Changing Physical and Ecological Landscapes in Southwestern Manitoba in Relation to Folsom (11,000–10,000 BP) and McKean (4,000–3,000 BP) Site Distributions

Matthew Boyd

ABSTRACT. Landscape and vegetation have changed dramatically across the Canadian prairies from the terminal late Pleistocene to the end of the middle Holocene. These transformations, in turn, are often assumed to have fundamentally impacted the ways in which Native Peoples have mapped on to these landscapes through time. In this study, a comparison of Folsom (11,000–10,000 BP) and McKean (4,000–3,000 BP) archaeological site distributions in the glacial Lake Hind basin of southwestern Manitoba illustrates the extent to which landscape evolution, environment, and settlement strategies are truly entangled. These site distributions are made meaningful in relation to lithostratigraphic and paleoecologic data obtained from a cutbank of the Souris River, in the Lauder Sandhills region of the Hind basin. Folsom incursions into the Hind basin correlate well with the period of gradual drainage of glacial Lake Hind, prior to c. 10,400 BP. The regional clustering of McKean sites across the basin, furthermore, correlates with the initiation of extensive eolian landscape stability and the widespread development of a prairie wetland mosaic in this area. While both physical and biotic landscapes have changed dramatically through this period of time, however, both Folsom and McKean site distributions may reflect a highly similar land-use strategy.

SOMMAIRE. Paysage et végétation ont subi des changements profonds dans les prairies canadiennes depuis la fin du pléistocène inférieur jusqu'à la fin du holocène moyen. On pense souvent que ces transformations ont eu un impact fondamental sur la manière dont les populations autochtones ont évolué par rapport à ces paysages. Dans la présente étude, une comparaison des distributions de sites archéologiques Folsom (11 000 av. pr.) et McKean (4 000-3 000 av. pr) dans le bassin glaciaire du lac Hind, au sud-ouest du Manitoba, illustre à quel point l'évolution du paysage, les stratégies d'implantation et l'environnement sont enchevêtrés. Ces distributions deviennent significatives à la lumière des données lithostratigraphiques et paléoécologiques tirées d'une rive de la Souris River, dans la région des Lauder Sandhills du bassin Hind, où les incursions de type Folsom sont en corrélation avec la période de drainage graduel du lac glaciaire datée avant 10 400 av. pr.. De plus, ce groupement régional des sites McKean du bassin est en corrélation avec un début de stabilité éolienne considérable et un développement généralisé de la mosaïque marécageuse de la région. Mais tandis que les paysages physiques et biotiques ont subi un changement dramatique durant cette période, les distributions de sites Folsom et McKean reflètent peut-être une stratégie d'utilisation des terres fort similaire.

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Introduction

Traditional Quaternary paleoenvironmental and geomorphic research has had, as a primary goal, the development of models that address regional changes in landscape form and biotic community composition (e.g., Antevs 1955; Ritchie

1976; Sorenson 1977; Knox 1983; Barnosky 1989; Lemmen 1996). While the correlation of these models to past human activities is often an explicit goal (COHMAP 1988; Wright et al. 1993), this objective has been largely neglected in practice. This neglect has the effect of perpetuating the image of pre-European landscapes in North America as entirely "natural" surfaces which are unaffected by, and without effect on, the course of human history.

This article addresses the extent to which human history, landscape evolution, and biotic change are truly intertwined through a comparison of two archaeological complexes[1] in southwestern Manitoba. These complexes — Folsom (c. 11,000–10,000 BP) and McKean (c. 4,000–3,000 BP) — have been chosen because they are the best represented archaeological materials in the study area produced during the terminal late Pleistocene (12,000–10,000 BP) and the beginning of the late Holocene (10,000–present), respectively. As a result, they provide the best means of illustrating the connection between the archaeological record and the dramatic sequence of paleoenvironmental and geomorphic changes initiated following deglaciation. Since little archaeological evidence is presently available for the period between 10,000 and 5,000 BP in southwestern Manitoba, an analysis of intermediate "cultures" (e.g., Mummy Cave Series [7,500–4,700 BP]) is not attempted.

Study Area and Modern Setting

The study area is defined as the south-central glacial Lake Hind basin, located in southwestern Manitoba (Figure 1). The modern landscape is a discontinuous dune field (the Lauder Sandhills) which stretches for approximately 25 km on the north side of the Souris River, between the towns of Hartney and Melita. Some of the most striking eolian landforms in the study area are large, stabilized, crescentic, parabolic sand dunes (6–10 m high, >500–1500 m long) which survive mostly as northwest-southeast trending parallel ridges. Other landforms include low conical, irregular, or sinuous mound dunes (1–3 m high, 4–0 m in diameter with no slipfaces), and eolian sand sheets (ranging from 1–3 m in thickness) in interdunal areas. Interdunal swales in the sand sheets are commonly occupied by shallow wetlands. Soils in the study area are mostly Orthic Regosols (Eilers et al. 1978; Soil Classification Working Group 1998: 117), with gleyed soils frequently occupying lower topographic positions. Prior to the initiation of a land drainage program in 1969, small wetlands were extremely numerous across the study area — a fact well illustrated by the nineteenth century Dominion Land Survey maps (Hamilton and Nicholson 1999). The proliferation of wetlands in the Lauder Sandhills stems from the underlying presence of the Oak Lake aquifer, which occupies most of the former glacial Lake Hind basin (Hamilton and Nicholson 1999) (Figure 2). This aquifer was formed by the entrapment of groundwater above impervious sedimentary and bedrock deposits (Hamilton and Nicholson 1999; Boyd 2000) (Figure 2). Throughout the Holocene, groundwater accumulated within the overlying sandy deposits to the point that surface undulations filled to create small lakes and sloughs (Hamilton and Nicholson 1999: 9). The development of the Oak Lake aquifer is a significant aspect of the middle Holocene geological record in the study area, and will be given further analysis in a later section.

An extremely diverse plant association has developed within this variable topography (Plate 5). Modern vegetation surveys (e.g., Hohn and Parsons 1993) identify at least five plant communities within the Lauder Sandhills:

