PDSI plots are less detailed and therefore more difficult to assess with the same degree of accuracy as the US version. Second, the relative abundance of historical documents regarding the northern Plains of modern-day Canada compared to those of the modern-day United States necessitated that I devote special attention to the PDSIs for the latter. For these reasons, I have chosen to present the US-focused PDSI plots alongside my discussion of the northern Plains climatic phenomena of 1774–82.[25]

While individual studies based on tree-ring samples from the grasslands of Montana and North Dakota demonstrate that the years between 1752 and 1786 witnessed significant fluctuation in terms of annual precipitation, the more comprehensive PDSI plots provide more insight into the climatic situation on the northern Great Plains during the late 1770s and early 1780s.[26] In a nutshell, the PDSI plots offer both a broader geographic scope and indications of precipitation variations across space. PDSI evidence for the years 1774–82 also suggests that climate variations transpired on the northern Plains on a year-to-year basis. However, as the plots only offer a snapshot of how much precipitation particular areas received over the course of an entire year, historical documents produced by contemporary observers are used in conjunction with research on La Niña teleconnections patterns to reveal (as much as is possible) the temporal distribution of that precipitation within those years. In some cases, we are able to determine that a particular month was particularly rainy or dry. In most cases, though, we must be satisfied with general ideas of seasonal patterns; the historical record is simply too fragmented and too ambiguous to allow for much more.

Journals of the Cumberland House and Hudson House between 1774 and 1782 provide abundant evidence about local climate. The Cumberland House and Hudson House were two Hudson's Bay Company trading posts situated along the Saskatchewan River that straddled the northern Plains and parklands environments (see figure 1).[27] In my later analysis I focus on winter records in particular, comparing the journal accounts with the PDSI evidence to make inferences about general northern Plains climate patterns. Journal records of prevailing weather patterns devote the most attention to winter, likely because even mild winters proved troublesome. Toward the end of the study period, a few relevant winter count records appear, allowing us a slightly broader perspective.

Food shortage evidence comes from hunting records and descriptions of food shortages. Both posts relied on local Plains Indians to supply most of their provisions. When a food shortage arose at either post, it typically reflected the fact that nearby Indians had experienced difficulty finding game. These food shortages often paralleled the arrival of starved Indians at the trading posts seeking sustenance.

Winter 1774–75

The winter of 1774–75 was harsh enough to lead the master of Cumberland House to send men away from the post during the winter to be "supported by the Indians" and thereby alleviate pressure on the house to feed so many men. The shortage of provisions parallels PDSI evidence suggesting that 1774 was an approximately average year for precipitation and therefore likely a year that included typical booms and busts in bison availability. PDSI plotting suggests that much wetter conditions prevailed in 1775, apparently setting the stage for a more abundant year in terms of grasslands production and supplies of provisions, as figure 2 shows.[28]

Winter 1775–76

The winter of 1775–76 appeared from journal accounts to be typical by northern Plains standards. Although Matthew Cocking, the master of Cumberland House, reported that the expected snow and

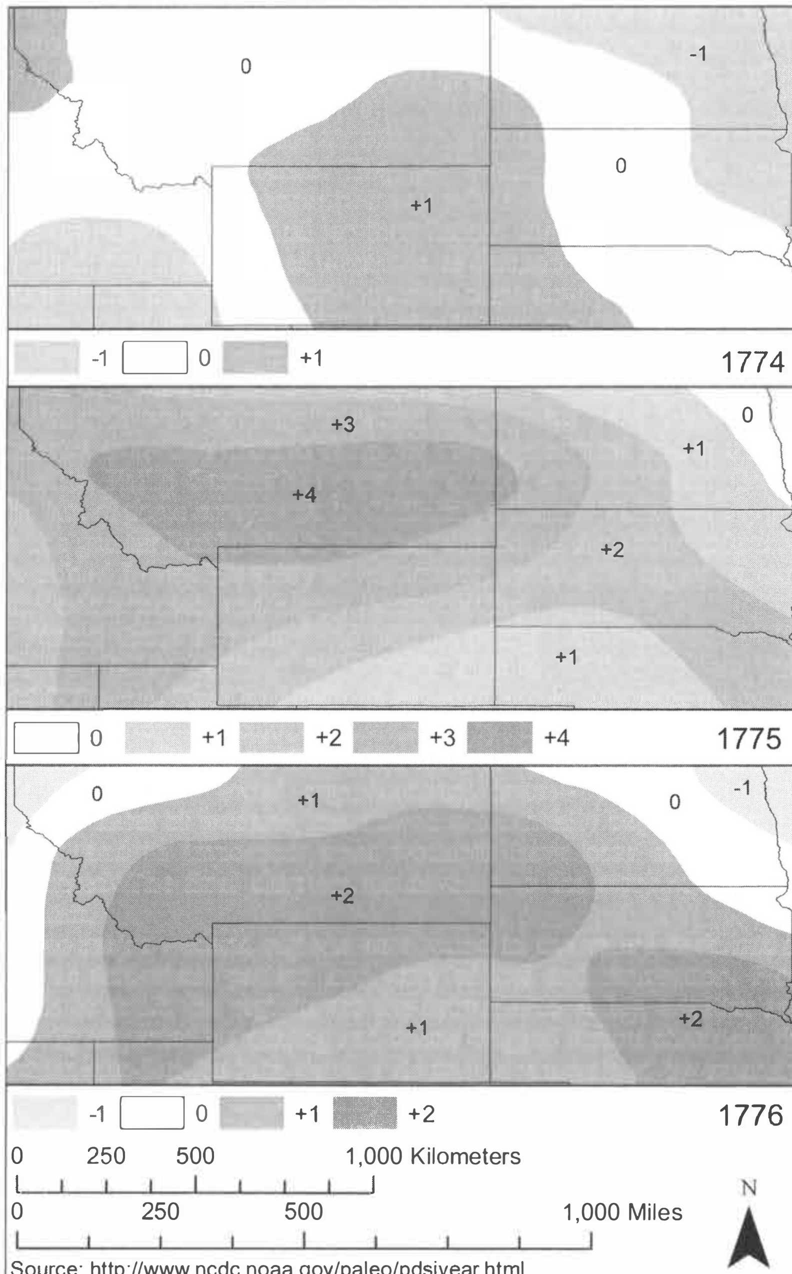

Figure 2: Palmer Drought Severity Index plots for 1774-1776. The succession of maps suggests that northern Plains precipitation was moderate in 1774, quite heavy in 1775, and then somewhere in between in 1776. This pattern parallels the reports of traders in the northern portion of the study area that supplies of provisions were problematic in 1774 and 1776, but not 1775. Credit: Prepared by Christine Nycz, School of Natural Resources, University of Nebraska-Lincoln, 2011.

cold descended on that post, he noted few instances of especially harsh weather and expressed few concerns about the post's food supply. Traders making journeys onto the Plains reported "an abundance of fresh Buffalo flesh." Yet the winter was noted for its cold and duration. With snow and cold persisting well into April, Indians and traders alike experienced a food shortage as game became scarce and travel remained difficult. Spring's eventual arrival alleviated the developing crisis. PDSI records for 1776 indicate that the year was drier than the previous one. Since a considerable portion of the year's precipitation fell during the long winter and the subsequent spring months, it is possible that the remainder of the year was quite dry.[29]

Winter 1776–77

Cocking received a few starved Indians at the post and worried about provisions, twice reducing his men's allowances that winter and sending a handful of them to live among the Natives. His concerns compelled him to consider the establishment of a post farther inland to gain greater access to bison herds. As the season progressed, though, the traders received more food from their Indian contacts than they anticipated, and the prospect of general starvation subsided. The initial food shortages parallel the PDSI evidence suggesting that 1776 was a drier year than 1775 (see figure 2). It was, however, still a year of approximately average rainfall, even if slightly below average on the far northern (Canadian) Plains. Although not an exceptionally dry year by Plains standards, that most of the rain fell during the first half of the year possibly produced the previously mentioned concerns about food supplies.[30]

Winter 1777–78

The winter of 1977–78 closely resembled that of 1775–76. Cumberland House's new master, Joseph Hansom, reported that the winter was typical for the region and that food supplies never became scarce. In August 1777, Hansom lamented that he had few provisions, for his "Prime Hunters" found little success and he would have to rely "intirely on a few Buffalo Indians who used to come down in the fall." He also remarked that an unusual amount of rain caused nearby bodies of water to rise considerably and obstruct any fishing activities. While dryness was often the most obvious cause of game shortages, extreme wetness also altered the productivity of the grasslands and could have affected game migration patterns, leading to the shortages noted by Hansom. PDSI evidence indicates that 1777 was slightly wetter than 1776, corroborating these journal accounts. Moreover, PDSI plots and the onset of a La Niña event in 1778 suggest that the ensuing spring and summer months were much wetter than those of the previous several years on the Plains and perhaps in the parklands as well (see figure 3). Indeed, as had been the case in 1776, Hansom notes that winter weather conditions persisted at Cumberland House well into the spring of 1778, causing another shortage of provisions and slowing travel and transportation into May.[31]

To the south, western Sioux bands reportedly experienced a difficult winter. The Battiste Good (Sicangu Sioux band) winter count denotes the winter of 1777–78 the "Spent-the-winter-in-no-particular-place-winter." Although the cause of those Sioux not remaining in a winter encampment is not stated, it could have been because of food shortages, an exceptionally mild winter, or enemy pressure. The American Horse (Oglala) count for the same winter reports that a man froze to death during a particularly cold winter, so it is possible that food supplies were short as well.[32]

