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**MICROCLIMATE OF
AN ABORIGINAL WINTER CAMPSITE
AT WANUSKEWIN HERITAGE PARK, SASKATOON**

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Abstract. *The microclimate of an aboriginal winter campsite, set in an incised, south-facing meander of a small creek, is compared to the conditions on the adjacent open prairie at Wanuskewin Heritage Park, Saskatoon, Saskatchewan. Maximum and minimum temperatures and wind speeds were measured daily, on the prairie and in the valley, along with temperatures in a modern canvas tipi erected in the valley. Maximum temperatures tended to be about 1°C higher in the valley, and 2°C higher in the tipi, than on the prairie, while minima were 1-2°C lower. Wind speeds were reduced to about 50% in the valley. Windchill factors, derived from these data, were reduced between 200 and 250 W m², suggesting that the valley site afforded considerable benefit as a winter habitation site.*

The habitation record for central Saskatchewan extends back at least 12,000 years to the time when the Wisconsin ice sheets finally withdrew from the region (Christiansen 1979). The prehistoric occupants were nomadic hunters and gatherers, so evidence of habitation is sporadic. Over the past 2,000 years, it is presumed that these groups lived in skin tents large enough to hold 7-8 people. Local bands likely numbered 35-50 persons, housed in 5-8 tents, although at times the total number might increase to

several thousand depending on available resources and social activities. Early winter was an especially important time as local bands congregated in resource-rich areas for the bison hunt, dispersing again in the early spring (Arthur 1975).

In post-glacial times, vegetation has evolved in response to the changing climate. By about 10,000 B.P., prairie vegetation was well established in southern Saskatchewan (Ritchie 1976), and bison had become a prominent ecosystem component. Relatively hot, dry conditions between 7,500 and 4,500 B.P. reduced the bison herds, resulting in somewhat different subsistence and settlement patterns (Walker 1992). A return to cooler, moister conditions undoubtedly resulted in an increase in human population, although there were substantial fluctuations as climatic variations affected resource availability.

It is estimated that there are approximately 42 archaeological sites per hundred square kilometers in the parkland region of central Saskatchewan (Dyck 1983). Included in each of the several thousand site records on file is a summary of the site's connection with the surrounding environment, which, along with artifacts and dates, assist in the interpretation of the functional role of the site.

Late prehistoric period habitation sites are most commonly recognised by tipi rings, consisting of circles of stones laid round the conical tents to secure them to the ground, as a substitute for pegs. Occasionally a central group of stones marks the position of a hearth, which was used not only for cooking, but was also the principal source of heat during winter. In this rigorous environment, winter temperatures often drop below -30°C , and considerable benefit may be gained from a well-chosen campsite. This study looks at the microclimate of a winter campsite (FbNp-1) at Wanuskewin Heritage Park in terms of its advantages for human habitation.

Site Description

Wanuskewin Heritage Park occupies an area of about 60 hectares of uncultivated prairie approximately 5 kilometers north of Saskatoon. Physiographically, the Park consists of undulating, eroded till plains and gravelly, glacio-lacustrine deposits. The uplands are dissected by the South Saskatchewan River and a small tributary, Opimihaw Creek. Coulees eroded in the valley walls generally contain colluvial slope-wash with alluvial terraces and point bars located in the valley bottom. The meandering course of Opimihaw Creek has created a broad, south-facing area at the confluence

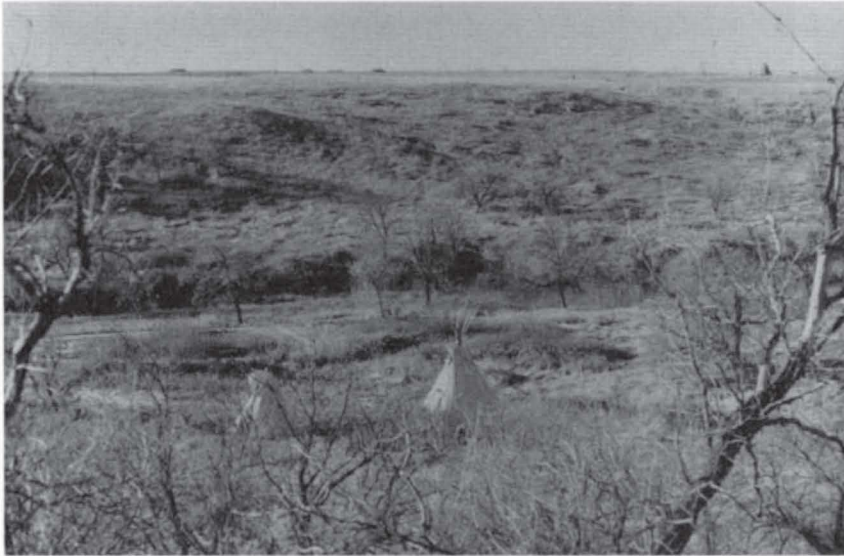


Figure 1. View from the prairie looking down on the valley site and tipi towards the west.

