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Bootlegger Trail Site

A Spring Bison Kill

THE BOOTLEGGER TRAIL SITE,

A LATE PREHISTORIC SPRING BISON KILL

by

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appendices by

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Foreword

Interagency Archeological Services (IAS), Heritage Conservation and Recreation Service, is proud to announce a new publication series, Interagency Archeological Services Investigation Reports.

This series will include exemplary reports produced as a result of data recovery activities coordinated by IAS. By publishing these outstanding reports, we hope to demonstrate that research archeology and compliance archeology are compatible endeavors, and that work conducted as a result of federal requirements can make substantive contributions to archeology and anthropology. We hope that the example set by these reports will encourage archeologists to view their own compliance work as an opportunity to conduct research oriented archeology.

The first report in the series, The Bootlegger Trail Site, by Dr. Tom Roll and Dr. Ken Deaver, was originally produced by Montana State University. Bootlegger Trail, like other projects reported in this series, was a result of a federal agency's compliance with historic preservation law. The sponsoring agency was the Water and Power Resources Service, then the Bureau of Reclamation. The site was located in an area impacted by the Water and Power Resources Service's Tiber Reservoir, and without this research project the valuable information content of this site would have been lost as a result of shoreline erosion.

The report presents excellent descriptions of excavation techniques at this bison kill site, as well as a model of subsistence. This model contributes greatly to our understanding of seasonal activities of late prehistoric hunters and gatherers in the project area.

Bennie C. Keel
Chief, Interagency Archeological Services

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I am indebted to a number of people and agencies who made the Bootlegger Trail Site excavations possible. Funds for the first year of basic research were administered by the National Park Service. The second year of excavation was funded directly by the Water and Power Resources Service. The Water and Power Resources Service contracted for the 1976 work to fulfill the terms of a Memorandum of Agreement to mitigate potential impacts to the Bootlegger Trail Site. This Memorandum of Agreement was entered into by the Water and Power Resources Service, the Advisory Council on Historic Preservation, and the Montana State Historic Preservation Officer. Montana State University assumed the burden of the Principal Investigator's salary and the costly transportation and provided necessary facilities and computer time. The Water and Power Resources Service provided field housing for the first year at minimal cost. The Reservoir supervisor, Mr. Don Stores, proved an excellent host. The second year, when Water and Power Resources Service housing was no longer available, Earl and Wanda Keith, Chester, Montana, graciously consented to rent us their house under most reasonable terms.

Other local people who made our stays memorable included Mr. Dale Nelson, Mrs. Iva Kolstad, and Mrs. Helen Aaberg, the postmistress in Chester, Montana, who aided us in many ways. Irwin Underdahl, who lives approximately two miles south of the site, on the Bootlegger Trail, provided assistance with several rather sticky situations. Mr. John Darroch, Bozeman, Montana, provided invaluable aid in setting up the camp and starting excavations in the summer of 1975. Michael Wilson, Calgary, Alberta, visited both summers and provided valuable assistance and insights to the faunal remains.

To the students and assistants who partook in the excavation, I offer particular thanks. In 1975, students included Steve Bolton, Nicholas Chevance, Holly Coursen, John W. Fisher, Jr., Paul Mattson, Keith Mobley, Jeanne Moe, Gary Nichol, Nancy Patterson, Mary Ann Semock, and Nancy Swilley. Claudia Mobley cooked for the crew. Student assistant was Kristie Arrington. Jean A. Roll acted as lab supervisory, and Ken Deaver was the field supervisor. 1976 students included Barbara Beroza, David Beumee, Richard Bly, Lenny Dwenger, Linda Gifford, James Hipsher, Denise Lyttle, Susan Parke, Anita Ritzhaupt, Dennis Schoepp, and Arlyn Stoltz. Darcy Klinkel produced the food. Steve Bolton and John W. Fisher, Jr., acted ably as student assistants. Jeanne Moe was the lab supervisor, and Ken Deaver assumed the onerous duty of field director.

Once back in the laboratory, a number of people provided computer support, in the particular Dr. C. Jack Gilchrist, Cel Allard, and Bob Hunter of the Center for Social Data Analysis. Charles Zeier acted as laboratory supervisor for a six-month period, during which time most of the data were coded, placed on cards, and

analysis begun. Zeier was also responsible for instituting the computer-organized distributional plot of artifacts and features.

The appendix to this report by Jeanne Moe, John W. Fisher, Jr., Steve Bolton, and Dennis Schoepp was a combined effort, but in many respects, the efforts of individuals need recognition. John W. Fisher, Jr., did most of the analysis on bone tools and ceramics. Steve Bolton and Dennis Schoepp shared the lithic analysis. Jeanne Moe handled miscellanea and organized the appendix, in addition to adding the contribution on lithic classification.

The majority of the drafting was ably accomplished by Marc Smith. Marilyn Bailey was faced with the task of aiding me to do artifact sorts and a tremendous number of last-minute alterations in schema that had developed over the two-year analysis period. Ken Deaver's almost superhuman task of analyzing more than 20,000 bones must receive recognition beyond that of his participation in this report. Any payment he received I consider far less than his contribution. Indeed, this report would amount to much less without his participation. Although as Principal Investigator I must accept ultimate responsibility for the flaws that may result, the ideas expressed and the efforts expended are the result of a collaboration by Ken Deaver and myself. Lastly, I want to thank my wife, Jean Roll, for her fortitude in dealing with this project throughout, during my moments of lassitude and of extreme energy. I also thank her for typing preliminary drafts and the final report.

Tom E. Roll
Principal Investigator

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I. INTRODUCTION

PROLOGUE

This report presents an interpretation of data recovered during two summers' work at the Bootlegger Trail site. From this interpretation, the following scenario may be developed.

For generations the ancestors of the People, and others, used the gully-dissected south bank of the Marias River breaks as a place to kill bison. They came to the winding, gentle draw this time in late winter for that purpose. They knew that the high, wind-swept, grassy plains provided conditions sufficient for aggregation of thousands of the shaggy beasts. Even during the long Montana winter, the chinook winds that flowed off the eastern slopes of the Rocky Mountains ensured the presence of exposed grasses at intervals. Rarely did a complete snow cover persist for more than several weeks.

Relying on their knowledge of the area and of the bison they hunted, the People had previously constructed a set of guidelines leading from the plains over a low bluff and onto a large, flat terrace several square miles in area. From the terrace the guidelines, composed of individual rocks interspersed with occasional low rock cairns, wound their way to the northeast and terminated at the crest of a ridge between two shallow draws. Some years earlier they attempted to kill bison here, but the herds failed to assemble and they killed only a few.

This winter when the People arrived to put the finishing touches on the drive and the killing place, the bison had not yet come together on the plain above; perhaps snow accumulated since the last chinook overlay the gathering area.

The People continued their preparation for the ensuing hunt while they waited for more bison to appear. They added finishing touches to the drive lines and the kill. To process and store the products of the impending hunt, they developed food-processing facilities and their necessary accouterments. They scoured the cottonwood-lined river bottoms for firewood and gathered quantities of rocks suitable for boiling stones. Pits had to be excavated, some to serve as hearths, others as stone boiling pits. They constructed smoking or drying racks nearby. As the time for the hunt neared, anticipation heightened and they carefully manufactured and inspected arrow points and shafts, knives, scrapers, and choppers.

During the preparation of the drive, the kill, and the processing facilities and implements, the People avoided the bison on the plains above and focused their hunting activities on smaller game

in the breaks and river bottoms. They hunted, killed, and ate beaver, rabbit, coyote, and fox. Several hunters brought in deer, pronghorn, a wapiti, and even a grizzly bear. The limited resources available slowly dwindled; ultimately they killed and ate several of the precious dogs.

Preparation for the big kill and acquisition of food, however, did not occupy all their time. During moments of leisure, they indulged themselves in nonutilitarian activities. The toe bones of both dogs and rabbits provided raw material for the manufacture of tubular bone beads, and they formed elk canines, fossil belemnites, and thick pearlescent shells of local molluscs into both pendants and beads. At the end of a long day, an occasional pipe was lighted, perhaps as an offering, perhaps for enjoyment.

Finally, in late February, a sufficient member of bison appeared on the plain above the kill. The hunters slowly hazed the herd, mostly cows and young bulls, downhill onto the large, flat terrace. Once on the terrace, the bison began to break up, but many turned to the northeast, toward the kill.

Once they had the animals contained, the hunters proceeded with the kill; arrows flew until the last animal dropped. Because of the animals' large size and the hunters' excitement, numerous arrows often struck the animal before it died. Since considerable work lay ahead, dismembering the animals began immediately. At this stage in the butchering process, the hunter removed the hide, using a sharp stone knife to make the initial incisions. Setting the knife aside for later use, the worker continued the butchering process with large, heavy quartzite chopping tools and implements manufactured from the dense bones of the bison itself. The worker abandoned these tools, so easily made, at the site of their use.

The People moved the appendicular elements of the dismembered bison downslope for more extensive processing but mostly abandoned the less desirable axial skeleton where it fell. Almost immediately they devoured particularly desirable portions of the animal, such as delectable internal organs and the developing fetus present in so many cows. They smoked or dried strips cut from muscle tissue of the more mature animals and immersed the bones and fatty tissue in vats manufactured by lining the previously excavated pits with impermeable membranes, either a hide or a paunch from a recently killed animal. Heated rocks dropped into the vats with the bones brought the water to a low boil. Gradually the rich bone grease floated to the surface, and they skimmed it off and stored it for future use. While thus reducing the animals to storable produce and raw material, the People sharpened, broke, reworked, exhausted, lost, and deliberately abandoned a variety of implements and utensils related to the activities accomplished.

After the work of killing and processing, clean-up and resupply began, for the People's requirements for food and raw materials had not yet been met. Over the next six weeks, they repeated their actions time after time. The number of animals killed each

time increased until the middle of March, then slowly the number taken decreased.

As gradually as the bison appeared on the plain, so did they disperse, and by early April they had moved to new grazing locales in anticipation of the birth of their calves. Before the bison abandoned the area, the People had killed and butchered nearly 900 of the thousands that had gathered.

Some time later, one year or 50 years, the People returned and the process began again. This time, the bison appeared in smaller numbers and fewer were killed. The smaller numbers forced the People to utilize those killed more completely. They produced smaller bone fragments, extracted the marrow more completely than previously, and this time they transported more of the axial skeleton to the processing area.

Once again the bison and the People moved on. Once again the bison and the People returned. The People repeated the cycle at least four times and finally abandoned the kill.

PROJECT LOCATION AND DESCRIPTION

The Bootlegger Trail originally traversed 160 km of the sparsely populated, gently rolling, glaciated portion of the northwestern Plains between the Canadian border and Great Falls, Montana. About 75 km south of the Canadian border, the trail forded the easterly flowing Marias River 115 km upstream from its confluence with the Missouri River. Tiber Reservoir (Lake Elwell), a 42-km-long impoundment completed in 1956, now inundates about 3 km of the Bootlegger Trail (Fig. 1).

The Bootlegger Trail site, named for its proximity to the locally renowned illicit liquor route, was discovered in 1974 by Montana State University students during a post-inundation archaeological assessment of Tiber Reservoir (Roll 1978). High reservoir pool levels during 1964 and 1965, abetted by subsequent spring runoff in the draw that contains the site, had exposed a small quantity of butchered bison bone at an elevation of about 915 m (3000 ft) above mean sea level, 4 m below maximum flood pool. Late in the 1974 field season, excavation of four 2x2 m test pits, .4-.8 m deep, produced two cultural strata (at that time the sparse quantity of bone in the uppermost strata led us to conclude it resulted from slope wash) and a single small side-notched obsidian projectile point that indicated a Late Prehistoric period (A.D. 700-1725) chronological affiliation. In addition to the four test pits at the bottom of the draw, careful surface collection and shovel tests farther upslope revealed occasional lithic artifacts and substantial quantities of broken bone and heat-fractured rock.

Based on the limited tests and intensive surface collection of 1974, our interpretation of the site was that the cultural debris

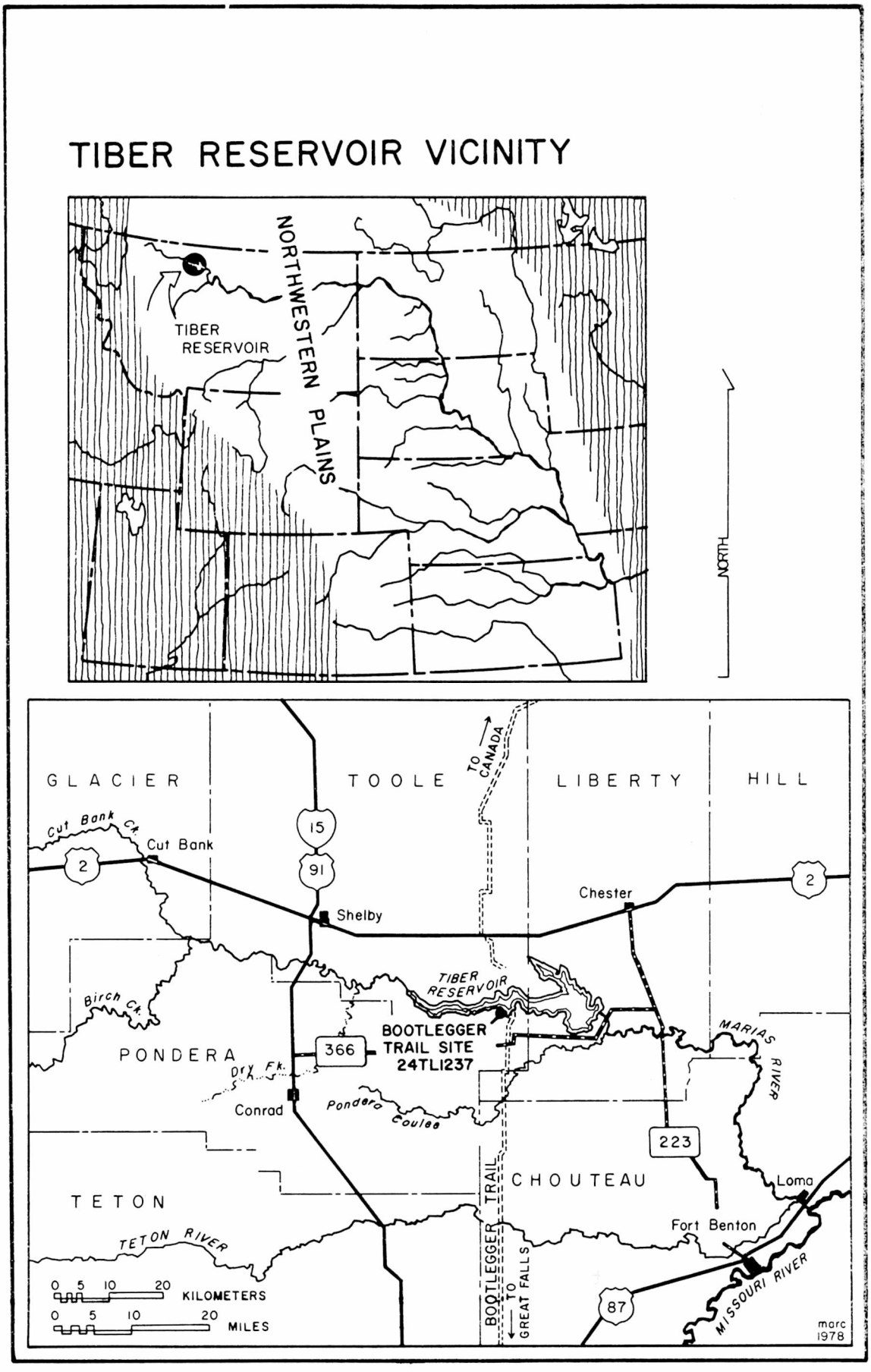


Fig. 1. Tiber Reservoir vicinity.

observed in the wave-cut exposure that first revealed the presence of the site resulted from redeposition and that essentially intact primary deposits lay about 200 m south (up-gully) at elevations from 920-935 m (3018-3067 ft) above mean sea level. Although an archaeological site clearly existed, accurate assessment of its significance proved difficult, as no incontrovertible evidence of its size, depth, or chronology appeared in available exposures.

Because of the inconclusive evidence produced by the limited 1974 investigations, we returned to the Bootlegger Trail site in 1975 with three purposes in mind.

1. To assess the nature of impact to the site that would result from an increase of 2.75 m (9 ft) in maximum flood pool (918.95 m to 921.70 m a.m.s.l.). Despite the fact that the 1974 survey was initiated as a post-inundation survey, it soon became an impact survey when the Bureau of Reclamation informed us that repairs to the Tiber Dam spillway structure would also involve increasing the height of the dam and enlarging the reservoir take area. In 1977 we received information from the Bureau of Reclamation that the increase in dam height had been reduced from 2.75 m to 1.52 m (5 ft). The increase in pool level is based on a projected 1000-year flood, and in effect the new dam height will not alter flood control or water storage levels.

2. To evaluate the site in order to determine eligibility for nomination to the National Register of Historic Places. According to 36CFR1202.6 (41FR1595) for "...districts, sites, buildings, and structures..." to receive consideration for inclusion on the National Register of Historic Places they must have "The quality of significance in American history, architecture, archeology, and culture . . ." and ". . . have yielded, or may be expected to yield, information important in prehistory or history." These criteria seem straightforward until one attempts to nominate an archaeological site to the National Register. At that time it becomes apparent that demonstration of "significance" or the potential to yield "information important in prehistory" requires information in the form of hard, empirical data, not blissful opinion.

3. To investigate a series of research-oriented problems pertinent to northwestern Plains prehistory.

a. From limited tests, the site appeared to be a single-event kill site. Many previous kill excavations have tended to focus on multiple-event kills with emphasis on diachronic relationships (cf. Forbis 1962; Kehoe 1967, 1973; Davis and Stallcop 1965, 1966; and Brumley 1976). The opportunity to excavate a single-event kill should permit observation of synchronous activities and cultural assemblages associated with bison killing and processing without the problem of isolating the multiple events present in many kill deposits (cf. Frison 1974 and Wheat 1972).

b. The intensive surface collection of 1974 disclosed three concentrations of cultural debris indicative of a kill-primary butchering area and one or more areas devoted to subsequent processing of the dismembered carcass. The proximity of these areas to one another offered the rare opportunity to investigate in detail the nature of interaction between kill and process areas, the specialization of rough butchering compared with processing, and the nature of tools and features related to these specific activities.

c. The site provided opportunity to test the value of more precise recovery and recording techniques than have typically been used in the excavation of bison kill sites. Because of the enormous volume of material recovered from many bison kills, excavation and recovery techniques have tended to focus on gross recovery rather than precise provenience. It was hoped that more accurate recovery and recording methods might yield additional information both in terms of synchronic interrelationships and the environmental (microfauna) data.

Information gained from the slow, tedious 1975 excavations provided insights into the site's spatial extent, depth of deposits, chronology, and location of activity-specific areas. By the end of 1975, there existed information sufficient for basic cultural resource management decisions. We could state that if maximum flood pool were established at 921.7 m a.m.s.l. the downslope portion of the large processing area (Area B) would be subjected to undesirable erosion. Other areas of the site, though not endangered by inundation, had received considerable attention simply through our presence. This, and proximity to a major recreation access, would likely result in predatory recreational collecting.

The nature of the buried deposits clearly indicated that the site qualified for nomination to the National Register of Historic Places, and nomination forms were submitted to the National Park Service and the Montana State Historic Preservation Officer in fall 1975.

Although the 1975 excavations helped clarify the cultural resources management problem and resolved some research questions, they also presented a series of new problems.

The discovery of two distinct and at least two ephemeral culture-bearing strata in the lower processing area quickly dispelled our earlier misconception that the site contained a single-event kill with associated processing areas. This intensified the problem of establishing chronological association between the kill and various processing area strata.

By the middle of the 1975 field season, preliminary analysis of the faunal remains revealed the presence of relatively substantial numbers of fetal bison remains. Other investigators have reported

the recovery of fetal bison bone (Brumley 1976; Wilson 1974; Quigg 1974; Frison and others 1978), but they appear in unprecedented numbers at Bootlegger. The fetal bison remains, cross-checked with bison dental eruption and wear patterns, provided an excellent opportunity to determine the Bootlegger kill season with some precision.

Cooper (1955) and Miller (1963) described ceramics excavated in 1950 and 1955 from the Galata site (24TL26) about 1.5 km northwest of Bootlegger. Others have reported sporadic finds of ceramics in north-central Montana and southern Alberta (Wedel 1951; Kehoe 1959; Byrne 1973; Keyser 1977). The discovery of seven sherds in the lower Bootlegger processing area presented a tantalizing lure for additional excavation.

II. THE ENVIRONMENTAL SETTING: PRESENT AND PAST

INTRODUCTION

The Bootlegger Trail site is approximately 45 km southeast of Shelby, Montana. The site is near the southeastern corner of Toole County, latitude 48°, longitude 111°. This location appears on the Pondera School Quadrangle, 7.5-minute series, topographic sheet issued by the United States Geological Survey.

A nearly flat plain characterizes the area around the site. In scattered localities it assumes the nature of a low rolling plain. Rivers and seasonal streams cut the entire area. The site lies at an elevation of 915-935 m; however, immediately north of the site the Marias River has cut a steep 45-meter-deep canyon into the upland plains. The area around the site lies on the extreme western edge of the northwestern Plains. The Rocky Mountains rise to elevations of over 3000 m in Glacier National Park, 160 km to the west. The Sweetgrass Hills, 50 km north of the site, reach elevations over 1850 m.

Fairly consistent climatic patterns characterize much of the northwestern Plains. Cold, dry winters and warm, relatively dry summers dominate the areal climate today. Extremes of temperature recorded at nearby Chester, Montana, range from -48°C (-55°F) to 40°C (104°F)(U.S. Department of Agriculture 1941), and during the summer daily fluctuation may range from 10°C to 38°C. A frost-free season of about 115 days typifies the immediate region, with mid-May and mid-September the times for the last and first freezes (Caprio 1965).

Although precipitation varies dramatically from year to year and cyclically ("the dirty thirties"), the entire northwestern Plains consistently receive little precipitation. Annual precipitation rarely exceeds 500 mm (20 in) and the record from 1941-1970 indicates a mean precipitation of 305 mm (12 in) (Ross and Hunter 1976:53). Most of the precipitation falls during the early spring and summer, but violent thundershowers may occur at any time during spring or summer. Relatively brief winter storms deposit snow that accounts for about 25 percent of the total precipitation. The chinook phenomenon brings warm downslope winds from the west, breaking the winter cold and keeping the plains devoid of snow throughout much of the winter.

Three main air masses contribute to the weather patterns of the entire northern Plains region (Borchert 1950). The dry, mild Pacific air mass dominates the entire region during the winter. This results in strong winds from the west. They are generally dry, having lost most of their moisture over the mountain ranges

to the west. By March this dry continental air flow becomes less dominant. From March through June, Arctic and Tropical Maritime air masses may bring winds from the north or south respectively. The Arctic air mass is normally cold and dry, but the Tropical Maritime mass brings warm wet air from the Gulf of Mexico. Characteristically, late summer and fall return to the dominance of the dry Pacific mass over most of Montana. Farther to the east, much of the northern Plains continues to receive wet Tropical Maritime air during the late summer. This results in two distinct climatic regions that receive substantially different amounts of annual precipitation (Borchert 1950).

Three types of grassland vegetation reasonably characterize the northern Plains: tall-grass, mixed-grass, and short-grass prairies (Kuchler 1964; Watts 1960). The three types contain many common species. With increasing effective precipitation to the east, the taller species dominate. In the western part of the region, increased aridity results in shorter dominants (Walter 1973: 171). Short-grass prairies occur in the area around the site. Mixed-grass prairies predominate to the north and west at slightly higher elevations.

We conducted a survey of vegetation near the site. On the flat or gently rolling plains above the river, the short-grass vegetation dominates. *Bouteloua gracilis*, *Stipa comata*, and one or more species of *Carex* dominate most communities. These form the climatic climax. Subordinates such as *Agropyron smithii* and *Poa secunda* occasionally become more common in topographic climaxes. *Artemisia frigida* and a species of *Opuntia* occur fairly commonly on well-drained south- and west-facing exposures. Communities of mixed-grass prairies exist in protected localities and in more poorly drained gully bottoms. *Andropogon scoparius* and a species of *Elymus* dominate these topographic and edaphic climaxes. Most of the shorter grasses still exist but now form subordinates in the association. In the river bottoms dense stands of arboreal vegetation populate a thin band along the river banks. *Populus deltoides* and *Salix interior* dominate these communities. This association rarely extends more than 500 m from the river.

ENVIRONMENTAL RECONSTRUCTION

Since archaeological events took place in earlier times, the environment of the present may not accurately reflect prevailing environments of the past. To reasonably assess the nature of prehistoric human adaptations, we must place the residue of their actions in an appropriate environmental setting.

Here, the environmental reconstruction attempts to establish the nature and distribution of the biotopes available to the human groups in the area. A biotope is more difficult to define than to recognize. As used here, the term delineates an ecological unit where the habitat, or ecotope, and the biocoenosis (life forms) adapted to it exhibit a roughly uniform appearance.

Each biotope displays distinctive physical characteristics and supports different plants and animals. The term connotes essentially the same meaning as in Nietschmann (1972:70) and Allee and Schmidt (1951:4).

Biotopes would not prove satisfactory as units for botanical or zoological studies of an area. A biotope, such as a pine forest or a savannah, might contain several plant or animal communities or associations as defined by Daubenmire (1968:25-35). This lumping could obscure specific synecological relations within each association. However, the biotope seems a most appropriate unit for the study of human utilization patterns. As stated, each biotope supports a particular set of plants and animals. Thus a particular set of hunting or gathering patterns can exploit the entire extent of a biotope.

We divided the area around the site into three biotopes. Away from the river valleys and gullies, a largely unbroken expanse of short-grass vegetation forms the upland biotope. The upland biotope has fairly uniform vegetation and exposure. This largely unprotected area affords an unobstructed view for great distances. The breaks biotope consists of broken terrain with gullies and dry stream beds leading to the rivers. Steep, eroded slopes border many of the gullies. Considerable variation of the terrain and vegetation occurs in this biotope. Mixed-grass communities grow commonly in protected gully bottoms, but on exposed and eroded slopes very few plants thrive. The bottoms of the winding gullies afford considerable protection. The riverine biotope develops only along the river bottoms. Here relatively lush vegetation flourishes, and the arboreal element provides substantial protection.

The availability of moisture acts as the determining factor in the distribution of these three biotopes. Frequent winter winds remove much of the snow received by the uplands during the winter. Most precipitation for this biotope falls in the spring and early summer. By late summer, any available moisture is very deep. The breaks receive the same amount of precipitation but retain the moisture better. Deep snow drifts accumulate in the gully bottoms and release their water slowly. The drying winds have less effect in protected exposures such as gully bottoms and on north- and east-facing slopes. On the other hand, exposed south- and west-facing slopes receive less effective moisture than the uplands and support minimal vegetation. A constant water source from outside the immediate area supplies the riverine biotope. A number of smaller streams such as Cut Bank Creek and Two Medicine Creek, which drain areas of Glacier National Park, feed the Marias River. Figure 2 provides a map of the distribution of these three biotopes in the vicinity of the Bootlegger Trail site.