Winter of 1778–79

Continued La Niña activity apparently produced particularly cold weather on the Plains and parklands. The winter of 1778–79 was easily the hardest one to hit the grasslands and parklands in several years, at least since before 1774–75. Concluding an exceptionally wet year (see figure 3), this winter was extremely cold, although snowfall appeared average. The Cumberland House journal, now maintained by William Tomison, reveals that the traders experienced an acute shortage of game that winter, as Saskatchewan country Natives brought, at most, small quantities of moose to trade. Previously determining that the troublesome weather and chronic food shortages that plagued most of 1778 would continue into the winter, Tomison had sent Robert Longmoor and a company of men to establish a post farther inland and closer to the Plains, where they would benefit from living on the boundary between bison- and moose-rich lands and not have to rely on Cree and Assiniboine hunters for meat. Longmoor's journal indicates that cold and snowy weather conditions around this new post, Hudson House, mirrored those at Cumberland House, approximately 350 miles downriver (see figure 1). Although the traders were unable to locate bison that winter, small amounts of meat that local Natives brought in proved sufficient. On one occasion, the arrival of two tents of Assiniboine Indians with some dried meat enabled Longmoor to provide his men with provisions for the first time in nearly a month. Nevertheless, it appears that neighboring Natives had a hard time finding food that winter, for starved Indians arrived at the post on at least two occasions. By late April 1779, however, spring brought the traders such a bounty of provisions that they struggled to transport it all to Cumberland House. The troubles experienced during the winter of 1778–79 at both posts are likely

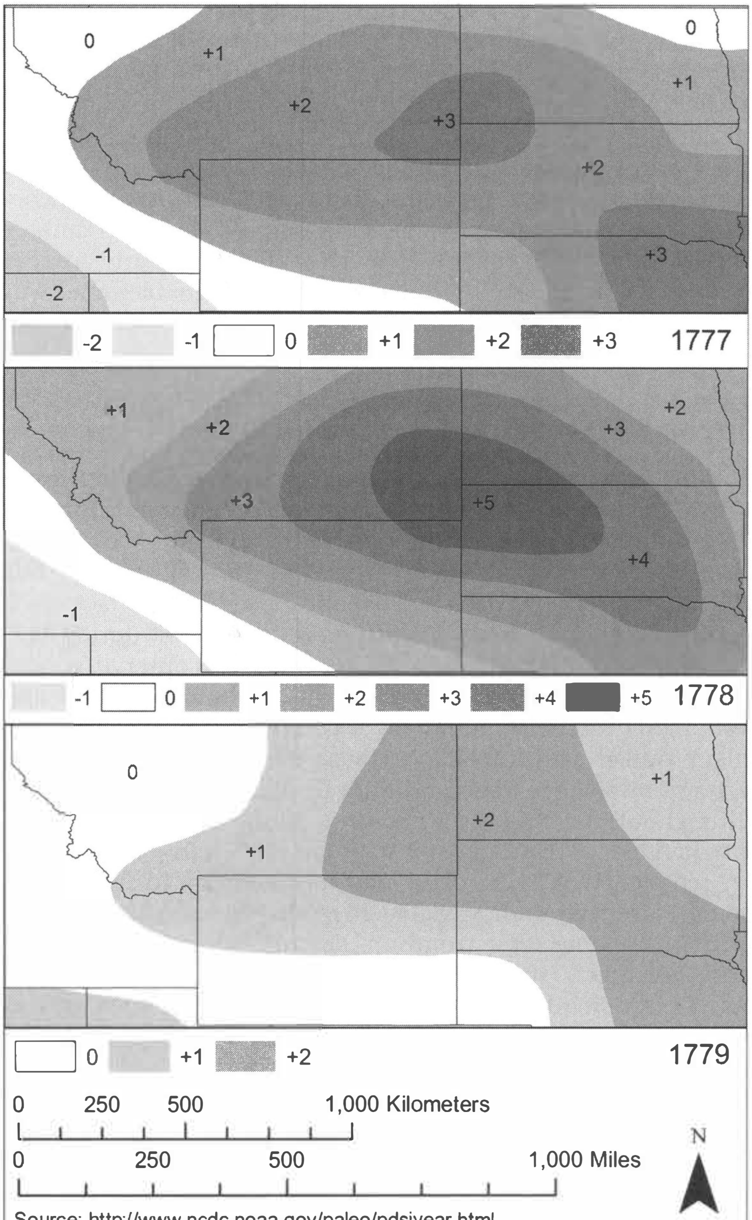

Figure 3: PDSI plots for 1777-1779. Precipitation in 1777 was comparable to that of 1776 (see figure 2), but it generally increased in 1778 (the first year of a La Niña event) before declining significantly in 1779, although rainfall remained above the regional average. These climate fluctuations, apparently associated with the concurrent La Niña event, paralleled three years of food supply concerns. Credit: Prepared by Christine Nycz, School of Natural Resources, University of Nebraska-Lincoln, 2011.

related to the combination of considerably wet climate conditions throughout the year, indicated by both the post records and the PDSI plots, as well as the exceptional cold noted by the traders.[33]

To the south, another Sioux winter count reported that at least one band did not winter in a single camp. Rather, the White Bull (Minneconjou) count indicates that some Sioux spent the winter in several different camps. Again, the cause of the relocation is unknown, but food shortages are one possibility. The John K. Bear (Yanktonai) count for 1778–79 explicitly refers to famine. Clearly at least a couple of western Sioux groups endured a troublesome winter. Others may have been similarly affected, but even more significant events may have overshadowed them.[34]

Winter 1779–80

PDSI plots suggest that 1779, a second consecutive La Niña year, was not nearly as wet as 1778, yet variable and problematic climate patterns continued to prevail on the northern Plains (see figure 3). Hudson House received many provisions throughout the fall of 1779, but that supply declined by mid-December. In fact, Indians brought so many furs and so much meat to the post during the fall that William Tomison curbed his business to conserve goods for winter trade. By December, though, his wisdom began to appear flawed as trade activity plummeted, compelling Tomison to inform William Walker at Cumberland House that "Provisions here is but scarce and by all appearances will not be plenty this Year."[35]

Throughout the following months, Tomison's hunters returned empty-handed to Hudson House from the Plains, reporting that "they see plenty of Buffalo but could not get nigh to shoot at them it being barren ground." One such report came in the midst of a stretch of weather that Tomison described as "clear mild" and "warm Weather," suggesting that temperate climate conditions enabled bison herds to remain on the open grasslands and away from the parklands, where, given the season, they should have been. Unsurprisingly, then, several starved Indians arrived at Hudson House during the following month, revealing that some local peoples suffered from want that winter.[36]

Up the Saskatchewan, Cumberland House experienced similar fall and winter trends. A hot and dry summer caused the post's master, William Tomison (who had not yet left for Hudson House at this point), some concern about food supplies, but fall brought an influx of provisions and left his successor, William Walker, in better shape to face the approaching winter. By January 1780, however, Walker informed Tomison that he had seen few Indians since winter began and that game was scarce. Natives arriving at the post brought some provisions, but they were few. An examination of the journal's daily notations on weather activity that winter demonstrate that weather fluctuations also occurred in the Cumberland House area. However, they proved too brief to cause serious subsistence problems because a blend of small supplies of fish, fowl, and game sufficed to carry the traders through the winter.[37]

As with the previous two winters, Sioux bands endured a difficult winter in 1779–80. The No Ears cycle (Oglala), for instance, notes that that band spent the year moving from camp to camp. Few such references during the several years before the Battiste Good report (1777–78) suggest that climate fluctuations may have had something to do with the series of difficult winter seasons reported between 1777 and 1780.[38]

PDSI plotting indicates that the continuation of the La Niña event that started in 1778 (which made the erratic nature of the northern Plains climate even more inconsistent) into its third and final year also brought unusually heavy rain to the northern Plains during the spring and summer of 1780 (see figure 4).[39] Although no apparent immediate shortages of provisions accompanied this development, continued climate variability portended a winter crisis.

Winter 1780–81

Throughout the fall of 1780, which saw relatively little rain and many fluctuations between cold and warm weather, Cumberland House hunters and Indian suppliers continued to procure provisions. When this mild weather persisted into the winter months, it incited general starvation, likely because the relatively temperate conditions made it unnecessary for bison herds to seek their usual shelter of the parklands. Until mid-January 1781, Tomison noted much warm weather and reported that many starving Natives from the south and west arrived at Cumberland House in pursuit of food, some of whom had already eaten their dogs in desperation. Although cold and snowy winter weather descended on the region soon thereafter and Indians, often from the north, brought more provisions to the post, Tomison nevertheless lamented to Robert Longmoor at Hudson House on February 4 that, "As to provisions, I never see a greater scarcity amongst the Natives, then what has been this year." Despite the upturn in provisions that accompanied the arrival of more typical winter weather, starving Indians continued to visit the post from all directions.[40]

Different weather patterns transpired at Hudson House during the winter of 1780–81 because the season appeared consistently harsh, but a nutritional crisis nevertheless also arose there. An uncharacteristically rainy fall witnessed Indians bringing sufficient supplies of dried and fresh meat to Hudson House, but fortunes changed with the weather. Enduring often "sharp" or extremely cold temperatures