with the South Saskatchewan River. The floor of this amphitheatre-like feature is at an elevation of 480 meters above sea level, with the land rising steeply to the surrounding uplands some 15 meters higher (Figs. 1, 2 and 3). The upland sites are covered by mixed prairie vegetation dominated by grasses and sedges, while the river valley supports a woodland cover. Tree species present at the site include balsam poplar (*Populus balsamifera*), Manitoba maple (*Acer negundo*), river birch (*Betula occidentalis*), white birch (*Betula papyrifera*) and green ash (*Fraxinus pennsylvanica*), together with shrubs such as red-osier dogwood (*Cornus stolonifera*), willow (*Salix* spp.) and hazel (*Corylus cornuta*).

Archaeological findings within the Wanuskewin Heritage Park include numerous habitation and bison-kill sites, as well as a medicine wheel boulder alignment, indicative of intensive occupation over the past 5,000 years. Evidence for even earlier occupation of the region has been revealed by artifacts recovered from nearby sites. These materials extend the period of habitation in the general area back to about 8,000 years (Walker 1988).

FbNp-1 is a particularly important multi-component habitation site. The uppermost level is clearly historic signified by the presence of trade beads and metal fragments, including projectile points, and glass fragments.

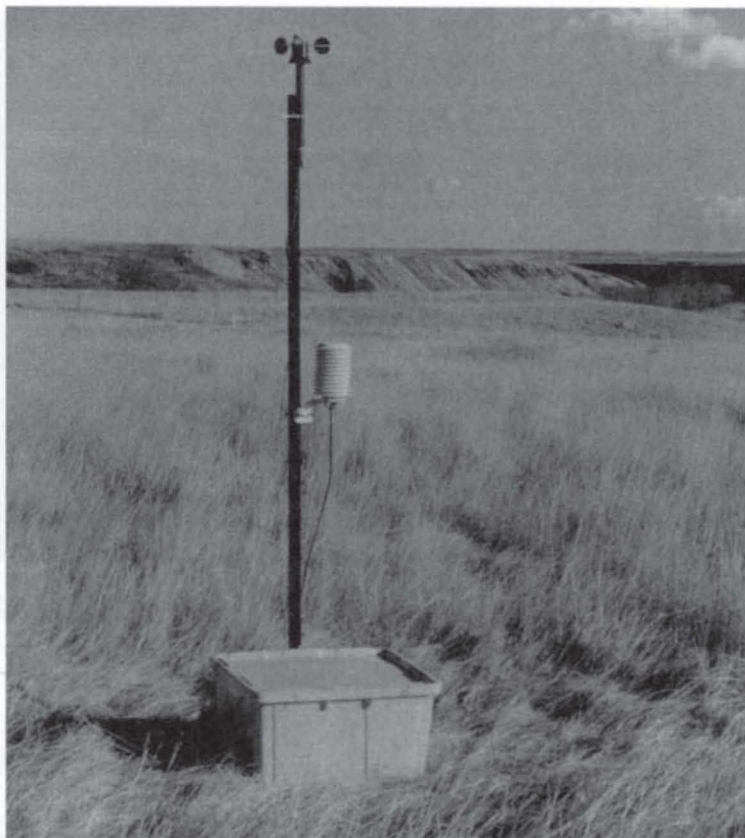


Figure 2. View of the upland measurement site, looking toward the valley, and showing the sensors and datalogger.

Below this, multiple levels contain a variety of projectile points, pottery and other artifacts providing evidence of occupation throughout Late Prehistoric times.