The modern fauna of north-central Montana is only slightly degraded from that present in precontact times. In the immediate area no comprehensive studies of the modern fauna exist. However, extensive field observations supplemented by two sources provide a close approximation of the local fauna. Lechleitner (1955) has

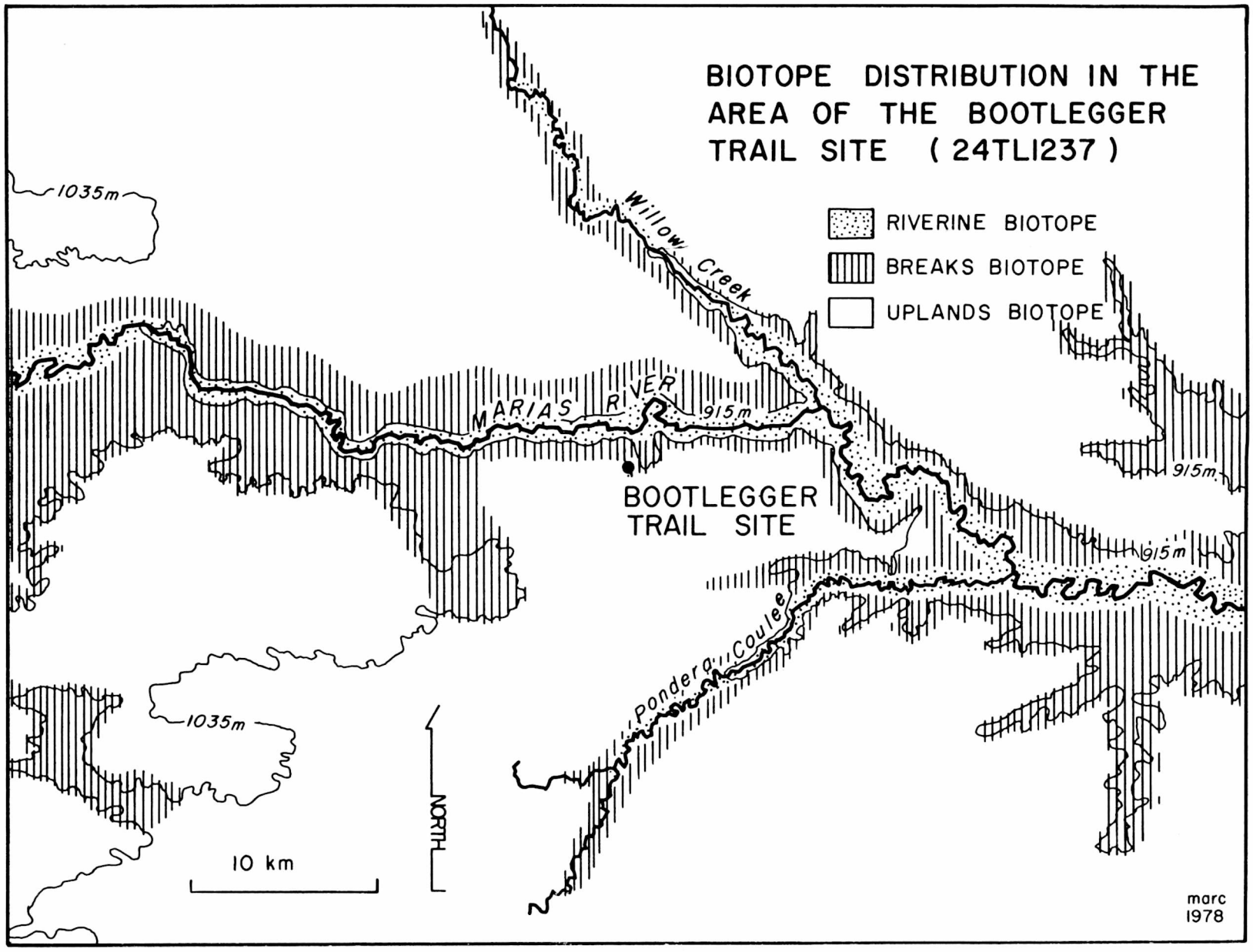


Fig. 2. Biotope distribution in the area of the Bootlegger Trail site (24TLl237).

reported on the mammalian fauna of Glacier National Park. Although not directly applicable to the vicinity of the site, many taxa found in his study area also occur on the adjacent prairie. Burt and Grossenheider's (1964) comprehensive volume details all taxa observed and known to occur in the vicinity of the site.

Less systematic, but widely available material concerning local fauna in contact and precontact times comes from a variety of sources. The best source of information comes from the journals of the Lewis and Clark Expedition. Part of this expedition included a foray by Meriwether Lewis down the Marias River in 1806 (DeVoto 1953; Walcheck 1976). He passed just north of the site and recorded a number of observations of the animals he saw in the immediate area.

A total of 58 mammalian taxa exist or existed in north-central Montana (Table 1). Twelve of these probably never resided in the vicinity of the site. Appendix II contains individual discussions of the remaining 46 species to discern their habit and distribution in the three biotopes around the site. Historic pressures eliminated six of these taxa, all large mammals, from the area in historic times.

Modern and historic sources report fauna completely compatible with that recovered from the Bootlegger Trail site. Most species still occur near the site. Pressures during the last 150 years have eliminated those taxa not present today. Species that inhabit each of the modern settings occurred in the faunal collection.

Faunal assemblages from other sites in north-central Montana are quite consistent with that from the Bootlegger Trail site. Unfortunately, few Late Prehistoric sites in north-central Montana have reported faunal assemblages. The Milk River Archaeological Society has excavated several late sites in Phillips and Hill counties, the Keaster site (24PH401), at the beginning of the Late Prehistoric period, the Wahkpa Chu'gn site (24HL101), and 24PH1020 being most notable. Faunal remains from all these sites consist principally of bison and a few dogs. Other taxa, such as deer, pronghorn, and bird, represent occasional finds (Brumley 1973; Davis and Stallcop 1965; Hoy 1973). Miller (1963) reported similar remains from the Galata site, 24TL26, only a short distance from the Bootlegger Trail site.

Most of the above-mentioned sites are bison kills. Other types of sites investigated include a pronghorn kill (Davis 1976a:44) and campsites. Again, all taxa reported receive mention in modern and historic accounts of the area.

In general, all faunal material from Late Prehistoric sites in the northwestern Plains indicates that the environment has changed very little, if at all, in the last 1000 years. All species represented still exist in the area today or did in historic times. Representatives of all modern biotopes have been reported.

Table 1. Mammals native to north-central Montana.

Insectivora
- *Sorex cinereus* (Masked shrew)*
- *Sorex merriami* (Merriam shrew)*
- *Sorex obscurus* (Dusky shrew)

Chiroptera
- *Myotis lucifugus* (Little brown myotis)*
- *Myotis evotis* (Long-eared myotis)*
- *Myotis volans* (Long-legged myotis)*
- *Myotis subulatus* (Small-footed myotis)*
- *Lasionycteris noctivagans* (Silver-haired bat)*
- *Eptesicus fuscus* (Big brown bat)*
- *Lasiurus cinereus* (Hoary bat)*

Carnivora
- *Ursus horribilis* (Grizzly bear)*
- *Ursus americanus* (Black bear)
- *Procyon lotor* (Raccoon)*
- *Martes pennanti* (Fisher)
- *Martes americana* (Marten)
- *Mustela erminea* (Shorttail weasel)*
- *Mustela frenata* (Longtail weasel)*
- *Mustela vison* (Mink)
- *Mustela nigripes* (Black-footed ferret)*
- *Lutra canadensis* (River otter)*
- *Taxidea taxus* (Badger)*
- *Mephitis mephitis* (Striped skunk)*
- *Canis latrans* (Coyote)*
- *Canis lupus* (Gray wolf)*
- *Vulpes fulva* (Red fox)*
- *Vulpes velox* (Swift fox)*
- *Felis concolor* (Mountain lion)*
- *Lynx rufus* (Bobcat)*

Rodentia
- *Marmota flaviventris* (Yellowbelly marmot)*
- *Cynomys ludovicianus* (Blacktail prairie dog)*
- *Citellus richardsoni* (Richardson ground squirrel)*
- *Citellus lateralis* (Golden-mantled squirrel)
- *Citellus tridecemlineatus* (Thirteen-lined ground squirrel)*
- *Eutamias amoenus* (Yellow pine chipmunk)
- *Eutamias ruficaudus* (Redtail chipmunk)
- *Tamiasciurus hudsonicus* (Red squirrel)
- *Thomomys talpoides* (Northern pocket gopher)*
- *Perognathus fasciatus* (Wyoming pocket mouse)*
- *Castor canadensis* (Beaver)*
- *Peromyscus maniculatus* (Deer mouse)*

Table 1, concluded.

Rodentia, continued
Onychomys leucogaster (Northern grasshopper mouse)*
Neotoma cinerea (Bushytail woodrat)*
Clethrionomys gapperi (Boreal redback vole)
Microtus pennsylvanicus (Meadow vole)*
Microtus longicaudus (Longtail vole)*
Microtus richardsoni (Richardson vole)*
Ondatra zibethica (Muskrat)*
Zapus princeps (Western Jumping mouse)
Erethizon dorsatum (Porcupine)*
Lagomorpha
Lepus americanus (Snowshoe hare)
Lepus townsendi (Whitetail jackrabbit)*
Sylvilagus nuttalli (Mountain cottontail)*
Artiodactyla
Cervus canadensis (Wapiti)*
Odocoileus hemionus (Mule deer)*
Odocoileus virginianus (Whitetail deer)*
Antilocapra americana (Pronghorn)*
Bison bison (Bison)*
Ovis canadensis (Bighorn sheep)*

*Taxa native to the area around the Bootlegger Trail site.

Many of the animal taxa from 24TL1237 could not be identified to exact species. Other taxa exhibit cosmopolitan habitat preferences. Plant material, particularly pollen, could establish a more accurate reconstruction of the environment at the site during its occupation. Unfortunately, we recovered very little plant material from the site. Ward F. Weakly of the Bureau of Reclamation examined several charcoal samples. He identified all samples as cottonwood (*Populus deltoides*). This indicates only that cottonwood grew along the river 700 years ago as it does today. We found no other plant macroremains from the site to indicate the nature of vegetation in nonriverine areas.

In general, prairie environments do not lend themselves to good pollen preservation. Thus, no pollen studies exist from near the site. However, several cores from mountain bogs on the edge of the northern Plains have produced useful information for this area. Hansen (1948) investigated two bogs in the Glacier National Park region. He found that since the last glacial period forest composition experienced several changes. However, during the last 4000 years a consistent period of increased moisture produced expansion of white pine (*Pinus monticola*), Englemann spruce (*Picea englemani*), and fir (*Abies*) much like modern conditions. He attributed the recent expansion of lodgepole pine (*Pinus contorta*) to increased pyric influence, not climatic change (Hansen 1948:152). In short, he notes little substantive change over the last 4000 years.

Kupsch (1960) sampled sediment from the vicinity of Herbert, Saskatchewan, approximately 250 km east of Medicine Hat, Alberta. He found evidence for spruce forests 10,000 years ago, but sediments from the last 2600 years, since the hypsithermal, indicated a mixed-grass prairie similar to the modern *Stipa-Agropyron* communities (Kupsch 1960:290).

Watts and Bright (1968) studied a core from Pickerel Lake in northeastern South Dakota, on the eastern edge of the northern Plains. Today a tall-grass prairie with occasional stands of deciduous forest in gullies and around lakes dominates the area around Pickerel Lake. The sediments sampled indicate that this condition has existed for the last 4000 years (Watts and Bright 1968:855).

Plant macroremains on the southern edge of the northwestern Plains, in the Laramie Basin of Wyoming, indicate a somewhat different trend. The modern vegetation of this area contains stands of short-grass prairie and arid shrub-steppe. In the past, however, *Juniperus scopulorum* and *Pinus ponderosa* were common (Wells 1970). Logs and trunks of these conifers occur in a subfossil form scattered over the basin. Radiocarbon dating of these conifers indicates a very gradual drying trend over at least the last 1500 years (Wells 1970:185). This does not imply substantive change over this period but merely a change from earlier periods. Slow-growing *Juniperus* trees established during more favorable times slowly died off with little replacement, and Wells found only three living trees in 1968.

In general, studies of pollen and plant macrofossils indicate minimal, if any, change in the environment of the northwestern Plains over the last 2000 years or more. Even on the edges of this area, where any climatic change might cause the most dramatic vegetational shifts, the vegetation indicated remained essentially unchanged for the last 2000 to 4000 years. However, most of the studies cited employed temporal units too gross to detect minor or ephemeral climatic shifts. In many cases, very few dates provide chronometric control of more modern periods of the material sampled. In most cases, only gross temporal units typify the profiles sampled. In short, these studies indicate that short-grass vegetation dominated the northwestern Plains for at least the last 2000 years, but the exact nature of this vegetation remains uncertain. In this case, more precise studies of geomorphology and sedimentology might demonstrate more accurately minor climatic changes in the recent past.

We did some work on sediment from the Bootlegger Trail site. The sediments derive from glacial till transported by both wind and water. Analysis classifies the soil from Area B as a ustic-torrifluvent (Appendix III). This indicates that the sediments were deposited in an arid environment that received little precipitation at least six months of the year. Virtually nothing is known about rates of deposition for the area around the site. Thus amount of deposit between cultural layers and since the last occupation provides limited environmental information. The rate of deposition varies with the nature of the topography and vegetation. Protected gullies where wind-blown particles settle out exhibit the most rapid deposition. Farmers in the area report that in a few protected spots fences have been buried completely within 30 years. All of this indicates depositional environments at the Bootlegger Trail site compatible with those that prevail today.

Heusser (1956) has studied glacial variations in the Canadian Rocky Mountains. He concentrated on advances and retreats of modern glaciers during the last postglacial period. This study indicates small but fairly stable glaciers from 3000 B.P. to 600 B.P. A major advance occurred between 300 and 600 B.P. Minor recessions and two minor advances followed. A gradual recession has prevailed for the last 100 years (Heusser 1956:298). The modern glaciers have become only slightly larger today than they were 600 to 700 years ago when the Bootlegger Trail site was occupied.

Recent studies indicate a similar situation in the Rocky Mountains of the United States. Richmond (1965) studied modern glaciers from Glacier National Park to southern New Mexico. He found evidence for two major periods of glacial advance, "stades," in the last 4000 years. He based both of these periods originally on evidence from the Wind River Mountains of western Wyoming. The earlier phase, called the Temple Lake Stade, is dated on the basis of alluvial depositional units at 3100 to 1600 B.P. The second advance, termed the Gannett Peak Stade, probably began around 400 years ago. In the last 100 years there has been gradual retreat (Richmond 1965:226).

Both of the glacial studies indicate climatic changes over the last 3000 years, occasionally referred to as the "Neoglacial Period." They both suggest major glacial advance around 400 to 500 years ago. However, both studies show that when the Bootlegger Trail site was occupied 600 to 700 years ago, small and fairly stable glaciers prevailed. Both studies consider this period an "interstade" and presume conditions comparable with those at present.

Several studies have attempted to correlate all of these diverse forms of paleoenvironmental evidence to present a detailed picture of changing conditions during the last 10,000 years. Two of these (Bryson and Wendland 1967; Reeves 1969) focus on areas adjacent to the vicinity of the site. Reeves incorporates the material presented by Bryson and Wendland and both use many of the same studies. Understandably, they present essentially the same results. Both divide the last 10,000 years into several climatic episodes following the European terminology (Table 2).

Table 2. Chronology of climatic episodes, 10,500 B.P. - A.D. 1950

Episode	Tentative Date B.P. (Bryson et al. 1970)	Tentative Date A.D. (Baerreis and Bryson 1965)
(Late-Glacial)		
	10,500	
Pre-Boreal		
	9650 ± 240	
Boreal		
	8450 ± 320	
Atlantic		
	4680 ± 490	
Sub-Boreal		
	2890 ± 510	
Sub-Atlantic		
	1690 ± 410	300-400
Scandic		
		800-900
Neo-Atlantic		
	BOOTLEGGER TRAIL OCCUPATION	1300
Pacific		
		1450
?		
		1550
Neo-Boreal		
		1880
Present		
		1950

Two of the postglacial periods are of interest in reconstructing the environment when the site was occupied. Increased precipitation and slightly warmer temperatures mark the Neoatlantic period, dated at A.D. 800-1300. Glaciers receded in the U.S. Rockies, the Canadian boreal forest expanded both north and south, and the prairie grasslands expanded westward at the expense of the steppe. This suggests a decrease in the dry Pacific winds and an increase in the Tropical Maritime air mass over the central and northern Plains (Bryson and Wendland 1967:294). Reeves (1969:8) adds that increased alluviation and minor fluctuations in storm patterns mark this period in southern Alberta.

The Pacific period, which dates from A.D. 1300-1450, follows the Neoatlantic. Two subepisodes with very minor differences divide the Pacific period. In general, the period experienced cooler and drier conditions than the Neoatlantic. The northern edge of the boreal forest retreated. The western edge of the prairie retreated but expanded east of the Mississippi River. This suggests a return to the dominant Pacific air mass with occasional winds from the Arctic regions (Bryson and Wendland 1967:294). In southern Alberta a period of stability led to soil formation and an essentially modern climate (Reeves 1969:8). Thus, essentially modern conditions prevailed during the Pacific period.

These two comprehensive works indicate that the area around the site should have experienced slightly different conditions during the two climatic periods examined. Certainly short-grass prairie continued as the dominant vegetation type around the site throughout the entire late postglacial. The degree of climatic change between the Neoatlantic and Pacific periods is not sufficient to eliminate any of the three biotopes around the site. However, during the Neoatlantic slightly wetter conditions should have produced some expansion of the riverine biotope and an increase of the mixed-grass communities in protected areas within the breaks biotope. The short-grass communities in the upland biotope may have been somewhat lusher, providing increased forage for grazers. (The significance of moisture to range conditions and ultimately bison is just beginning to receive serious consideration as a variable in bison procurement [Reher 1977; Frison 1978].) This pattern occurred historically on a smaller scale. In 1975, the area received more precipitation during the late spring and early summer than in previous years. The uplands around the site produced substantially more forage and stayed green longer into the summer. At an experimental farm in southern Alberta, Smoliak (1956) reported a direct correlation between increased precipitation and increased forage yields. No such relation exists for mean annual temperature or hours of sunlight.

The Pacific period marks the change to conditions essentially the same as those witnessed today. The three biotopes around the site must have approximated their present distributions. The amount of forage available probably compared with the modern norm. Radiocarbon dates place the occupation of the site near the beginning of the Pacific period or the end of the Neoatlantic period.

It thus appears that conditions around the site would have been very similar to those present today. If there was a difference, it was probably in the direction of very slightly moister conditions and a bit lusher vegetation. Any change in the fauna and flora present would be of a minor quantitative nature, certainly not qualitative.

III. DESCRIPTIVE ARCHAEOLOGY

SURFICIAL FEATURES

The draw in which the Bootlegger Trail site rests contains the remnants of a once more extensive kill complex. During the period, or periods, of occupation, an extensive set of drive lines probably served to direct animals from the plains about 3 km south of the kill, down to a high Holocene river terrace, and from there toward the dissected breaks where the kill took place. This is a commonly noted feature of bison kill sites (Conner 1962; Frison 1978).

At the time of discovery (late July 1974) we examined the terrace above the site for evidence of guide lines or stone piles. The examination revealed a few stone piles on the ridge crest immediately above the kill, but they terminated at the tilled fields near the terrace edge. These fields extended southwestward for about 400 m, where unbroken but disked prairie sod began again. In 1975, the owner of the uncultivated area began breaking the sod. Shortly thereafter, we discovered on an undisturbed prairie remnant about 2 km southwest of the site a set of slightly converging rock lines about 100 m apart leading from the tilled plain onto the newly cultivated terrace. These remnant lines likely represent the drive lines associated with the Bootlegger kill. Examination of similar draws downslope from the drive lines revealed no indication of additional kills in the locality. If the bison killed at Bootlegger accumulated in the high plain above the site, the drive lines are situated in the only reasonable location for the movement of animals toward the kill. The possibility of driving the animals from the river bottom updraw to the kill seems remote. Figure 3 is a photo-reproduction of the vicinity of the Bootlegger Trail site taken during the summer of 1957, before cultivation of most of the terrace.

Other anticipated aspects of the complex should include the kill proper with a drop, or in this instance probably a holding corral, processing areas, and a nearby campsite. The modern floodplain probably offered the best location for access to water, firewood, and a protected environment. The vicinity of the Galata site, 24TL26 (Miller 1963; Cooper 1955), about 1.5 km northwest of the Bootlegger kill, provides a likely location for an associated campsite. Our excavations focused on a limited area of the kill and associated processing areas.

EXCAVATION PROCEDURES

To facilitate accuracy in surface collections, test pits, and excavation, the Bootlegger Trail site was divided into areas

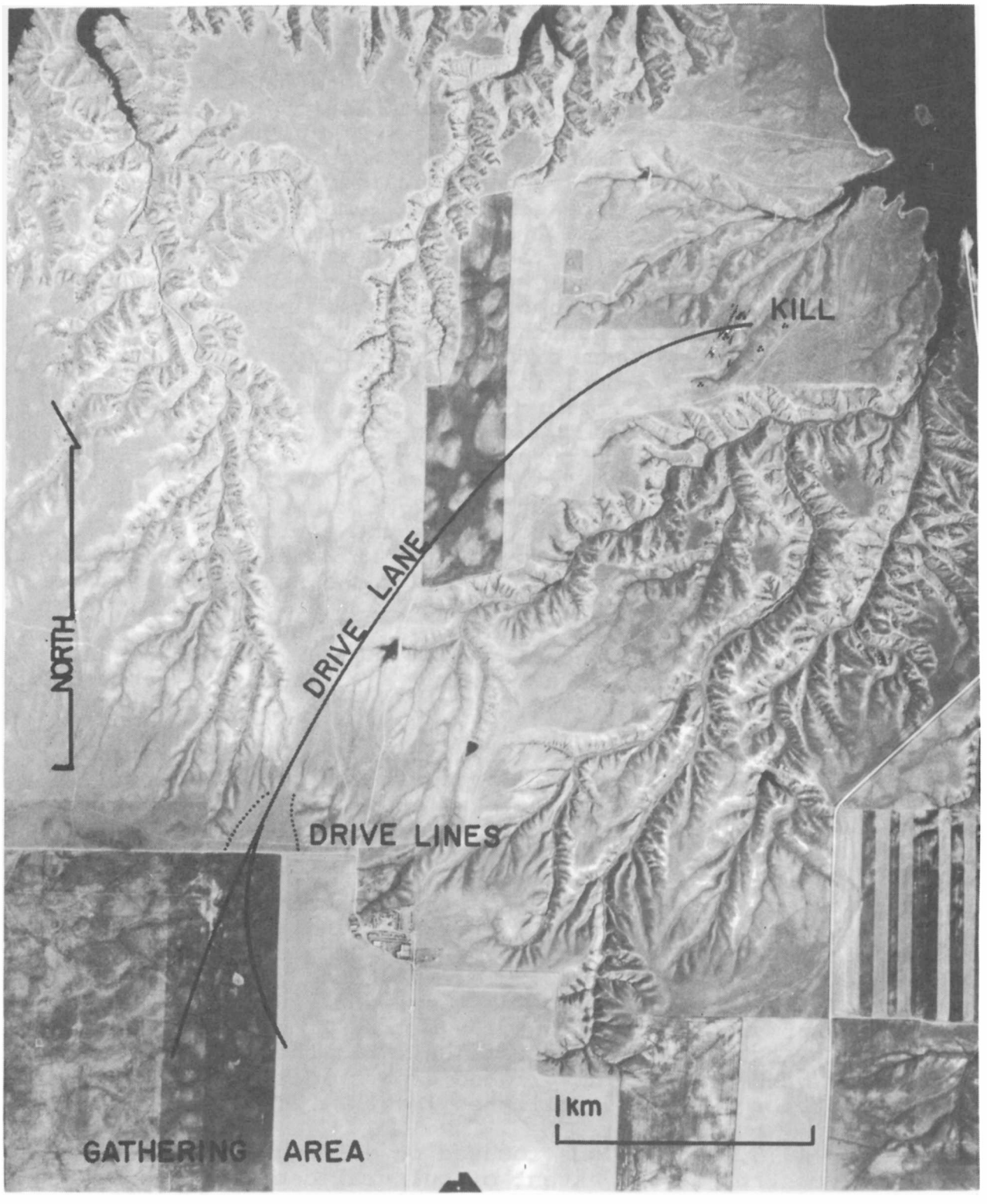


Fig. 3. The Bootlegger Trail site, surface features.

arbitrarily designated with letters A through E (Fig. 4). In the beginning, Area A designated the confluence of two draws where cultural materials first appeared. The two draws received the area designations of B and C, as preliminary surface collections recovered cultural debris from both. Eventually we determined that draw B contained the heaviest depositions and that little buried material remained in draw C. More thorough evaluation disclosed several discrete concentrations of culture-bearing sediment in draw B, and these concentrations received area designations B, D, and E. Areas B and E contained materials interpreted as the result of processing bison remains after killing and initial butchering. Area D apparently comprised the kill and initial butchering locale. After the initial 1974 testing of four 2-m units in Area A, excavation concentrated in Areas B, D, and E. Distribution and depth of culture-bearing sediments in various areas were determined through exploration with a backhoe and extensive use of a 30-cm-diameter power auger. Unfortunately, sufficient erosion and deposition has taken place to preclude determination of stratigraphic continuity between the areas of the site (Fig. 5). In effect, each area and the cultural levels within the area stand as cultural isolates.

Working datum consisted of a capped 1.2-m-long, 5-cm-diameter galvanized iron pipe driven into the ground approximately 1.15 m. We arbitrarily designated the top of the stake as 100.00 m. The Bureau of Reclamation has established a gauge near Tiber Dam that permits accurate recording of reservoir water levels. With the cooperation of Don Stores, then reservoir supervisor, we recorded the vertical distance from our 100.00-m datum to the reservoir surface at noon on a calm day. The actual elevation of datum is close to 927.7 m (3044 ft) above mean sea level.

In addition to serving as vertical control for all excavations, the datum point established the northeast corner of Square 1 in Area B. Additional secondary data points established throughout the course of excavation aided triangulation to maintain horizontal control.

The established grid system differs from common practice because of the peculiar, but convenient, artifact labeling system discussed later. Within the designated area scheduled for excavation, we assigned numbers to all possible 2-m units. Beginning at datum, the first 2-m square to the west received number 1. This continued westward to Square 50, 100 m west from datum. The first square south of Unit 1 became Unit 51; the first square south of 50 became 100. The gridded area so designated has a maximum width of 100 m and unlimited length.