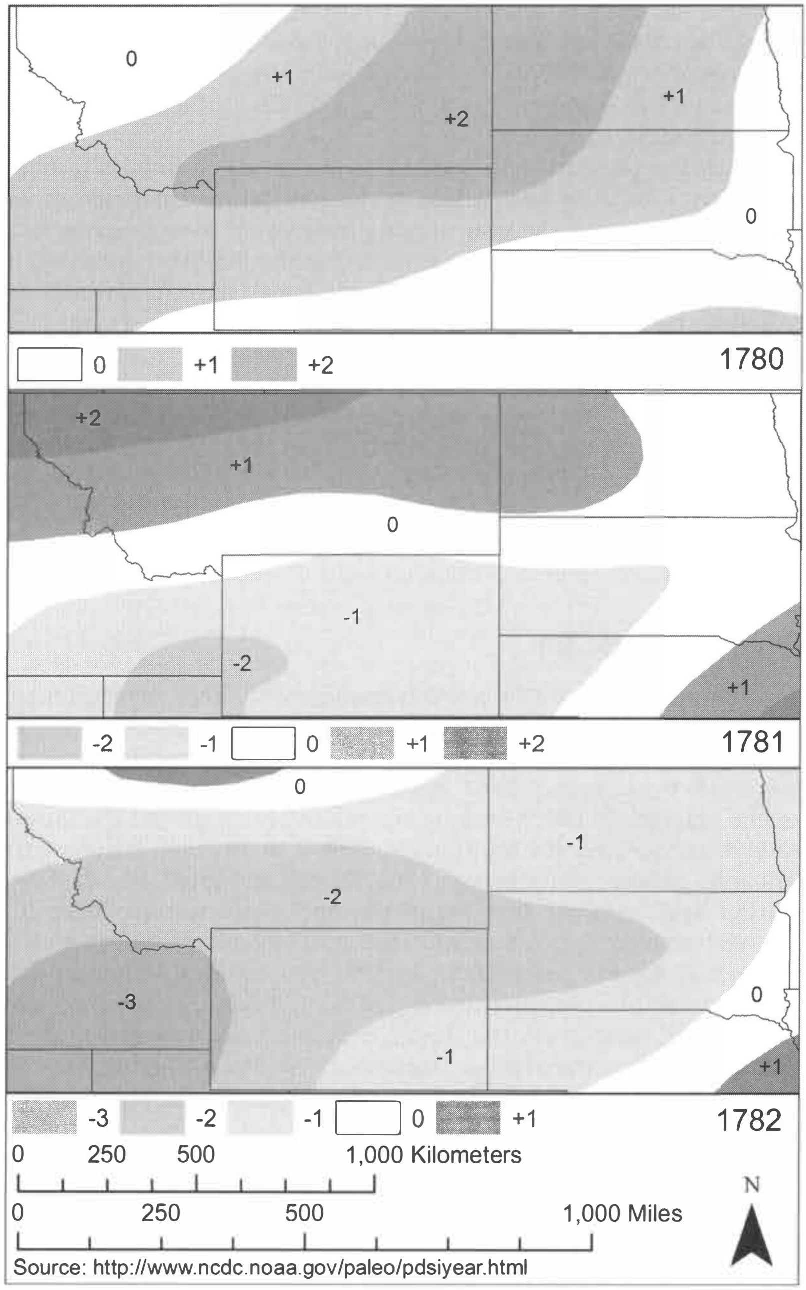

Figure 4: PDSI plots for 1780-1782. The final La Niña year, 1780, witnessed above-average precipitation, with the following two years bringing increasingly dry weather. This transition from uncharacteristically wet and variable weather to relatively dry conditions occurred alongside the 1780-1782 smallpox epidemic, during which observers in the northern part of the study area reported chronic food shortages. Credit: Prepared by Christine Nycz, School of Natural Resources, University of Nebraska-Lincoln, 2011.

between mid-November 1780 and mid-March 1781, as well as "thick" snow, Longmoor's traders and neighboring Natives, many of whom arrived at the post in search of food, simply starved.

Coming on the heels of the previous winter, which included much relatively warm and mild weather, the much colder and snowier winter of 1780–81 proved difficult for northern Plains and parklands inhabitants in the neighborhood of Hudson House. Moose and deer comprised the small quantities of flesh that the men at Hudson House consumed because bison essentially disappeared from the region, possibly drawn to areas of the Plains enduring less extreme weather (perhaps, as seen earlier, the Plains south of Cumberland House). Indeed, Longmoor's reports of Natives burning the grasses of the Plains late that fall suggest that perhaps the aberrant climate conditions of the previous months enabled bison to remain on the Plains longer than their human hunters desired. So while more "typical" winter weather (if a bit harsh) prevailed near Hudson House during the winter of 1780–81, repeated reports of bison absence indicate that the firing of the grasslands flushed bison away from that area, from the Plains and adjacent parklands alike. Bison were simply not present where they should have been during that season. Consequently, local Indians, like those who visited Cumberland House at this time, also found it necessary to feed on their dogs. As late as May 1, Longmoor wrote to Tomison that "I am but very short of provisions," with those few supplies mostly consisting of deer meat and very little bison.[41]

Smallpox

As food shortages intensified on the northern Plains in late 1780, smallpox gradually approached the far northern reaches of the grasslands. The epidemic on the northern Plains began when Shoshones, who participated in the horse trade of the Southwest, contracted the disease and transmitted it to the Crows while conducting commerce. It appears that the Crows then passed it on to the semisedentary villagers of the upper Missouri. From there, it spread to the western Sioux and other bison-hunting groups by late 1780.[42]

It should not be surprising, then, that many winter counts for the years 1780–82—namely those of Battiste Good, High Hawk (Sicangu), American Horse, Cloud Shield (Oglala), White Bull, and No Ears—do not mention weather patterns or hunger. Rather, they define those years by the great smallpox epidemic that struck. So while the smallpox outbreak was undoubtedly the paramount event during that time, it is possible, even likely, that underlying climate variations and nutritional crises transpired and are now lost to history. PDSI evidence and the course of events farther north on the Plains suggests that this might very well have been the case. Moreover, several winter count records, as we have seen, suggest that at least a few western Sioux groups experienced difficult winters during the years leading up to 1780; continued climate fluctuations and hunger were entirely possible.[43]

To the north, climate fluctuations accompanied by food shortages marked the several years preceding the 1780–82 smallpox epidemic on the northern Plains. Although the end of the 1778–80 La Niña event should have brought the return of drier climate conditions and less extreme temperature variations, climatic inconsistency and food scarcity continued to trouble the inhabitants of the northern Plains (see figure 4). At Cumberland House, William Tomison noted that an exceptionally cold and dry early spring in 1781 paralleled a lack of success on the hunt. When rain and warmer weather arrived during the late spring and early summer, though, food supplies at Cumberland House stabilized.[44] Tomison and his stand-in, George Hudson, noted that the entire summer of 1781 was marked by hot, rainy, and often stormy weather. These troublesome conditions apparently had an effect on game migration patterns. Both traders lamented that both Plains and parklands Natives had few provisions to trade. As fall approached, though, the situation improved as Indians, including some from the "Barren Ground," began procuring greater quantities of provisions. Weather conditions, as well as the state of affairs, again took a turn for the worse, though, as Tomison commented in early October that "the badness of the weather prevents the Indians from getting away to their Winter quarters."[45]

On December 11, 1781, the first news of smallpox reached Cumberland House. The report arrived via a group of infected Indians "from the southward," probably Assiniboines, the first of many whose pursuit of food would lead them to the post that winter. Although accounts of the smallpox epidemic dominated the journal's subsequent entries, an underlying story of weather variations and game scarcity also emerges. On the same day that the first smallpox-stricken Natives arrived at the post, another group, perhaps Crees or one of the parklands groups such as the Basquiau, visited from the "Westward." While these Indians exhibited no symptoms of smallpox infection, they did complain of hunger. Similar instances of starving Indian groups untouched by the epidemic appear frequently throughout the journal for the rest of the winter. This is especially remarkable because, in theory, the epidemic alleviated some of the hunting pressure on the bison herds, but the ongoing climate fluctuations ensured that buffalo population remained stressed and little able to grow. With Natives and Tomison's hunters returning from the Plains and parklands empty-handed because bison were not present where expected, the traders at Cumberland House endured a hard winter. From December 1781 through February 1782, Tomison reported little snow falling, with more than a few spells of "warm" weather interspersed throughout those months. Such conditions may have enabled bison to remain on the Plains while encouraging other game to deviate from their usual winter behavior. The arrival of colder and snowy winter weather in late February coincided with an upturn in the post's food supply. Paralleling the documentary evidence, the PDSI plot for 1782 indicates that year was drier than the previous one on the northern Plains (not to mention every year since 1775). It is conceivable that this relative dryness played a role in the mild conditions that prevailed in the neighborhood of Cumberland House (see figure 4).[46]

Up the Saskatchewan, William Walker at Hudson House produced a chronicle during the fall and winter of 1781–82 that paralleled Tomison's. The arrival of a smallpox-stricken Indian man from the "Barren Ground" on October 22, 1781, was the first of a wave of infected Natives to reach the post that year. The infected Indian informed Walker that "one of their [seven] Tents they was oblidged to leave standing in the Barren Ground with Seven Indians laying dead in the Inside that died of the Small Pox." As for the Native man, Walker admitted that, "he him self is taken so bad that I believe he will never recover." At about the same time, Walker reduced his men's rations and began sending groups of traders onto the Plains to "maintain" themselves, but they usually returned to Hudson House before too long in a starving condition, as did most of Walker's hunting parties.

While an influx of infected Natives from the Plains and parklands plagued the post throughout that winter, so did starved Indians who had no knowledge of the smallpox epidemic. The disease outbreak and concurrent food shortage transpired during what was, by all appearances, a harsh winter preceded by a fall marked by fluctuations between dry, moderate weather and cold, snowy conditions. For the most part, the winter of 1781–82 was bitterly cold, snowy, and windy at Hudson House. While milder weather to the east, near Cumberland House, may have permitted the bison to forage on the Plains that winter, conditions 350 miles to the west probably compelled bison to seek shelter in the parklands. This might explain why Walker's men, who reported that the Plains were again burned that year, failed to find any bison on the grasslands. Indians, of course, knew that during a typical winter buffalo would be found in the Parklands anyway, yet even healthy Natives found little success on the hunt that winter; bison sightings in the woods were few and far between. Faced with difficult weather in which to travel and few bison nearby, Indians around Hudson House, even those untouched by smallpox, starved during the winter of 1781–82.[47]

Despite testimony that recurring food shortages troubled the Saskatchewan region before smallpox struck, Walker had difficulty believing that game was truly scarce. As he wrote in January 1782, "[The Indians] say that there is no Beasts about, but that is false, for I know when Us Englishmen can murder a Chance One, If they was to hunt with dexterity, they might keep themselves and Us too, they fancy themselves ailing and so have no Heart to hunt any thing."[48] By dismissing the current food shortage as a product of Indian lethargy, Walker failed to consider the fact that previous incidences of game scarcity occurred despite the absence of smallpox.