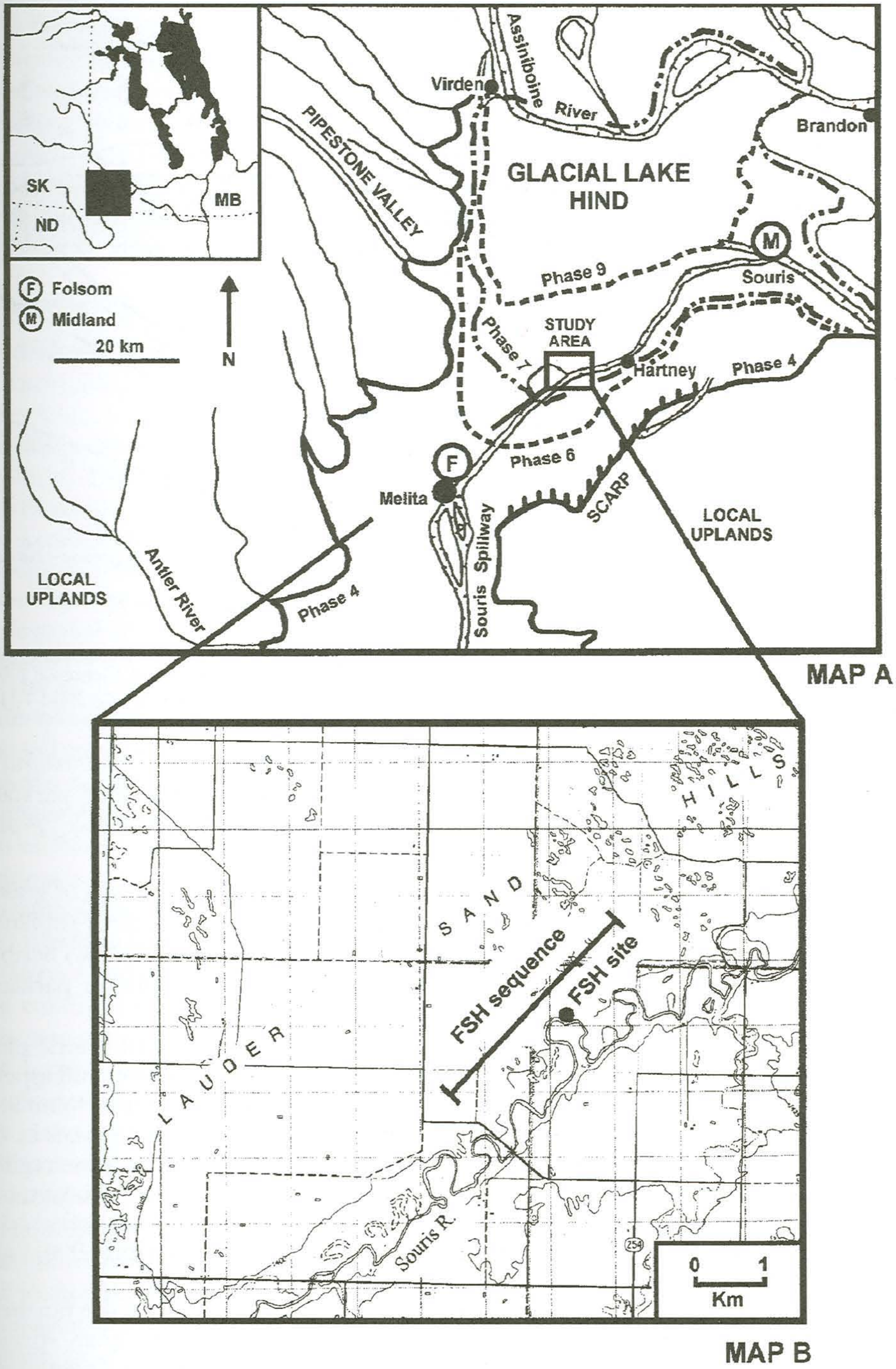

Figure 1. Paleogeography of glacial Lake Hind and location of study area. Map A: Glacial Lake Hind basin. Phase 4 to Phase 9 shorelines after Sun (1996). Map B: Close-up of study area with Flintstone Hill (FSH) site and minimum distance of FSH lithostratigraphic sequence.

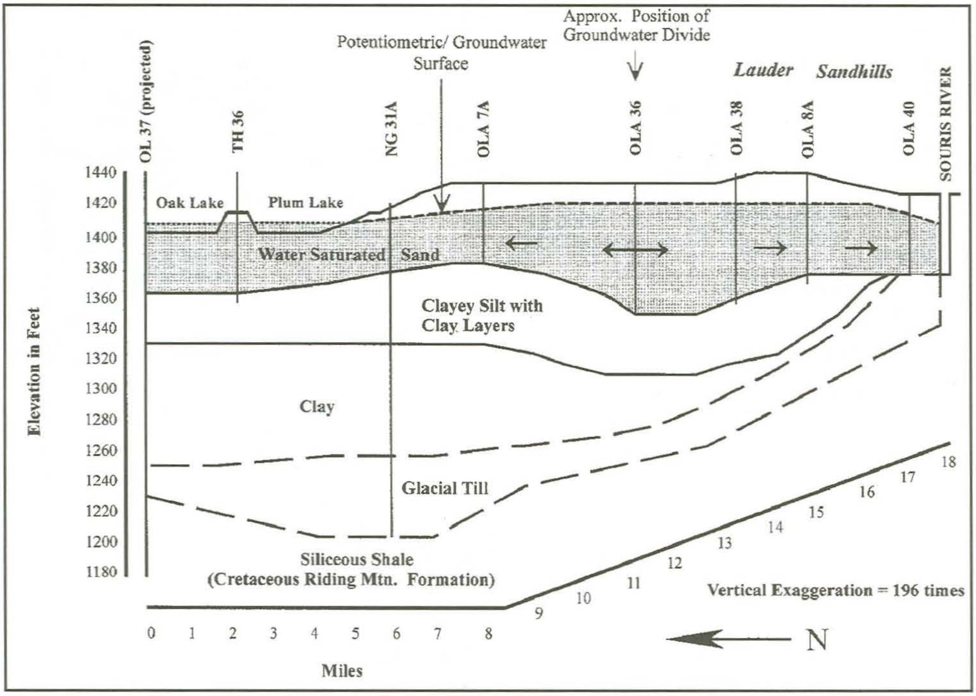

Figure 2. Sedimentological cross-section of the Oak Lake Aquifer. After Hamilton and Nicholson (1999, Figure 6) and Manitoba Department of Natural Resources Water Resources Branch File #90-1-7-1141, 1986.

1) *Aspen forest*: dominated by *Populus tremuloides* Michx. and *P. balsamifera* L. with *Quercus macrocarpa* Michx. on small sand ridges, and common parkland associates in the understory such as *Symphoricarpos occidentalis* Hook., *Prunus virginiana* L., and *Amelanchier alnifolia* Nutt.
2) *Forest-grassland transitional areas*: incorporate a higher frequency of grasses (compared to the aspen forest). These grasses are predominantly subfamily Festucoideae taxa such as *Poa* spp. and *Calamovilfa longifolia* (Hook.) Scribn., and are associated with open *P. tremuloides* forest and common parkland associates.
3) *Grassland*: this rapidly diminishing habitat includes a range of prairie plant species distributed according to topography (e.g., slope position and aspect) and moisture regime. In the remnant grasslands, ground cover is dominated by *Ambrosia psilostachya* DC., *Rosa arkansana* Porter, *Equisetum hyemale* L. var. *affine* (Engelm.) A.A. Eaton, and *Solidago* spp. Native grasses in these regions are dominated by species in the Chloridoideae (warm, dry short grasses, e.g., *Bouteloua gracilis* [HBK.] Lag.) and Panicoideae (warm, moist tall grasses, e.g., *Andropogon gerardii* F. Vitman subsp. *hallii* [Hack.] J. Wipff [Wipff 1996]) subfamilies.
4) *Sandhills proper*: dominated by Quercus macrocarpa stands on the northern dune slopes, interspersed with *Populus tremuloides*, diverse grass species, *Juniperus horizontalis* Moench, as well as the regionally rare *Tradescantia occidentalis* (Commelinaceae) (Britt.) Smyth.
5) *Wetlands (interdunal and lacustrine)*: common emergent taxa include *Caltha palustris* L., *Petasites sagittatus* (Pursh) A. Gray, and *Typha angustifolia* L.

More complete plant catalogues for this unique area are contained in several sources (Scoggan, 1953; Hohn and Parsons 1993; Boyd 2000).

Normal climate values at the nearest station (Deloraine) include a mean maximum summer temperature (in July) of 19.7°C, with the coldest month (January) averaging about -16.3°C. Yearly rainfall is approximately 360 mm (114 mm falling as snow), and the current ratio of precipitation to potential evapotranspiration (P/PE) is about 0.8 (Environment Canada, 1993). In general, the study area is within the subhumid continental climate zone ("Dfb" under the Koeppen system) (Eilers et al. 1978).