In 1974 and 1975, excavations focused on gaining vertical and horizontal control of the extent of cultural deposit. To maintain vertical control, excavation and recording progressed by 20-cm levels. Roman numerals designated the levels: I, 0-20 cm from surface; II, 20-40 cm; III, 40-60 cm, etc. Maximum depth attained in 1975 was 160 cm or Level VIII. In 1975 we gained sufficient

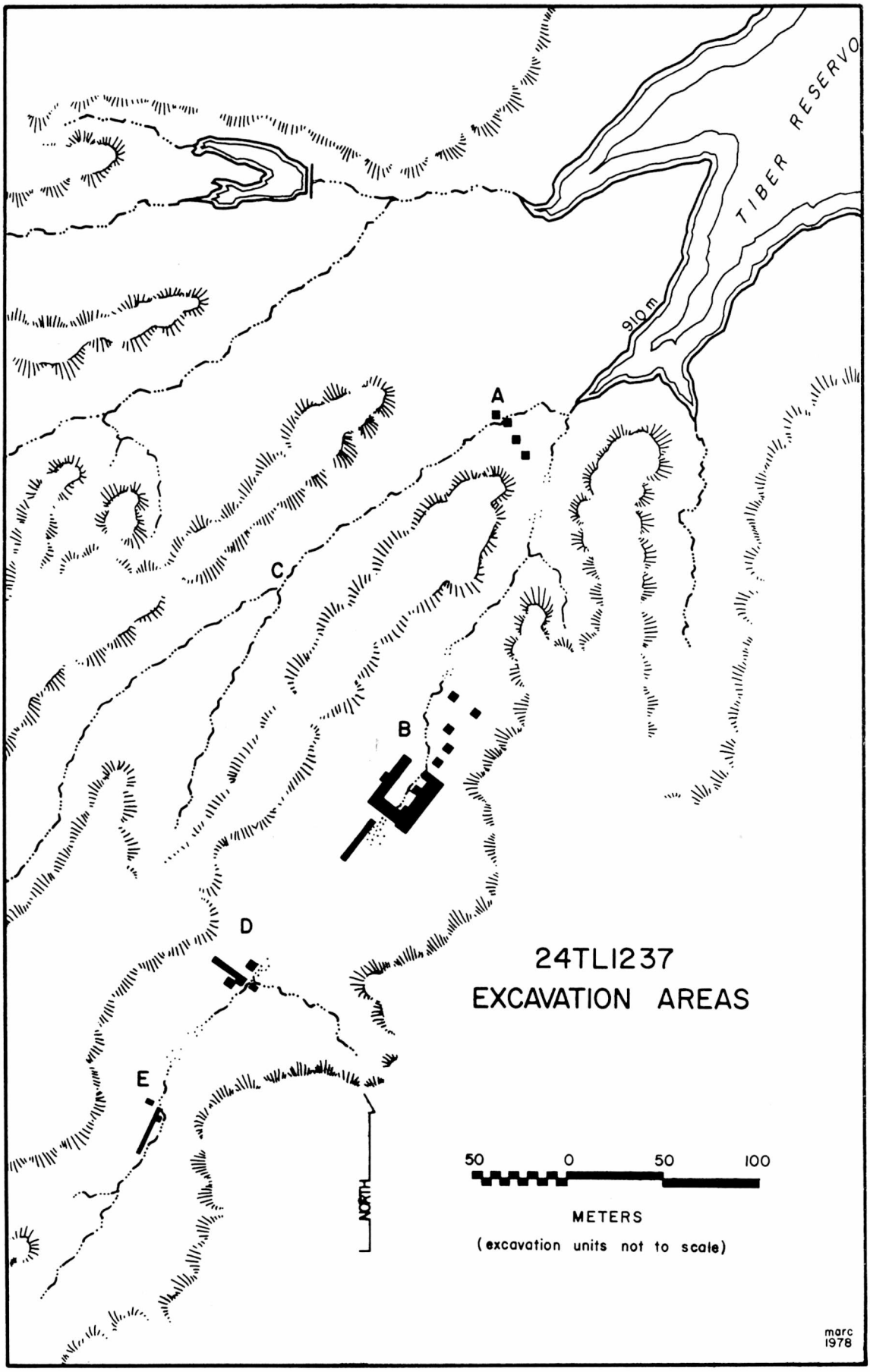


Fig. 4. 24TL1237, excavation areas.

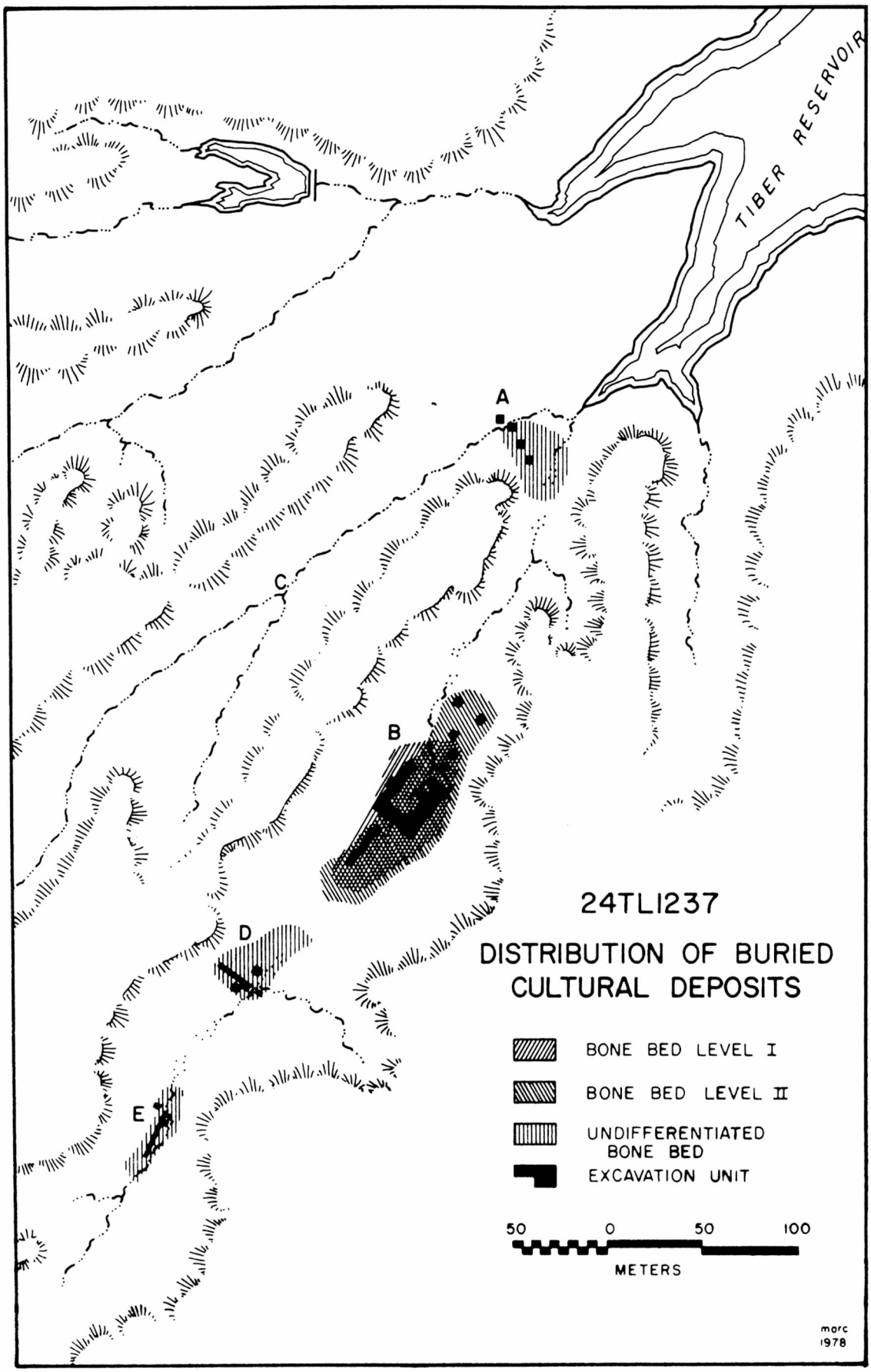


Fig. 5. 24TL1237, distribution of buried cultural deposits.

control over the sediments in the site to proceed with stratigraphic excavation in 1976. The two reliably identifiable cultural strata we designated as levels X and XI for field identification purposes. For the remainder of this report, these two levels are discussed as Cultural Level I and II, I the uppermost.

Upon discovery of an artifact or any other item deemed sufficiently significant to receive a catalog number, the excavator designated the specimen in the field and entered the number, with a precise vertical and horizontal provenience if available, in his/her field diary. Each cataloged specimen received a code that identified it as to site, area, square, level, and number within that level, square, and area. Thus our specimens received labels such as 24TL1237/B/509/V/22. Individual bones cataloged for one reason or another would receive the designation 24TL1237/B/509/V/1b. Features and samples were identified 24TL1237/D/527/F1 or S1. Although somewhat longer and more cumbersome than the more common accession number (24TL1237/528), this system encourages better field control and facilitates rapid comparison of specimens by the enumerated criteria.

In 1975 we maintained an almost slave-like devotion to accurate recording of provenience information and to recovery of small specimens. To ensure our ability to record specimens *in situ*, most excavation proceeded by trowel, dental pick, and brush. *In situ* discovery of any specimen deemed sufficiently significant to receive a catalog number entailed sketch mapping the vicinity to establish associations, recording of vertical distance from datum by transit, and horizontal location within the excavation unit. We assigned numbers to the specimen and recorded the specimen and provenience information in field diaries. This procedure applied to all artifacts, samples, features, and identifiable bone. To further increase the level of recovery, and as a check on the excavators' proficiency, one-half the sediment from each level of each pit was water screened through 6.4-mm (1/4-inch) and 3.2-mm (1/8-inch) mesh. We processed all sediment not water screened through the usual 6.4-mm dry shaker screens.

Although we anticipated that water screening would produce quantities of plant and microfaunal remains, no plant and perhaps a handful of microfauna appeared. Use of the water screens did yield literally thousands of tiny cryptocrystalline silica pressure flakes, and these provide additional information about stone material selection.

With the recovery procedures used in 1975, we could, given sufficient time, virtually rebuild the site. In a bison kill and processing area, the tremendous quantities of bone and other materials truly hamper excavation if the archaeologist adheres to such precise technique. In 1976 we decided that delineation of spatial distribution of artifacts and features would have to take precedence over precise recovery. Because we had gained reasonable control of the stratigraphy, the use of shovels increased in deposits now recognizable as sterile or disturbed. Recovery of

specimens with provenience data remained about the same as 1975. Bones received labels only by area, excavation unit, and cultural level. Fewer flakes were recovered per excavation unit, but because of the larger area opened the total number actually increased and probably provides a more representative sample. By the end of 1976 the total area excavated exceeded 180 m^2 with a total volume of sediment around 150 cubic meters (Table 3).

Table 3. Area and volume of excavated sediments at 24TL1237.

Area	m^2	% of Total	Mean Depth (m)	Volume (m^3)	% of Total
A - 1974	16	9	.60	9.60	6
B - 1975	32	18	.73	23.36	16
B - 1976	92	51	1.01	92.92	62
D - 1975	16	9	.67	10.72	7
D - 1976	9	5	.47	4.23	3
E - 1976	16	9	.53	8.48	6
Total	181	101		149.31	100

STRATIGRAPHY

During both 1975 and 1976 we photographed all horizontal and vertical exposures and made scale drawings of stratigraphic profiles. Descriptions that accompanied stratigraphic profile drawings followed standard soil recording procedures and included color (moist), structure, textural class, inclusions, nature and depth of strata. A soil monolith taken from the southern portion of the east wall of Unit 609, Area B, was submitted to the Soils Department, Montana State University. The description of that monolith by Marilyn Kenfield appears as Appendix III.

In Area B sterile sediments 50-60 cm thick (characteristically a clay loam with three to five thin charcoal layers, probably from prairie fires, each associated with and lying above a buried "A" horizon) overlie the first clearly defined cultural layer. Bones and heat-fractured stones appear in abundance in this 5-cm-thick stratum. A thin stratum of sterile clay loam 2-15 cm thick separates cultural stratum I from II. Stratum II, 8-10 cm thick, again contained numerous bones and heat-fractured stones. Both cultural strata are visually distinct from their

matrix because of charcoal intermixed with the culture-bearing sediments. Beneath cultural layer II, sterile clay loam continues for an undetermined depth to the glacial till from which it derives (Fig. 6 and Fig. 7). On the northern extremity of the site and near the modern stream bed (Fig. 10 and Fig. 11); erosion apparently removed the uppermost cultural level, as only cultural level II was manifest in excavation units 59, 63, and 310, Area B.

Area E contains much the same sequence as Area B but with fewer charcoal layers overlying the cultural strata. In addition, compaction of the strata occurs. The entire sequence is contained within 50 cm; the culture-bearing sediments contain less cultural material than in Area B, are rarely more than 3-5 cm thick, and rarely separated by more than 5 cm of sterile deposits. Here, sandy clay loam forms the soil matrix (Fig. 8).

Area D, the kill, lies near the base of a low bluff. The slope where the kill area rests averages about 10 degrees. On the easternmost (downslope) portion of the excavated area, sandy loams overlying the bone bed range from 15 to 35 cm in depth. Sediments about 25 cm thick contained the bone bed at the eastern edge of the deposit. The bone bed tapered westward (upslope) about 6 m, where it gradually disappeared (Fig. 9). Occasional lenses of sterile sediment appeared within the bone bed but did not provide sufficient indication to justify stratigraphic distinction of more than one cultural unit. The possibility exists that the bone bed in the kill area contains multiple but indistinguishable events. This report treats the bone bed in Area D as a single event, but the possibility of multiple events must remain as a consideration.

FEATURES

Nonportable artifacts labeled as features include hearths, stone boiling pits, ash-filled pits, and associations such as heavy concentrations of flakes (flaking stations). All of these features occurred within the processing areas (B and E), but none appeared in the kill (D). Table 4 provides data on location, level, and size of features. Probably because of the small area excavated in Area E, we discovered only two features, a stone boiling pit and a small charcoal-filled hearth. Area B contained 25 designated features, 11 in level I, 14 in level II (Fig. 11 and Fig. 12).

Features labeled as hearths typically consisted of ash and charcoal, often with small fragments of bone intermixed, overlying a patch of orange earth oxidized to depths from 10 to 20 cm. The majority of hearths represent surface features with no prepared or excavated surface. Two hearths rimmed with stones (Fig. 13a) and one stone-filled hearth provide the exceptions (Fig. 13b). Originally we identified the stone-filled hearth as a stone boiling pit. The presence of 4 cm of cottonwood charcoal in the bottom of the pit, underlying the heat-fractured stones, seems to preclude this explanation. Perhaps the reduced atmosphere of a pit heats stones more rapidly or to higher temperatures than the oxidizing atmosphere of an open fire.

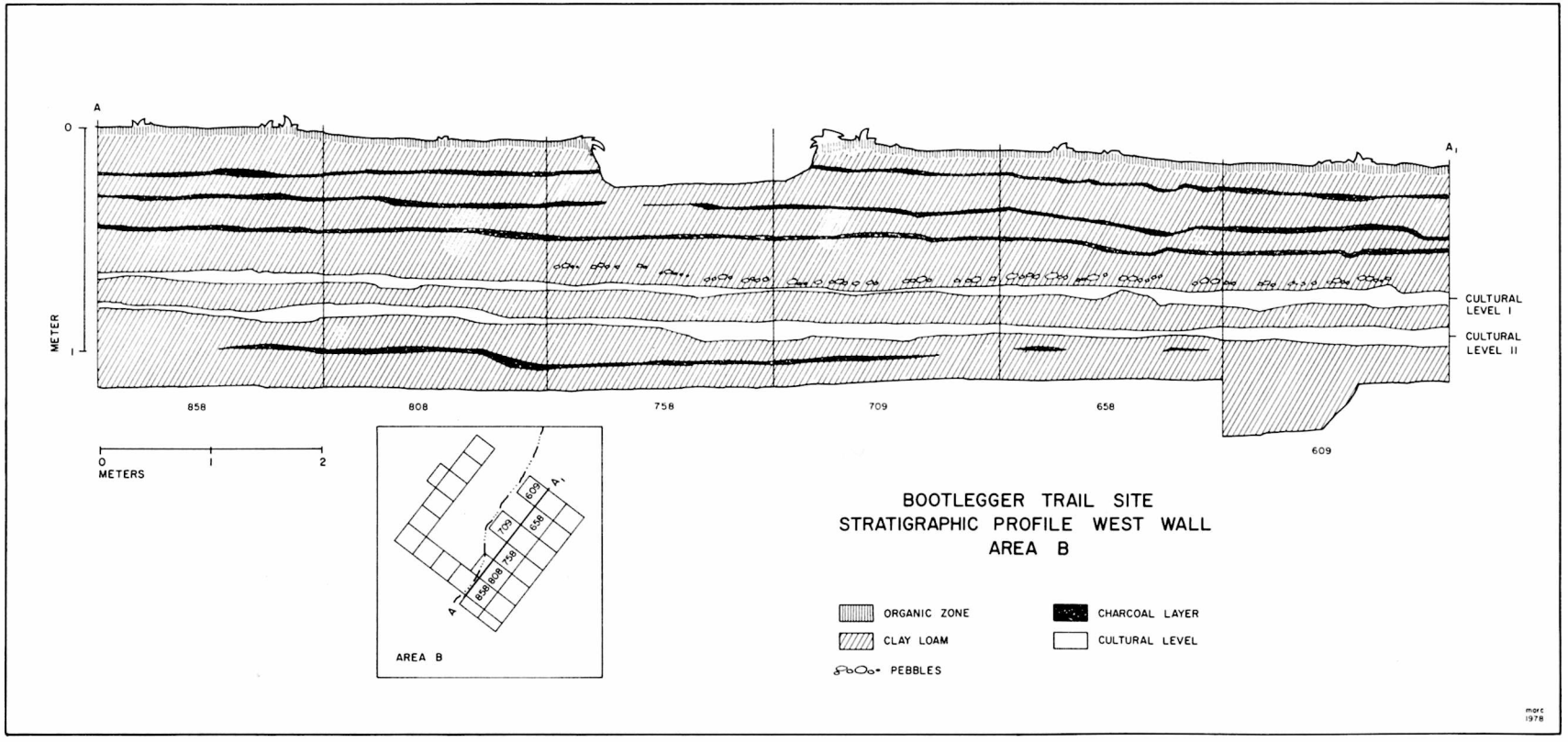


Fig. 6. Stratigraphic profile, west wall, Area B.

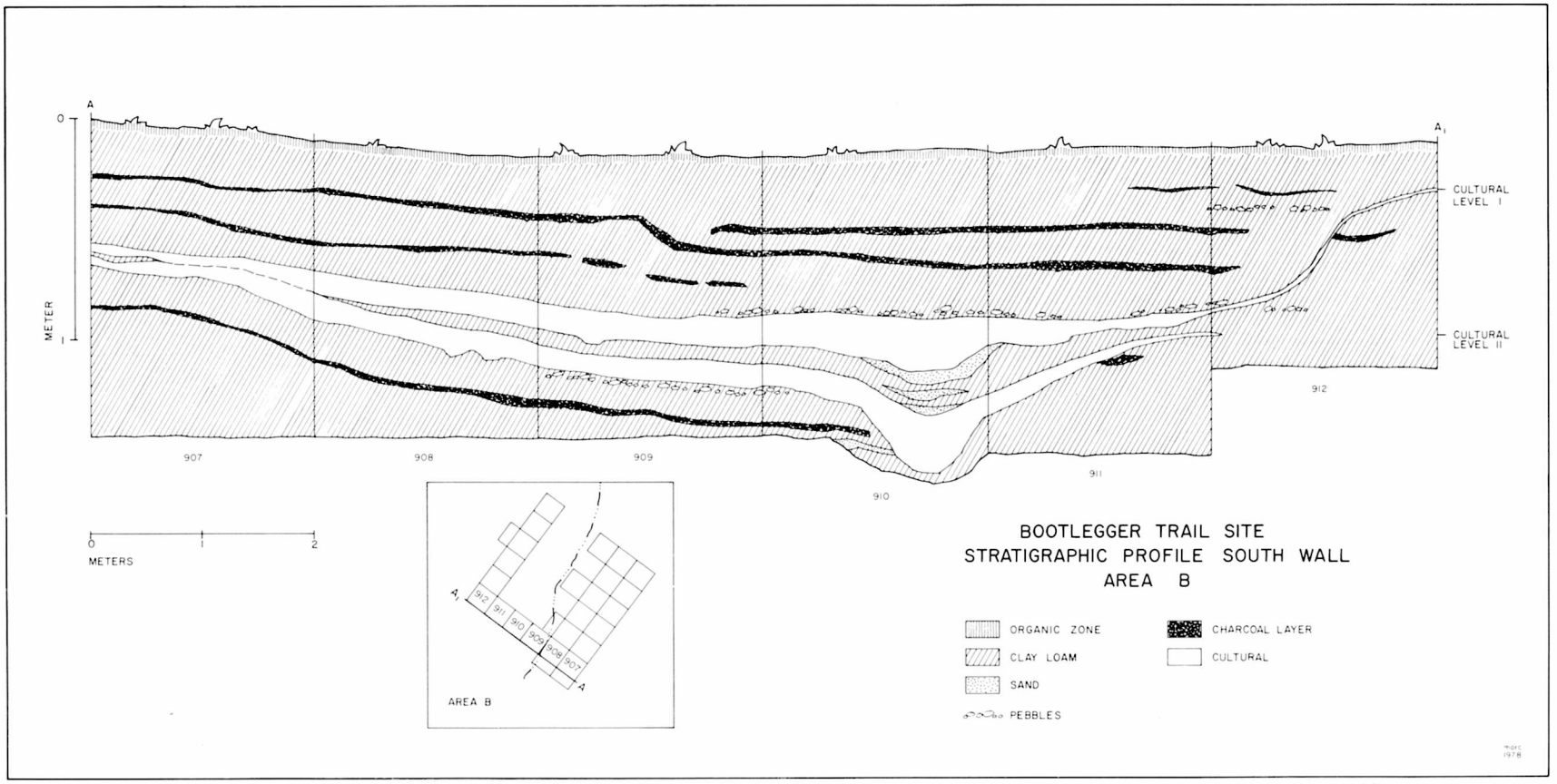


Fig. 7. Stratigraphic profile, south wall, Area B.

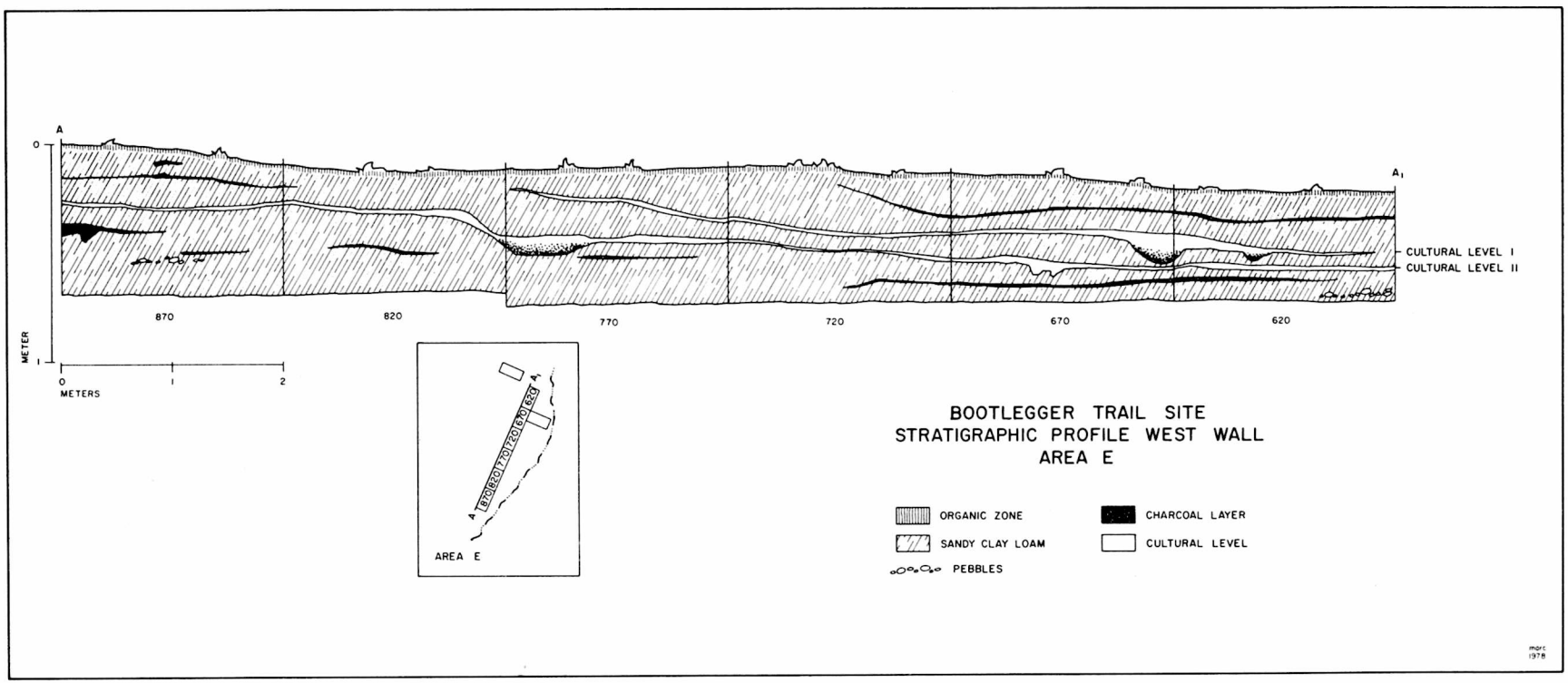


Fig. 8. Stratigraphic profile, west wall, Area E.