Smallpox victims clearly suffered severe physical and psychological trauma that made it difficult for them to hunt, but the inability of healthy Indians and traders alike to find game indicates that the shortage was real. Trader Mitchell Oman's testimony to David Thompson corroborates this conclusion, for he reported that when the company established Hudson House in 1778, "animals of every kind were in abundance."[49] But during the winter of 1781–82, as one of the traders sent away from Hudson House to survive the season in the field, Oman found that not only were the bison "vagrant," but also "the Moose and other Deer [that] are supposed to keep within a range of ground, which they do not willingly leave, but all were much lessened in number." Visiting the same area a few years later, however, he "found the Bisons far more numerous." When Thompson later traversed the region, in 1786 and 1787, in the midst of another La Niña event, he saw few bison.[50] Unpredictable game migration patterns and hardships of human subsistence were correlated with climate fluctuations on the historic northern Great Plains, before and during the 1780–82 smallpox epidemic.

Starvation and Smallpox

How might hunger and starvation have influenced the smallpox epidemic of 1780–82? Researchers recognize that many infectious diseases, smallpox among them, differentially affect individuals suffering from nutritional stress. Both malnutrition (deficiencies of essential vitamins and minerals) and undernutrition (the general deprivation of food) influence the incidence, severity, duration, and outcome of infectious disease outbreaks.[51]

On the northern Plains, starvation likely promoted the spread of the smallpox pathogen (its specific causal agent, in this case the virus *Variola major*[52]) by increasing interaction between different Native groups that were usually separated during the winter months. Traders' observations suggested that starved individuals searched more widely for food than under normal cold conditions when they traditionally maintained a stationary winter camp. Thus Indians lacking acquired immunity (which the vast majority of northern Plains Natives did in 1780–82) unknowingly increased the odds that they would come into contact with smallpox. Individuals who already carried the disease but were not yet symptomatic could transmit it to individuals in other groups. Indeed, such searches for provisions in the midst of a food shortage might explain why explorer Alexander Mackenzie remarked that during the 1780–82 epidemic, "The fatal infection spread around with such a baneful rapidity."[53]

Physiologically, starvation compromises an individual's immune system, depressing resistance to infection. As the epidemiologist Peter Lunn writes, "An association between malnutrition and depressed host resistance to infection has been recognized for centuries. Only in recent times, however, has it become clear that tissues associated with the immune system, such as the thymus gland and lymphoid tissues, are more susceptible to nutritional deficits than other organs of the body." Especially problematic for the immune system was protein-energy malnourishment, a form of nutritional stress that members of northern Plains hunting societies probably endured when bison were scarce, especially in the winter months when their numbers were few and the animals were lean. In other words, the little food that northern Plains Indians consumed before and during the epidemic was not only insufficient in terms of quantity but also in terms of nutritional quality, and Natives likely suffered from both malnourishment and undernourishment. With their resistance reduced by the effects of famine, individuals were more susceptible to contracting foreign pathogens, including that which caused smallpox.[54]

In addition to promoting the spread of the smallpox virus and increasing its morbidity rate, the physiological effects of famine also increased the mortality rates of those who contracted the disease. With an individual deprived of nutrients needed to combat the painful and exhausting course of smallpox infection, the disease's effects on the human body intensified and his or her chances of survival diminished. Epidemiologists have found that mortality rates among undernourished and malnourished individuals who contracted smallpox were greater than those of hosts who were otherwise healthy.[55]

This relationship between smallpox and starvation might explain Alexander Mackenzie's observation that the 1780–82 epidemic had "a fatal effect that nothing could resist," as it "destroyed with its pestilential breath whole families and tribes."[56] On many occasions, Tomison and William Walker received reports of the disease wiping out entire Native camps. As Walker wrote on December 2, 1781, a party of his men returned from the Plains, informing him of "the Indians all dying in the Barren Ground, and the Tents all standing, the Bodies inside unburied, and hardly a live Indian to be seen."[57] Such high rates of mortality compelled Tomison to remark that, "there is something very malignant, that we ar[e] not sensible of, either in the Constitution of the Natives, or in the Disorder."[58] That "something very malignant" may have been the combination of a lack of acquired immunity compounded by hunger's erosion of the immune system.

Ultimately, the Native groups located in the Plains-parkland region of present-day Canada, the region whose erratic climate conditions the Cumberland House and Hudson House records vividly captured, suffered population losses of at least 50 percent during this epidemic. Yet even if a malnourished or undernourished smallpox victim survived, a number of complications remained possible, the most common being blindness, which explorer Alexander Henry (the Younger) observed when he met "a young [Blackfoot] man who had become perfectly blind from smallpox."[59]

Although Lunn argues that smallpox had only a "slight" biological association with an individual's nutritional status (but nevertheless one meriting consideration), at the population level, the historical record reveals many incidences of food shortages and famines followed by smallpox epidemics. Donald R. Hopkins's global history of smallpox, for instance, highlights many epidemics throughout Africa, Asia, and Europe that occurred in the wake of nutritional crises. In Angola, Jill R. Dias finds that drought-induced famines and smallpox epidemics developed an "alternating rhythm" as early as the seventeenth century. Other studies have uncovered similar trends elsewhere, in Great Britain, the Philippines, and Southeast Asia, for instance. The same holds true for North America.[60]

Why might epidemiologists find little correlation between an individual's nutrition and smallpox while population-level studies seem to suggest a correlation? The answer may lie in the cultural effects of mass hunger and epidemics, rather than in the individual physiological effects of nutritional status. By killing off so many members of Native groups and undermining what historian Elizabeth A. Fenn calls "traditions of mutual support," smallpox made it difficult for Indians to procure sufficient food, especially when game was already scarce. As healthy but fearful individuals abandoned their afflicted kinsmen and others who remained with the infected also became ill, those who might have recovered from the disease perished because they simply did not have the strength to sustain themselves. Smallpox epidemics not only eroded individual resistance to disease, but they exacerbated matters by also compromising the strength of entire communities.[61] When Walker and Tomison noted that smallpox-stricken Indians arrived at their posts during the winter of 1781–82, they usually observed that the Natives were starving, "[s]ome of them in a fair way to recover, only are in want of nourishment for to keep them alive."[62] Nevertheless, the traders soon became accustomed to almost daily burials of the Indian dead, a task that surviving kin were physically unable to carry out. When traders visited the Plains, they found camps where incapacitated Crees or Assiniboines could do little more than leave their dead kinsmen in their tents and relocate a short distance away.

The relationship between starvation and smallpox was synergistic, for while food shortages contributed to the virulence of the epidemic, the disease's impact on individuals and communities fostered further nutritional stress. Consequently, those who survived the epidemic began their struggle to recover by focusing entirely on hunting, which proved difficult as the game scarcity continued throughout the winter of 1781–82. As Saukamappee told David Thompson, "To hunt for our families was our sole occupation," but "the Bisons and Red Deer were also gone, we did not see half of what was before, whither they had gone we could not tell."[63] Hunger heralded the onset of the 1780–82 smallpox epidemic and remained problematic in its aftermath.

Conclusion

Remarking on the parallel decline of bison and Native American populations in the late nineteenth century, Walter Prescott Webb observed, "The buffalo and the Plains Indians lived together, and together passed away." As the case of the 1780–82 smallpox epidemic demonstrates, this statement suggests an unsettling correlation. During the eighteenth century, when many Plains societies adopted horses and abandoned agriculture in favor of following the bison herds, they became dependent on the bison for their survival. Long before the nineteenth-century near extinction of the bison, the fluctuating nature of the northern Plains climate revealed the vulnerability inherent in this ecological interdependence.[64] Both major and subtle changes in climate patterns reverberated throughout the historic northern Great Plains environment, sometimes causing tremendous hardship for its human inhabitants when their mobility proved unable to respond to bison migrations.

The northern Plains smallpox epidemic of 1780–82 left the region's Native population "reeling." The epidemic's toll among the migratory bison-hunting Native groups was surprisingly high. Troubled by several years of climate fluctuations that affected the composition of the grasslands and apparently influenced the bison's annual patterns of migration, northern Plains hunting societies endured chronic food shortages between 1778 and 1782. These episodes of hunger may have rendered them more susceptible to contacting *Variola* and perishing from the resulting smallpox infection. The death toll rose rapidly as starved Indians transmitted the pathogen to their neighbors while they pursued provisions and nutritionally stressed Natives had little strength to combat the effects of smallpox.[65]

By examining the intricate relationship between climate, the grasslands, bison, Natives, and smallpox, this study suggests how environmental factors influenced the course of infectious disease epidemics. I am not arguing that environmental stress in the form of climate fluctuations caused the 1780–82 smallpox epidemic on the northern Plains. The outbreak was contingent on multiple factors. The arrival of the disease's pathogen in the region was critical. So too were the existing networks of human contact (particularly trade and warfare) necessary to diffuse the pathogen. Because smallpox was a disease that had no animal vector and spread primarily from one human to another, either directly or by means of their contaminated material goods, patterns of human interaction ultimately coincided with environmental developments to make conditions on the northern Great Plains ripe for a major smallpox epidemic.

Ultimately, this study contributes to our understanding of the complex relationship between climate and human history. A number of recent works have highlighted the incidence of major climate variations (particularly decadal and multidecadal droughts) paralleling considerable upheaval among Native cultures in North America, as well as societies elsewhere. In many cases, climate variability compromised the subsistence bases of Native societies and likely caused population losses or relocation to another area. Among the past developments with which scholars associate climate variability were starvation and disease, as well as warfare and other factors.[66] This project suggests that more subtle climate variations (less obviously destructive ones) also strained societies and worked synergistically with hunger, disease, and other pressures to produce social turmoil and depopulation.