The Opimihaw Creek site was used for habitation mainly during the winter period. Mean temperatures are usually below freezing from November to April, falling as low as -37°C in January (Fig. 4) and, when coupled with high wind speeds, produce extreme windchill conditions. At Saskatoon, windchill factors average 1200, 1460, 1600, 1510, 1350 and 950Wm^{-2} , respectively, during the months of November to April. Many of the habitation sites located on the terraces and point bars of Opimihaw Creek, includ-

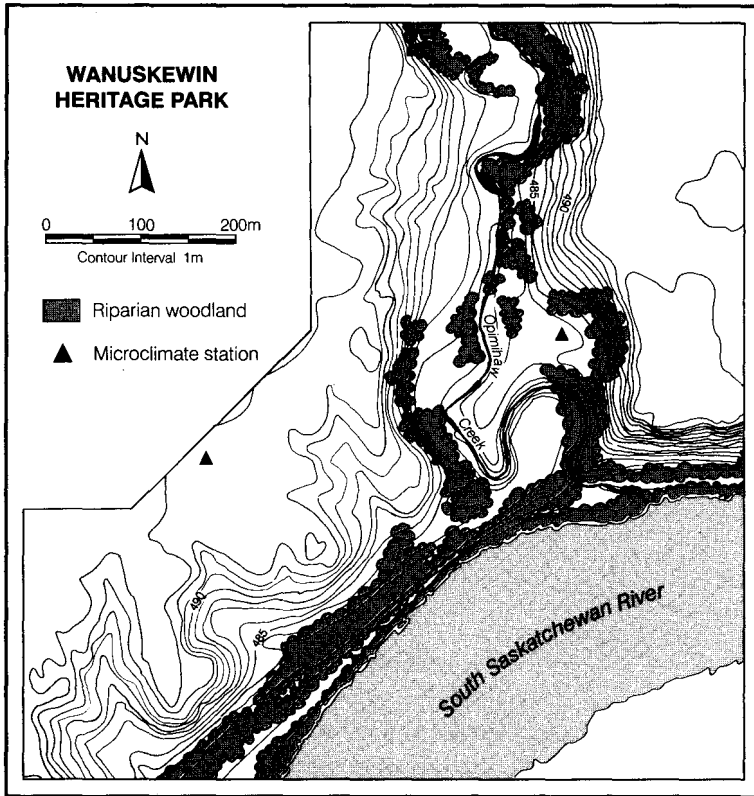


Figure 3. Map of the Wanuskewin Heritage Park area showing topography and the locations of the microclimate measurement sites.

ing at least some of the levels at FbNp-1, are thought to represent winter occupations. Although the analysis of recovered faunal materials has yet to be completed, the aging of bison dentitions to determine seasonality supports the winter occupation hypothesis. The south-facing aspect of the FbNp-1 campsite suggests that it may have been chosen to maximize solar radiation input during the winter months and also to benefit from the shelter of the surrounding slopes and the woodland vegetation cover in the river bottom. The valley-bottom location provides good protection from the coldest winter winds, which come from the northwest quadrant (Fig. 5). The degree to which these benefits accrue is the subject of this research.

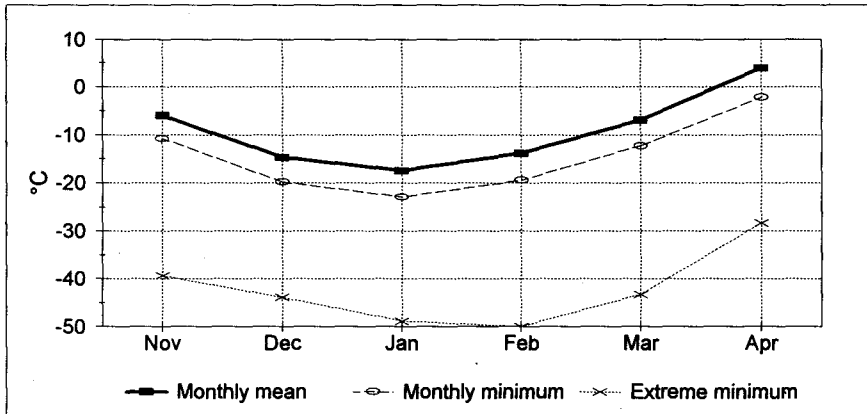


Figure 4. Mean 1961-90 and extreme minimum winter temperatures for Saskatoon.