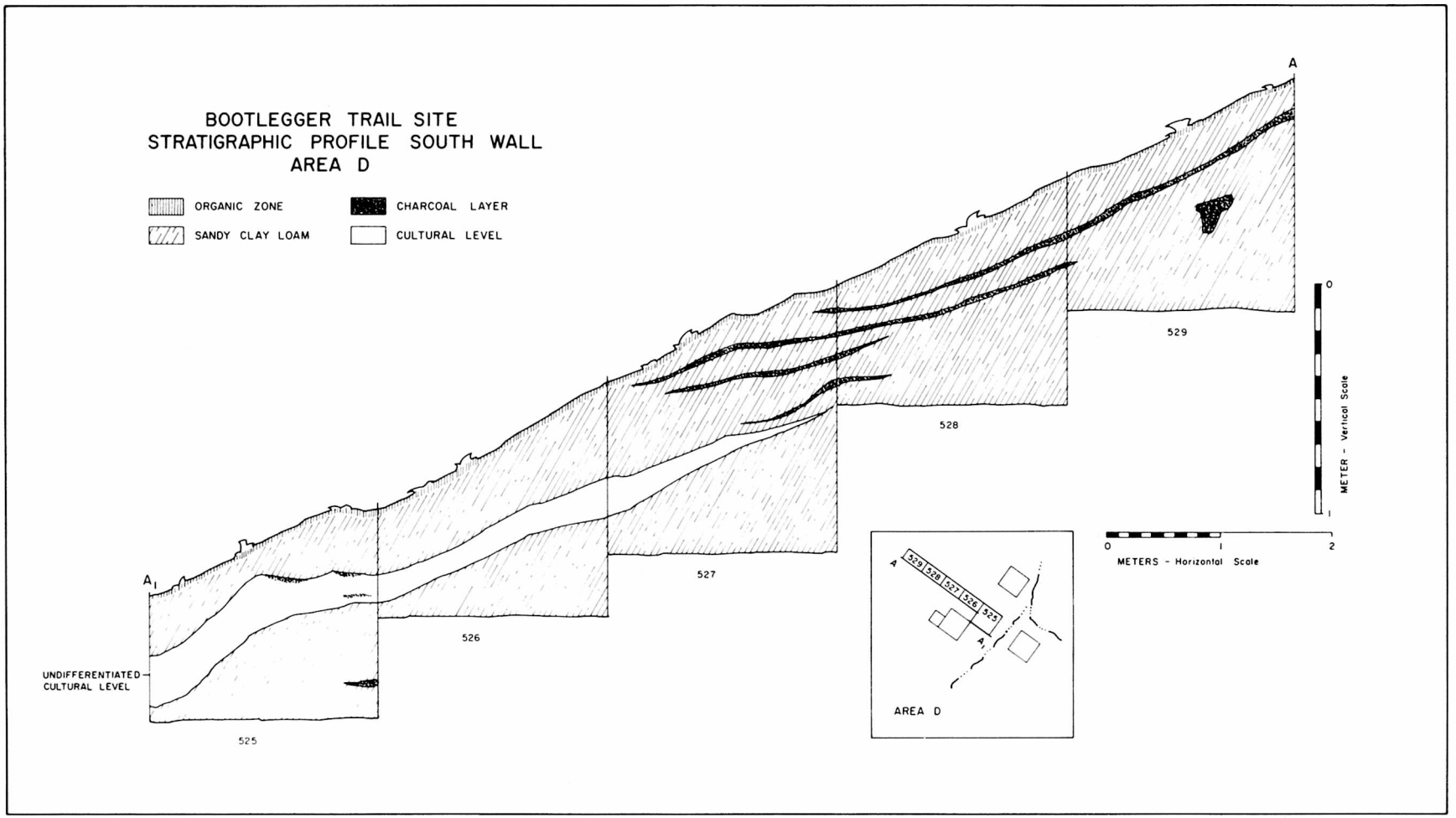


Fig. 9. Stratigraphic profile, south wall, Area D.

Table 4. Location, level, and size of features.

Feature	Location	Level	Size	Remarks
Hearth	B409	I	40 cm dia, 8 cm deep	Charcoal and ash concentration with heat-fractured stone and bone fragments overlying oxidized earth.
Hearth	B807 B757	I I	100x70 cm, 10 cm deep	Shallow basin-shaped concentration containing charcoal, ash, heat-fractured stone; burned earth continues for some 20 cm.
Hearth	E620	I	20x13x2 cm	Charcoal and ash concentration overlying oxidized earth.
Hearth	B310	II	40 cm dia, 4-8 cm deep	Charcoal and ash concentration with heat-fractured stone and bone fragments overlying oxidized earth.
Hearth	B310	II	50 cm dia, 8 cm deep	Charcoal and ash concentration with heat-fractured stone and bone fragments overlying oxidized earth.
Hearth	B609	II	95+ x 38+ x 18 cm deep	Shallow basin-shaped pit, heavy concentration of ash and oxidized earth, ash 5 cm thick.
Hearth	B707	II	75x50 cm	Shallow concentration of fine white ash overlying thin charcoal and oxidized earth.

Table 4, continued.

Feature	Location	Level	Size	Remarks
Hearth	B709	II	50 cm dia, 25 cm deep	Bowl-like depression with charcoal and ash, oxidized earth extends downward 15 cm. 670±80 years: A.D. 1280 (I9204).
Hearth	B757	II	61x34 cm, 10 cm deep	Shallow patch of charcoal, oxidized earth, burned and broken bone.
Hearth	B758 B808	II II	60x80 cm	Thin scatter of ash overlying 8-10 cm of oxidized earth.
Hearth	B907 B859	II II	60x45 cm	Ash and oxidized earth 10 cm thick overlying charcoal concentration.
Hearth	B957	II	85x35 cm	Charcoal and ash fill 4 cm thick, oxidized earth 14 cm from bottom of ash. 565±115 years: A.D. 1385 (GX-4713).
Rock-rimmed hearth	B907	II	90 cm dia	Rock-rimmed ash and charcoal concentration, oxidized earth extends downward 18 cm.
Rock-rimmed hearth	B908 B909	II II	62 cm dia	Rock-rimmed ash and charcoal concentration, oxidized earth overlying ash layer, charcoal layer at bottom of pit.
Stone-filled hearth	B59	II	60 cm dia, 23 cm deep	Large basin-shaped pit with heavy charcoal concentration in bottom of pit, 52 heat-fractured stones. 680±80 years: A.D. 1270 (I-9205).

Table 4, continued.

Feature	Location	Level	Size	Remarks
Stone boiling pit	B608	I	60 cm, 15 cm deep	Basin-shaped pit containing bone fragments concentrated over heat-fractured stone.
Stone boiling pit	B657 B658	II II	80 cm dia, 35 cm deep	Large basin-shaped pit containing ash, charcoal, fragmented bone, 308 heat-fractured stones (286 lbs). 580±115 years: A.D. 1370 (GX-4711).
Stone boiling pit	E670 E620	I I	71x65 cm, 5 cm deep	Basin-shaped pit containing concentrated ash and heat-fractured stone and bone fragments scattered throughout.
Ash-filled pit	B509	I	23 cm dia, 20 cm deep	Cylindrical pit, fill consists of charcoal, coarse ash, small bones, fine heat-fractured stones. 260±75 years: A.D. 1690 (I-9203).
Ash-filled pit	B709	I	32 cm dia, 30 cm deep	Cylindrical hole filled with ash and charcoal. 645±80 years: A.D. 1305 (I9202). 640±135 years: A.D. 1310 (GX-4710).
Ash-filled pit	B858	I	28 cm dia, 27 cm deep	Expanding base pit; oxidized, burned earth above concentration of ash and charcoal. 185±120 years: A.D. 1765 (GX-4712).
Ash-filled pit	B907	I	24 cm dia, 22 cm deep	Cylindrical pit, slightly expanded at bottom, ash and charcoal fill.

Table 4, concluded.

Feature	Location	Level	Size	Remarks
Ash-filled pit	B908	II	42 cm dia, 19 cm deep	Basin-shaped pit, ash fill with occasional flecks of charcoal.
Flaking station	B609	I	20 cm dia, 2 cm deep	21 small siltstone pressure flakes and siltstone point tip.
Flaking station	B709	I	1 m dia	Large quartzite primary and secondary flakes (10) concentrated near center of square.
Flaking station	B762	I	30 cm dia	8 gray quartz breccia core fragments with associated flakes, 2 projectile points of same material from immediate area. 993 flakes of assorted size, 2-35 mm long.
Flaking station	B862	I	40x15 cm, .5 cm deep	Dense accumulation of 3575 gray quartz breccia flakes, most smaller than 5 mm, some 30-50 mm.

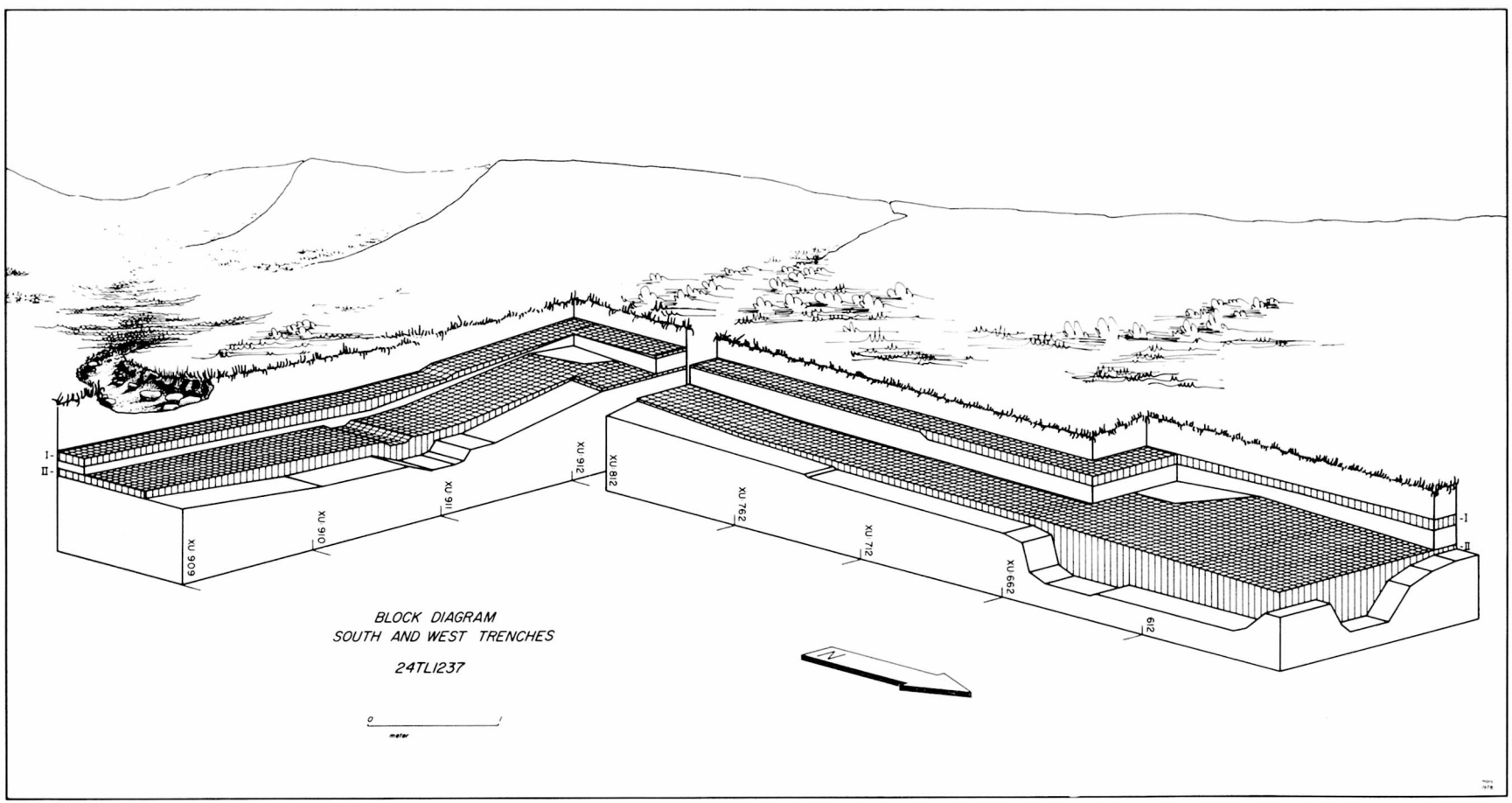


Fig. 10. Block diagram, south and west trenches.

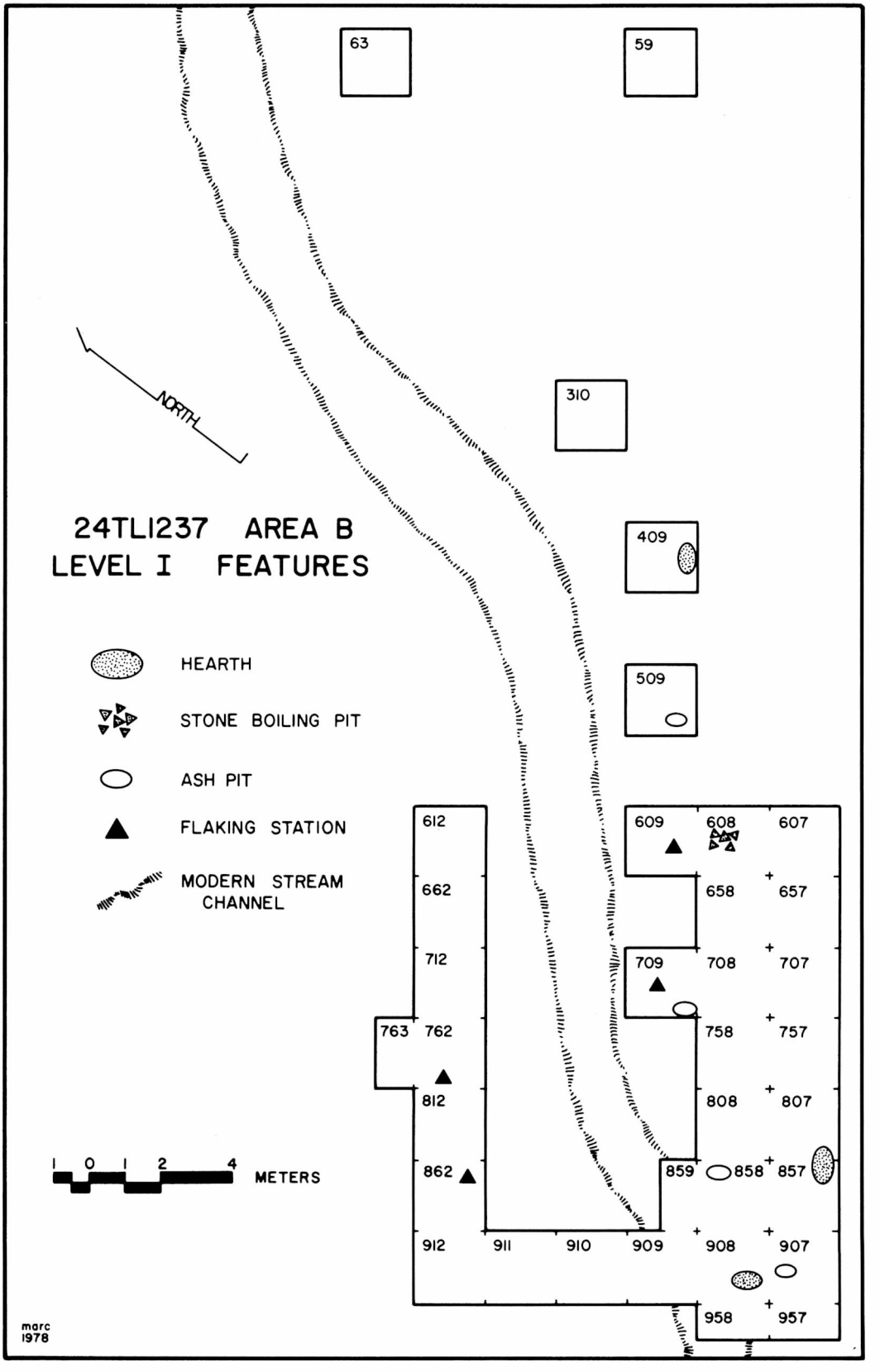


Fig. 11. 24TL1237, Area B, Level I, features.

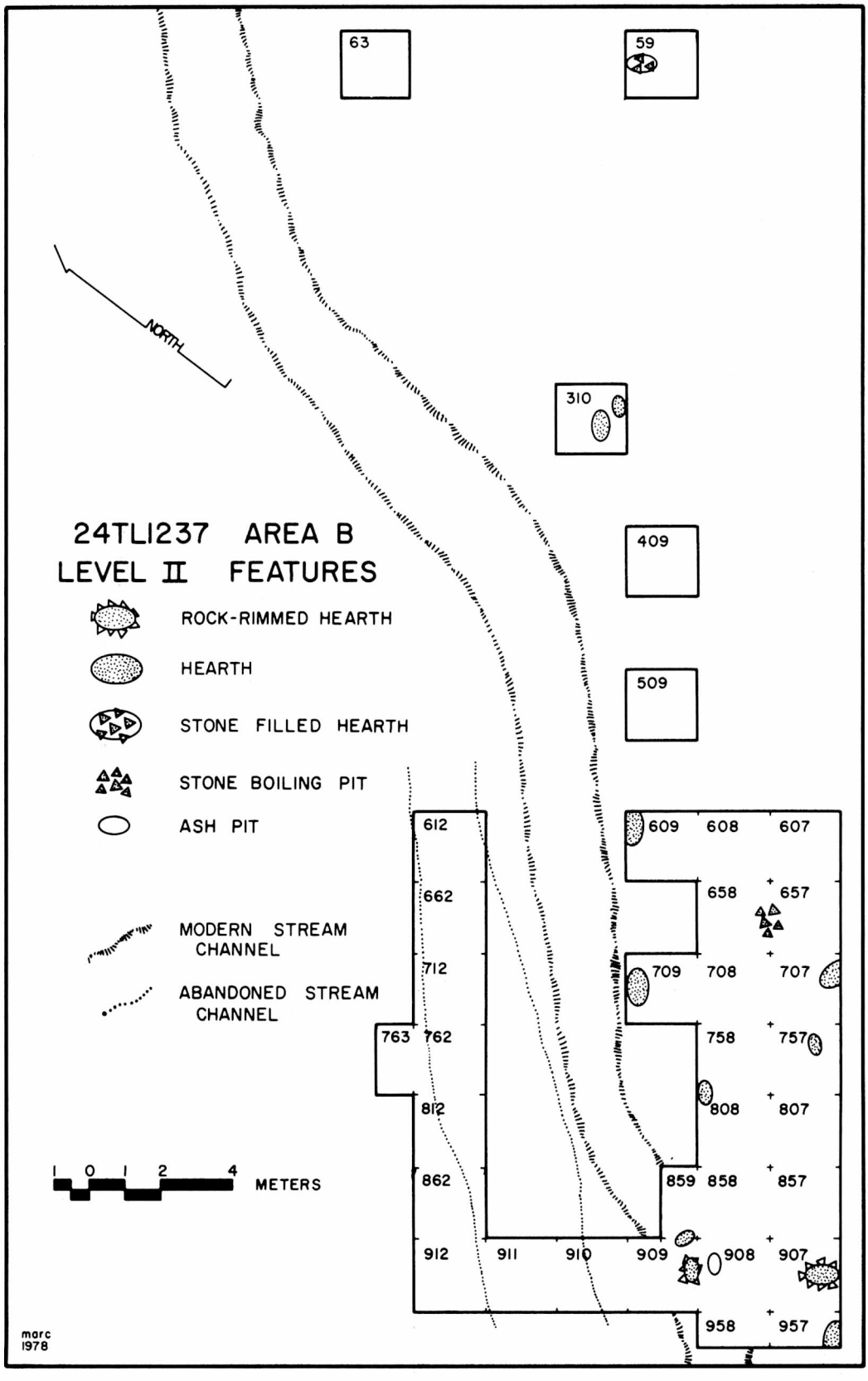


Fig. 12. 24TLl237, Area B, Level II, features.

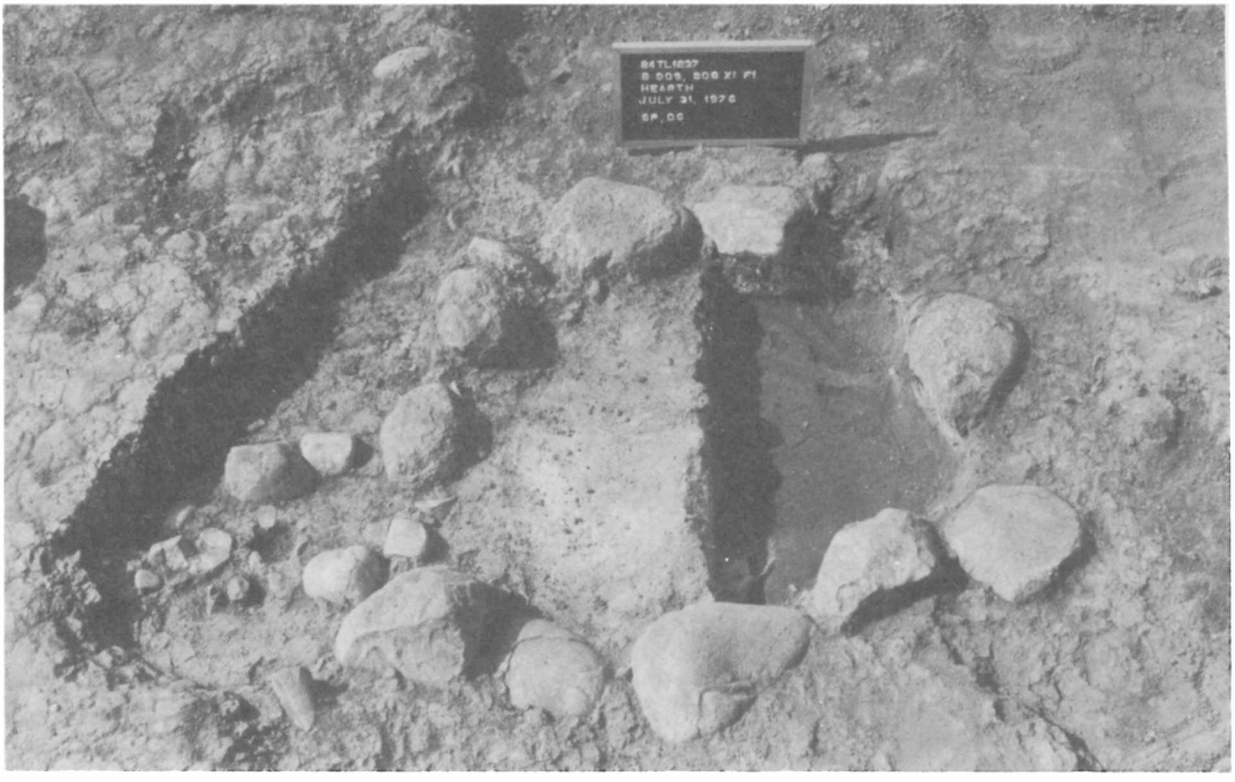


Fig. 13a. Stone-rimmed hearth.

Fig. 13b. Stone-filled hearth?

Five features, called ash pits, occurred in Area B, four in level I, one in level II. These features consist of a small, usually cylindrical, excavated pit containing ash and smaller quantities of charcoal; as a minor fraction, small bone and heat-fractured stone fragments also appear. When first observed in horizontal section, most ash pits resemble post molds in which the post has burned out rather than rotted, and we originally designated most of these features as post molds. A vertical cross-section rapidly determined that these features were not post molds. At the present time, we offer no functional explanation (Fig. 14).

Three features, labeled as stone boiling pits, were excavated: one in Area E, level I, and one in each level of Area B. In every instance an excavated pit filled with broken bone and heat-fractured stone comprise the principal observable attributes. Typically, the broken bone overlies the heat-fractured stones (Fig. 15).

Presumably, the aboriginal occupants of the site heated stones and dropped them into water contained in the pits by a water-impermeable membrane. The heated stones brought the water to a boil, and the facility served as an all-purpose kettle that sufficed to boil meat or to render fats and bone grease.

Flaking stations consisted of observable concentrations of deliberately detached stone flakes, presumably the result of stone tool manufacture. Flaking stations concentrated in Area B in the uppermost stratum (level I). Quartz breccia comprised the entirety of two concentrations in the westernmost trench in Area B. One concentration contained 3575 flakes in an area 40x15 cm, forming a virtual flake pavement; the other feature, 993 flakes, eight core fragments, and two projectile points of the same material in a slightly smaller area. The two flaking stations on the eastern edge of the excavation produced fewer flakes; one contained 21 small siltstone pressure flakes and a broken point tip, the other 10 large primary and secondary percussion decortication flakes of quartzite.

Comparison of features and their distribution within the site presents an interesting but expected contrast. All features occurred within the designated processing areas; none appeared in the kill. Hearths, stone boiling pits, and ash-filled pits all probably associate with secondary and tertiary processing of products resulting from the kill. The flaking stations provide indication of manufacturing processes not directly associated with the kill. Absent, or at least not located, from the kill and the processing areas were post molds. The likelihood of bison being injured or impeded by the low bluff above Area D seems remote. Although we hoped to find some evidence of a corral structure, we were unsuccessful. In retrospect, it seems likely that additional exploratory trenching in Area D, near the limits of the bone bed, might have yielded the desired structural remains.

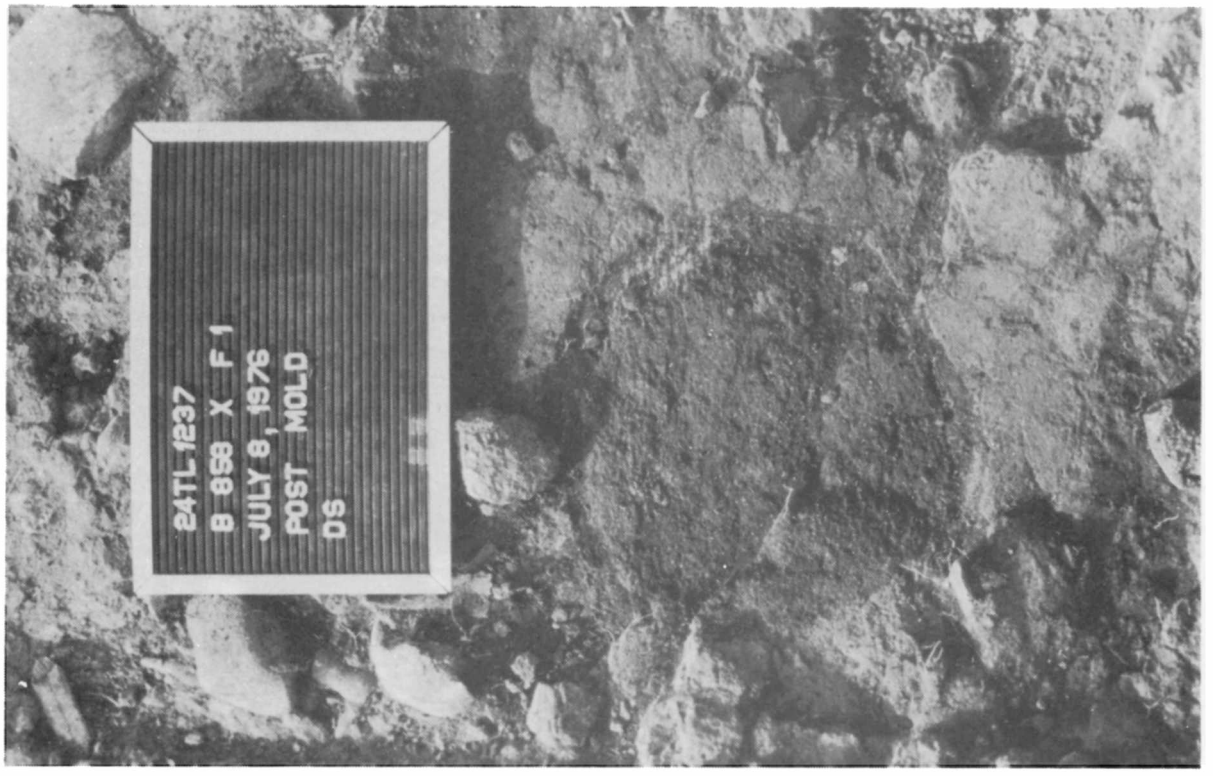


Fig. 14a. Ash-filled pit, plan view.