Archaeological and Geological Sources Used in This Study

The Archaeological Record

Archaeological research in the Lauder Sandhills has been largely confined to the "Makotchi-Ded Dontipi" locale (see Hamilton and Nicholson, 1999), a contemporary Dakota designation for a sub-region on the western end of the Sandhills. This archaeological locale defines a cluster of at least thirteen distinct sites of mostly Late Precontact (c. 2000 BP to historic period) cultural affiliation. Archaeological materials dating to the early and middle Holocene, however, consist almost entirely of "culturally" diagnostic projectile points recovered as surface finds, rather than from undisturbed and buried sites. This study draws largely from professional archaeological surveys, complemented by excavated site reports where available.

The most extensive professional surface collection program in Manitoba was undertaken as part of the Glacial Lake Agassiz Survey (e.g., Syms 1970). This database led to the production of Paleoindian (e.g., Buchner and Pettipas 1990) and McKean complex (Syms 1970) projectile point distribution maps for much of southern Manitoba. While several new sites have been located since the termination of this survey programme, it remains an important source of information on regional spatial patterning of diagnostic archaeological materials across the province. Other surveys included in this study are focused on smaller areas (e.g., the Winnipeg River system [Buchner 1982]).

Three fundamental limitations are placed on interpretations derived from surface collected material. For one, archaeological materials collected in these contexts may not usually be dated by any absolute (i.e., radiometric) means. As a result, one is confined to the total known time range established for a diagnostic type across its entire geographical range. For example, the oldest Folsom date (10,900 BP) is at Owl Cave, Idaho (Miller and Dort 1978), and the youngest is from the Lubbock site, Texas, at 9,900 BP (Haynes 1964: 1410). Hence, the temporal range for any given Folsom surface recovery in southern Manitoba can only be assumed to fall somewhere between c. 11,000 and 10,000 BP. It should be noted, however, that the majority of Folsom sites in North America are usually dated to between 11,000 and 10,400 BP (Haynes 1982: 384).

The second limitation, closely related to the first, is that surface recoveries seldom provide clear and reliable spatial associations between the diagnostic projectile point(s) and other contemporaneous materials (e.g., faunal remains, other artifacts, etc.) of economic and cultural importance. This places a serious limitation on the ability of the archaeologist to infer the function of the site, season of occupation, and economic orientation, as well as other characteristics.

Thirdly, there is little doubt that surface collections are affected by "visibility biases." In other words, the representation of diagnostic archaeological materials found on the surface may be affected by landscape changes through time — most notably, the deep burial of early-to-middle Holocene sites by mass wasting processes. In the Sheyenne Delta of North Dakota, for example, Running (1995) argues that greater landscape instability (i.e., alluvial fan formation and eolian activity) characterized the mid-Holocene between 8,000 and 5,000 BP. Therefore, one would expect an inherent bias towards the over-representation of surface components that postdate the major period of instability.

The Geological Record

A previous study (Sun 1996) established the general history of glacial Lake Hind during the late Pleistocene. This work demonstrates quite clearly that, while glacial Lake Hind was relatively small (c. 4000 km^2) in comparison to adjacent glacial Lake Agassiz, it was a part of the larger proglacial lake-spillway system. Lake Hind received meltwater from western Manitoba, Saskatchewan, and North Dakota via at least ten channels, and discharged into glacial Lake Agassiz through the Pembina spillway (Sun 1996). Therefore, the major geological events occurring within the Hind basin reflect a larger sequence of catastrophic proglacial lake drainage across the northern prairies (Sun 1996; Sun and Teller 1997). For this reason, the chronostratigraphic record preserved within the Hind basin has significance at the local and at the broader, regional scale.

For archaeological purposes, however, the work of Sun (1996) is of limited use. This largely stems from the absence of radiometric dates linking this geological

Table 1. Radiocarbon dates referred to in text. Depths refer to Figures 3 and 5.

Provenience; Depth	Lab. Number	Material/ Fraction	Radiocarbon Age (^{14}C yrs. BP)	2-δ Calibrated Range* (cal BP)
Upper eolian sand sheet paleosol (565 cm)	Beta-109529	Archaeological (hearth) organics	3250 ± 70 BP	3650–3350 cal BP
Mud above evaporite (485 cm)	Beta –109900	Bison long bone fragment	4090 ± 70 BP	4840–4440 cal BP
Lower eolian sandsheet (245 cm)	Beta-111142	Wood (*Salix*)	6700 ± 70 BP	7667–7462 cal BP
Upper gyttja (145 cm)	TO-7692	*Menyanthes* seeds	9250 ± 90 BP	10596–10228 cal BP
Lower gyttja (125 cm)	Beta-116994	*Menyanthes* seeds	10420 ± 70 BP	12677–11911 cal BP

*Calibration assessed using Stuiver and Reimer (1993). This calibration converts the radiocarbon age to "real" (i.e. calendar) years. The calibrated range contains all probable dates within two standard deviations (2-δ) from the mean.

record to an absolute timescale. Much of the literature on the North American proglacial lake-spillway system lacks reliable absolute dates (Elson 1983: 37). Indeed, many radiocarbon samples collected in the past consisted of limnic sediments shown to be contaminated, in some cases, by pre-Quaternary palynomorphs and weathered lignite (Nambudiri et al. 1980; Elson 1983: 37). To some extent, this problem has been alleviated by using only dates on wood and other plant macrofossils (Clayton and Moran 1982). Despite this cautionary measure, however, the potential for error due to the reworking of older wood into more recent contexts remains a significant problem.

Additionally, the literature on the geology of the Hind basin is of limited archaeological use because it is almost entirely confined to the late Pleistocene (18,000–10,000 BP). Since the vast majority of the North American archaeological record is restricted to the Holocene (10,000 BP to present), only minimal overlap is available for integrating human history with landscape evolution in this region.

For the study area, a series of cutbanks located adjacent to the Souris River in the Lauder Sandhills promise a means of connecting the early record of human settlement to post-glacial landscape evolution in the southern Hind basin. These cutbank sites are unique because they expose a near-complete and widespread (c. 2 km minimum) sedimentological sequence spanning the terminal late Pleistocene to the present. This sequence is defined by the Flintstone Hill (FSH) site (Figure 1), which has yielded the major lithostratigraphic database used in this study. Rather than present all results generated from this site, a summary of the major paleoenvironmental changes for the periods of interest suffices for the purposes of this article. The full database is available in Boyd (2000). All relevant radiocarbon dates from the Flintstone Hill site are presented in Table 1.

A Brief Overview of the Folsom and McKean Archaeological Complexes

Folsom Complex (c. 11,000–10,000 BP)

The Folsom complex is recognized by its distinctive full-fluted spear points, although an unfluted variant — "Midland" — is also known (Wendorf et al. 1955; Hofman et al. 1990; Hofman and Graham 1998: 101). At excavated sites elsewhere in North America, these artifacts have been associated with a diverse tool kit that included small end scrapers, drills, biface knives, choppers, stone beads, as well as a range of bone tools (Dyck 1983: 75). The Folsom economy on the southern plains appears to be largely focused on bison hunting, although at the Owl Cave site (Idaho), mammoths may also have been procured in the beginning (Miller and Dort 1978: 129–39). At later sites, Folsom game also included mountain sheep, deer, marmots, rabbits and wolves as secondary components to a bison-dominated diet (Dyck 1983: 74).