This essay adds to the growing body of literature on the role of biological forces in European colonialism and their collective impact on Native societies. Alfred W. Crosby's work began the process by which the "virgin soil" theory became exposed as an oversimplified and inaccurate description of why Old World infectious diseases caused massive Native American depopulation. Native societal responses to foreign disease outbreaks, he suggested, were part of the reason why so many Natives died. David S. Jones has argued that historians must confront the troubling truth that Euro-American colonial processes—not biology—were to blame for the introduction and spread of Old World pathogens. Rather than focusing on whether Natives lacked acquired immunity, he writes, scholars should examine the disease environments produced by Euro-American colonialism and ask how those led to Indian depopulation. Paul Kelton shows how specific conditions produced by British colonial endeavors, namely the Native slave trade, provided Old World diseases with the necessary means of becoming epidemic among geographically dispersed Indian groups in the colonial Southeast.[67]

This study highlights the complexity of the 1780–82 northern Great Plains smallpox epidemic. That epidemic was more than a classic "virgin soil" case among populations lacking acquired immunity. Nor was it simply a by-product of processes associated with European colonialism. Rather, the epidemic was a catastrophe in which the workings of the natural environment, particularly climatic variations, played an important role. Humans alone do not shape the course of history.

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Notes

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1 George Catlin, *North American Indians*, ed. Peter Matthiessen (New York: Penguin, 1989), 96. For the death toll of the 1780–82 smallpox epidemic on the northern Plains, see Elizabeth A. Fenn, *Pox Americana: The Great Smallpox Epidemic of 1775–82* (New York: Hill and Wang, 2001), 270–74; Colin C. Calloway, *One Vast Winter Count: The Native American West before Lewis and Clark* (Lincoln: University of Nebraska Press, 2003), 419–23; Loretta Fowler, "The Great Plains from the Arrival of the Horse to 1885," in *The Cambridge History of the Native Peoples of the Americas*, Vol. I, Part II: *North America*, ed. Bruce G. Trigger and Wilcomb E. Washburn (Cambridge: Cambridge University Press, 1996), 20–21; Jody F. Decker, "Depopulation of the Northern Plains Natives," *Social Science & Medicine* 33 no. 4 (1991): 381–93. Theodore Binnema writes that the epidemic killed as much as two thirds of the northwestern Plains Indian population. Theodore Binnema, *Common and Contested Ground: A Human and Environmental History of the Northwest Plains* (Norman: University of Oklahoma Press, 2001), 122.

2 For the role of trade and warfare in spreading smallpox, see Calloway, *One Vast Winter Count*, 418–23; Anthony McGinnis, *Counting Coup and Cutting Horses: Intertribal Warfare on the Northern Plains, 1738–1889* (Evergreen: Cordillera Press, 1990), chapter 1; Fenn, *Pox Americana*, 194–5, 199, 223; Binnema, *Common and Contested Ground*, 120; R. G. Robertson, *Rotting Face: Smallpox and the American Indian* (Caldwell: Caxton, 2001), xi, 52, 125–26, 180, 239, 310–11. For disease among the semisedentary villagers, see Henry F. Dobyns, "Native American Trade Centers as Contagious Disease Foci," in *Disease and Demography in the Americas*, ed. John W. Verano and Douglas H. Ubelaker (Washington, DC: Smithsonian Institution Press, 1992), 215–22; Donald J. Lehmer, "The Other Side of the Fur Trade," in *The Selected Writings of Donald J. Lehmer*, ed. W. Raymond Wood (Lincoln: J&L Reprint Co., 1977), 91–104; Donald J. Lehmer, "Epidemics Among the Indians of the Upper Missouri," in *The Selected Writings of Donald J. Lehmer*, ed. W. Raymond Wood (Lincoln: J&L Reprint Co., 1977), 105–11. For a discussion of acquired immunity, see Sheldon Watts, *Disease and Medicine in World History* (New York and London: Routledge, 2003), 92–93. For a treatment of the causes of great mortality among Native

American populations to European-introduced infectious disease, see Watts, *Disease and Medicine*, 93–98.

3 David Thompson, *David Thompson's Narrative, 1784–1812*, ed. Richard Glover (Toronto: The Champlain Society, 1962), 237–38, 246–47.

4 Andrew C. Isenberg, *The Destruction of the Bison: An Environmental History, 1750–1920* (New York: Cambridge University Press, 2000), 62. Also see Fenn, *Pox Americana*, 187–89; Binnema, *Common and Contested Ground*, 127; Robertson, *Rotting Face*, 127.

5 While discussing the game shortage that Saukamappee "perceived," historian Elizabeth A. Fenn concedes that "it is possible that unusual weather, ecological upheaval, or an unknown pathogen was responsible for the [bison] decline" noted by Saukamappee, other Natives, and traders.[0] Fenn, *Pox Americana*, 189.

6 Linea Sundstrom, "Smallpox Used Them Up: References to Epidemic Disease in Northern Plains Winter Counts, 1714–1920," *Ethnohistory* 44 (1997), 305–43: 317. Although Sundstrom stresses that epidemics did not always follow famines, she points out that disease outbreaks were much more likely to follow periods of food shortage than times of abundance. See Sundstrom, "Smallpox," 320. For studies that highlight the relationship between climate, famine, and infectious disease epidemics throughout the world, see Donald R. Hopkins, *The Greatest Killer: Smallpox in History* (Chicago and London: University of Chicago Press, 1983, 2002); Jill R. Dias, "Famine and Disease in the History of Angola, c. 1830–1930," *The Journal of African History* 22 (1981): 349–78; Samuel K. Cohn, "The Black Death: End of a Paradigm," *The American Historical Review* 107 (June 2002): 703–38; Brian Fagan, *Floods, Famines and Emperors: El Niño and the Fate of Civilizations* (New York: Basic Books, 1999); Brian Fagan, *The Little Ice Age: How Climate Made History, 1300–1850* (New York: Basic Books, 2000); Marshall T. Newman, "Ecology and Nutritional Stress in Man," *American Anthropologist* 64 (February 1962): 22–34. For climate and the 1837–38 smallpox epidemic, see Michael K. Trimble, "The 1837–1838 Smallpox Epidemic on the Upper Missouri," in *Skeletal Biology in the Great Plains: Migration, Warfare, Health, and Subsistence*, ed. Douglas W. Owsley and Richard L. Jantz (Washington, DC: Smithsonian Institution Press, 1994), 81–89, 86 (quotation); Michael K. Trimble, *An Ethnohistorical Interpretation of the Spread of Smallpox in the Northern Plains Utilizing Concepts of Disease Ecology* (Lincoln: J&L Reprint Co., 1979, 1986), 3–4, 11, 19–20, 47–49; Michael K. Trimble, "Epidemiology on the Northern Plains: A Cultural Perspective" (PhD diss., University of Missouri–Columbia, 1985, 5–7, 89); Clyde D. Dollar, "The High Plains Smallpox Epidemic of 1837–38," *The Western Historical Quarterly* 8 (January 1977), 15–38; 28–29; Robertson, *RottingFace*, 1–8, 61, 64, 67, 76–77, 86–88, 146, 167–70. The 1837–38 northern Plains smallpox epidemic has received considerably more scholarly attention than its predecessor, the 1780–82 epidemic. Although it lies outside the bounds of this study to explain why, it is worthwhile to point out that northern Plains Indian population losses (in percentages) during the two epidemics were comparable. See the studies cited earlier for more information. Jody F. Decker suggests that seasonal factors and weather conditions might have influenced the spread of smallpox in 1780–82 but does not delve into the topic. Jody F. Decker, "Tracing Historical Diffusion Patterns: The Case of the 1780–1782 Smallpox Epidemic among the Indians of Western Canada," *Native Studies Review* 4 (1988), 1–24: 10.

7 This study generally uses the term *weather* in reference to localized phenomena and *climate* to describe collective weather patterns, for, say, a region. It uses localized historical records referring to weather conditions in conjunction with more wide-scale scientific findings to generate an idea of northern Plains climate conditions in the late eighteenth century. For a discussion of the distinction between these terms, see Mike Hulme, "Geographical Work at the Boundaries of Climate Change," *Transactions of the Institute of British Geographers* 33 (2008): 5–11: 7–8.

8 Readers will note that this study refrains from using the term *famine* to describe the nutritional crises that transpired on the northern Great Plains during the late 1770s and early 1780s. As Robert Dirks observes, famine is a severe condition of general starvation among populations that in itself leads to widespread mortality. In recent years, the term *famine* has been too loosely used, often applied to relatively minor cases of food scarcity (in terms of both intensity and duration), such as seasonal shortages. While it is clear that northern Plains Natives suffered from on-and-off general starvation (sometimes relating to seasonal shortages and more unexpected periods of game scarcity) on the eve of and during 1780–82, there is not sufficient evidence to argue that they were mired in famine. For a discussion of famine and general starvation, see Robert Dirks, "Famine and Disease," in *The Cambridge World History of Human Disease*, ed. Kenneth F. Kiple (Cambridge: Cambridge University Press, 1993), 157, 162–63.

9 Walter Prescott Webb, *The Great Plains* (Boston: Ginn, 1931), 32. Also see Bamforth, "Bison Ecology," 4.

10 Pierre-Antoine Tabeau, *Tabeau's Narrative of Loisel's Expedition to the Upper Missouri*, ed. Annie Heloise Abel (Norman: University of Oklahoma Press, 1939, 1968), 151. For precipitation, see Isenberg, *Destruction of the Bison*, 16–17; Robert T. Coupland, "The Effects of Fluctuations in Weather upon the Grasslands of the Great Plains," *The Botanical Review* (May 1958): 274–317: 278, 283; Lauren Brown, *Grasslands* (New York: Knopf, 1985), 56; Webb, *Great Plains*, 6, 19; A. H. Laycock, "Drought Patterns in the Canadian Prairies," in *Weather and Climate*, ed. J.G. Nelson et al. (Toronto: Methuen, 1970), 137–51; Friedrich Kraenzel, *The Great Plains in Transition* (Norman: University of Oklahoma Press, 1955), 16.