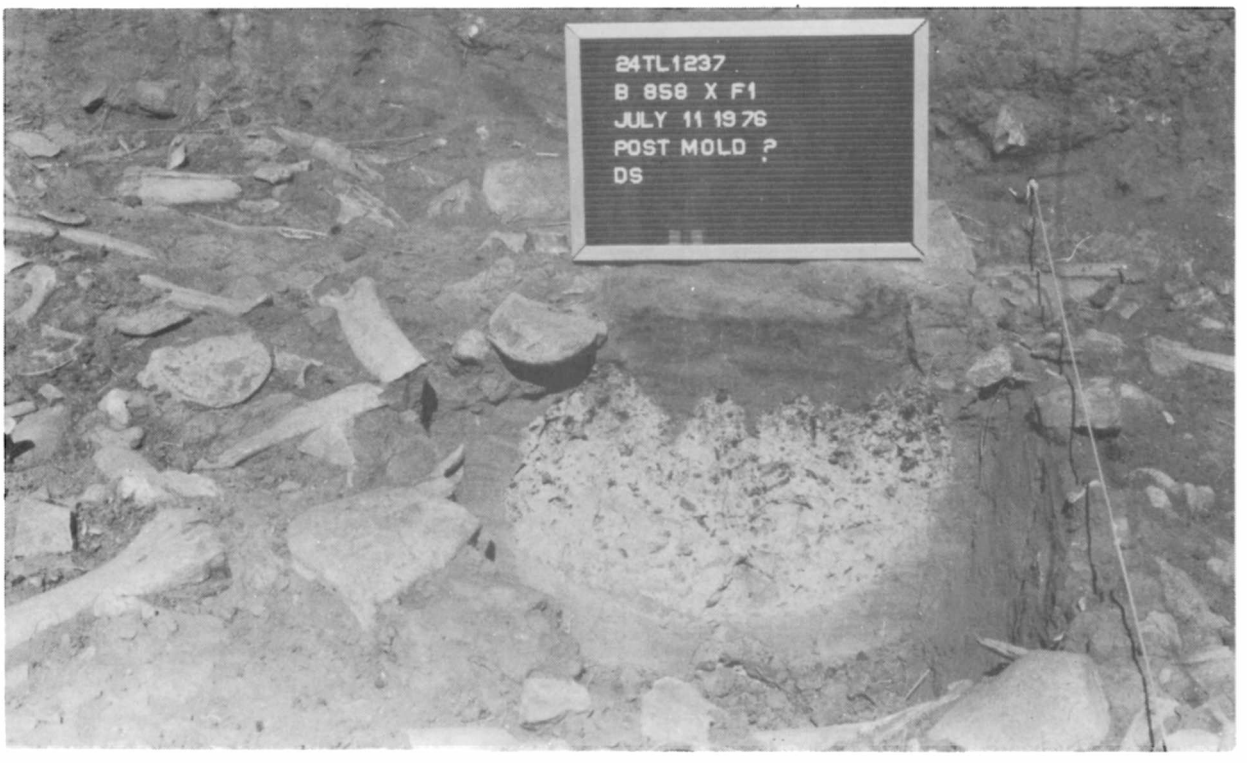


Fig. 14b. Ash-filled pit, cross section.

Fig. 15. Stone boiling pit, cross section.

ARTIFACTS: DISTRIBUTION AND ASSOCIATION

Stone and bone artifacts excavated from the Bootlegger Trail site approximate the forms found at other Late Prehistoric period bison kill sites in the northwestern Plains. Exhaustive treatment of the various lithic and bone specimens is necessary but largely inappropriate to the general interpretation of the events that occurred at this site. A compilation and description of artifacts is presented in Appendix I.

For the purpose of this discussion, artifacts are divided into three groups: (1) primary procurement implements, those involved directly in acquiring sustenance; (2) procurement support or modification implements, those involved either in modification of sustenance procurement or in the manufacture of primary procurement implements or facilities necessary or desirable for survival; and (3) miscellaneous, specimens for which use in either primary or secondary procurement is improbable. As an example, items used directly in food procurement such as arrow points, spears, digging sticks, etc., represent primary procurement implements. Support or modification procurement implements include such things as knives, involved in dressing of game; choppers for breaking bone or breaking muscle tissue loose; scrapers for defleshing hides; abrading stones used to smooth arrow shafts; etc. Specimens relegated to miscellaneous include ornamental items such as shell beads, bone beads, pendants, and a variety of others with doubtful importance in either primary or secondary procurement setting.

The assigned categories must in large part remain provisional, and some overlap between categories surely exists. An aboriginal hunter might use the same implement in both primary and secondary procurement activities; a projectile point used to kill a bison might be removed during butchering and later reused as a butchering tool.

A principal goal of the project involved an attempt to discern specific activity areas within the site. This included not only differentiation of kill and process areas, but, also definition of task-specific areas within both the kill and the processing areas. Our attempts to identify activity areas met with varying degrees of success. Definition of the kill and processing areas was fairly straightforward, and a series of attributes relating to those activities may be defined. On the other hand, no particular clusters of artifacts or features appeared in the kill and while obvious associations of artifacts and features occurred in the processing areas, their interpretation remains problematical.

Kill-Process Comparisons

The condition and degree of utilization of faunal remains provide the most obvious difference between the kill and process areas. In the kill, articulated elements of the entire forelimb, hind limb, or axial skeleton occurred with some regularity. In the processing areas, articulation of elements most commonly consisted of distal legs. Whole bones occurred with high frequency in the kill; whole bones rarely appeared in the processing areas. These distributions surely provide indication of differential activities.

In addition to the condition and degree of utilization of faunal remains, the distribution of fire hearths, stone boiling pits, and other facilities provides differentiation between kill and process areas. None of the above-mentioned facilities had representatives within the area identified as the kill, yet their occurrence was common in the identified process areas.

Distribution of artifacts should in some way parallel the distribution of faunal remains and features and reflect the activities represented within those areas. Indeed, the distribution of artifacts supports the contention of separate kill and process areas. Artifacts from the kill are indicative of the activities that took place there: killing the animals, skinning, and disarticulation of the carcass. Artifacts recovered from the kill area consist of 48 side-notched projectile points; one triangular unnotched "point;" 22 undifferentiated projectile point fragments; two bifacially modified microquartz fragments interpreted as knife fragments; two heavy-duty quartzite choppers; 13 flakes; two bone awls (Class 1); one split, smoothed rib (Class 3); one proximal rib fragment broken near the head and distally smoothed (Class 4); one humerus chopper (Class 6); two scalloped humeri (Class 7); one broken and smoothed rib shaft; and a single bone bead. All of these specimens except the awls and bone bead may in some way be related to the killing, skinning, or disarticulation of bison. If the processing area contained any surprises, they occurred in the underrepresentation of heavy choppers, either stone or bone; knives and knife fragments; and retouch flakes indicative of resharpening various tools.

The processing areas, in particular Area B, contained a wide variety of implements, projectile points, knives, endscrapers, modified flakes (predominantly of sidescraper form), thousands of retouch and manufacturing flakes, bone awls, ceramics, and a variety of ornamental items. In summary, the processing areas contained the projectile points brought in with butchered elements from the kill or in various stages of manufacture and retouch, the utensils necessary to complete the processing of the bison, and a variety of nonutilitarian items.

As might be expected, any artifact found in the kill also appeared in the processing area at the Bootlegger Trail site; the reverse is not true. An abbreviated checklist of attributes that distinguish the kill and process areas appears as Table 5. Unfortunately, these

attributes cannot serve by themselves to identify whether newly encountered materials represent a particular use area. If the kill and process areas of a site were restricted to the same space, an archaeologist using the above criteria might conclude he had failed to locate the kill. Differential utilization of discrete activity areas seems to have occurred at the Bootlegger Trail site; whether this is a recurrent pattern remains to be determined.

Table 5. Comparison of attributes in kill and process areas, Bootlegger Trail site.

Item	Process	Kill
Side-notched projectile points	C	C
Unnotched projectile points	C	-
Production tools (knives, scrapers)	C	-
Heavy-duty choppers	R	R
Primary decortication flakes	C	-
Retouch flakes	A	R
Ceramics	R	-
Hearths	R	-
Ash-filled pits	R	-
Stone boiling pits	R	-
Heat-fractured stone	A	R
Flaking stations	R	-
Shattered, burned bone	A	R
Complete bone	R	A
Complete articulated butchering units (hind limb, forelimb, etc.)	-	R

A = Abundant; no excavated units without representatives.
C = Common.
R = Rare.
- = Absent or extremely rare; occurs in no more than a single unit.

Intra-Processing Area Artifact Concentrations

In our attempt to discern activity-specific areas, we examined the distribution of artifacts by assumed use categories within the distinction of primary procurement implements, secondary or procurement support implements, and miscellanea.

Because both vertical and horizontal provenience information was accurate to within 2 cm for most artifacts, we utilized computer-generated plots of the various artifact categories to visually inspect for associations with other artifacts, stacked bone, and features. Fig. 16 illustrates a computer-generated plot of ceramics located in Area B, Level I. Similar plots were generated for the three major categories (primary procurement, secondary procurement, and miscellanea) and for subclasses such as cutting implements (bifaces), scraping implements (unifaces), heavy choppers, bone tools, ornaments, etc.

The primary procurement category consists exclusively of projectile points and assumed projectile point fragments. Distribution of side-notched projectile points appears random within the confines of excavated areas. An interesting by-product of the computer plots of projectile points was the discovery that unnotched forms occurred most consistently in the eastern half of the lower processing area. We had previously determined that these unnotched forms were virtually absent in the kill (one specimen).

Inspection revealed that processing features are also limited to the eastern edge of Area B and that the heavy bone concentrations that filled the aboriginal stream bed occurred on the western margin of the excavation.

Speculation has existed for some time as to whether unnotched forms represent projectile points, projectile point blanks, or some as-yet-unspecified tool. At least one archaeologist has stated that they are never (or at least rarely) observed within actual kill deposits (Dale Fredlund, Personal Communication 1965). Of the 45 specimens from Area B, 43 correspond with the distribution of processing features. The Bootlegger Trail sample appears to offer some confirmation of Fredlund's contention.

Three fairly obvious associations of secondary procurement artifacts with processing features occurred in Area B, one in cultural level I and two in cultural level II. In cultural level I, 14 artifacts identified as cutting implements (bifacially modified knives or knife-like fragments) clustered around the western margin of the large hearth feature in excavation units 807 and 857 (Fig. 10). This represents approximately 21% of all cutting implements found in Area B, Level I. Within a 1.5-m radius of the large stone boiling pit in excavation units 657 and 658, Level II (Fig. 11), 14 scraping implements (both end and side-scraper forms) and 21 cutting implements appeared. This represents 21% of the scraping implements, 26% of the cutting implements, and 24% of the combined categories found in Area B, Level II. Scattered over an area less than .5 m from the western periphery of a large stone-rimmed hearth in excavation unit 907, Level II (Fig. 11), were found an additional 24 cutting implements (30% of the sample from that level) and two scraping implements. The associations with these features account for 56% of all cutting implements and 25% of all scraping implements recovered from Area B, Level II. The implications of these associations remain uncertain.

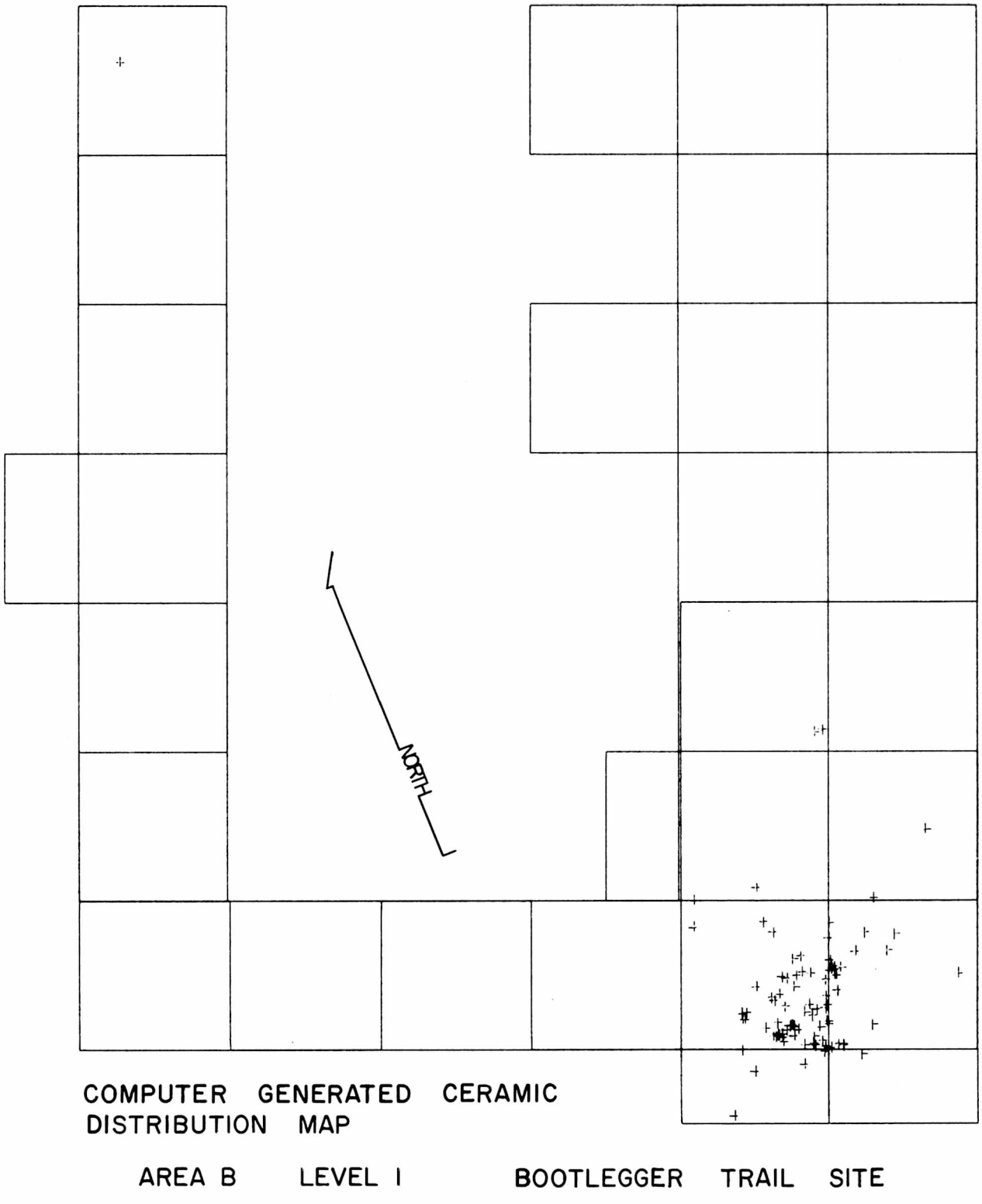


Fig. 16. Computer generated ceramic distribution map, Area B, Level I, Bootlegger Trail site.

We expected to discover large chopping implements, presumably used to break up bone for marrow extraction and subsequent stone boiling, in association with stone boiling pits but observed no obvious concentrations.

The most obvious concentration of artifactual materials was found in Area B, Level I. We recovered a total of 169 potsherds from the Bootlegger Trail site during the two years' excavations. All ceramics came from Area B, 158 from Level I, 11 from Level II. Within Level I, rimsherds provide indication of three vessels, Level II, one vessel. Of the 158 sherds contained in Level I, 90 occurred within excavation unit 908 and another 53 appeared in the adjoining five excavation units. The remaining 15 sherds from Level I were scattered in other units of Area B (Fig. 16).

Comparison of the ceramic distribution illustrated in Fig. 16 with the distribution of features (Fig. 10) shows that the broken remains of three pots coincide closely with a fire hearth in excavation unit 908 and an ash-filled pit located in excavation unit 907. Indeed, 91% of the ceramic remains from the site were found within 2 m of those features.

Comparison of distributions reveals that most processing apparently occurred on the eastern leg of the excavations in Area B. The westernmost excavations in Area B contained significantly fewer secondary procurement-associated artifacts (knives, scrapers, etc.), almost no ceramics, but primary procurement implements (side-notched projectile points) seem to distribute throughout the area randomly. To the list of artifact associations we should probably add the two flaking stations from Area B, units 862 and 762. These two heavy concentrations of flaking debris contain both primary decortication flakes and secondary trimming flakes in abundance (B762I, 993 flakes; B862I, 3575 flakes). Almost certainly these concentrations represent manufacturing activity. The features identified in units B609 and B709, Level I, contain fewer flakes (21 and 10 respectively), and probably retouching or sharpening activities rather than manufacture took place.

The concentrations discussed apparently result from the residue of relatively intense activities in their immediate vicinity. The parts of Area B on the eastern side of the stream bed served for processing of butchered bison products; manufacture and dumping of processed bones occurred on the west side of the stream. This pattern of use prevailed during both principal occupations.

CHRONOLOGICAL PLACEMENT OF THE SITE

The artifacts recovered from the Bootlegger Trail site establish the site as a Late Prehistoric manifestation (A.D. 700-1725) on the northwestern Plains. The absence of historic trade materials from all excavated areas places the occupation sometime before the 1800's. The absence of several late artifact forms, in

particular the tri-notched projectile point, suggests that the site was probably occupied sometime during the first two-thirds of the Late Prehistoric period, A.D. 700 to 1400. Homogeneity of the artifact sample from all areas and cultural levels further suggests that occupation spanned a relatively brief temporal interval.

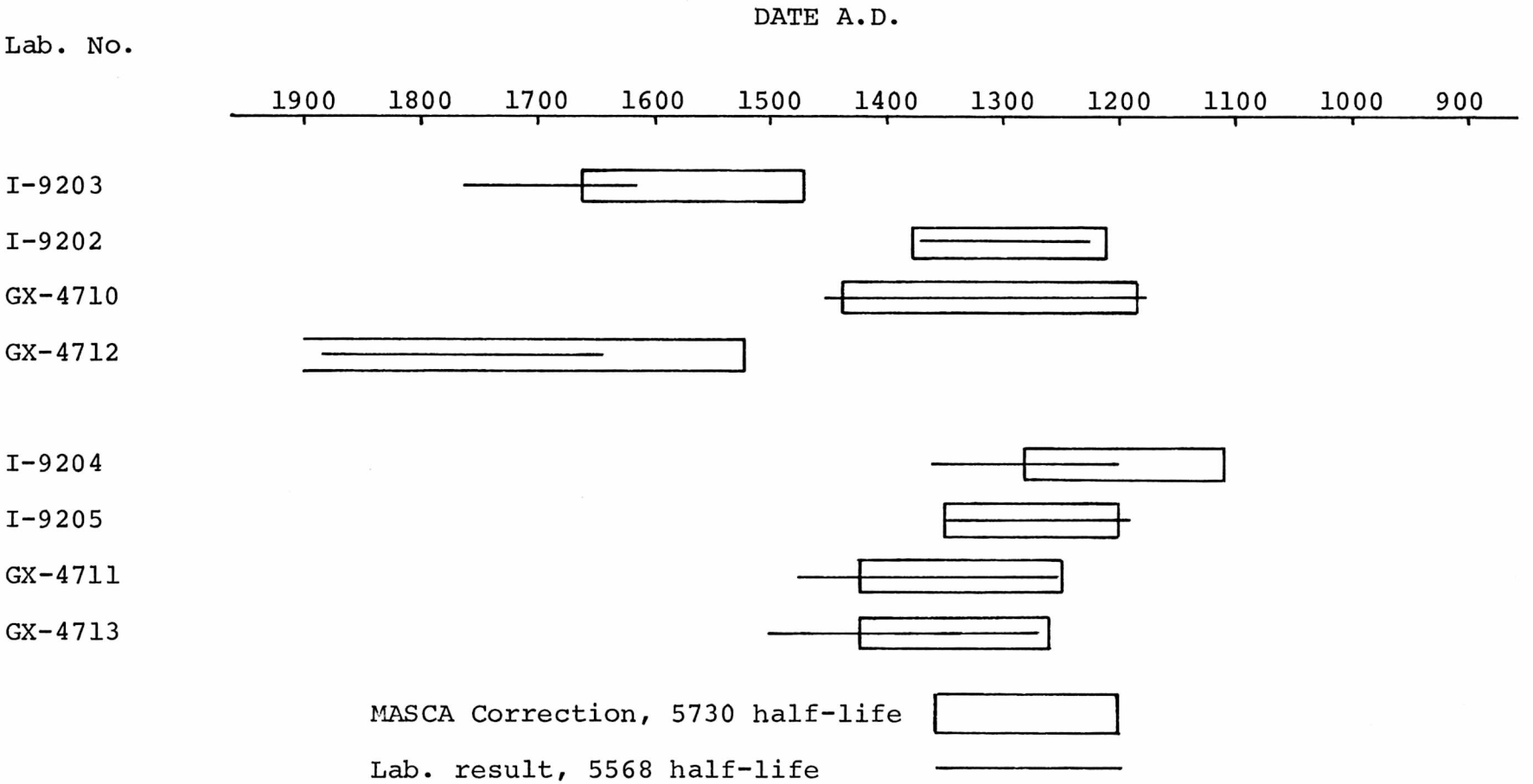
Eight charcoal samples secured from features associated with the two major cultural levels (I and II) were submitted for radiocarbon age determinations. Four of the selected samples came from each strata. In the lab, all samples were treated for removal of carbonates and humic acids, and the Libby half-life of 5568 years was used to calculate the age. The results of the radiocarbon analysis are presented in Table 6.

Table 6. Bootlegger Trail site radiocarbon dates.

Cultural Level	Lab No.	MSU No.	Years B.P.	Calendar Date Uncorrected	Calendar Date Corrected
I	I-9203	B/509/IV/S1	260±75	A.D. 1690	1660-1470
I	I-9202	B/709/IV/S1	645±80	A.D. 1305	1376-1196
I	GX-4710	B/709/IV/S2	640±135	A.D. 1310	1436-1146
I	GX-4712	B/858/X/S2	185±120	A.D. 1765	modern? - 1510
II	I-9204	B/709/V/S1	760±80	A.D. 1280	1290-1110
II	I-9205	B/59/V/S2	680±80	A.D. 1270	1350-1200
II	GX-4711	B/657/XI/S2	580±115	A.D. 1370	1420-1250
II	GX-4713	B/957/XI/S2	565±115	A.D. 1385	1420-1260

Considering the homogeneity of the artifact assemblage, the absence of very late diagnostics, and the apparent stratigraphic integrity of the culture-bearing sediments, two of the dates (I-9203, A.D. 1690±75, and GX-4712, A.D. 1765±120) do not appear to accurately reflect the temporal position of the site. Both dates considered inappropriate derive from the same cultural stratum as two earlier dates (I-9202, A.D. 1305±80, and GX-4710, A.D. 1310±135). Both of the suspect dates come from features in apparently undisturbed stratigraphic context and in continuous association with the two more acceptable dates. Application of the MASCA calibration curve (Ralph and others 1973) to the radiocarbon dates brings the lower limits of the suspect dates closer to the expected temporal interval but fails to conclusively resolve this conflict (Table 6, Fig. 17).

Fig. 17. Comparison of 5568 half-life uncorrected dates with 5730 half-life MASCA corrected dates.



In order to further clarify the temporal placement of the Bootlegger occupational events, Mrs. Nancy Marshall, director of the Pennsylvania Obsidian Dating Laboratory, measured the hydration rims of 114 archaeologically provenienced obsidian specimens (Area B, 106: Level I, 74, Level II, 32; Area D, 6; Area E, 2). The summarized hydration measurements appear in Table 7. Unquestionably, the profiles of the obsidian hydration values for levels I and II of Area B closely resemble each other (1.8 and 1.9 microns, with standard deviations of .3 for both samples) (Fig. 18). This suggests that radiocarbon determinations I-9203 and GX-4712 are inaccurate.

Table 7. Obsidian hydration values (microns).

	BI	BII	D	EI	EII
Mean, microns	1.8	1.9	1.9	2.0	1.9
Range, microns	.7-3.0	1.2-2.4	1.6-2.0	-	-
Standard deviation	.3	.3	.2	-	-
N	74	32	6	1	1

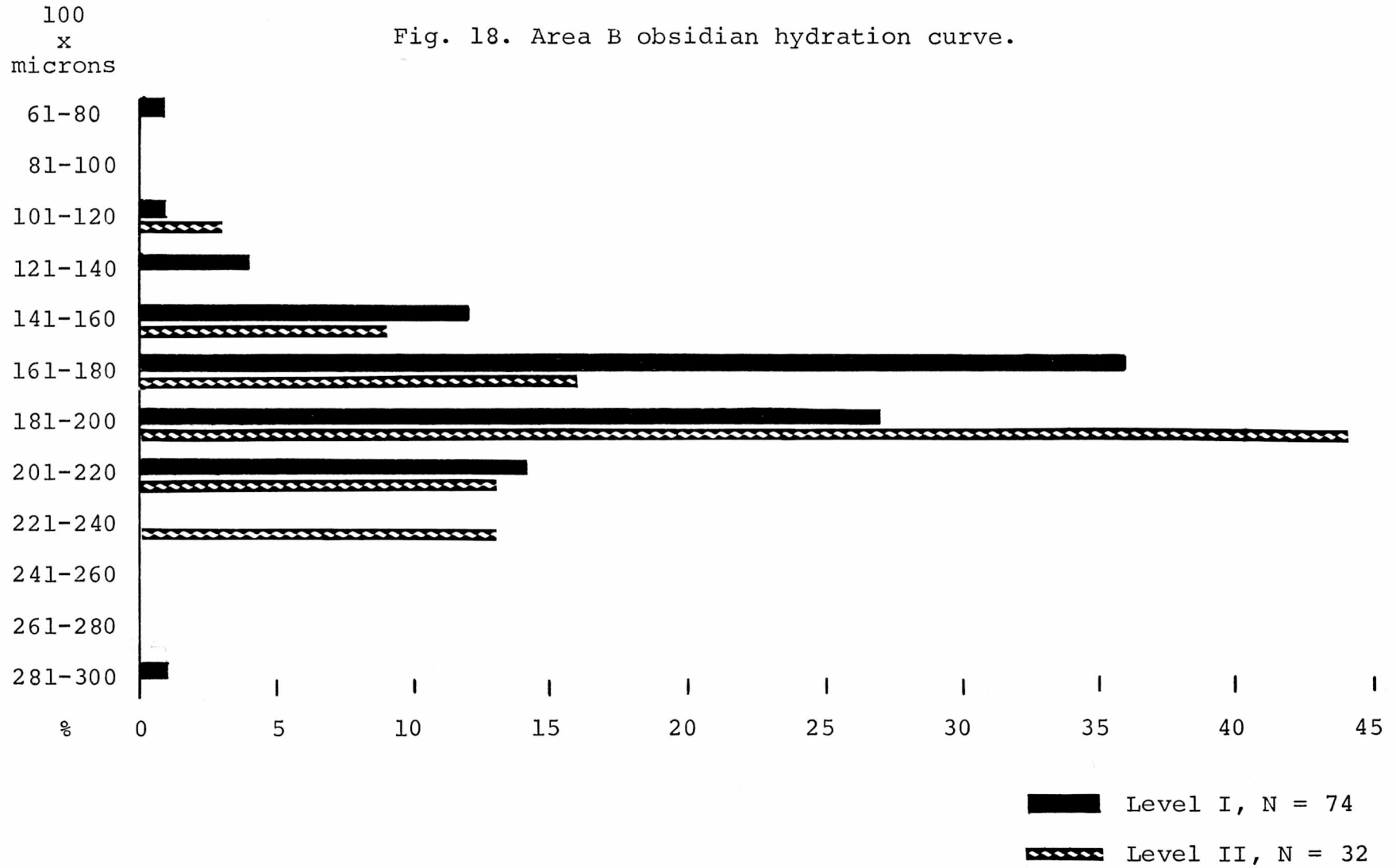
Nine obsidian samples taken in the vicinity of and in association with I-9203 (B/509/IV/S1) provide a mean hydration value of 1.8 microns (standard deviation .2, min 1.4 microns, max 2.1 microns). Five samples in similar association with GX-4712 (B/858/X/S2) produced a mean hydration value of 1.7 microns (standard deviation .3, min 1.2 microns, max 1.9 microns). Obsidian from Level II in the same excavation units appears concomitantly older. These results suggest that radiocarbon determinations I-9203 and GX-4712 fail to accurately assess the age of associated cultural materials.