Folsom surface recoveries are present across the Canadian Prairies only in small numbers. Vickers (1986: 35) suggests that the limited penetration of the complex may have been due to its short duration and "southern" (i.e., United States High Plains) origin. Pettipas and Buchner (1983: 421), on the other hand, argue that the scarcity of fluted Paleoindian points in Manitoba may be due to the failure of ice-marginal communities to attract significant populations of game.

McKean Complex (c. 4,000–3,000 BP)

The McKean complex subsumes three projectile point types (McKean, Duncan and Hanna) which were originally considered to be independent. Not long after their initial description, however, all three were lumped into a single complex because they were found mixed together at the type site in Wyoming (Dyck 1983: 100). The geographic distribution of the complex is quite extensive, with sites known throughout the northern prairies, aspen parklands, and the southern edge of the boreal forest (Dyck 1983). The number of McKean sites across the northern prairies is also quite large, in comparison with early Precontact materials such as the Folsom complex. In Alberta, for example, at least 139 McKean sites or isolated projectile points are known; Folsom, on the other hand, is represented by only three isolated points (Vickers 1986: figure 3).

The Cactus Flower site gives one of the best images of the McKean complex on the Canadian Prairies. This extensive site is located on the South Saskatchewan River north of Medicine Hat, in southeastern Alberta. The occupations associated with McKean, Duncan, and Hanna points yielded radiocarbon dates ranging from 4,130 ± 85 BP to 3,620 ± 95 BP. Other artifacts attributed to this complex include bifaces, gravers, endscrapers, spokeshaves, marginally retouched flake tools, pebble cores, hammerstones, anvils, a ground stone disk, a tubular pipe, bone awls, bone and shell beads, a shell disk, and an ammonite septum (Brumley 1975). The faunal assemblage from the site was dominated by bison (which indicated October/November and spring occupations from mandible age estimates), with smaller numbers of antelope, mule deer, canid, and trace quantities of kit fox, rabbit, birds, freshwater clam and fish (Brumley 1975). Based on a comparison of element numbers per individual, Brumley (1975: 83) suggests that bison were hunted nearby and antelope were taken from a greater distance. Repeated occupation of the Cactus Flower site by McKean groups was probably a result of the site's ideal location for opportunistic bison ambushing at a major river crossing (Brumley 1975: 91).

Late Pleistocene-Early Holocene Transitions in the South-Central Hind Basin: Lake Recession and Folsom Incursions

The Geological and Paleoecological Records from the Flintstone Hill Site

At the Flintstone Hill site, two basal units record the sequence of events occurring within the south-central Hind basin during the terminal late Pleistocene and early Holocene (Figure 3). The earliest of these, the glaciolacustrine unit, is approximately 1.2 m thick (above the level of the Souris River) and is composed of gleyed, carbonate-rich, massive to planar bedded clay to silty clay which grades upwards into an organic rich and finely laminated buried organic deposit (i.e., the "gyttja unit"). The c. 30 cm thick gyttja unit is composed of alternating planar beds of fine-texture clastics (clays and silts) and thin (c. 1–5 mm thick) detrital organic beds. Some occasional symmetrical ripple structures (≤ 5 mm high) are preserved in the organic bedding, suggesting periodic, low energy/low velocity flooding.

Together, the glaciolacustrine and gyttja units at the Flintstone Hill site are interpreted as showing a gradual transition from a deep-water to a shallow-water depositional environment (Boyd 2000). An accelerator mass spectrometry (AMS) radiocarbon date on seeds of the boreal emergent *Menyanthes trifoliata* (buckbean) recovered from the bottom of the gyttja indicates that this process was completed in the Flintstone Hill region by at least c. 10,400 BP (Figure 3). When linked to the model of glacial Lake Hind produced by Sun (1996), this sedimentological transition very

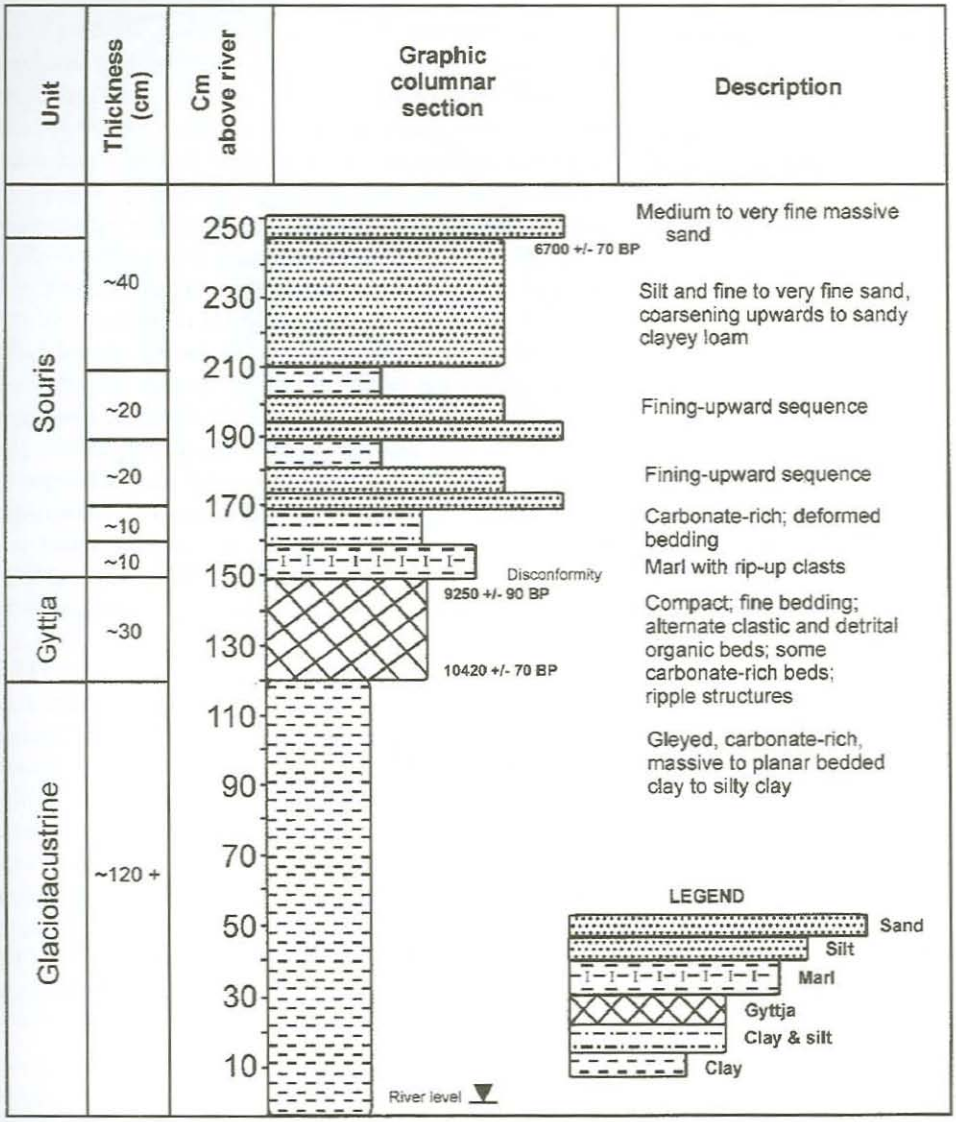

Figure 3. Composite Schematic Column of the Flintstone Hill Cutbank (Glaciolacustrine, Gyttja, and Souris Units), Southwestern Manitoba (Source: M.J. Boyd and G.L. Running IV, July 1998).

likely corresponds to the drainage of the southern Hind basin following the catastrophic routing of meltwater through the Souris-Pembina spillway system during Phase 8. As illustrated in Figure 1, Sun's (1996) shoreline positions for Phases 7 and 9 indicate that the Flintstone Hill site was within the region of the Hind basin that was drained by this event.