11 For grassland zones, see Douglas B. Bamforth, "Historical Documents and Bison Ecology on the Great Plains," *Plains Anthropologist* (February 1987): 1–16: 4 (quotation); Webb, *Great Plains*, 6, 17; Kraenzel, *Great Plains in Transition*, 33–34; Isenberg, *Destruction of the Bison*, 19–20; Binnema, *Common and Contested Ground*, 21–24; Douglas B. Bamforth, *Ecology and Human Organization on the Great Plains* (New York: Plenum Press, 1988), 38–39.

12 For grasslands production and bison migration in general, see Bamforth, "Bison Ecology," 3–4; Bamforth, *Ecology*, 84; Brown, *Grasslands*, 50.

13 For grasslands production and bison migration from spring through fall, see Isenberg, *Destruction of the Bison*, 23; Binnema, *Common and Contested* Ground, 21, 24, 27, 31–34, 40–45; Kraenzel, *Great Plains*, 14; Bamforth, *Ecology*, 38–39; Brown, *Grasslands*, 56; Robertson, *Rotting Face*, 25, 233–234; Bamforth, "Historical Documents," 3; Boyd, "Reconstructing a Prairie-Woodland Mosaic," 249; Roe, *North American Bison*, 571–72. For grasslands production and bison migration during the winter, see Tabeau, *Tabeau's Narrative*, 71; Binnema, *Common and Contested Ground*, 21, 24–31,47–49; Bamforth, "Bison Ecology," 3–6; Robertson, *Rotting Face*, 158; Kraenzel, *Great Plains*, 15; Roe, *North American*

Buffalo, 197–98, 561, 571–72; Isenberg, *Destruction of the Bison*, 23, 43–44; Webb, *Great Plains*, 19.

14 For Native migration, from spring through fall, see Binnema, *Common and Contested* Ground, 40–41; Robertson, *Rotting Face*, 209, 233–34. For the boom-and-bust nature of bison availability, see Tom McHugh, *The Time of the Buffalo* (Lincoln: University of Nebraska Press, 1972), 75. Natives also used fires in the fall as a means of clearing away dead grass and providing spring growth with a jump start. The higher nutritional productivity of burned areas kept bison in those areas during the spring until they grazed them out. For Native use of grassfires on the northern Great Plains, see Binnema, *Common and Contested Ground*, 32–34, 45, 47; Brown, *Grasslands*, 50; M. Boyd et al., "Reconstructing a Prairie-Woodland Mosaic on the Northern Great Plains: Risk, Resilience, and Resource Management," *Plains Anthropologist* 51 (August 2006): 235–52: 249; Robertson, *Rotting Face*, 25. For Native organization during the winter, see Isenberg, *Destruction of the Bison*, 43–44; Scott Hamilton and B. A. Nicholson, "Aboriginal Seasonal Subsistence and Land Use on the Northeastern Plains: Insight from Ethnohistoric Sources," *Plains Anthropologist* 51 (August 2006), 253–80: 263–65, 275; Frank Roe, *North American Buffalo: A Critical Study of the Species in its Wild State* (Toronto: University of Toronto Press), 367–69; Binnema, *Common and Contested Ground*, 49–51. For a detailed description of the annual bison and Native migration cycle, see Binnema, *Common and Contested Ground*, 37–54. Also see D. W. Moodie and A. J. Ray, "Buffalo Migrations in the Canadian Plains," *Plains Anthropologist* 21 (1976), 45–52: 50; Roe, *North American Buffalo*, 571–72; Kraenzel, *Great Plains in Transition*, 14; Webb, *Great Plains*, 19; Bamforth, *Ecology*, 38–39; Bamforth, "Historical Documents," 3; Isenberg, *Destruction of the Bison*, 23; Brown, *Grasslands*, 47–48, 50, 56; Scott Hamilton et al., "Extrapolating to a More Ancient Past: Ethnohistoric Images of Northeastern Plains Vegetation and Bison Ecology," *Plains Anthropologist* 51 (August 2006), 281–302, 300; Boyd, "Reconstructing a Prairie-Woodland Mosaic," 249; Robertson, *Rotting Face*, 25, 209, 233–34. For the northern Plains winter, see Binnema, *Common and Contested Ground*, 47–54; Matthew Cocking, "An Adventurer from Hudson Bay: Journal of Matthew Cocking, from York Factory to the Blackfeet Country, 1772–3," in *Proceedings and Transactions of the Royal Society of Canada*, Series 3, Vol. 2, ed. Lawrence J. Burpee, 89–121 (Ottawa: The Royal Society of Canada, 1908), 103–17; Matthew Cocking, "Cumberland House Journal, 1775–1776," in *Cumberland House Journals and Inland Journals, 1775–82*, vol. 1, ed. E. E. Rich (London: The Hudson's Bay Record Society, 1952), 39; Alexander Henry, *Alexander Henry's Travels and Adventures in the Years 1760–1776*, ed. Milo Milton Quaife (Chicago: Lakeside Press, 1921), 257–63, 268–71, 275–87, 300; Dan Flores, "The Great Contraction: Bison and Indians in Northern Plains Environmental History," in *Legacy: New Perspectives on the Battle of the Little Bighorn*, ed. Charles E. Rankin (Helena: Montana Historical Society Press, 1996), 3–22; Bamforth, "Historical Documents," 3; Hamilton, "Extrapolating," 294; Kraenzel, *Great Plains*, 15; Webb, *Great Plains*, 19; Roe, *North American Buffalo*, 572–73, 576. For wintertime northern Plains Native nutrition, see Bamforth, *Ecology*, 7–8; Binnema, *Common and Contested Ground*, 49–51; Sundstrom, "Smallpox," 317, 320; Newman, "Ecology," 22–23; Isenberg, *Destruction of the Bison*, 12. The freezing and thawing of major northern Plains waterways, such as the Missouri River, killed thousands of bison each year as they drowned while trying to cross thin ice or were swept away by strong currents in the spring. Sometimes Indians' hunger was so acute and live bison so scarce that they waded into

rivers to retrieve rotting, bloated carcasses for food. See Robertson, *Rotting Face*, 2. For the northern Plains spring, see Binnema, *Common and Contested Ground*, 40, 52.

15 "Pounding" was a means of hunting by which hunters constructed an enclosure (or utilized an existing one) into which they drove groups of bison and afterward slaughtered them. For the evolution of equestrian Plains societies and their relationship with the grasslands, see Pekka Hämäläinen, "The Rise and Fall of Plains Indian Horse Cultures," *The Journal of American History* 90 (December 2003), 833–62, 846–48; Paul H. Carlson, "Indian Agriculture, Changing Subsistence Patterns, and the Environment on the Southern Great Plains," *Agricultural History* 66 (Spring 1992), 52–60, 57–60; Isenberg, *Destruction of the Bison*, 39.

16 Fluctuations in wet and dry air moving eastward from the Rocky Mountains caused significant changes in northern Plains weather patterns, sometimes for brief periods, but in other cases for years at a time. For climate fluctuations and game responses, see Carlson, "Indian Agriculture," 59; Isenberg, *Destruction of the Bison*, 11, 12, 27; Coupland, "Effects of Fluctuations," 281–82; Bamforth, *Ecology*, 18–20, 34–36, 39, 52; Bamforth, "Historical Documents," 6, 13; Flores, "Great Contraction," 9–10, 18; Kraenzel, *Great Plains*, 12–13, 17–22; Brown, *Grasslands*, 47–48, 51; Wally Nicholaichuk, "Climate Variability and Change and Water Supply on the Canadian Prairies," in *Symposium on the Impacts of Climatic Change and Variability on the Great Plains*, ed. Geoffrey Wall (Waterloo, ON: University of Waterloo Department of Geography, 1991), 173–78; Hamilton, "Extrapolating," 288, 300.

17 For a discussion of the carrying capacity of the Great Plains and bison numbers, see Isenberg, *Destruction of the Bison*, 24–27; Coupland, "Effects of Fluctuations," 288. For drought and the grasslands, see Coupland, "Effects of Fluctuations," 283–84, 287–90; Robert T. Coupland, "Effects of Changes of Weather Conditions upon Grasslands in the Northern Plains," in *Grasslands*, ed. Howard B. Sprague (Washington, DC: American Association for the Advancement of Science, 1959), 291–306; Isenberg, *Destruction of the Bison*, 19–20; Kevin Sweeney, "Thirsting for War, Hungering for Peace: Drought, Bison Migrations, and Native Peoples on the Southern Plains, 1845–1859," *Journal of the West* 41 (Summer 2002): 71–78: 74.

18 For drought's impact on bison, see Sweeney, "Thirsting for War," 72–74; Binnema, *Common and Contested Ground*, 42; Isenberg, *Destruction of the Bison*, 11, 17–20, 27–28; Dan Flores, "Bison Ecology and Bison Diplomacy: The Southern Plains from 1800 to 1850," *The Journal of American History* 78 (September 1991): 465–85: 482; Flores, "Great Contraction," 10; Bamforth, *Ecology*, vi, 52; Bamforth, "Historical Documents," 6; Hamilton, "Extrapolating," 296.

19 For drought's impact on Native bison hunters, see Isenberg, *Destruction of the Bison*, 17; Sweeney, "Thirsting for War," 72, 77; Bamforth, *Bison Ecology*, 52; Binnema, *Common and Contested Ground*, 37, 39.