Methods

The study period covered a single winter season (November 1994 to April 1995). Microclimate stations were set up in the valley at a site called Juniper Flats, and on the upland native prairie about 200 meters to the west (Fig. 3). Measured parameters included daily maximum and minimum air temperatures, and daily average and maximum wind speeds. In addition, temperature was measured at a height of one meter above ground within a tipi of modern construction. The data were recorded using Campbell Scientific CR21 dataloggers, thermistor temperature sensors, and Met-1 anemometers. There was a brief period of missing data in late February due to observer illness.

Windchill values were calculated using a form of the relationship developed by Siple and Passel (1945) and improved by Steadman (1971):

$$Q = 1.2 \cdot (33 - T) \cdot (9 - 0.278 V + 5.75 \sqrt{V})$$

in which Q represents the rate of heat loss ($W m^2$) from a lightly-clothed human body as influenced by ambient temperature T ($^{\circ}C$) and wind speed (kilometers/hour). Although not directly applicable to prehistoric humans,

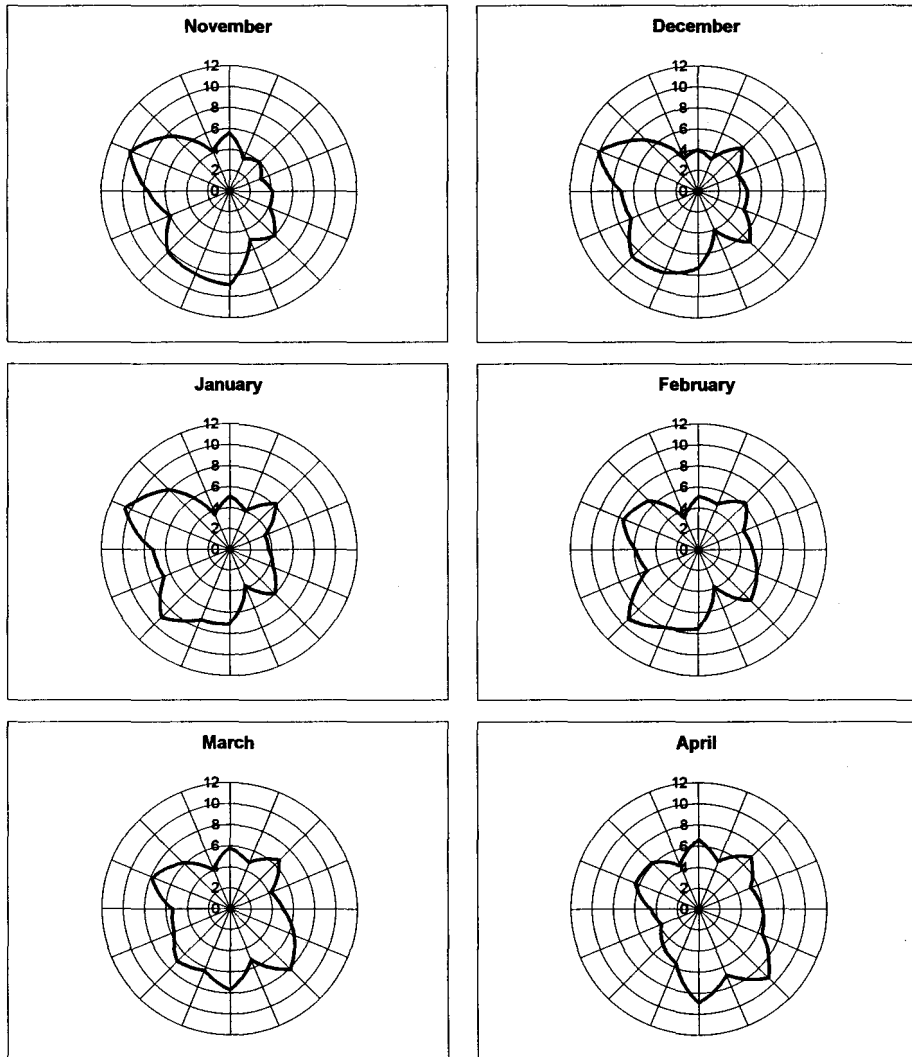


Figure 5. Wind roses for the winter months at Saskatoon (1951-1980 data).

this expression may be used as an indicator of the benefit of the valley location for human winter habitation (Hare and Thomas 1979:Chapter 10). Verbal descriptors of windchill values, according to Canada's Atmospheric Environment Service, are shown in Table 1.