Plant macrofossils and microfossils preserved in the gyttja provide a sequence of paleoenvironmental change for the period between c. 10,400 and c. 9,300 BP (Boyd 2000). Based on pollen evidence, upland communities surrounding the Hind basin were initially dominated by *Picea glauca* (white spruce), *Artemisia* (sage), grasses, *Shepherdia canadensis* (Canada buffaloberry), *Populus* (poplar), and

Juniperus (juniper), among others. At the same time, within the Hind basin in the area of the Flintstone Hill site, at least one small (< 1 km diameter), shallow, treeless wetland remained following drainage. This small wetland was rapidly colonized by the aquatic and semi-aquatic taxa *Menyanthes trifoliata* (buckbean), *Carex* spp. and *Eleocharis* sp. (sedges), and *Potamogeton* (pondweed). Beginning shortly after c. 10,400 BP, glacial retreat and a warming climate are evidenced by the rapid deterioration of white spruce populations on the surrounding uplands. This process was briefly interrupted by a sharp cooling trend and a corresponding increase in the relative frequency of white spruce pollen. This subsequent Picea peak is seen in pollen spectra across southwestern Manitoba (e.g., Ritchie and Lichti-Federovich 1968; Ritchie 1969; Boyd 2000), and probably corresponds to a re-advance of the Laurentide ice sheet at c. 10,000 BP during the Emerson Phase of glacial Lake Agassiz (Teller et al. 1996: 62). By 9,300 BP, however, white spruce populations were virtually eliminated from the local uplands, leaving mostly *Populus, Juniperus,* and grasses. Within the Hind basin, at the Flintstone Hill sample location, the period following 10,400 BP was characterized by the dominance and subsequent decline (in terms of total seed numbers) of *Menyanthes trifoliata.* This emergent species probably dominated the local wetland due to highly fluctuating water levels produced by periodic, low energy, flooding (Haraguchi 1991; Boyd 2000). Presently, the distribution of *M. trifoliata* is mainly restricted to bogs and swamps in the boreal forest (Looman and Best 1987: 592).

The early postglacial forest reconstructed for the uplands surrounding the Hind basin was part of a larger, spruce-dominated assemblage (lacking a modern analogue) that spread across much of Canada's western interior immediately following deglaciation (Ritchie 1976: 1793). *Picea glauca* forests were established in North Dakota by c. 12,000 BP (Grimm 1995), and extended into southern Saskatchewan by at least 10,200 BP (Yansa and Basinger 1999: 151). Further west, open grasslands have apparently existed continuously in Montana over the past 12,000 years, with spruce being notably absent (Barnosky 1989). As well, in southeastern Alberta, *Populus* was present but *Picea* was probably absent (Beaudoin 1992). In North Dakota, the spruce forests were replaced by grassland vegetation at c. 10,000 BP (Grimm 1995) while, in southern Saskatchewan spruce forests were succeeded by deciduous parklands after c. 10,200 BP (Yansa and Basinger 1999: 151).

Folsom Site Distributions and Implications

The distribution of fluted Paleoindian (i.e., Clovis and Folsom) projectile points in southern Manitoba is largely restricted to the uplands located on the western side of the province (Figure 4). This pattern is sensible, given the fact that the eastern half was covered by glacial Lake Agassiz at this time (see Buchner and Pettipas 1990). In the study area, one Folsom projectile point from a private collection has a provenance within the Melita locality (Pettipas 1967: 356), and an unfluted ("Midland") form was recovered *in situ* from a river terrace outside of Souris, at an elevation of 442 metres above sea level (Pettipas 1967: 355) (Figures 1 and 4). These recoveries are significant because they are located well below the maximum outline of the glacial Lake Hind basin (i.e., 457 metres above sea level). More precisely, the Melita point was found in an area of the basin covered by water during Phase 4 (Figure 1). Although no radiocarbon dates are available for this early phase of glacial Lake Hind, it must postdate the initiation of deglaciation

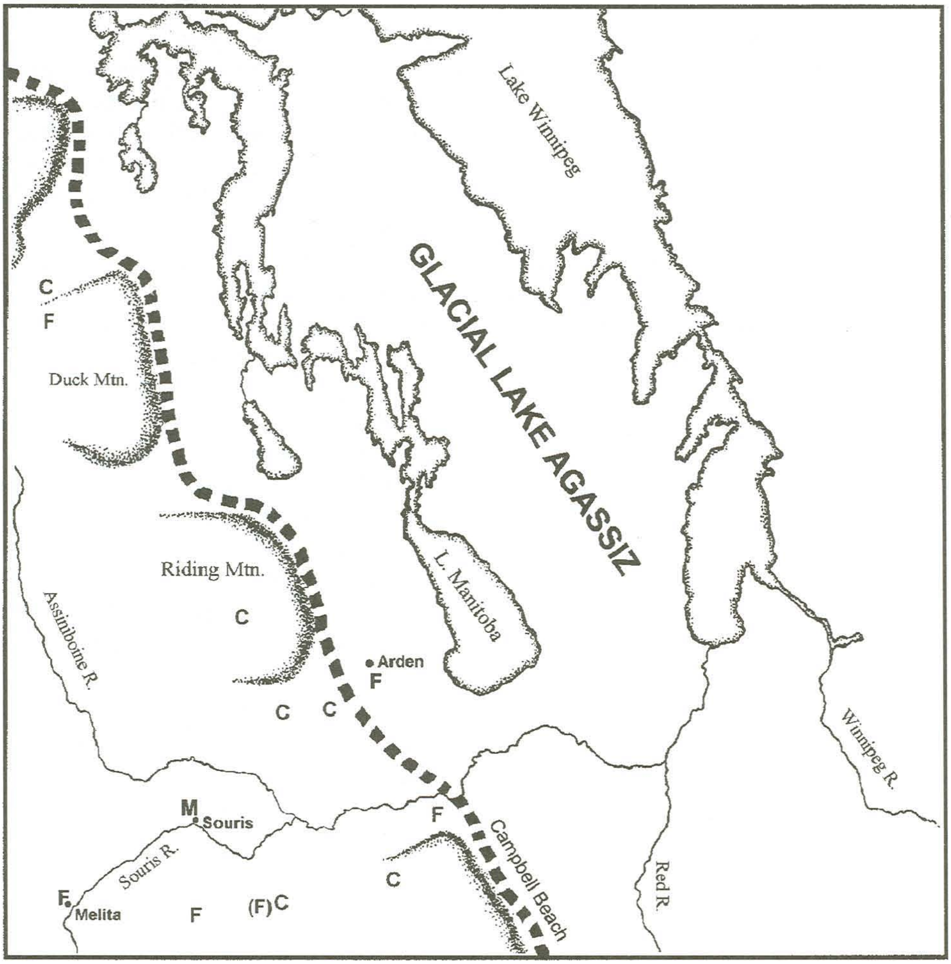

Figure 4. Early Paleoindian Surface Recoveries in Southern Manitoba (C = Clovis, F = Folsom, M = Midland, (F) = authenticity disputed).