Results from application of the standard obsidian hydration dating equation substantiate this conclusion.

$$\frac{\text{Rate of Hydration}}{1000} = \frac{(\text{Hydration Value in Microns})^2}{\text{Age in Years B.P.}}$$

This equation includes three interrelated variables: the empirical hydration value, an accepted or provisional rate, and an associated age in years before present. Knowledge of two of the variables

Fig. 18. Area B obsidian hydration curve.



permits solution of the equation for the third. To determine the acceptability of I-9203 or GX-4712, we must establish a reference point. This may be accomplished in one of two ways. First, because of temporal cohesiveness and acceptability, a specific, but provisional, hydration rate may be established for cultural level II. This rate can then be applied to obsidian specimens from cultural level I. Second, independently determined and provisionally accepted obsidian hydration rates for the Tiber Reservoir area can be employed in the same manner.

Method One

Four radiocarbon assessments provide an uncorrected mean radiocarbon age for cultural level II of 646 years before present (A.D. 1330). Using this age and a mean hydration value of 1.9 microns (N=32)

$$\frac{\text{Rate of Hydration}}{1000} = \frac{(1.9)^2}{646}$$

produces a provisional hydration rate of 5.3 microns^2/1000 years. (Using one standard deviation from the mean hydration value of 1.9 for Area B, Level II, produces rates from 8.8 to 3.1. Application of the mean extreme dates derived from the MASCA radiocarbon calibration curve results in hydration rates from 6.2 to 5.2 microns^2/1000 years.) We may now use this rate to determine the age of cultural level I. Application of the provisional rate (5.3) and the mean hydration value of 1.8 microns for specimens from cultural level I

$$\frac{5.3}{1000} = \frac{(1.8)^2}{\text{Age in Years B.P.}}$$

results in an age of 611 years before present (A.D. 1365). There is substantial agreement between this date and both I-9202 and GX-4710; it also falls well within one standard deviation for either. Application of the same method to mean hydration values from either excavation unit 509 (1.8 microns) or 858 (1.7 microns) exclusively results in dates of 611 B.P. (A.D. 1365) and 545 B.P. (A.D. 1431), respectively. Both results are considerably older than the contested radiocarbon determinations.

Method Two

Davis (1972) suggests a hydration rate of 3.4 microns^2/1000 years for the northern Montana Plains. The fact that Davis' rate is slower than that derived using the Bootlegger Trail site data should be anticipated, because the reliability of any rate depends on the time spread of determining radiocarbon dates (Davis 1972:96).

Hydration takes place at an exponential rate; the rate of diffusion of molecular moisture into the obsidian decreases with each

passing year. Proportionately more of the hydration rim will develop during the first "hydration years" of an artifact's history than during its later "hydration years." An artifact will exhibit an ever-decreasing rate of hydration. Therefore, in summarizing hydration data on a regional basis for considerable time, averaging of the early and late "hydration years" must occur. For practical purposes, the established regional rate evens out the initially rapid and later slower hydration years.

Davis established his rate of 3.4 microns^2/1000 years on obsidian-radiocarbon date associations that span 3300 years. The 5.3 microns^2/1000 years from cultural level II at Bootlegger spans only 646 years. For this reason, one should not take the disparity between Davis' hydration rate and the calculated rate too seriously.

The 5.3 rate at Bootlegger, while it does exceed the provisional all-time regional rate of 3.4, nevertheless is congruent with other more recently derived rates at Late period sites in north-central and southwestern Montana. The Avonlea phase Lost Terrace site (24CH68), east of Bootlegger along the upper Missouri River, yielded a rate of 6.0 (hydration $\bar{X}$ = 2.5 microns/C14 A.D. 880) (Davis and Fisher n.d.). Old Women's phase sites--the Thompson Bottom site (24CH452) near Lost Terrace (Davis 1976b) and the Antonsen site (24GA660) (Davis and Zeier 1978) near the Missouri headwaters--yielded rates of 8.5 (hydration $\bar{X}$ = 1.4 microns/C14 A.D. 1720) and 9.3 (hydration $\bar{X}$ = 1.3 microns/C14 A.D. 1770), respectively. If anything, the Bootlegger local rate(s) of hydration might be expected to be faster than derived, perhaps on the order of 7.0 microns^2/1000 years before present. For the moment, the 5.3 Bootlegger rate must be considered statistically and empirically solid. Employment of the method still permits checking the validity of the radiocarbon dates for cultural level I.

Using Davis' rate produces the following results.

Level II $\quad \frac{3.4}{1000} = \frac{(1.9)^2}{YBP} = 1061$ YBP (A.D. 915)

Level I $\quad \frac{3.4}{1000} = \frac{(1.8)^2}{YBP} = 953$ YBP (A.D. 1023)

509/I $\quad \frac{3.4}{1000} = \frac{(1.8)^2}{YBP} = 953$ YBP (A.D. 1023)

858/I $\quad \frac{3.4}{1000} = \frac{(1.7)^2}{YBP} = 850$ YBP (A.D. 1126)

Keeping in mind the differences between hydration rates, these results suggest sufficient unity within cultural level I that the differences among the four radiocarbon dates represent an anomaly. For these reasons, and because of stratigraphic continuity, we do not believe that either I-9203 or GX-4712 accurately reflects the

temporal position of cultural level I at the Bootlegger Trail site. These dates will therefore receive no further consideration.

Six obsidian hydration measurements for Area D produced a mean hydration value of 1.9 microns; using the rate 5.3 microns^2/1000 years produces a date of 681 B.P. (A.D. 1295), essentially identical to the hydration date for cultural level II with the same hydration value. We do not consider this evidence that the kill and the events at cultural level II in the processing area are coeval, but that all occupations at the site occurred within a relatively brief time.

Our current technological capability permits only a relatively crude assessment of actual prehistoric dates. The standard deviations of all samples overlap. If the sediments at the site had not contained visibly separable strata, separation of the cultural events using either obsidian hydration or radiocarbon measurements would have proved impossible.

Considering the artifact forms, stratigraphic integrity, radiocarbon dates, and obsidian hydration samples, we believe that the Bootlegger Trail site was occupied for a relatively brief interval on several occasions. The time of occupation, considering the analysis of the available information, was probably sometime during the late 13th and early 14th centuries A.D. Although subsequent occupations probably occurred, they appear only as ephemeral traces in stratigraphic profiles. Certainly their duration and impact on samples from the major culture-bearing levels was limited.

IV. FAUNAL REMAINS

Faunal analysis involved examination of all bones from all levels of all units in Areas B, D, and E. Where possible, identification specified taxon, element, side, and age for each bone. Additional comments distinguished fragments modified into tools, modified by use, charred, and dog- or rodent-gnawed from butchered bone. Analysis resulted in identification of 20,911 bone fragments from the Bootlegger Trail site. Representatives of 18 taxa occur in the sample (Table 8). Where possible, all mammalian remains were identified to the species level. Identification of mammals follows the taxonomic system presented by Burt and Grossenheider (1964). Lacking an adequate comparative collection, we attempted no specific identifications of mollusc, fish, or bird remains.

Although representatives of several taxa occur at the Bootlegger Trail site, *Bison bison* accounts for over 90% of the fragments. Bison dominates the species in all areas of the site and is the only species identified in the kill area (Area D). The horizontal distribution of the nonbison remains appears fairly random in the processing areas. However, their vertical distribution concentrates in the bottom of both cultural levels.

Particular bison elements do not display a random horizontal distribution. Percentages for skeletal units vary greatly between the kill and processing areas (Table 9). Bones of the hooves are particularly common in the processing area, while vertebrae and proximal ribs occur in higher percentages in the kill area. Nonrandom distribution of elements also characterizes Area B. Some excavation units contain high percentages of distal ribs. Others contain numerous mandibles. This pattern persisted in both cultural levels in Area B, although localities of specific elements differed. This nonrandom distribution apparently resulted from different butchering activities in the kill and processing areas and as the result of stacking of skeletal units within the processing area.

The particular distribution of bison elements and butchering marks on many elements provide a reasonable basis for reconstruction of major steps in the butchering sequence. For the prehistoric butcher, like his modern counterpart, the first steps involved removal of the viscera and then skinning the slain animals. This step apparently took place in the kill area. Initial cuts in the skinning process required a sharp, chipped-stone implement to make a transverse incision. The diaphysis of the metapodials present the easiest place to do this, and many metapodials, particularly metacarpals, display transverse scratches. Inserting the cutting implement into the opening created by the transverse cut and keeping the skin taut permitted a long, continuous cut up the limb. After this, the butcher chopped off the tail at the sacrum, and the caudal vertebra remained with the hide. Most radii and tibiae

Table 8. Species list for Bootlegger Trail site.

Mammalia
- Rodentia
  1. *Citellus richardsoni* (Richardson ground squirrel)
  2. *Castor canadensis* (Beaver)
  3. *Microtus* sp. (Vole)
  4. *Erethizon dorsatum* (Porcupine)
- Lagomorpha
  5. *Lepus townsendi* (Whitetail jackrabbit)
  6. *Sylvilagus nuttalli* (Mountain cottontail)
- Carnivora
  7. *Ursus* cf. *horribilis* (Grizzly bear)
  8. *Canis* cf. *latrans* (Coyote)
  9. *Canis familiaris* (Domestic dog)
  10. *Vulpes* cf. *velox* (Swift fox)
  11. *Lynx rufus* (Bobcat)
- Artiodactyla
  12. *Odocoileus* sp. (Deer)
  13. *Cervus canadensis* (Wapiti or elk)
  14. *Antilocapra americana* (Pronghorn)
  15. *Bison bison* (Bison)

Pelecypoda
  16. River mussel

Osteichthyes
  17. Fish

Aves
  18. Bird

exhibit green bone breaks probably produced by a heavy stone chopper. These breaks appear most frequently immediately above the distal end. All elements distal of these breaks (carpals, tarsals, metapodials, and phalanges) probably remained with the hide. These breaks may, however, result from later processing, as virtually all metapodials display evidence of a similar breakage pattern. Either way, most of the hides and distal limb units eventually were transported to the processing area. The hide with the distal limb units attached provides an excellent container for transportation of the meaty units produced by subsequent butchering.

Table 9. Distribution of adult bison elements (listed by butchering units).

Area	Skull	Mandible	Vertebra	Distal Ribs	Hind Limb	Fore Limb	Hoof	Total
BI	430	565	1146	534	278	393	2795	6141
BII	425	459	1261	959	330	850	5469	9753
D	167	289	773	254	113	136	723	2455
EI	2	4	6	1	2	4	54	73
EII	24	5	13	14	1	15	71	143
Total	1048	1322	3199	1762	724	1398	9112	18565

The next step for the butcher involved stripping the meat from the forelimb containing the scapula, humerus and proximal radius and ulna. Further reduction of the strips of muscle and many of the bones probably took place in the processing area. The hind limb, containing the femur, patella, and proximal tibia, yielded its meat in a similar fashion. Using either a stone chopper or a heavy bone chopper produced from a previously killed animal, butchering continued by grasping the patella as a handhold and chopping off the trochanter major of the femur. This produced a long strip of meat that contained several muscles and the patella. Later, breaking the neck of the femur permitted removal of the hind limb.

The next process entailed excision of the muscles lying between the ribs and dorsal spines of the vertebrae. Removal of the sublumbar muscles as a unit necessitated breaking the transverse processes of the lumbar vertebrae. This produced two or more long strips of meat. The innominate may have traveled to the processing

area with this unit and then been separated during later processing. A stone chopper parted the mandibles from the skull. In some cases, butchers carried the mandibles and tongue to the processing area as a unit, but often cut out the tongue and discarded the mandibles.

Chopping through or between the atlas or axis vertebra separated the skull from the vertebral chain. This frequently resulted in broken atlases and occipital condyles, but occasionally the atlas remained intact with the skull. They transported many intact skulls to the processing areas, but split some longitudinally and removed only the brain from the kill area. Not a single complete braincase was found at the Bootlegger Trail site.

Detachment of the ribs probably represented the last major butchering process. Virtually all ribs have breaks just below the neck and at the costal cartilage, and the distal ribs normally were removed as two sets of racks to the processing area. Most proximal ribs remained articulated to the vertebrae. Some of the vertebrae appear as units in the processing area, but many remained in the kill area. Other authors describe roughly similar butchering processes (Wheat 1972; Frison 1978).

Substantial stacking of butchered units took place in the processing area. Some areas served for final processing of rib units and backstrap muscles, others for processing forelimb units. In the processing area, further reduction involved cutting the strips of muscles into small strips of boneless meat for drying and later consumption. Consumption of some of this meat, marrow from the broken long bones, and some of the internal organs no doubt occurred during processing of storable products.

Some of the available meat and bone remained unutilized. We found one complete articulated side of an adult cow in the kill area (Fig. 19a). The butchers stripped and removed the left side, the skull, atlas vertebra, and caudal vertebra but abandoned the entire right side and the remaining axial skeleton. Apparently they skinned and butchered the animal on one side but failed to flip it over to process the right side. We also found two complete forelimbs and one entire hind limb in the kill area (Fig. 19b). Each unit remained articulated and bore no butchering marks. We discovered many articulated partial units in the kill area and a few in the processing area. These displayed chopping and cutting marks. Apparently they stripped the meat but did not subject the bones to further processing.

In general, the occupants of Level I processed the bone more completely than those of Level II. Apparently they stripped all of the bones in both levels of Area B of meat but did not process a large percentage of the bones in Level II for the marrow and bone grease. They apparently stone boiled virtually all of the bones in Level I. Only some distal limb units (distal tibia or distal radius through the phalanges) were found articulated and without evidence of cooking. All bones in all levels of Areas A and E were processed completely. Our evidence indicates that the butchers abandoned potential food only in Level II of Area B and in the kill area.

a

b

Fig. 19. Articulations, Area D.
a - Articulated axial skeleton.
b - Articulated forelimb.

Although we present estimates of the minimum number of individuals killed and processed in the various levels and areas at the Bootlegger Trail site, these represent only rough approximations. Two prominent reasons preclude more accurate assessment. Initially, we failed to establish how, or if, the two levels in the two processing areas (Areas B and E) and the single level in the kill area (Area D) correlate with each other. Complete comparison produces 17 possible combinations of these stratigraphic units. Fortunately, all possible combinations indicate similar minimum numbers of individuals. Second, excavations encompass less than one-sixth of the total site. It is impossible to say exactly what remains in the unexcavated portion. However, the total number of individuals can be approximated by multiplying the minimum individuals identified in each area by the inverse fraction of the area that has been excavated. This, of course, assumes that the area thus far excavated represents a reasonably random sample.

Given these two limitations, estimates have been made for the minimum number of bison individuals (Table 10). Level I in Area B yielded a total of 66 right astragali from adult and subadult bison. Level I also produced nine left humeri from fetal bison. It appears that we excavated a little over 14% of Level I to produce this sample. If the remaining sediments contain similar densities and types of bones, then the level represents 471 adult and subadult bison and 64 fetuses. Likewise, Level II of Area B disclosed 104 left distal and whole tibia. We also found the same number of adult and subadult right proximal and whole metacarpals. A total of 45 left humeri of fetal bison accrued from identification. Approximately 12% of Level II was excavated. Again, if this represents a valid sample, then Level II would represent 866 minimum individuals of adult and subadult bison and 375 fetal bison.

Area D contained 15 adult and subadult left calcanei. Area D also yielded 15 right fused second and third carpals and 15 atlas vertebrae. In addition, we found two fetal left humeri. Excavation opened approximately 14% of Area D. Assuming we obtained and identified a valid sample, Area D would represent 107 adult and subadult bison and 14 fetal bison. Level I in Area E produced two right calcanei and two left fused second and third carpals. There were no fetal remains. Level II of Area E provided three left astragali, three right naviculo-cuboids, and one fetal rib. Excavations tapped approximately 12% of Area E. If this constitutes a valid sample, Level I would represent 16 adult and subadult bison and Level II 25 adult and subadult bison and eight fetal bison.

If it is assumed that each level and area represents independent occupations, then the figures obtained above can be added together to obtain an estimate of the minimum individuals present at the Bootlegger Trail site. Given this assumption, the analysis indicates 1485 adult and subadult bison and 461 fetal bison. However, the possibility exists that the kill area may correlate with one or more levels in the processing areas. Likewise, levels in the two processing areas may represent two localities of a single occupation. When two or more units are correlated, a single

Table 10. Minimum bison individuals from Bootlegger Trail site.

Area	Minimum Adults	Minimum Fetuses	% Excavated	Estim. Min. Adult	Estim. Min. Fet.
If All Areas Stratigraphically Distinct					
BI	66	9	14	471	64
BII	104	45	12	866	375
D	15	2	14	107	14
EI	2	0	12	16	0
EII	3	1	12	25	8
Total	190	57		1485	461
If BI = D = EI and BII = EII					
Level I	80	11	14	571	79
Level II	105	45	12	875	375
Total	185	56		1446	454
If BII = D = EII and BI = EI					
Level I	66	9	14	471	64
Level II	118	47	12	983	392
Total	184	56		1454	456
If BI = EI, BII = EII and D Contains Both Levels					
Level I	66	9	14	471	64
Level II	105	45	12	875	375
Unknown	...	2	14	...	14
Total	171	56		1346	453

anatomical unit must be chosen to estimate minimum individuals. Table 10 presents several possible combinations. In the case of the greatest number of possible combinations, Level I of Area B is assumed to correlate with Level I of Area E, Level II of Area B is assumed to correlate with Level II of Area E, and both of these occupations are assumed to be present (and inseparable) in Area D. In this case, Level I would represent 471 postnatal and 64 fetal bison. Level II would represent 875 adult and subadult bison and 375 fetal individuals. Area D would contain additional evidence for 14 fetal bison, but their level of origin would be indeterminable. In this case, a total of 1346 adults would be represented at the site along with 453 fetuses. This is the smallest number of minimum individuals for all possible combinations. The exact number of individuals probably lies somewhere between 1346 and the maximum of 1485 adult and subadults and 453 and 461 fetuses depending on the exact correlation of the stratigraphic units and the randomness of the sample obtained.

We also attempted to estimate the minimum number of individuals for nonbison taxa. Table 11 presents these numbers for the remains identified. In most cases, the very small sample precludes any assumption as to the validity of the sample for the entire site. For this reason the data have been presented only on the basis of material recovered.

Two methods were employed to establish age pyramids of the bison populations represented at the Bootlegger Trail site. The long bones of bison have epiphyseal caps that fuse to the diaphyses at known ages (Duffield 1973; Koch 1935). The number of fused and unfused elements were compared to obtain the percentage of the population above the age of fusion (Table 12). The results are not entirely internally consistent. For example, 99% of the proximal radii from Level I are fused. This fusion occurs at three to three and one-half years of age (Duffield 1973:133). Thus, 99% of the population would be at or over this age. However, only 88% of the atlas vertebrae from Level I are fused. The two segments of the atlas fuse at eight months to one year (Duffield 1973:133). This presents an impossible situation where 99% of the population is over three years old, but only 88% is over one year old.

The population of bison at a kill site should (no cultural selection assumed) approximate a natural situation subjected to a catastrophic event. Deevey (1947) established life tables for natural populations. When graphed, age categories should appear in a decreasing sigmoid curve. Large numbers of calves should decline to a fairly stable number during middle age (four to eight years for bison) and then decline rapidly for older individuals. The population structure, based on long bone fusion, deviates from a natural population. There are far too few individuals at or under the age of two years. This is not an unusual situation at bison kills on the Plains. Indeed, most sites have very few individuals in the younger age groups (Reher 1974). Perhaps the hunters preferred and killed old and large bison in greater numbers. The possibility

Table 11. Minimum individuals for nonbison taxa based only on sample recovered.

Taxa	BI	BII	D	EI	EII	Total
Citellus richardsoni	0	1	0	0	0	1
Castor canadensis	0	1	0	0	0	1
Microtus sp.	0	1	0	0	1	2
Erethizon dorsatum	0	1	0	0	0	1
Lepus townsendi	1	1	0	0	0	2
Sylvilagus nuttalli	1	2	0	0	1	4
Ursus cf. *horribilis*	1	0	0	0	0	1
Canis cf. *latrans*	0	1	0	0	0	1
Canis familiaris	2	6	0	1	1	10
Vulpes cf. *velox*	3	4	0	1	0	8
Lynx rufus	1	1	0	0	0	2
Odocoileus sp.	1	1	0	1	0	3
Cervus canadensis	0	1	0	0	0	1
Antilocapra americana	2	3	0	1	1	7
River mussel	1	1	0	0	0	2
Fish	1	1	0	0	0	2
Bird	4	3	0	0	0	7
Total	18	29	0	4	4	55

Table 12. Age structure of bison population based on bone fusion.

Element	BI Fused	BI Unf.	% Fus.	BII Fus.	BII Unf.	% Fus.	D Fus.	D Unf.	% Fus.	Age of Fusion
Acetabulum of pelvis	90	10	90	80	13	86	22	2	92	8 mo-1 yr
Atlas vertebra	23	3	88	19	2	90	12	4	75	8 mo-1 yr
Prox. 2nd phalange	267	14	95	460	34	93	86	11	89	2-3 yr
Distal humerus	60	14	81	118	25	83	10	3	77	3-3½ yr
Proximal radius	73	1	99	157	3	98	10	1	91	3-3½ yr
Distal tibia	69	18	79	157	38	81	6	3	67	3½ yr
Prox. 1st phalange	233	24	91	483	76	86	69	20	78	3½ yr
Calcaneus	53	48	52	84	82	51	11	17	39	3½-4 yr
Distal metapodial	135	72	65	210	117	64	26	18	59	3½-4 yr
Olecranon of ulna	18	19	49	57	36	61	8	12	40	4-4½ yr
Proximal femur	15	18	45	15	14	52	5	9	36	4½ yr
Proximal tibia	6	5	55	6	4	60	7	12	37	4½-5 yr
Distal femur	5	5	50	5	3	63	5	8	38	4½-5 yr
Distal radius	37	34	52	80	58	58	8	14	36	5-5½ yr
Head of humerus	8	5	62	6	6	50	7	18	28	5-5½ yr
Caps of vertebrae	70	188	27	51	164	24	101	229	31	6-7 yr

SOURCE: Duffield (1973).

also exists that some selection of bones happened after the kill. Many of the bison bones served as tools, and if the bones of certain age categories received preference this could bias the sample recovered.

A second method of aging bison remains is based on dental eruption and wear. Bison teeth erupt at known ages and wear at fairly constant rates (Frison and Reher 1970; Fuller 1959). It is probably not possible to accurately assign all isolated teeth to exact age categories, but some prove fairly sensitive, and articulated dental units assign to categories fairly precisely. Nearly all teeth from this site were judged to represent individuals of yearly categories. That is, they were at or just under 1, 2, 3, etc., years old and not 1½, 2½, 3½, etc., years old. Table 13 presents the number and percentage for each dental age category. Note the underrepresentation of categories under two years of age.

Table 13. Age structure of bison population based on tooth eruption and wear.

Area	Under 1 yr	1 yr	2 yr	3 yr	4-8 yr	8-10 yr	Over 10 yr	Total
BI	3	18	28	22	70	19	6	166
BII	5	24	22	19	71	25	5	171
D	5	10	12	13	41	1	3	85
EI	0	0	0	1	0	0	0	1
EII	0	2	1	0	2	0	1	6
Total	13	54	63	55	184	45	15	429
% of Total	3	13	15	13	43	10	3	100

The two methods of aging the bison at the Bootlegger Trail site yield slightly different results. The method based on dental evidence more closely approximates a natural population, and most investigators prefer this method. Interestingly, both methods indicate a mean age of around four years for the entire population.

In addition to adult and subadult remains, analysis identified a substantial number of fetal bison remains. Bison gestate for 270-300 days (McHugh 1958:31). Breeding of most cows takes place during a limited period of the summer. Thus, a strong concentration

of births tends to result during a short period in late spring. At the latitude of the Bootlegger Trail site, most bison gave birth during the month of May (McHugh 1958:31). The presence of a small number of fetal bison remains in a site does not reliably indicate seasonality of the site. Cows drop occasional calves at virtually any season, but extreme winter conditions usually eliminate out-of-season calves. Indeed, Wilson (1974:151) established the Casper site as a fall kill, but it contained a minimum of three bison fetuses. However, the large number of bison fetuses at the Bootlegger Trail site clearly indicates an early spring kill. The dental evidence supports this by indicating full-year ages for all specimens.

Spring kills are not common on the northern Plains. An attempt was made to establish more accurately the developmental age of fetal remains and more precisely the time of year of the kill. The rate of development of fetal bison bone has not been established exactly. However, on the basis of size and degree of development of the periosteum strata, five overlapping age categories were created. During the investigation, all fetal long bones were assigned to one of these categories. Additionally, all postnatal bones were reexamined to locate any that might be at or shortly after birth (less than four months old). All of this data is presented in Table 14. Both levels display a substantial degree of diversity in terms of size and development. However, in both levels, and particularly in Level II, the vast majority of the remains derive from seven-month fetuses. This indicates that both levels represent activities during the month of March.