TABLE 1
EFFECTS OF VARIOUS WINDCHILL FACTORS ON HUMANS
(ATMOSPHERIC ENVIRONMENT SERVICE)

Windchill ($W m^{-2}$)	Effect
1,200	pleasant for outdoor travel on overcast days
1,400	pleasant for outdoor travel on sunny days
1,600	outdoor travel disagreeable; freezing of human flesh begins
2,300	outdoor travel dangerous; exposed areas will freeze within one minute

Results

On the prairie upland, daily maximum temperatures varied from about 14°C in early November to -20°C in early February (Fig. 6); daily minimum temperatures varied from 5°C to -34°C over this period. The diurnal range varied between 2 and 23°C (Fig. 6). Differences between the prairie, valley and tipi temperatures were small, as becomes apparent when the valley and tipi temperatures are expressed as departures from the prairie temperature (Figs. 7 and 8). Although daytime maximum temperatures were almost always higher at the valley site than the prairie, the difference was typically less than 1°C. Maximum temperatures were generally highest in the tipi, on a few occasions as much as 5-6°C above those on the prairie. Conversely, minimum temperatures were usually lower in the valley than on the prairie, often by as much as 3-4°C. A similar trend is seen in the tipi minima, and these sometimes dropped below the nighttime air temperatures in the valley.

Regression analyses of the daily maximum and minimum temperatures in the valley (V), in relation to the prairie (P) site, yielded the following relationships:

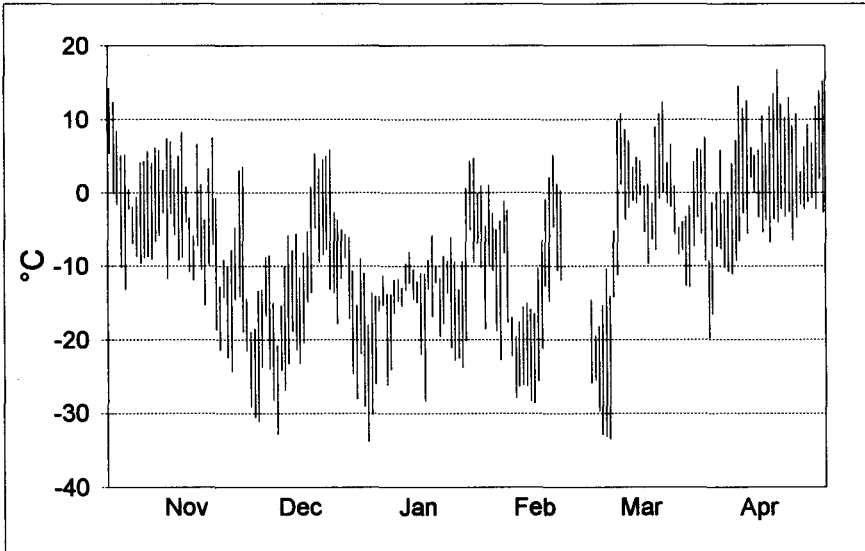


Figure 6. Daily range of temperatures at the Wanuskewin prairie site during the 1994/95 winter period.

$$\text{Maximum: } V_x = 1.016 P_x + 0.82 \quad (r^2 = 0.99)$$

$$\text{Minimum: } V_n = 1.006 P_n - 0.87 \quad (r^2 = 0.98)$$

These expressions show that maximum temperatures were on average 0.82°C higher in the valley than on the prairie, with the difference varying from 0.5°C at a temperature of -20°C to 1°C at +10°C. Minimum temperatures in the valley averaged 0.87°C lower than on the prairie, varying from 1°C lower at -20°C, to about 0.83°C less at +10°C.

Daily-mean wind speeds, during the winter, ranged from 4 to 27 kilometers/hour on the prairie and 3 to 11 kilometers/hour in the valley (Fig. 9). The overall averages were 11 kilometers/hour on the prairie and 5 kilometers/hour in the valley, while mean peak daily wind speeds were 24 kilometers/hour on the prairie, compared with 14 kilometers/hour in the valley. A plot of daily wind speed ratios (Fig. 10) indicates that mean wind speeds in the valley are about half those on the upland; while the peak values in the valley are slightly higher fractions. This wind speed difference has a pronounced effect on windchill.