(i.e., after c. 12,000 BP [Sun, 1996]). The Souris specimen, furthermore, was found in an area of the basin that would have been covered by water during, and prior to, Phase 7 (Figure 1). Since the Phase 7 to 9 transition is known to have been completed shortly before c. 10,400 BP, the drainage of this region was probably either well underway, or entirely completed by Folsom (11,000–10,000 BP) times. Significantly, on the western shore of glacial Lake Agassiz, the purported recovery of a Folsom point near Arden — below the elevation of the Campbell beach (Figure 4) — is consistent with a contemporaneous drop in the level of Agassiz during the low water-level Moorhead Phase (c. 11,000–10,000 BP) (Buchner and Pettipas 1990: 53).

From this evidence, therefore, it seems that at least one component of the Folsom land-use strategy in southwestern Manitoba included the utilization of recently drained proglacial lake surfaces. Since the paleoecological data from the Flintstone Hill site indicate that at least one residual wetland in the Hind basin was a low-diversity, treeless fen — assuming the sample location is broadly representative of similar contexts — it seems unlikely that these drained regions would have provided an adequate hunter-gatherer resource base in themselves. Instead, given indications at several Plano[2] Paleoindian sites of a bison mass-drive and entrapment hunting technique in association with natural barriers (e.g., sand dunes [Frison 1971], arroyos [Wheat 1972], ponds [Sellards et al. 1947], and glaciolacustrine sands at the Fletcher site in Alberta [Forbis 1968; Quigg 1976; Vickers and Beaudoin 1989]), these areas may have provided reliable opportunities for the planned entrapment of bison in wet clay beds and spillway channels. Although a Folsom bison kill site in Manitoba has yet to be found, this argument is supported in a general way by the location of early fossil bison remains in the province.

The presence of fossil bison in association with the proglacial lake-spillway system is reasonably well established. In the Swan River valley of west-central Manitoba, for example, fossil bison remains have been recovered from gravels on an extensive spit complex situated between the Upper and Lower Campbell strandlines of glacial Lake Agassiz (Nielsen et al. 1984). These remains are, morphologically, rather large and were assigned to either *Bison bison occidentalis* or *B. bison antiquus* by the original analysts (Nielsen et al., 1984: 834). Three radiocarbon dates were obtained from these materials: 10,300 ± 200, 9400 ± 125, and 9,500 ± 150 BP (Nielsen et al. 1984: 832). Other bison remains of the "*occidentalis*" phenotype have also been recovered from middle Holocene fluvial contexts in southern Manitoba (e.g., Dyck et al. 1965; Steinbring 1970; Nielsen et al. 1996: 12–13). These recoveries suggest that the former range of early bison, at least in part, included lake margins, rivers, and other wetland locales. This pattern, furthermore, was probably established by at least Folsom Paleoindian times (Nielsen et al. 1984: 838). On this basis, the Folsom materials recovered from within the glacial Lake Hind basin may indicate a deliberate exploitation of this behaviour. Given the paucity of Folsom projectile points in southern Manitoba, this strategy may have been a relatively late and short-term development, perhaps coinciding with the initial deterioration of *Picea glauca* woodlands prior to the Emerson Phase glacial readvance (i.e., shortly before c. 10,000 BP).

The McKean Complex and the Development of Prairie in the Hind Basin

The Middle Holocene Geological and Paleoecological Records

Following c. 9,300 BP, but prior to c. 6,700 BP, a series of crude fining upward sequences of clays, silts and some sands was deposited in the area of the Flintstone Hill site (Figure 3). Based on the radiocarbon constraints, as well as the relative sequence of events outlined in Sun (1996) and Sun and Teller (1997), these sediments are probably alluvium, deposited after the initial incision of the Souris River into lacustrine deposits (Boyd 2000). After c. 6,700 BP (c. 7,600 cal BP[3]), at least one eolian sand sheet was deposited across the 2 km study area. The lowest of these overlies the Souris unit (i.e., the alluvium) without evidence of an erosional unconformity. Instead, a coarsening upward sequence is indicated: from gleyed silts and clays, to silty sand, to the sand-dominated lower sand sheet subunit (Figure 5). At the contact between the Souris unit and the lower eolian sand sheet subunit, plant macrofossils (which yielded a date of 6,700 ± 70 BP [Table 1]) are abundant, and consist mostly of leaves from the thermophilous tree species *Quercus macrocarpa*

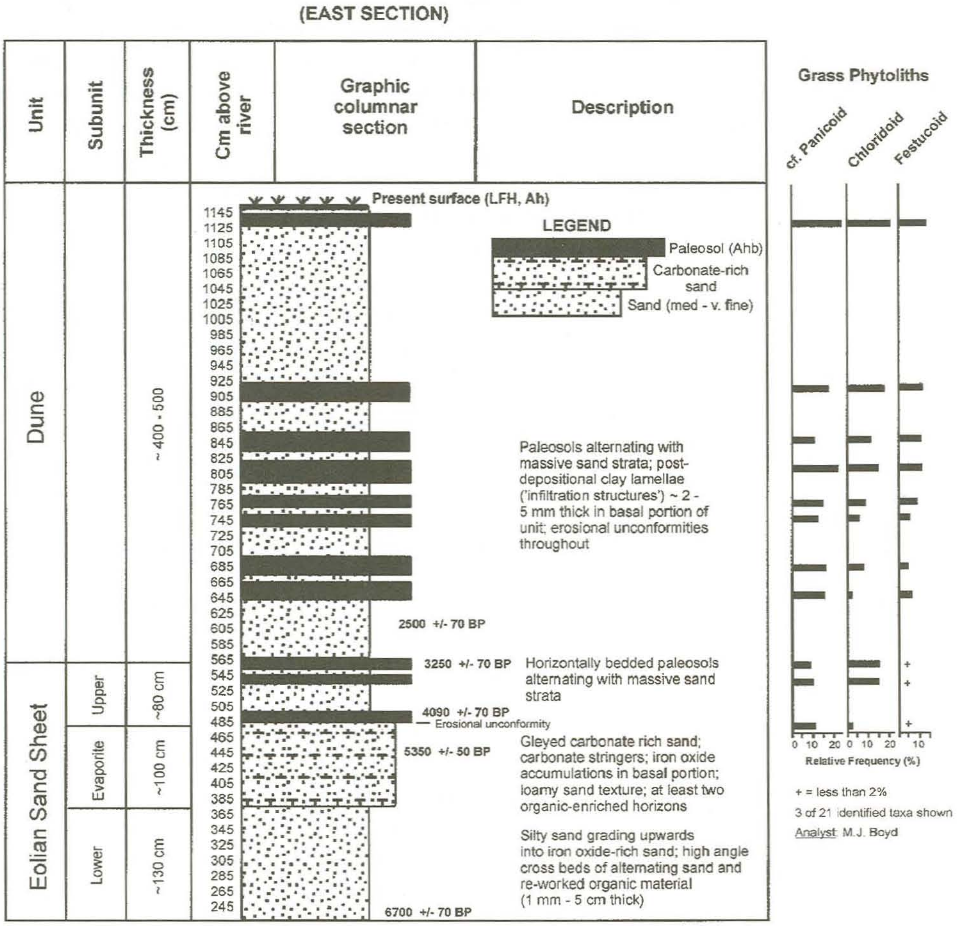

Figure 5. Composite Schematic Column of the Flintstone Hill Cutbank (Eolian Sand Sheet and Dune Units), Southwestern Manitoba (Source: M.J. Boyd and G.L. Running IV, July 1998).