It is very difficult to sex isolated bison bones. Metric indices comparing length and width of metapodials and other distal limb elements have been used (Bedord 1974; Duffield 1973). All of these require the use of entire metapodials. Most metapodials from 24TL1237 are broken. Sexing of small samples can produce misleading results when subadult males are classed as adult females. No attempt was made to sex the metapodials for the above reasons.

The fetal remains provide another method for establishing sex ratios for the population. Cows are sexually mature at two years and generally conceive at that time. McHugh (1958:31) reported an 87% pregnancy rate of the cows between two and 12 years of age autopsied on the National Bison Range. Surveys of cows on several ranges during the summer indicated around 65% pregnancy (McHugh 1958:32). This suggests that in March, midway between the two reported periods, approximately 75% of the adult cows might be carrying fetuses. Thus, the estimates of minimum individuals for fetal bison would represent 75% of the cows over two years of age. This would mean 84 adult cows are represented in Level I of Area B and 493 adult cows in Level II of Area B. Dental evidence from both levels indicates that 70% of the individuals were over two years old. If this figure is used, the fetal remains indicate the presence of a total of 120 cows in Level I and 705 in Level II. When compared with the total minimum individual estimates, this suggests that around 25% of the individuals in Level I were female but over 80% of those in Level II were cows.

Table 14. Age distribution of fetal bison long bones.

Age	Ileum			Ischium			Femur			Tibia			Scapula			Humerus			Radius			Ulna			Total
	L	R	?	L	R	?	L	R	?	L	R	?	L	R	?	L	R	?	L	R	?	L	R	?	
BI																									
4-6 mo	1	1	0	0	0	0	1	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	4
5-7 mo	1	2	0	0	0	0	2	0	0	2	0	0	2	0	0	0	1	1	2	1	0	1	0	0	15
6-8 mo	0	2	0	0	0	0	2	1	0	0	1	0	1	1	0	5	2	0	1	1	0	0	1	0	18
7-9 mo	2	1	0	0	0	1	2	0	0	2	3	4	0	3	0	3	1	1	2	3	1	1	8	0	38
8-9 mo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
Birth	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	1	0	0	0	1	0	0	0	0	4
Total	4	6	0	0	0	1	7	1	0	5	4	4	3	5	0	10	5	2	5	6	1	2	9	0	80
BII																									
4-6 mo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	1
5-7 mo	5	4	0	1	0	0	1	2	0	1	4	0	1	2	0	5	2	0	2	0	0	2	0	0	32
6-8 mo	10	8	0	3	2	0	10	10	0	7	6	0	8	9	0	14	11	0	10	8	0	9	10	0	135
7-9 mo	14	10	1	3	6	2	12	16	2	9	14	1	13	16	0	23	21	1	18	19	0	11	6	0	218
8-9 mo	0	0	0	0	2	0	2	1	0	1	0	0	2	3	0	2	1	0	0	0	0	0	0	0	14
Birth	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	1
Total	29	22	1	7	10	2	25	29	2	18	24	1	24	30	0	45	36	1	30	27	0	22	16	0	401
D																									
4-6 mo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5-7 mo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6-8 mo	0	0	0	0	0	0	1	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	3
7-9 mo	0	0	0	0	0	0	0	0	1	0	0	1	0	0	0	2	1	0	0	0	0	0	0	0	5
8-9 mo	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Birth	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Total	0	0	0	0	0	0	1	0	1	1	1	1	0	0	0	2	1	0	0	0	0	0	0	0	8

As previously stated, dental evidence from the site produces data to indicate an unnaturally old population. If it is assumed that this picture deviates from reality due to various selective factors, the population tables for natural groups might prove more accurate. In this case, approximately one-third of the population in Level I would be female, but the entire population in Level II would represent cows. Regardless of which figures are used, the composition of the populations in the two levels is very different.

During the winter and spring months, bison normally reside in sexually segregated herds (Dary 1974; McHugh 1958). Cows, calves, and sexually immature bulls exist in smaller separate groups (McHugh 1958:15). Perhaps much larger groups prevailed in prehistoric time, but the composition should have approximated that of modern herds. Apparently, the hunters who left the bison remains in Level II massed and killed several cow herds. Level I likely represents mixed cow and bull herds and possibly resulted from more than one closely spaced kill. The slightly greater diversity in age of fetal remains from Level I could support an hypothesis of more than one drive. Ethnographies for Indian groups in this area (Denig 1929) report the repeated use of bison drives and pounds during a single season.

V. THE SUBSISTENCE STRATEGY

by Ken Deaver

Determination of the subsistence strategy reflected at the Bootlegger Trail site necessitated establishing which of the taxa identified actually were eaten. No single criterion suffices to separate utilized from intrusive taxa. To separate naturally and culturally deposited species, Thomas (1971) proposed a system involving an index based on the degree of skeletal completeness for each taxa. It assumes that species naturally in the sediments will incur less disruption than will culturally utilized taxa. An index of the percentage of all recovered skeletal elements indicates the degree of disturbance for each taxon. The technique seems to have application to sites with a generalized hunting economy, such as those in the Great Basin, but does not work well at a site displaying very specialized hunting activities. At the Bootlegger Trail site, bison display the highest degree of skeletal completeness, so Thomas' technique eliminates bison from the list of culturally utilized species, an unlikely state of affairs.

A combination of criteria intuitively applied to the remains from the site suffices to isolate culturally utilized species. Five characteristics are most significant for this purpose: (1) bones broken in a consistent butchering pattern; (2) presence of scratches and other butchering marks; (3) charring or eroded surfaces on bones, indicative of cooking; (4) the extent of separation or disarticulation of bones from an individual; and (5) the likelihood that a particular taxon burrowed into the sediments at the site or died naturally on the archaeological surface. A brief discussion of these criteria appears below.

1. Bison remains exhibit a consistent butchering pattern. Preparation for final processing apparently required separation of the carcass at particular points, resulting in consistent breaks on particular bones. This pattern appears essentially unchanged on bones from other large mammals (deer, pronghorn, and dog). As expected, smaller forms (lagomorph, fox, and bobcat) display a different, unique pattern of breakage. These smaller species required less extensive breakage to produce manageable, easily cooked and consumed units of meat.

2. Many bison bones, and often those of dog and pronghorn, display scratches or hacking marks from the butchering sequence. Different marks on beaver, lagomorphs, fox, bobcat, river mussel, and bird remains indicate utilization but not necessarily for food. Many bones of these animals were modified for tools or ornamental objects such as beads and pendants; the scratches so produced cannot be considered evidence of utilization for food. River mussel and some bird remains bear only marks associated with making tools

and ornamental objects. Ground squirrel, vole, coyote, bear, and fish remains show no marks.

3. Charred or eroded surfaces on bones indicate they were cooked, charred coincidentally when a fire was built on them, or eroded by exposure to the elements. This criterion suggests cooking when several bones of a particular taxon display the characteristic. Those cooked frequently include bison, dog, and pronghorn; occasionally, lagomorph, fox, bobcat, deer, and bird; never, ground squirrel, beaver, vole, coyote, bear, river mussel, and fish.

4. The degree of disarticulation resembles Thomas' (1971) skeletal completeness criterion. Thomas concerned himself with completeness of skeletons within the entire site; our principal concern focused on the completeness of articulated units from a single individual. Larger carcass units of nonculturally utilized individuals should have been deposited in an undisturbed state. Although a few articulated, probably unutilized, bison units occurred in the kill area, the vast majority of bison remains, particularly in the processing area, appeared as completely disarticulated single bones. Complete disarticulation also prevailed for beaver, lagomorph, dog, fox, bobcat, deer, pronghorn, river mussel, fish, and bird. Ground squirrel and vole frequently occurred as articulated skeletons.

5. Some individuals, particularly in species that burrow, die naturally and their remains become interred in their normal habitats, leaving fairly complete articulated units. Krotovina commonly contained ground squirrel and vole remains. Some of the recovered remains of small ground birds may result from natural death and surface deposition. This same explanation could suffice to account for some cottontail bones, but other evidence of cultural utilization casts doubt on this.

The opposite of this principle is also true. Beaver, river mussels, fish, or waterfowl did not die naturally at the site; they must result from cultural deposition. All of these taxa depend closely on standing water; the closest water lies more than one kilometer away.

Application of these combined criteria eliminates ground squirrels and voles from consideration as food sources and renders river mussels and fish suspect. River mussel shells appear most frequently as beads and pendants; fish vertebrae could readily serve a similar function. If used as food, neither would necessarily exhibit marks indicative of such utilization. No evidence indicates that either served as a food source. Because of scarcity, neither could represent a significant food source. River mussels and fish, therefore, receive no further consideration.

Because of the several species involved, birds present a special case. Remains of waterfowl, such as large ducks and geese, usually appeared in a broken, scratched, or disarticulated state. Natural deposition of these species seems unlikely, as mentioned previously.

For these reasons, waterfowl may have provided a minor part of the diet. Small ground bird remains did not exhibit these characteristics and probably resulted from natural death and deposition.

The remains of four taxa occurred in such small numbers that their status as food sources remains undetermined. The remains of these four taxa all exhibit modification or the possibility of modification. The remains include: one porcupine incisor modified into a chisel; dog and fox metapodials, used to produce tubular bone beads (this may also explain the presence of two coyote phalanges); two wapiti teeth, one drilled for suspension as a pendant; one bear mandible with teeth missing, perhaps removed for ornaments. These four taxa remain as questionable food sources for lack of definitive evidence. Removal from the fauna list of nonutilized taxa and doubtful food resources leaves these definite food sources: beaver, lagomorph (cottontail and jack rabbit), dog, fox, bobcat, deer, pronghorn, bison, and waterfowl.

Although the people who occupied the Bootlegger Trail site utilized ten taxa as food sources, good documentation exists for only one form of subsistence activity. The site was a bison kill and thus the result of a very specialized form of activity. Stratigraphic evidence at the site indicates the occupants hunted and ate the nonbison forms just prior to the kill, providing food while preparing for the main activity. Analyzing the subsistence pattern of the Late Prehistoric period necessitates establishing what other activities, besides communal bison hunting, occurred. This cannot be done solely from evidence at a single-purpose site, but must include information from other sites and from ethnographic and historical accounts.

Communal bison hunting prevailed as the most productive subsistence activity of the inhabitants of the northwestern Plains in the Late Prehistoric period. Ethnographic accounts of the succeeding period (Denig 1929; Ewers 1958; Kroeber 1908; Lowie 1910) and numerous archaeological sites document this statement. However, all groups also used other food sources. Many people utilized the same taxa as in the generalized hunting activities that preceded the Bootlegger bison kill.

Although not as commonly as with bison, the northern Plains people occasionally applied the specialized technique of large communal traps to other artiodactyls. Traps similar to bison pounds and usually including drive lines ending in a corral sufficed to capture both pronghorn and bighorn sheep in Wyoming (Frison 1971). Some documentation for pronghorn kills also exists along the upper Missouri River in Montana (Davis and Fisher n.d.). As in the bison kill sites, the pronghorn trap sites indicate that meat was preserved.

Roe (1951:405) estimated that a young cow buffalo yielded around 180 kg of butchered meat or 20 kg of jerky when dried. With this procurement system, a kill site occupied for only a few weeks would represent an easily carried, adequate food supply for months. This activity occurred most frequently in the fall or

winter, when the group needed sufficient surpluses to tide them over periods of inclement weather.

Single individuals acquired much of the food supply throughout the year by practicing a generalized hunting and gathering pattern. Lowie (1935:72) stated that individual hunters among the Crow Indians in southern Montana stalked deer, pronghorn, wapiti, and bison. The Assiniboine of northern Montana and southern Alberta also used the large herd animals but occasionally ate porcupine, fish, and even insects (Lowie 1910:12).

Edwin Thompson Denig spent over 20 years among several Indian tribes of the upper Missouri River in Montana and North Dakota. In 1854 he filed a report to the Office of Indian Affairs describing the groups he had seen, particularly the Assiniboine, Gros Ventres, and Cree. Although not a trained ethnographer, and with many biases abundantly clear in his report, Denig presents a great deal of generally accepted data. He listed (1929:583) 22 native mammals, nine birds, three reptiles and amphibians, and one fish as eaten by these Indian groups. Single hunters might take any of these at any time of the year, but Denig clearly states that they considered only bison, deer, pronghorn, wapiti, beaver, wolves, and fox as good food.

The Blackfoot Indians of northwestern Montana represent one of the best known modern northwestern Plains tribes (Ewers 1958; Wissler 1910), and they presently reside immediately northwest of the Bootlegger Trail site. Again, the large herd animals provided the preferred food sources, with bison, deer, pronghorn, wapiti, bighorn sheep, and mountain goats hunted singly or by groups. Smaller mammals occasionally taken included wolves, fox, muskrat, beaver, badger, mink, marten, rabbits, skunk, and porcupine (Ewers 1958:9). They tended to avoid bears as too dangerous and considered birds and fish very poor food (Ewers 1958:87). Dogs, raised as beasts of burden and considered starvation food, tided most groups over times when they could obtain nothing else.

Nomadic prior to white contact and cultivating few, if any, plants, the Indians of the northwestern Plains traded with agriculturalists to the east. The Arikara of the Middle Missouri region raised corn (Denig 1929:414) and traded some of this into the northwestern Plains. The Indians along the upper Missouri offered meat, hides, and ornamental objects for agricultural products and decorative items. A fragment of sheet copper found at the Bootlegger Trail site likely resulted from such trade. Although adding some diversity to the diet, trade probably contributed little to the volume, as all nomadic groups apparently preferred meat to corn.

Most ethnographies on northwestern Plains groups make little mention of different seasonal subsistence activities. Seasonal changes dictating the direction and extent of moves were very significant to these people but represent only one factor in the choice of immediate subsistence strategy. The main factor revolved around the feasibility of communal hunting, which required sufficient numbers of bison and large concentrations of people. Groups of

80 to 200 or occasionally more participated in communal hunts (Denig 1929:531). Throughout much of the year, particularly in winter, groups of this size could not assemble. Winter weather made it difficult to set up drives and concentrate sufficient numbers of the scattered herds. Small bands usually wintered in sheltered river valleys (Ewers 1958:88). With indications of approaching spring, small groups of Indians came to spots where early spring forage would make communal hunts possible. Summer signs predicted the drying up of grasses in many exposed areas. As fall approached, bison herds would concentrate in protected spots with still available forage. Once in a potentially productive spot, the group chose a particular subsistence strategy. If apparently feasible, they attempted communal hunts; otherwise they hunted single animals.

The exact location of bison herds during the year was not entirely predictable. A location might support a heavy population during a particular season of one year and very few bison the next year for no apparent reason. In general, however, the availability of forage determined the distribution of bison. A multitude of seasonal signs with which all Indian groups were extremely concerned heralded the approaching availability of suitable grasses in a particular location. The Blackfoot kept bundles of notched sticks to mark the passing of days. They kept careful watch on the development of embryos in female bison killed individually during the winter. As soon as the fetuses developed hair, planning of spring communal hunts began. The migration of waterfowl provided a significant seasonal sign in both fall and spring (Ewers 1958:89).

Archaeological manifestations known as medicine wheels, found throughout the northwestern Plains, are now interpreted as calculators of seasonal change. The arrangement of stone cairns and lines appears to mark the summer solstice and the position of several stars during late summer (Eddy 1977).

During the historic period Indian groups had horses, greatly increasing their mobility and enabling communal hunting during the summer when good forage prevailed over much of the Plains. The horse made great concentrations of bison unnecessary; horsemen could surround and kill them readily (Lowie 1935:72). Archaeological sites from the prehistoric periods indicate most communal hunts occurred in the fall and early spring. It took several weeks to move enough people to a suitable location and set up a bison drive (Ewers 1958:11). The groups had to predict where sufficient bison would assemble and reach the chosen spot before the forage dried up and the bison moved on.

While preparing the trap, small groups of hunters and scouts slowly and cautiously moved groups of bison toward the drive lines. This might take days but had to be done carefully to avoid frightening the entire group from the vicinity (Lowie 1935:73). The actual drive began only when the trap was ready and enough bison were concentrated in the right position.

The part precision played in predicting the location of herds and in moving these animals compares with the management of domestic cattle on open range. The seasons limited the possibilities and directed the locations. Chance factors dictated the actual strategy employed. Figure 20 presents a flow chart of various hunting strategies and the decisions that dictate each.

All northwestern Plains groups clearly preferred meat to other food (Kroeber 1908:148). Lowie (1935:72) reported that older individuals refused excellent maize and chose poor quality beef as the closest approximation to bison. However, plant materials played a part in the diet of all groups. All ethnographic sources report consumption of a wide variety of plant products and some sources indicate they represented a very significant part of the diet.

Denig (1929:583) reported that 20 plant species contributed significantly to the diet of upper Missouri tribes. Not all of these are identifiable from his description. Johnston (1969), in an ethnobotany for the Blackfoot groups, reported 51 consumed species. Some of those listed by Denig and Johnston did not grow on the prairie of north-central Montana. Those species available prehistorically in the three biotopes of the site area are discussed below, using the taxonomic systems of Hahn (1973) and Booth and Wright (1959).

1. Riverine biotope:

Aquatic plants. Roots and tubers of submerged plants such as cattail (*Typha latifolia*), arrowhead (*Sagittaria cuneata*), pondlily (*Nuphar variegatum*), and bullrush (*Scirpus acutus*) were collected in the summer and fall. They usually were eaten raw or roasted and often were cooked with meat. *Scirpus* tubers occasionally were dried for winter use (Johnston 1969:125,129).

Bulbs. Bulbs of the lily family were used occasionally. Wild onions (*Allium* sp.) and camas (*Camassia quamash*) were gathered during the summer and roasted (Johnston 1969:131). Neither of these plants occurred in sufficient number for extensive preservation.

Roots. Enlarged roots of various terrestrial plants were dug. Roots of bistort (*Polygonum bistortoides*), yampa (*Perideridia gairdneri*), tobacco-root (*Valeriana edulis*), and white thistle (*Circium hookerianum*) were collected occasionally throughout the summer and fall and were eaten raw or cooked with meat. The roots of Solomon's seal (*Smilacina stellata*) were collected in the fall and dried for winter use.

Berries. Berries and fruits of many species were collected in quantity. Currant and gooseberries (*Ribes* sp.), service berries (*Amelanchier alnifolia*), bearberries (*Arctostaphylos uva-ursi*), and huckleberries (*Vaccinium* sp.) were gathered during the summer. Most were eaten raw. Service berries occasionally were dried or pounded into meat and dried as pemmican (Denig 1929:583). The fruits of

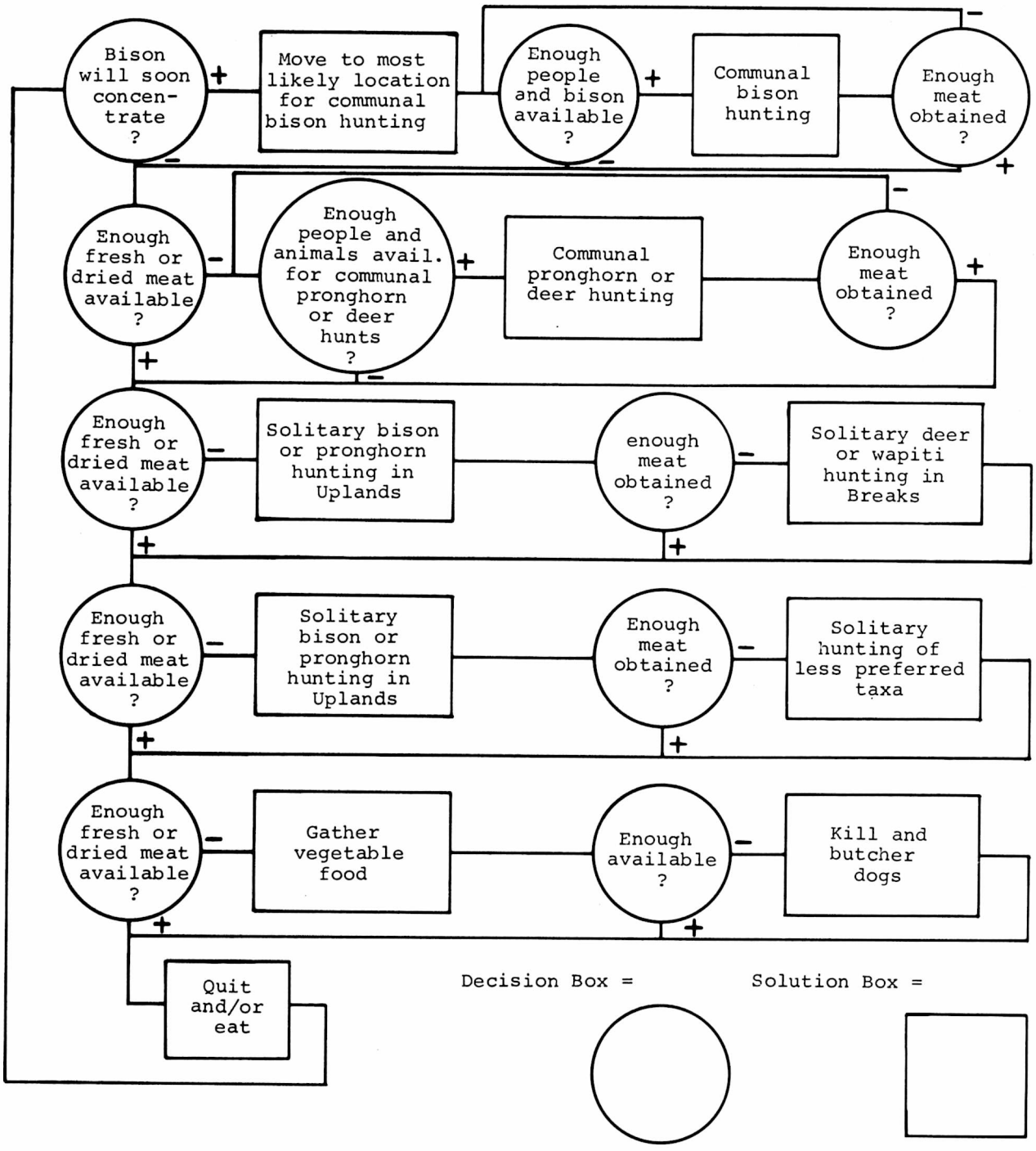


Fig. 20. Flow chart of hunting strategy.
(This chart is designed as a closed system; entry may be effected at any point.)

hawthorn (*Crataegus douglasii*), choke cherry (*Prunus virginiana*), and buffalo-berry (*Shepherdia argentea*) were gathered in the fall and most were dried for winter use (Ewers 1958:86).

Leaves. Leaves and stems of a few plants were collected. The inner bark of cottonwood (*Populus deltoides*), the stalks of cow parsnip (*Heracleum lanatum*), and the leaves of wild mint (*Mentha arvensis*) were gathered during the spring and occasionally summer (Johnston 1969:136,155,161). These products usually were eaten raw or, in the case of mint, used as flavoring.

2. Breaks biotope:

Bulbs. Bulbs and tuberous roots of mariposa lily (*Calochortus apiculatus*), glacier lily (*Erythronium grandiflorum*), and yellow bell (*Fritillaria pudica*) occurred in moist areas of the breaks. They were collected in the spring and early summer and eaten raw (Johnston 1969:131-133).

Roots. Roots of several species were collected widely. Spring beauty corms (*Claytonia lanceolata*), silverweed roots (*Potentilla anserina*), milk vetch roots (*Astragalus canadensis*), and balsam-root (*Balsamorhiza sagittata*) were dug in the spring and normally were eaten raw (Johnston 1969:138,146,147,167). Two species were dug extensively in the summer and preserved in large numbers. Bitter root (*Lewisia rediviva*) is not common near the site but was collected extensively to the west. Indian breadroot or Indian turnip (*Psoralea esculenta*) was utilized widely on the prairie (Denig 1929:582; Ewers 1958:86; Lowie 1910:12). It was collected in large quantities, eaten raw, roasted, or preserved for winter.

Summer fruits. Berries of at least two species were collected during the summer. Fairy bells (*Disporum trachycarpum*) and wild strawberries (*Fragaria virginiana*) were encountered occasionally and eaten raw (Johnston 1969:132,145).

Fall fruits. Berries and fruits of three plants were collected in the fall and winter. Wolf willow berries (*Elaeagnus commutata*) and snowberries (*Symphoricarpos occidentalis*) were considered starvation food and were eaten only when necessary (Johnston 1969: 153,164). Rose hips (*Rosa* sp.) were a bit more popular and occasionally were dried and pounded into pemmican (Denig 1929:582). All of these plants hold their fruits over the winter, are tall enough to be found in the snow, and could be collected when little other vegetable material was available.

3. Upland biotope:

Roots. Roots and tubers of two plants were available in the uplands. Prairie parsley (*Lomatium triternatum*) and wild artichoke roots (*Helianthus maximilianii*) were collected in the summer but rarely preserved (Denig 1929:583; Johnston 1969:156).

Seeds. Seeds and pods of several species were collected occasionally when encountered. Lamb's quarters (*Chenopodium album*),

ground plum (*Astragalus crassicarpus*), and sunflower (*Helianthus annus*) were available in late summer (Johnston 1969:138,147,169). None of these was sought extensively or preserved.

Fruits. Cactus fruits and stems of two species, prickly pear (*Opuntia polyacantha*) and cushion cactus (*Mamillaria vivipara*), were available during the early summer. These were collected occasionally and eaten raw (Johnston 1969:152).

Many of the species listed are not restricted to a single biotope. For example, *Psoralea* might be found in the uplands or breaks. Each species is listed in the biotope where it is found most commonly near the site. Several of the species were not encountered in the site area during the 1975 and 1976 seasons. However, all have been reported within 100 km, well within the reach of the migratory occupants of the site.

No available evidence indicates that northwestern Plains groups made major moves to utilize plant resources. However, women usually gathered plants from all areas that they occupied (Ewers 1958:86). Because products of most species are seasonal, some form of scheduling would have been necessary for efficient plant utilization. Figure 21 presents a flow chart for one possible plant-gathering strategy.

The foods eaten by northwestern Plains groups contain all the nutrients essential to support human life. However, the proportion of meat in the diet probably resulted in more protein and fats than we consider healthy today. Robinson (1973) recommends that 50% of the calories consumed should come from fats and protein combined. The other 50% should come from carbohydrates (Robinson 1973:54,71,87). The calories from both fresh and dried meat, such as beef or bison, come almost strictly from protein and fat (Adams 1975:28-29). Virtually no carbohydrates are available in muscle meat. Northern Plains groups consumed meat in unbelievable quantities when abundant. Ewers (1958:87) reported that a single individual often consumed five or more pounds of bison meat at a sitting. Although considered undesirable by modern nutritional standards, this overabundance of protein and fats and deficiency of carbohydrates will not create a lethal situation. Carbohydrates provide the principal source of energy and allow use of protein for building and maintaining tissue. Carbohydrates are widely available in vegetable materials and to a lesser degree in animal organ meats (Adams 1975). During the spring, summer, and fall, northern Plains groups consumed plant products and organ meat. Unavailability or scarcity of these products occurred only during the winter. Since winter was a period of minimal activity due to the weather, energy sources were less necessary than during periods of peak activity.