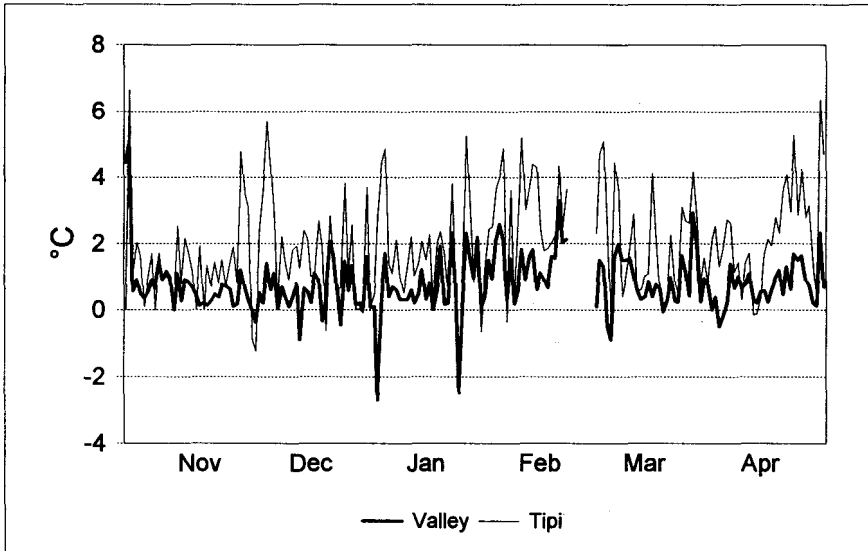


Figure 7. Differences between the daily maximum temperatures at the valley and tipi locations, and those on the prairie, for Wanuskewin during the 1994/95 winter period.

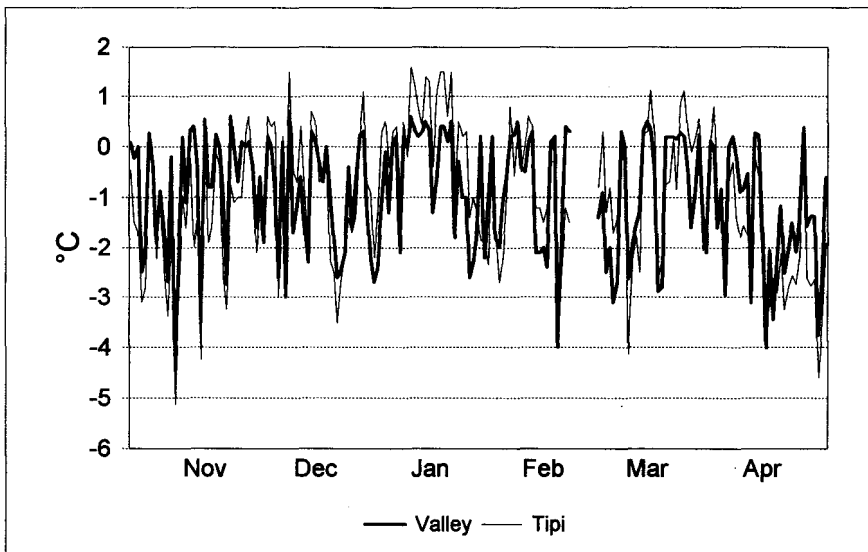


Figure 8. Differences between the daily minimum temperatures at the valley and tipi locations, and those on the prairie, for Wanuskewin during the 1994/95 winter period.