(bur oak), and seeds of *Cornus stolonifera* (red-osier dogwood), *Vitis riparia* (riverbank grape), *Sparganium* sp. (bur-reed), and *Rubus idaeus* (raspberry) (Boyd 2000). The pollen profile, while indicating the predominance of *Quercus* (35–85 percent), also attests to the importance of *Populus* (5–40 percent) and grasses (2–15 percent), and the local presence of *Salix* (willow) (0–10 percent) (Boyd 2000). Based on the range of moisture regimes implied by the plant assemblage, a mosaic of dry (i.e., prairie), mesic/riparian oak forest, to wetland habitats probably lined the inside edges of the south-central Hind basin (in the vicinity of the Souris River) by c. 6,700 BP. While no paleosols (buried soils) have been found in the lower eolian sand sheet subunit, some alternating, thin (1 mm–5 cm), high-angle cross beds of sand and reworked organic duff were observed (Boyd 2000).

Following c. 6,700 BP, the development of the Oak Lake aquifer in the south-central Hind basin is strongly indicated in the lower eolian sand sheet and evaporite subunits (Figure 5). These subunits indicate a progressively rising water table for at least part of the middle Holocene on the basis of the following: 1) post-depositional, upward-contorted, accumulations of iron oxide in the lower eolian sand sheet subunit; 2) the presence of thick gleyed sediment in the overlying evaporite subunit; and 3) the appearance of iron oxide accumulations below the concentration of more soluble carbonate minerals in the evaporite subunit, implying upward water movement (Figure 5) (Boyd 2000). The rather profound accumulation of carbonate minerals in the evaporite subunit suggests mineral concentration by evapotranspiration of groundwater (Boyd 2000).

Together, the lower eolian sand sheet and evaporite subunits suggest that the period following c. 6,700 BP was characterized by an initial increase in effective precipitation (producing a rising water table), followed by a period of drought (producing high rates of evapotranspiration and the evaporite deposit). Significantly, this trend mirrors recent evidence from Ingebrigt lake (southwestern Saskatchewan) for high relative humidity between 7,200–6,500 BP, followed by a period of much lower relative humidity between 6,500–5,500 BP (Shang and Last 1999: 107).

Following 4,090 ± 70 BP (c. 4600 cal BP), but prior to 3,250 ± 70 BP (c. 3,500 cal BP), a series of significant changes were initiated in the study area (Figure 5). By this time, at least two parallel planar-bedded paleosols formed across the site, interbedded with massive sand strata (Figure 5). These paleosols (c. 10–20 cm thick) consist of simple, black, Ah-horizons, suggesting development under predominantly grassland vegetation (Dormaar and Lutwick 1966; Buol et al. 1989). This pedologic interpretation is supported by a grass-dominated microfossil assemblage associated with the buried soils, and a simultaneous absence of arboreal indicators. Grasses, in this analysis, were identified on the basis of diagnostic phytolith forms produced by the precipitation of hydrated silicon dioxide inside the living plant tissue (see Brown 1984; Twiss 1992). As Figure 5 shows, grass phytoliths from the upper eolian sand sheet paleosols are mostly derived from the Chloridoideae (warm/dry short grasses) and Panicoideae (warm/moist tall grasses) subfamilies. This is consistent with the modern composition of grasses in the open prairie and sandhill locales across the study area; in contrast, as summarized above, the regions covered by open *Populus tremuloides* forest tend to have a greater Festucoideae native grass component.

These lines of evidence suggest that the period between c. 4,100 and 3,300 BP was characterized by extensive eolian landscape stability and the widespread growth of prairie taxa on uplands in the south-central Hind basin. The trend towards increased landscape stability during this period may be due to the onset of higher relative humidity between c. 5,000 and 2,000 BP on the northern prairies (Shang and Last 1999). This rather lengthy period of landscape stability and relatively moist conditions is recorded in many basins across the region (see summaries in Lemmen 1996; Vance 1997; Xia et al. 1997).

In contrast, between c. 6,700 and 4,100 BP, the Flintstone Hill lithostratigraphic record shows little evidence of landscape stability. Instead, this period was characterized by the deposition of at least one eolian sand sheet, a rising water table and the development of a playa system, followed by high rates of groundwater evapotranspiration. These conditions may have prohibited, in the long run at least, widespread prairie growth across the south-central Hind basin. Instead, for at least part of the middle Holocene, grassland vegetation may have been far more "patchy" across the study area due to circumscription by extensive playas and greater eolian activity. This model would imply a far more lengthy process of grassland succession for the Hind basin as a whole, in contrast with upland regions on the northern plains. In North Dakota, for example, open prairie rapidly replaced the early postglacial spruce forests at c. 10,000 BP (Grimm 1995). In southern Saskatchewan and Manitoba, spruce forests were succeeded by deciduous parklands prior to establishment of open prairie at c. 8,800–9,000 BP (Ritchie and Lichti-Federovich 1968; Yansa and Basinger 1999).

McKean Complex (c. 4,000–3,000 BP) Site Distributions and Implications

McKean sites are scattered across much of southern Manitoba, although some prominent clusters are apparent (Figure 6). These concentrations seem to be broadly associated with modern lowlands, rivers, wetlands, and lakes (e.g., Swan River Valley [I], the Hind basin [II], Pembina River and Rock Lake [III], and the Winnipeg River system [IV]). Although, in small part, these site distributions may reflect some collection biases (e.g., slightly higher concentrations near towns and

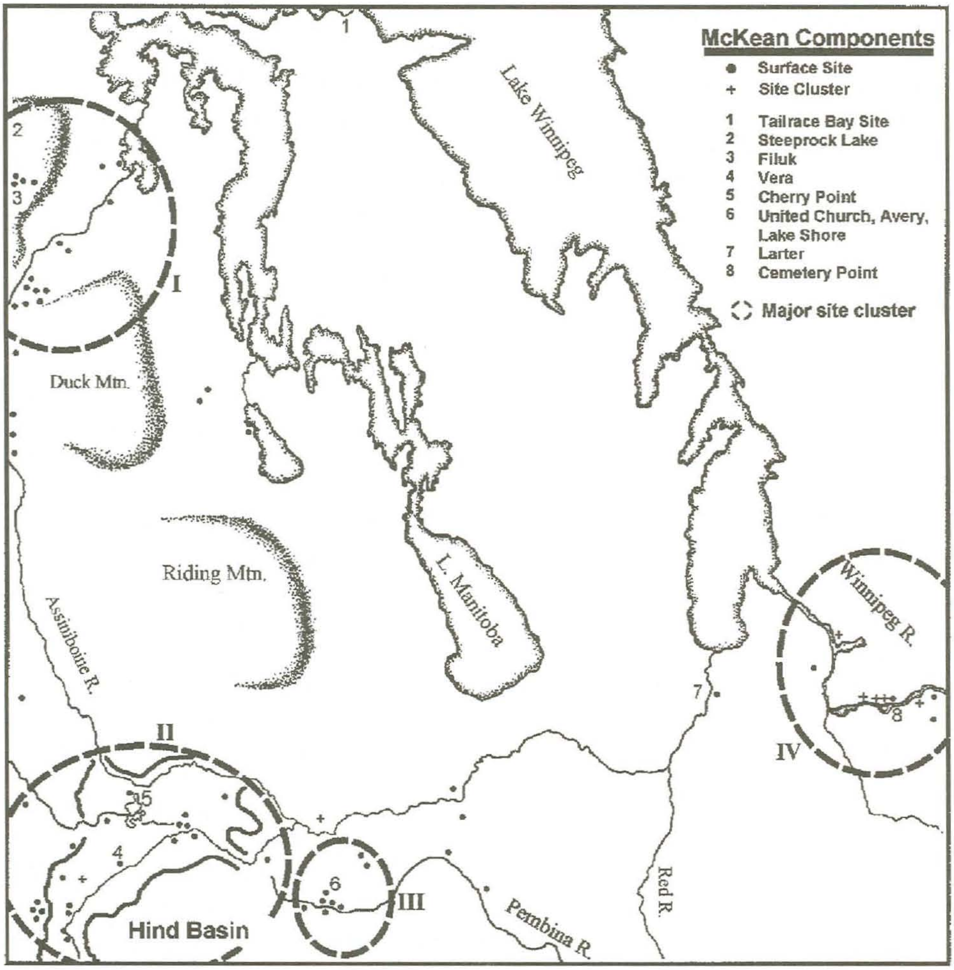

Figure 6. Location of McKean sites in southern Manitoba.