20 For climatic instability and trade, see Tabeau, *Narrative*, 74–75, 151; Donald J. Lehmer, "Climate and Culture History in the Middle Missouri Valley," in *Selected Writings of Donald J. Lehmer*, ed. W. Raymond Wood (Lincoln: J&L Reprint Co., 1977), 59–71; John C. Ewers, *Indian Life on the Upper Missouri* (Norman: University of Oklahoma Press, 1968), 20–22; Roy W. Meyer, *The Village Indians of the Upper Missouri: The Mandans, Hidatsas, and Arikaras* (Lincoln: University of Nebraska Press, 1977), 15, 39; Isenberg, *Destruction of the Bison*, 47.

21 For the impact of subtle climate shifts, see Bamforth, *Ecology*, 34–36; Moodie and Ray, "Buffalo," 45–46, 49; Binnema, *Common and Contested Ground*, 47; Roe, *North American Buffalo*, 571–72.

22 See, for example, M. Kat Anderson, "The Contribution of Ethnobiology to the Reconstruction and Restoration of Historic Ecosystems," in *The Historical Ecology Handbook: A Restorationist's Guide to Reference Ecosystems*, ed. Dave Egan and Evelyn A. Howell (Washington, DC: Island Press, 2001), 55–72; Raina K. Plowright et al., "Causal Inference in Disease Ecology: Investigating Ecological Drivers of Disease Emergence," *Frontiers in Ecology and the Environment* 6 (October 2008): 420–29.

23 For the Little Ice Age, see Peter B. deMenocal, "Cultural Responses to Climate Change during the Late Holocene," *Science*, New Series, 292 (April 27, 2001): 667–73, 668; Reid A. Bryson and Thomas J. Murray, *Climates of Hunger: Mankind and the World's Changing Weather* (Madison: University of Wisconsin Press, 1977), 71–88; Bamforth, *Ecology*, 68–72; Fagan, *Little Ice Age*.

24 For El Niño and La Niña teleconnections, see Michael H. Glantz, *Currents of Change: Impacts of El Niño and La Niña on Climate and Society*, 2nd ed. (Cambridge: Cambridge University Press, 2001), 73–74, 133; Amir Shabbar et al., "Canadian Precipitation Patterns Associated with the Southern Oscillation," *Journal of Climate* 10 (December 1997): 3016–27; Fagan, *Floods*, 39–54; "U.S. La Niña Impacts," NASA: Earth Observatory, http://earthobservatory.nasa.gov/Features/LaNina/la_nina_2.php (accessed September 29, 2009); "La Niña," National Oceanic and Atmospheric Administration, http://www.publicaffairs.noaa.gov/lanina.html (accessed September 29, 2009). For the 1778–80 La Niña event, see Joelle J. Gergis and Anthony M. Fowler, "A History of ENSO Events since A.D. 1525: Implications for Future Climate Change," *Climatic Change* 92 (2009): 44, 57. After only three La Niña events occurred during the 1760s, five followed during the 1770s, and seven in the 1780s.

25 The following plots (figures 2, 3 and 4, for the years 1774–1782) are adapted from Edward Cook at al., "Reconstruction of Past Drought across the Coterminous United States from a Network of Climatically Sensitive Tree-Ring Data," NOAA Paleoclimatology Program, http://www.ncdc.noaa.gov/paleo/pdsiyear.html (accessed September 8, 2009). For the less refined (more ambiguous in terms of plotting), but more comprehensive mapping system that reconstructs annual precipitation patterns throughout most of North America (including the far northern Plains and parklands regions, see Paul J. Krusik and Edward R. Cook, "North American Drought Atlas: A History of Meteorological Drought Reconstructed from 835 Tree-Ring Chronologies for the past 2005 years," Lamont-Doherty Earth Observatory and the National Science Foundation, http://iridl.ldeo.columbia.edu/SOURCES/.LDEO/.TRL/.NADA2004/.pdsi-atlas.html (accessed January 26, 2011). To date, few historical studies have used PDSI plots as part of their research base. A strong example, though, is Sweeney, "Thirsting for War."

26 For tree-ring studies, see Kraenzel, *Great Plains*, 17–22; Geo. F. Will, *Tree Ring Studies in North Dakota* (Fargo: North Dakota Agricultural College, 1946), 20–21.

27 The chronicles of Hudson House are particularly valuable to this study, for that post's location farther south and west from Cumberland House placed it on the fringes of the grasslands while the latter establishment was deeper in the parklands. Whereas the diet of the traders living at Cumberland House consisted primarily of fish, deer, fowl, and moose, as well as an occasional bison, that of the

men inhabiting Hudson House was much more oriented toward a balance between bison and moose flesh. Therefore, the records of Hudson House are more relevant to this analysis, but the fact that traders did not establish the post until 1778 necessitates a reliance on Cumberland House records for a look at previous years.

28 Cocking, "Cumberland House Journal, 1775-1776," 14; Krusik and Cook, "North American Drought Atlas," 1774-1775.

29 Cocking, "Cumberland House Journal, 1775-1776," 36 (quotation), 21-44; Krusik and Cook, "North American Drought Atlas," 1775-1775.

30 Matthew Cocking, "Cumberland House Journal, 1776-1777," in *Cumberland House Journals and Inland Journals, 1775-82*, vol. 1, ed. E. E. Rich (London: The Hudson's Bay Record Society, 1952), 100-36; Krusik and Cook, "North American Drought Atlas," 1775-76.

31 Joseph Hansom to Humphrey Martin, 17 August 1778," in *Cumberland House Journals and Inland Journals, 1775-82*, vol. 1, ed. E. E. Rich (London: The Hudson's Bay Record Society, 1952), 255 (quotation). For further comments on the rainy weather, see Joseph Hansom, "Cumberland House Journal, 1777-1778," in *Cumberland House Journals and Inland Journals, 1775-82*, vol. 1, ed. E. E. Rich (London: The Hudson's Bay Record Society, 1952), 249-51. For climate and provisions in 1777-78, see Joseph Hansom, "Cumberland House Journal, 1777-1778," in *Cumberland House Journals and Inland Journals, 1775-82*, vol. 1, ed. E. E. Rich (London: The Hudson's Bay Record Society, 1952), 197-223, 232-37; Krusik and Cook, "North American Drought Atlas," 1776-1778.

32 Winter counts were annual pictographs produced by some Native American groups to record their history. Typically, the most notable event that transpired during the course of a given year is chosen to represent that year in the winter count record. Each western Sioux band kept its own winter count (as identified in the text). It should be noted that specific years for individual winter counts may be off by one year— ambiguities in the records sometimes make it unclear if a particular pictograph refers to, for example, 1778-79 or 1779-80. I base my dating in this text on the works of Ronald T. McCoy and Garrick Mallery. Ronald T. McCoy, "Winter Count: The Teton Chronicles to 1799" (PhD diss., Northern Arizona University, 1983), 207-8. Garrick Mallery, *Picture-Writing of the American Indians*, vol. 1 (New York: Dover, 1893, 1972), 307.

33 In the spring, Tomison wrote to the master of the newly established Hudson House, Robert Longmoor, that the only reason that his men did not starve during the winter was because they had great success fishing. William Tomison, "Cumberland House Journal, 1778-1779," in *Cumberland House Journals and Inland Journals, 1775-82*, vol. 1, ed. E. E. Rich (London: The Hudson's Bay Record Society, 1952), 264-93; William Tomison to Robert Longmoor, March 5, 1779, *Cumberland House Journals and Inland Journals, 1775-82*, vol. 1, ed. E. E. Rich (London: The Hudson's Bay Record Society, 1952), 285-86; Robert Longmoor, "Inland Journal," in *Cumberland House Journals and Inland Journals, 1775-82*, vol. 1, ed. E. E. Rich (London: The Hudson's Bay Record Society, 1952), 310-28, 331; Binnema, *Common and Contested Ground*, 118; Thompson, *Narrative*, 235.

34 McCoy, "Winter Count," 207, 218.

35 William Tomison to William Walker, December 12, 1779, in *Cumberland House Journals and Inland Journals, 1775–82*, vol. 2, ed. E. E. Rich (London: The Hudson's Bay Record Society, 1952), 27 (quotation); William Tomison, "Hudson House Journal, 1779–1780," in *Cumberland House Journals and Inland Journals, 1775–82*, vol. 2, ed. E. E. Rich (London: The Hudson's Bay Record Society, 1952), 67–96; Krusik and Cook, "North American Drought Atlas," 1779.

36 Tomison, "Hudson House Journal, 1779–1780," 84 (quotation), 80–90.

37 William Walker to William Tomison, January 4, 1780, in *Cumberland House Journals and Inland Journals, 1775–82*, vol. 2, ed. E. E. Rich (London: The Hudson's Bay Record Society, 1952), 87–88; William Walker, "Cumberland House Journal, 1779–1780," in *Cumberland House Journals and Inland Journals, 1775–82*, vol. 2, ed. E. E. Rich (London: The Hudson's Bay Record Society, 1952), 9–41.

38 McCoy, "Winter Count," 207.

39 Krusik and Cook, "North American Drought Atlas," 1780.

40 William Tomison to Robert Longmoor, February 4, 1781, in *Cumberland House Journals and Inland Journals, 1775–82*, vol. 2, ed. E. E. Rich (London: The Hudson's Bay Record Society, 1952), 136 (quotation); William Walker and William Tomison, "Cumberland House Journal, 1780–1781," in *Cumberland House Journals and Inland Journals, 1775–82*, vol. 2, ed. E. E. Rich (London: The Hudson's Bay Record Society, 1952), 105–14, 121–43.

41 Robert Longmoor to William Tomison May 1, 1781, in *Cumberland House Journals and Inland Journals, 1775–82*, vol. 2, ed. E. E. Rich (London: The Hudson's Bay Record Society, 1952), 149 (quotation); Robert Longmoor, "Hudson House Journal, 1780–1781," in *Cumberland House Journals and Inland Journals, 1775–82*, vol. 2, ed. E. E. Rich (London: The Hudson's Bay Record Society, 1952), 161–65, 166–85; Robert Longmoor to William Tomison, January 17, 1781, in *Cumberland House Journals and Inland Journals, 1775–82*, vol. 2, ed. E. E. Rich (London: The Hudson's Bay Record Society, 1952), 134–35. For Plains Natives' use of fire as an ecological tool, see McHugh, *Time of the Buffalo*, 69–71.