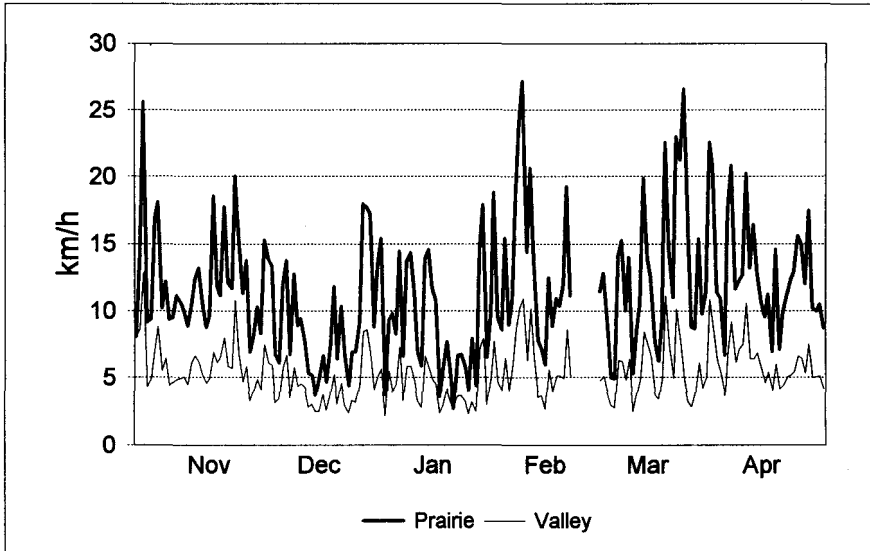


Figure 9. Daily mean wind speeds for the prairie and valley sites at Wanuskewin during the 1994/95 winter period.

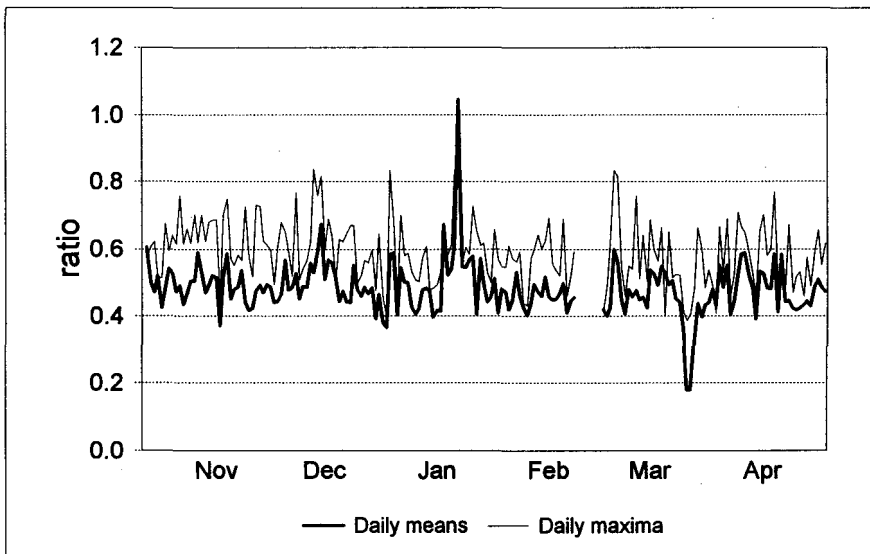


Figure 10. Ratios of valley-to-prairie mean and maximum daily wind speeds at Wanuskewin during the 1994/95 winter period.

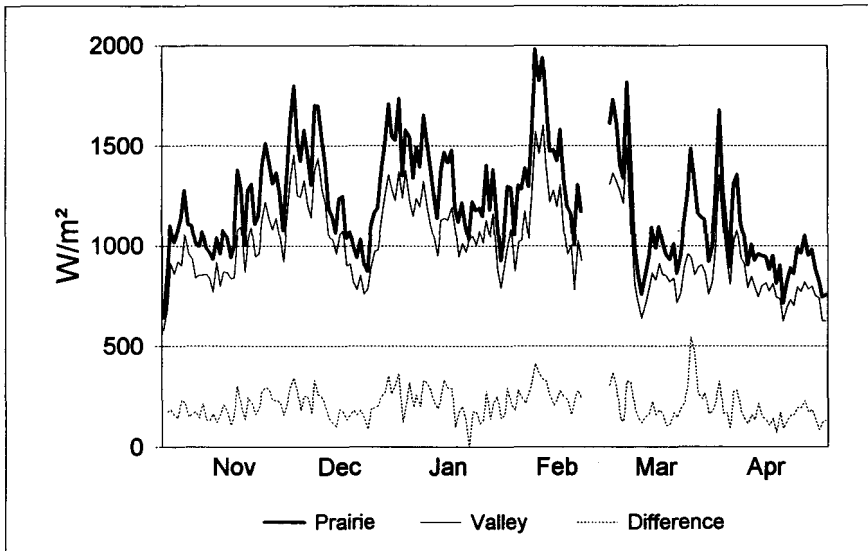


Figure 11. Calculated windchill factors for the prairie and valley sites, and the difference between the two, at Wanuskewin during the 1994/95 winter period.