cities, differences in site visibility, etc.), the apparent paucity of sites on higher areas within the Manitoba Escarpment suggests that other factors are involved. This must be the case since the Glacial Lake Agassiz Survey — the major effort responsible for mapping the majority of McKean surface sites shown in Figure 6 — also examined these more elevated regions. For this reason, the distribution of McKean complex sites in Manitoba is mostly accepted as an artifact of real settlement patterning, rather than simply a collection bias (Syms 1970).

In the context of the geological and paleoecological reconstructions presented above, the duration of the McKean complex is clearly contemporaneous with the initiation of widespread landscape stability and the more extensive growth of prairie vegetation in the study area. Since there is also strong evidence for the development of a high water table (i.e., the Oak Lake aquifer) prior to the late Holocene, by at least 4,000 BP the region had probably developed into a large mosaic of wetland and prairie. Since the Hind basin seems to be associated with a regional cluster of McKean sites, deliberate selection for this type of landscape may be indicated. Indeed, close proximity to an ancient marsh or slough is found at both the Cherry Point (Haug 1976; #5 in Figure 6) and Vera sites (Nicholson and Hamilton 1998; #4 in Figure 6). Significantly, Wright (1995: 316) observes that McKean bison kill sites across the Canadian Prairies as a whole tend to be associated with modern sloughs (Wormington and Forbis 1965; Haug, 1976), river valleys (Adams 1976), tributaries (Wettlaufer and Mayer-Oakes 1960), and major moraines (Kelly and Connell 1978). The choice of site location probably reflects several criteria. To some extent, as suggested for the Cactus Flower site (Brumley 1975), these locations may have been key points on the landscape that afforded reliable opportunities for the entrapment of bison along their seasonal migration routes.

Conclusions

Southwestern Manitoba was a very different place from Folsom to McKean times. In the study area, Folsom hunter-gatherers would have encountered a proglacial lake which, by c. 10,400 BP was confined to only the deeper, north-central portion of the Hind basin (i.e., the Phase 9 boundary [Figure 1]). At some point following the gradual recession of glacial Lake Hind, Paleoindian populations probably made limited incursions into recently drained areas within the basin. These locales may have provided reliable opportunities for the entrapment of bison in wet clay beds, spillway channels, and other landscape obstacles. To some extent, this hypothesis is supported by the recovery of early fossil bison remains on Holocene floodplains (Dyck et al. 1965; Steinbring 1970), and adjacent to the western margin of glacial Lake Agassiz (Nielsen et al. 1984). Radiocarbon dates indicate that bison were exploiting these locales in Manitoba by at least 10,100 BP (Nielsen et al. 1984: 838).

The Folsom land-use strategy suggested in this study may have been part of a larger pattern. In west Texas, for example, Boldurian (1991: 285) argues that *Bison bison antiquus* probably established patterns of movement along deeply incised fluvial systems, "where an adequate supply of water and vegetation existed." Assuming that Folsom groups in the southern plains focused mainly on bison procurement, their seasonal rounds would have coordinated with major movements of these herds (Broilo 1971; Boldurian 1991: 285). It is perhaps not coincidental that many of the major river valleys in west Texas also pass through the source areas for the predominant siliceous stone materials used by Folsom hunter-gatherers in this region: Edwards chert, Alibates agate, and Tecovas jasper (Boldurian 1991: 284–85). As in most regions, however, Folsom settlement pattern studies in Texas are hampered by statistically insignificant projectile point distribution data (Largent et al. 1991).

In southern Ontario, Paleoindian settlement strategies have been linked to strandlines and beaches of former glacial lakes (e.g., Storck 1982; Stewart 1984; Ellis and Deller 1990). An association with the contemporaneous strandline of glacial Lake Algonquin appears particularly strong (Storck 1982; Deller et al. 1986); notably, approximately 66 percent of sites along this physiographic feature occur near "complex" (i.e., indented rather than straight) strandline features such as former lagoons, islands, peninsulas, and embayments (Storck 1982: 19). Such locales may have provided access to larger areas of shoreline habitat within a short radius of the site than would locations on straight coastlines (Storck 1982: 23). This strong "orientation" to the strandline, moreover, is also supported by the fact that all of the sites have unrestricted visibility of this feature and, for approximately 40 percent of the sites, visibility is restricted by the surrounding terrain to the strandline only (Storck 1982: 23).

By the end of the middle Holocene (c. 4,100–3,300 BP), a period of greater landscape stability was initiated in the south-central Hind basin. This period was characterized by the development of more extensive grasslands above the Oak Lake aquifer, creating what may have been a very large mosaic of wetland and dry prairie. Since the Hind basin appears to be associated with a regional cluster of McKean sites, deliberate selection for this prairie wetland-riverine locale may be indicated. This, in turn, argues that the larger spatial association between McKean sites and modern lakes, sloughs, and river valleys across the Canadian Prairies may indeed be a faithful reflection of the original land-use pattern. Given the evidence of repeated bison kills at several McKean sites in Canada (e.g., Brumley 1975; Haug 1976), these locations may have been key points on the landscape that afforded reliable opportunities for the entrapment of bison along major migration routes. It is also important to note, however, that these locales may have been attractive for a number of additional reasons: e.g., aquatic/semi-aquatic plants and animals, and drinking water in the summer; firewood and windbreaks during the winter, etc. More than any one reason, it is perhaps this characteristic — i.e., the intersection of a number of different types of resources — which made these locales important points on the Precontact "economic landscape."

Despite significant changes in landscape and vegetation from the terminal late Pleistocene to the end of the middle Holocene in the Hind basin, it is interesting to note that Folsom and McKean hunter-gatherers may have spatially "mapped on" to the physical world according to a highly similar, and successful, economic strategy. At least in part, this shared strategy may have involved the entrapment of small numbers of bison in association with wetlands and river/spillway systems. Thus, while the precise location of sites may not necessarily be the same from Folsom to McKean times, a common land-use strategy may still have existed.

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Notes

1. A complex is a consistently recurring assemblage of artifacts or traits which may be indicative of a specific set of activities, or a common cultural tradition.
2. The Plano complex, originally defined by Jennings (1955), is a general term used to refer to several, presumably distinct groups recognized by unfluted, lanceolate projectile points. These materials post-date the Clovis and Folsom types (i.e., c. 10,200–8,000 BP), and are found throughout the United States Great Plains and Canadian Prairies.
3. This value is the approximate mean of the calibrated range presented in Table 1.

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