42 For more on smallpox's journey to the northern Plains and its diffusion throughout the grasslands, see Fenn, *Pox Americana*, 215–20; Adam R. Hodge, "Vectors of Colonialism: The Smallpox Epidemic of 1780–82 and Northern Great Plains Indian Life" (MA thesis, Kent State University, 2009, 72–85); Calloway, *One Vast Winter Count*, 418–22.

43 McCoy, "Winter Count" (PhD diss., Northern Arizona University, 1983, 217–18).

44 Nevertheless, as late as June a cold spell brought snow to the region. William Tomison, "Cumberland House Journal, 1780–1781," in *Cumberland House Journals and Inland Journals, 1775–82*, vol. 2, ed. E. E. Rich (London: The Hudson's Bay Record Society, 1952), 143–47, 148–54; Krusik and Cook, "North American Drought Atlas," 1781.

45 William Tomison and George Hudson, "Cumberland House Journal, 1781–1782," in *Cumberland House Journals and Inland Journals, 1775–82*, vol. 2, ed. E. E. Rich (London: The Hudson's Bay Record Society, 1952), 213 (quotation), 197–208; George Hudson to Humphrey Martin, 26 June 1781, in *Cumberland House Journals and Inland Journals, 1775–82*, vol. 2, ed. E. E. Rich (London: The Hudson's Bay Record Society, 1952), 200.

46 Tomison and Hudson, "Cumberland House Journal, 1781–1782," 223–24 (quotation), 217–250; Krusik and Cook, "North American Drought Atlas," 1782.

47 William Walker, "Hudson House Journal, 1781–1782," in *Cumberland House Journals and Inland Journals, 1775–82*, vol. 2, ed. E. E. Rich (London: The Hudson's Bay Record Society, 1952), 262 (quotations), 260–87; William Walker to William Tomison, December 4, 1781, in *Cumberland House Journals and Inland Journals, 1775–82*, vol. 2, ed. E. E. Rich (London: The Hudson's Bay Record Society, 1952), 226; Fenn, *Pox Americana*, 175–77.

48 Walker, "Hudson House Journal, 1781–1782," 275.

49 Thompson, *Narratives*, 234 (quotation), 236–37, 246.

50 Thompson, *Narrative*, 238 (quotations); Gergis and Fowler, "History of ENSO Events," 57.

51 Peter Lunn, "Nutrition, Infection, and Immunity," in *The Decline of Mortality in Europe*, ed. R. Schofield, D. Reher, and A. Bideau (Oxford: Oxford University Press, 1991), 131–45; Dirks, "Famine and Disease," 157–63. Fenn, *Pox Americana*, 15–18; F. Fenner et al., *Smallpox and its Eradication* (Geneva: World Health Organization, 1988); C. W. Dixon, *Smallpox* (Boston: Little, Brown, 1962).

52 Although other types of smallpox existed before the World Health Organization officially declared its global eradication in May 1980, the strain of virus that swept the northern Great Plains between 1780 and 1782 was the most deadly form, *Variola major*. For the sake of brevity, hereafter *Variola major* is simply referred to as *Variola*. Fenner et al., *Smallpox and Its Eradication*, 1134–40; Fenn, *Pox Americana*, 6, 20.

53 Alexander Mackenzie, *The Journals and Letters of Sir Alexander Mackenzie*, ed. W. Kaye Lamb (New York: Cambridge University Press, 1970), 74 (quotation); Fenner et al., *Smallpox and its Eradication*, 182; Fenn, *Pox Americana*, 22, 187, 202; Robertson, *Rotting Face*, 38–39. For discussions of population movements stimulating the spread of smallpox, see Hopkins, *Greatest Killer*, 86, 152; Dias, "Famine and Disease," 359.

54 Lunn, "Nutrition," 141 (quotation). For nutritional deficiencies and the immune system, see Lunn, "Nutrition," 141–45; Dirks, "Famine and Disease," 160–61; Newman, "Ecology," 26, 31–32; Calvin E. Martin, *Keepers of the Game: Indian-Animal Relations and the Fur Trade* (Berkeley: University of California Press, 1978), 104.

55 Lunn offers an excellent synthesis of this subject. Lunn, "Nutrition," 136. Also see Dirks, "Famine and Disease," 157.

56 Mackenzie, *Journals*, 74.

57 Walker, "Hudson House Journal," 1781–1782," 268 (quotation), 285; Walker to Tomison, December 4, 1781, 225; Tomison, "Cumberland House Journal, 1781–1782," 234.

58 Tomison, "Cumberland House Journal, 1781–1782," 234.

59 Alexander Henry and David Thompson, *New Light on the Early History of the Greater Northwest: The Manuscript Journals of Alexander Henry and David Thompson, 1799–1814*, vol. 2, ed. Elliot Coues (Minneapolis: Ross & Haines, 1897, 1965), 726 (quotation); Decker, "Depopulation," 382; Fenner, *Smallpox*, 164; Fenn, *Pox Americana*, 22, 187–88; Robertson, *Rotting Face*, 41.

60 Lunn, "Nutrition," 137 (quotation). For examples in Africa, see Hopkins, *Greatest Killer*, 169, 177, 184, 185, 192, 196–97; Dias, "Famine and Disease," 359, 378. For examples in Asia, see Hopkins, *Greatest Killer*, 112, 142, 143, 145, 148, 152, 158. For Europe (particularly Ireland), see Hopkins, *Greatest Killer*, 34, 86. For global examples, see S. R. Duncan, Susan Scott, and C. J. Duncan, "The Dynamics of Smallpox Epidemics in Britain, 1550–1800," *Demography* 30 (August 1993), 405–23; See Ken De Bevoise, "Until God Knows When: Smallpox in the Late-Colonial Philippines," *Pacific Historical Review* 59 (May 1990): 149–85; Tim Dyson, "On the Demography of South Asian Famines," *Population Studies* 45 (1991): 5–25. For examples in North America, see Paul Kelton, *Epidemics and Enslavement: Biological Catastrophe in the Native Southeast, 1492–1715* (Lincoln: University of Nebraska Press, 2007), 13–14, 16, 20, 23, 25, 27–29, 31, 156, 159; David J. Wishart, *An Unspeakable Sadness: The Dispossession of the Nebraska Indians* (Lincoln: University of Nebraska Press, 1997), 77, 93; Pekka Hämäläinen, *The Comanche Empire* (New Haven: Yale University Press, 2008), 302; For examples in the northern Great Plains, see Trimble, *Ethnohistorical Interpretation*; Trimble, "1837–1838 Smallpox Epidemic," 85–86; Trimble, "Epidemiology," 5–7, 89; Robertson, *Rotting Face*, 1–8, 61, 64, 67, 76–77, 86–88, 146, 167–70.

61 Fenn, *Pox Americana*, 186–87 (quotation); Crosby, "Virgin Soil Epidemics," 296–97.

62 Walker, "Hudson House Journal, 1781–1782," 277 (quotation), 263–65, 269, 274–75, 278; Robertson, *Rotting Face*, 99; Binnema, *Common and Contested Ground*, 122; Tomison, "Cumberland House Journal, 1781–82," 232, 233, 240.

63 Thompson, *Narrative*, 246–47 (quotation), 236; Tomison, "Cumberland House Journal, 1781–1782," 232–33, 239, Walker to Tomison, December 4, 1781, 226; Walker, "Hudson House Journal, 1781–1782," 285; Fenn, *Pox Americana*, 180; Binnema, *Common and Contested Ground*, 126. Dirks, "Famine and Disease," 160–61. Hunger, disease, and a variety of other disruptive forces associated with European colonialism in the New World in many cases combined to decrease the fertility and reproduction rates of Native groups and, therefore, their rate of population recovery in the wake of major epidemics; Massimo Livi Bacci, *Conquest: The Destruction of the American Indios*, trans. Carl Ipsen (Cambridge, UK and Malden, MA: Polity Press, 2008), 28, 39–40, 51.

64 Webb, *Great Plains*, 44 (quotation). For a discussion of the many factors that led to the bison's near-extinction, see Isenberg, *Destruction of the Bison*.

65 Binnema, *Common and Contested Ground*, 128 (quotation); Fenn, *Pox Americana*, 274.

66 deMenocal, "Cultural Responses"; Henry F. Diaz and David W. Stahle, "Climate and Cultural History in the Americas: An Overview," *Climatic Change* 83 (2007): 1–8; David W. Stahle, Falko K. Fye, Edward R. Cook, and R. Daniel Griffin, "Tree-Ring Reconstructed Megadroughts over North America since A.D. 1300," *Climatic Change* 83 (2007): 113–49; D. A. Hodell, M. Brenner, and J. H. Curtis, "Climate and Cultural History of the Northeastern Yucatan Peninsula, Guintana Roo, Mexico," *Climatic Change* 83 (2007): 215–40; Larry Benson, Kenneth Petersen, and John Stein, "Anasazi (Pre-Columbian Native-American) Migrations During the Middle-12th and Late 13th-Centuries— Were they Drought Induced?" *Climatic Change* 83 (2007): 187–213.

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David S. Jones, "Virgin Soils Revisited," *The William and Mary Quarterly* 60 (October 2003): 703–42; Kelton, *Epidemics and Enslavement*, xvii–xxii. Also see Alfred W. Crosby, *The Columbian Exchange: Biological and Cultural Consequences of 1492*, 2nd ed. Westport: Praeger, 1972, 2003); Alfred W. Crosby, *Ecological Imperialism: The Biological Expansion of Europe, 900–1900* (New York: Cambridge University Press, 1986).