Windchill factors averaged above $1,000 \text{ W m}^{-2}$ from November to February (Fig. 11), well below the average monthly values for Saskatoon. Although there were no days having values above the dangerous level (Table 1), 9% of the days on the prairie, compared with 1% in the valley, were above $1,600 \text{ W m}^{-2}$ (Table 2). Similarly, 23% of the days were above $1,400 \text{ W m}^{-2}$ on the prairie, compared with only 4% in the valley. The highest windchills of the winter occurred in early February, peaking near $2,000 \text{ W m}^{-2}$ on the prairie and $1,500 \text{ W m}^{-2}$ in the valley. The differences between the two varied from 200 to 250 W m^{-2} , and were due almost entirely to the wind speed differential. This windchill difference conferred a considerable comfort advantage to the Juniper Flats site (see Table 1).

Discussion

Selection of habitation sites is not a random process. In the Arctic, for example, proximity to available resources and protection from the elements were important considerations in Thule culture winter campsites (Jacobs and Sabo 1978). These sites are found along the eastern coast of Baffin Island

TABLE 2
 FREQUENCY OF OCCURRENCE OF DAILY WINDCHILLS
 IN VARIOUS CLASSES DURING THE WINTER OF 1994/95
 AT WANUSKEWIN (%)

Windchill ($W\ m^{-2}$)	Prairie	Valley
< 1200	56	80
1200 - 1400	21	16
1400 - 1600	14	3
1600 - 2300	9	1
> 2300	0	0

and their choice was clearly influenced by factors such as aspect, height of land behind the site, and shelter to seaward by islands. Reduced wind speed and lower rates of heat loss are considered to be the principal microclimatic benefits at these sites. Observations at one shoreline site in the lee of an island indicated a 50% reduction in wind speed and 40% reduction in heat loss. These values are similar to those found in the present study.

On the Northern Plains, campsite selection was also based on proximity to resources, as well as shelter. Of critical importance were accessibility to firewood and bison herds, as well as potential sites for bison pounds or traps. There is ample ethnographic evidence for increased bison sedentism during the winter months (Arthur 1975; Morgan 1978). Bison remained on the open range until adverse weather forced them into wooded, sheltered areas such as valley bottoms and associated coulee systems. Parallel human behavior seems likely, with hunting bands shifting to a reliance on dried foods and use of traditional pounds in place of larger-scale operations on the uplands. As bison herds moved into these winter ranges, human groups focussed their attention on the same areas. The Opimihaw Creek valley provided just this opportunity, and the comparatively intensive use of this

topographic feature as a bison procurement and habitation area involving eight large multi-component sites, is consistent with the settlement pattern described above.

Clearly, the Opimihaw site provides some benefit from radiation during the daytime, and the effect is most pronounced within the confined space of the tipi. The amphitheater-like setting of the winter campsite acts as a heat trap, absorbing solar energy which it re-emits as long-wave radiation. Lower nighttime temperatures presumably result from cold air drainage, indicating a disadvantage of the location in the early mornings. However, this would be offset by the lower windspeeds. The apparent advantages of winter campsites would have been further enhanced by the comfort provided by man-made structures. The tipi monitored in this study was a modern canvas structure; apart from shelter from the wind, and trapping of solar radiation, it provided little modification of the thermal regime. This unoccupied tipi would afford much less protection than one covered with buffalo skins, and containing people and campfires (Campbell 1915). In addition, traditional tipis would have been prepared for winter by adding a second layer of hide to a height of about 2 meters above ground, with the intervening space filled with dry grass (Laubin and Laubin 1977). This would have provided considerably greater insulation, often augmented by a covering of snow around the base. With additional warmth provided by a fire and human metabolic heat, the tipis would have provided great comfort for the occupants.

The above is in agreement with the Ewers (1955:124) description of the Blackfoot of the northern Great Plains, based on earlier literature. He noted that, in late-October or early November, bands moved into winter camp areas located in "broad, timbered river valleys offering shelter from winds and snows." The areas were chosen for availability of firewood, water, and grass for horse pasturage.

Conclusion

The significant changes in climate that have occurred in the Great Plains over the past several thousand years have undoubtedly had important influences on the early aboriginal peoples. Concomitant changes in plant and animal distributions over time would perhaps be the most important aspects of such temporal instability to these nomadic peoples. Suitably protected sites are as necessary for survival as are other staples. Even though landforms are subject to inexorable change, the relative permanence of ideal campsites such as those situated in the Opimihaw Creek valley is reflected in the extended archaeological record of habitation.

Acknowledgments

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