Table 15 presents a seasonal distribution of the essential nutrients in foods eaten by northwestern Plains Indian groups. Only two nutrients might have proven difficult to obtain at certain times of the year. Vitamin A occurs in many fresh roots and in organ

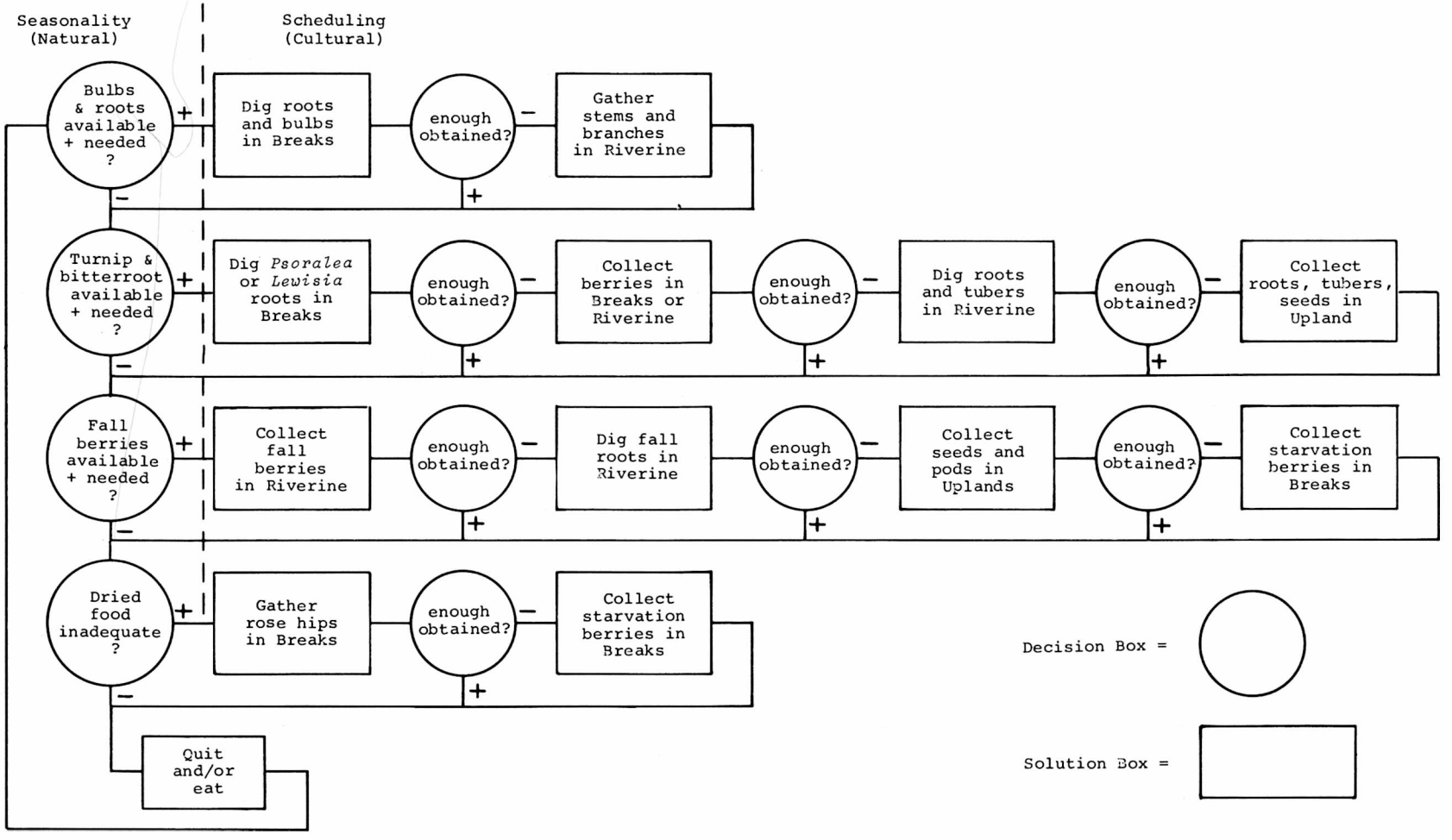


Fig. 21. Flow chart of possible plant-gathering strategy.
(This chart is designed as a closed system; entry may be effected at any point.)

Table 15. Seasonal distribution of essential nutrients in the diet of northern Plains Indians.

Nutrients Required	Sources			
	Spring	Summer	Fall	Winter
Protein	meat	meat	meat	dried meat
Carbohydrates	roots lily bulbs	roots, bulbs seeds, berry	roots, seeds berry	dried roots and berries
Fats	animal fat	animal fat, seeds	animal fat	animal fat
Vitamins:				
A	organ meat pl. stalks	organ meat roots	organ meat roots	dried berries?
B group	meat	meat, seeds	meat, seeds	dried meat
C	dried berries?	berries	berries	rose hips dried berries?
D	-- synthesized by body in presence of sunlight -- dried meat			dried meat
E	meat oil	seeds meat oil	seeds meat oil	dried meat
Minerals:				
Calcium & Phosphorus	meat marrow	meat marrow	meat marrow	dried meat dried berries
Iron	meat	meat	meat	dried meat
Sodium	meat	meat	meat	dried meat
Potassium	meat roots	berries roots	berries roots	dried meat dried berries
Magnesium	meat marrow	meat marrow	meat marrow	dried meat
Zinc	meat	meat seeds	meat seeds	dried meat

meat, sources not available during the winter. Dried roots and berries probably contained sufficient supplies, but occasional deficiencies might have occurred. Vitamin C probably proved difficult to obtain during the winter and early spring. Fresh fruits and berries provide good sources, but the vitamin preserves poorly. Rose hips might have provided enough to tide the population over the winter.

Quantity as well as quality is an important aspect of nutritional requirements. A successful bison drive normally yielded more food than the hunters could utilize. However, winter made drives difficult, and not all drives succeeded. Food scarcities might happen at any season but became a particular concern during the winter (Ewers 1958:14). A single animal whose availability was at least partially seasonal received the primary focus of northwestern Plains subsistence. This form of specialization is somewhat analogous to a monocrop economy. Enough food must be obtained and preserved when it is available to sustain the group throughout the entire year. If food reserves ran out during the hard winter months, less desirable food sources could be exploited. However, if these were unobtainable the bands went hungry or starved (Ewers 1958:14).

A single bison drive could yield huge quantities of meat. By northern Plains standards, the Bootlegger Trail site is a small bison kill. However, larger bison kill sites such as Wahkpa Chu'gn and Boarding School contain more material because of more occupations. The number of bison killed at 24TL1237 is probably close to the minimum individual estimate in Table 10. The estimates of 471 adults from the upper occupation of the processing area and 866 adults from the older occupation are entirely consistent with ethnographic accounts of successful bison drives. Lowie (1910:11) reported 600 bison killed in one drive. Denig (1929: 533) stated that a small camp could obtain 300-600 bison in a single day.

The amount of meat available from the bison killed in a drive depends not only on the number of animals killed but on their age and sex as well. Novakowski (1965) and Halloran (1961) have presented dressed carcass weights for bison by age and sex. The mean age of bison in both levels at the Bootlegger Trail site was just under four years. At this age a dressed cow carcass weighs around 200 kg, a bull carcass around 250 kg (Novakowski 1965:405). This corresponds well with Roe's (1951:405) statement that a cow yielded just over 182 kg of meat. Although sexing of bison remains is difficult, we approximated sex ratios for the two levels based on the number of fetal remains present. For the purposes of meat yields we used ratios of 67% bulls and 33% cows in Level I and 100% cows in Level II. While doubtlessly at deviance with the actual population, this produced the most conservative yield estimates. Fetuses also provided a small amount of meat. No figures exist for weights of seven- to nine-month fetuses, but bison calf carcasses weigh over 50 kg a few

months after birth (Novakowski 1965:176). We used a carcass weight of 15 kg for both cow and bull fetuses in accounting for meat available from them.

Carcass weights represent only the amount of meat available, not the amount actually used. Virtually all bones in Level I indicated "heavy butchering," processing as completely as possible for marrow, brains, and bone grease in addition to meat. Loss in bone and wastage probably accounted for less than 15% of the carcass weight. Level II indicated less efficient "light butchering," with up to 35% of the carcass weight lost in bone and wastage. Most of the muscle meat probably was utilized, but many bones were not processed. In both levels, internal organs, such as liver, heart, kidneys, brain, and intestines probably were utilized. Ethnographic accounts indicate that most northwestern Plains groups ate these organs either raw or cooked when they killed the animals (Denig 1929:541; Ewers 1958:13,73). All internal organs obtained from an adult bison produced about 25 kg of additional food from each animal. Table 16 presents figures for total kilograms of bison utilized in each bone bed of Area B.

The meat available at the Bootlegger Trail site represents a huge caloric value. Bison produce lean meat, comparable in food value with lean beef steaks or roasts. A kilogram of this meat contains around 2500 calories (Adams 1975:26-29), sufficient to sustain a person for one day. However, when large quantities of meat were available, adult Plains Indians normally consumed two or more kilograms at a single meal. A group of 100-200 individuals could have accomplished the drives and kills at the site. If they stayed at the site for a week after the kill, they could have consumed 1500-3000 kg. Additionally, each family had six to twelve dogs (Lowie 1910:15), approximately one per person. Many of the bones at the site exhibit gnawing marks. The dogs approached the size of wolves and one to two hundred of them could have consumed 500-1000 kg of meat plus some of the wastage in a week. Thus, 2000-4000 kg of the total yield can be subtracted for the time spent preparing the dried meat. An average figure of 3000 kg is used in Table 16.

The meat not eaten immediately or wasted probably was dried. Roe (1951:405) stated that an adult cow could provide 20 kg of dried meat. This means that dried meat weighs only about one-tenth of its fresh weight. In caloric content, dried bison meat compares with dried beef, which contains 2030 calories per kilogram (Adams 1975:29). Humans in temperate climates need 1500 to 3000 calories daily depending on age and extent of activity (Robinson 1973:98). We used a figure of 2400 calories for each person. This may be higher than needed, considering the lower requirements for children, but represents a reasonable estimate of what northwestern Plains Indians ate when the food was available. One and two-tenths kilogram of dried meat could supply this caloric average, so 100-200 individuals occupying the site would have consumed 120-240 kg of dried meat daily. We used an average of 180 kg. Dogs probably received scraps and a small amount of the meat. If humans

Table 16. Available and utilized meat yields from levels in processing area.

Meat Units	BI	BII	Total B
Estimated number of adult cows	157	866	1,023
Estimated number of adult bulls	314	0	314
Estimated number of fetuses	64	375	439
Potential kg meat from cows (200 kg/c)	31,400 kg	173,200 kg	204,600 kg
Potential kg meat from bulls (250 kg/b)	78,500 kg	0	78,500 kg
Potential kg meat from fetus (15 kg/f)	960 kg	5,625 kg	6,585 kg
Total carcass meat available	110,860 kg	178,825 kg	289,685 kg
Amount of kg not utilized	16,629 kg	62,589 kg	79,218 kg
Total carcass meat utilized	94,231 kg	116,236 kg	210,467 kg
Additional kg of internal organs	11,775 kg	21,650 kg	33,425 kg
Total kg of food utilized	106,006 kg	137,886 kg	243,892 kg
Amount of food consumed at site	3,000 kg	3,000 kg	6,000 kg
Amount of dried meat removed (10 kg fresh equals 1 kg dried)	10,300 kg	13,488 kg	23,788 kg

and dogs consumed a total of 200 kg daily, the dried meat alone could have fed the population for over 50 days in Level I and over 65 days in Level II. Undoubtedly, other hunting and gathering activities contributed to the available food, stretching the time the dried meat lasted.

Northwestern Plains groups clearly preferred a communal bison hunting strategy, although other possibilities existed. Many animals could have been and were hunted individually. Pronghorns were hunted communally, and other social forms could have been so obtained.

The efficiency of hunting different taxa in different ways can be calculated. Table 17 lists the larger mammals available in the area. Average carcass weights were calculated from figures given by Cleland (1966), White (1953), and Ziegler (1973). Because these three sources often differ drastically in live weight estimates, all were rejected and the normal range of adult live weights was calculated from data presented by Burt and Grossenheider (1964). We figured carcass weight as a percentage of live weight, averaged the percentages, and calculated the food value of a single carcass. Caloric content figures for very lean, lean, and fat-rich meat were used. These are presented by Adams (1975) and U.S.D.A. (1969).

The final column in Table 17 shows the potential caloric return from the capture of a single individual of each species. However, these figures are meaningless without assessing the effort expended and the difficulty in obtaining each form. The effort expended to obtain a single individual was calculated by measuring the round trip distance to get and retrieve the animal.

The Bootlegger Trail site shows no evidence of use as a habitation site. For the purposes of this analysis, we assumed that some spot near the site served as a home base from which hunters pursued any of the available animal forms in the surrounding area. Most taxa show habitat preferences. Encountering and killing an animal requires hunting a fair amount of its preferred habitat. We assumed that hunting took place only inside that area in Figure 2, within a radius of 35 km of the site. Evenly hunting the entire area would not have placed excessive pressure on any species.

The three biotopes are not randomly distributed in the site area. If all of the riverine biotope were hunted evenly over a period of time the average round trip distance of each hunt would cover 33 km. Some of the breaks biotope is more distant; average round trip to all locations is 36 km. Much of the upland biotope in the site area is fairly distant from the site itself, requiring an average round trip of 40 km to cover it evenly. The habitat preference indicates the appropriate biotope to hunt, enabling us to calculate the average round trip distance to hunt each taxon. For some small herbivores with high population densities, hunting the entire site area would not be necessary. Hunting lagomorphs

Table 17. Carcass weights and calories available from north-central Montana mammals larger than .4 kg.

Taxa	Range of Adult Live Weights[a]	Average Carcass Weight*[b]	Calories Available per Individual[c]
Ursus horribilis	145.0-385.0 kg	136.0 kg	340,900
Mustela nigripes	.8- 1.2 kg	.6 kg	1,320
Mustela vison	.6- 1.4 kg	.5 kg	1,100
Lutra canadensis	4.5- 11.3 kg	5.4 kg	12,000
Taxidea taxus	5.9- 11.3 kg	5.4 kg	12,000
Mephitis mephitis	1.4- 6.0 kg	2.3 kg	5,000
Canis latrans	8.2- 27.0 kg	7.7 kg	11,900
Canis lupus	31.8- 54.4 kg	20.4 kg	31,500
Vulpes velox	2.0- 2.7 kg	2.0 kg	3,500
Felis concolor	36.3- 90.7 kg	31.8 kg	49,000
Lynx rufus	6.9- 16.1 kg	6.8 kg	10,500
Marmota flaviventris	1.8- 4.5 kg	1.8 kg	3,200
Cynomys ludovicianus	.5- .8 kg	.4 kg	800
Citellus richardsoni	.2- .6 kg	.2 kg	480
Castor canadensis	13.6- 31.8 kg	13.6 kg	33,000
Ondatra zibethica	.9- 1.8 kg	.9 kg	2,200
Erethizon dorsatum	4.5- 12.7 kg	5.0 kg	12,100
Lepus townsendi	1.8- 5.4 kg	1.8 kg	2,800
Sylvilagus nuttalli	.4- 1.4 kg	.5 kg	700
Cervus canadensis	136.0-453.0 kg	140.0 kg	277,200
Odocoileus hemionus	56.7-181.4 kg	50.0 kg	99,000
Antilocapra americana	34.0- 59.0 kg	23.0 kg	45,000
Bison bison	300.0-800.0 kg	225.0 kg	562,500

*Carcass weight includes muscle tissue, internal organs, and bone marrow.

SOURCES: [a]Burt and Grossenheider (1964).
[b]Cleland (1966); White (1953); Ziegler (1973).
[c]Adams (1975); U.S.D.A. (1969).

and ground squirrels within 15 km of the site would not deplete populations. Thus, an average round trip distance of 15 km suffices for these taxa (Table 18).

The difficulty of hunting each taxon can be calculated using population densities and ethnographic accounts of hunting success. Population densities in Table 18 were estimated from figures presented in Burt and Grossenheider (1964) and Kendeigh (1961). Density figures for porcupine and wapiti may be too high because of the lack of tree cover near the site. Likewise, there are very few areas with good rocky cover or talus slopes for marmots. If any of these three taxa were principal prey species, the hunters probably moved to areas with more suitable cover.

The ratio of successful hunts among Plains Indians has not been studied thoroughly. Several sources (Denig 1929; Ewers 1958; Wissler 1910) have reviewed the difficulties involved in individually stalking large forms such as pronghorn, bison, and deer. Pronghorn display substantial curiosity and are probably the easiest of the three forms to hunt. We used a success ratio of one kill in two attempts, a figure comparable to the success ratio for hunters of other artiodactyls in other parts of the world (Lee 1969; Nietschmann 1972). Deer and wapiti are less abundant and thus a one-in-three success ratio was assigned. Bison were probably more abundant than pronghorn but warier and more likely, because of their larger size, to suffer nonfatal wounds. A success ratio of one in three seems more justified and compares with ratios given for large herd animals in South Africa (Lee 1969). Success ratios probably varied seasonally. These are intended to represent a yearly average.

Success ratios for all other species were calculated principally on the basis of population densities. Cottontails occur in high densities, so a return of four animals on each hunt seems reasonable. This is entirely consistent with our efforts to run down bunnies at the site. Ground squirrels occur in fairly high densities, and killing one requires only a well-aimed arrow. However, their ability to disappear underground results in many misses. Additionally, ground squirrels hibernate or estivate much of the year. Here we used a lower success ratio of three animals per hunt.

Jack rabbits, muskrats, and prairie dogs are fairly common, but all have very efficient forms of escape. Muskrats have dens with submerged entrances and frequently escape underwater. The wary prairie dogs can escape to underground burrows and tunnels. Jack rabbits can run 65 km per hour and clear 5 m at a jump (Burt and Grossenheider 1964:214). All present fairly small targets. An average hunt probably did not yield more than one individual of any of these species. Swift fox also were assigned a one-animal-per-trip success ratio. While not as common as these other forms, they are notoriously unwary. The ease of trapping and hunting them (Burt and Grossenheider 1964:79) probably led to their present scarcity in the area.

Table 18. Efficiency for individual hunting of species around site.

Taxa	Main Biotope*	Round trip Dist.	Pop. Density**	Succ. Ratio	No. Hunting	Cal. to get one indiv.	Add. Cal. to Retrieve	Total Cal.	Eff. Index
Ursus	RB	35km	1/65sqkm	1/10	3	26,250	1,750	28,000	12.2
M. nigripes	U	40km	1/10sqkm	1/4	1	4,000	0	4,000	0.3
M. vison	R	33km	1/5sqkm	1/3	1	2,475	0	2,475	0.4
Lutra	R	33km	1/20sqkm	1/5	1	4,125	0	4,125	2.9
Taxidea	U	40km	1/2sqkm	1/3	1	3,000	0	3,000	4.0
Mephitis	RB	35km	2/1sqkm	1/3	1	2,625	0	2,625	1.9
C. latrans	RBU	38km	1/13sqkm	1/4	1	3,800	0	3,800	3.1
C. lupus	RBU	38km	1/130sqkm	1/15	2	28,500	0	28,500	1.1
Vulpes	U	40km	1/1sqkm	1/1	1	1,000	0	1,000	3.5
Felis	B	36km	1/130sqkm	1/15	3	40,500	0	40,500	1.2
Lynx	RB	35km	1/10sqkm	1/4	1	3,500	0	3,500	3.0
Marmota	B	36km	3/1sqkm	1/2	1	1,800	0	1,800	1.8
Cynomys	U	40km	8/1sqkm	1/1	1	1,000	0	1,000	0.8
Citellus	U	15km	40/1sqkm	3/1	1	125	0	125	3.8

Table 18, concluded.

Taxa	Main Biotope*	Round trip Dist.	Pop. Density**	Succ. Ratio	No. Hunting	Cal. to get one indiv.	Add. Cal. to Retrieve	Total Cal.	Eff. Index
Castor	R	33km	1/10sqkm	1/4	1	3,300	0	3,300	10.0
Ondatra	R	33km	8/1sqkm	1/1	1	825	0	825	2.7
Erethizon	RB	35km	1/10sqkm	1/4	1	3,500	0	3,500	3.5
Lepus	U	15km	10/1sqkm	1/1	1	375	0	375	7.5
Sylvilagus	BU	15km	200/1sqkm	4/1	1	94	0	94	7.5
Cervus	RB	35km	1/1sqkm	1/3	4	10,500	0	10,500	26.4
Odocoileus	B	36km	2/1sqkm	1/3	2	5,400	0	5,400	18.3
Antilocapra	U	40km	4/1sqkm	1/2	1	2,000	0	2,000	22.5
Bison	U	40km	6/1sqkm	1/3	2	6,000	4,000	10,000	56.3

*R = riverine, B = breaks, U = uplands.
**SOURCE: Kendeigh (1961); Burt and Grossenheider (1964).

Success ratios for other taxa were calculated on the basis of population densities. Beaver, porcupine, and black-footed ferrets all have estimated densities of one per ten square kilometers. Each was assigned a success ratio of one kill for four trips. Wolves and mountain lions have very low population densities, so we used a success ratio of one animal for fifteen attempts.

Single hunters could efficiently pursue most small mammals. Ethnographic sources state the northwestern Plains groups hunted larger forms singly or in groups of two or three hunters (Ewers 1958:84; Lowie 1910:10). We used an average of two hunters per attempt for deer, bison, and wolf. Wapiti normally were hunted by larger groups (Denig 1929:537), and we assigned an average of four hunters per attempt. Large, dangerous carnivores would also require larger hunting parties, so we used a figure of three persons per hunt for bear and mountain lion.

Combining estimates of round trip distance, success ratio, and number of hunters per attempt results in an approximation of the caloric investment to obtain a single individual of each species. The caloric expenditure in hunting is little more than the calories used in walking to and from the place the animal is killed. That number of calories usually accounts for the expenditure in obtaining and utilizing an animal. Most animals can be carried back by the hunter(s) that killed it. However, for two large forms, bear and bison, the animal would be too large for the hunters to retrieve. Bringing an entire bear or bison back to camp (presence of all skeletal parts evidences that all butchering occurred there) would entail dispatching extra bearers whose caloric expenditures must be added to those of the hunters. Table 18 presents the total estimated calories expended to kill and retrieve each species. Finally, an efficiency index can be calculated for each species by dividing calories per carcass in Table 17 by calories expended to get and retrieve a single individual. This index represents the number of calories obtained per calorie expended if the society sought to hunt this taxon as its only source of food.

The efficiency indices clearly show the inefficiency of hunting the small carnivores. More calories would be burned in the pursuit of weasels and ferrets than could be obtained. The artiodactyls are the most cost-efficient forms. Interestingly, all taxa with an efficiency index of over 3.0, except badger, occurred in the faunal remains at the Bootlegger Trail site. No mammalian species with a lower efficiency index was considered as a food species.

All of the figures presented so far deal with the hunting of a particular taxon by single hunters or small groups. The evidence at the Bootlegger Trail site indicates communal hunting as the preferred strategy. The efficiency of communal hunts also can be calculated from data presented in ethnographic accounts. Denig (1929:532) mentioned camps of up to 30 lodges with two to 10 people per lodge accomplished major drives. We used an average figure of 150 people.

Initially, the group moved to a suitable location for the drive, a slow, laborious job involving packing up all possessions. Ewers (1958:11) stated that nine kilometers constituted a good daily march. An average move could cover 80 km and each person would expend 4000 calories with the added weight to be carried. Thus, the entire group expended 600,000 calories to get to the drive site.

Frequently, getting the corrals set up and locating the animals involved several weeks. Not all members of the group participated at any time, and the work was not as strenuous as moving. We estimated that each of half of the group would expend an average of 4000 calories during this period, thus requiring 300,000 calories to set up the drive.

Finally, the meat was processed after the kill. This is sedentary work and some members, particularly young children, would not have been involved. The task might have taken a week or less. We estimated that half the group would have expended 2000 calories per person, an investment of 150,000 calories in final processing of the carcasses. In the end, capturing and processing the bison consumed 1,050,000 calories. Table 19 presents these numbers.

The caloric yield of the bison present in the two levels of the processing area at the Bootlegger Trail site was calculated using the meat yields in Table 16. A total of 3000 kg of fresh meat was consumed during final processing. At 2500 calories per kilogram, that represents a total of 7,500,000 calories. Drying the remaining meat produced 10,300 kg of pemmican in Level I and 13,488 kg in Level II. Dried meat was estimated to have 2030 calories per kilogram. Table 19 lists the total calories utilized from each kill. Dividing calories utilized by calories expended produced the efficiency index for each kill. The indices obtained are fairly close and average around 30. No success ratio for communal hunts is employed because it is assumed that virtually all major communal drives were successful. Elaborate preparation and substantial knowledge went into predicting a productive site for a drive. Great skill and care went into the construction of the kill site and the driving of the herds. Conducting a kill required too great an investment in time and calories to allow many failures.

A few other animals were hunted communally in this area. Pronghorn drives are mentioned most often, and their efficiency index can be calculated with data from one drive excavated by George C. Frison (1971). Frison (1971:282) estimated that only 75 people would have been required to accomplish the drive. Therefore, the calories expended equal only half or less of the figure for bison drives. Actually this may be too high since the much smaller pronghorn might require far less substantial corrals. A total of 212 animals were obtained and according to Frison (1971:282) could have produced 3946 kg of fresh food. Seventy-five people could have consumed 1500 kg of still relatively fresh meat and made the rest into pemmican or jerky. A total of slightly over four million

Table 19. Efficiency of communal hunting.

Units	Bison from Bootlegger B, Level I	Bison from Bootlegger B, Level II	Pronghorn from Eden-Farson*
People participating	150	150	75
Cal. expended to move to site	600,000	600,000	300,000
Cal. expended to set up kill	300,000	300,000	150,000
Cal. to process carcasses	150,000	150,000	75,000
Total calories expended	1,050,000	1,050,000	525,000
Adult animals killed	471	866	212
Kg fresh meat used	106,006	137,886	3,946
Kg fresh meat eaten at site	3,000	3,000	1,500
Kg dried meat eaten later	10,300	13,488	247
Cal. of fresh meat eaten	7,500,000	7,500,000	3,750,000
Cal. of dried meat eaten	20,909,000	27,380,640	501,410
Total calories utilized	28,409,000	34,880,640	4,251,410
Efficiency Index	27.1	33.2	8.1

*SOURCE: Frison (1971).

calories likely were utilized (Table 19). This indicates an efficiency index of a bit over eight for communal pronghorn hunting.

It is surprising to note that communal hunting was the preferred strategy and yet was only about half as efficient (using these figures) as pursuing the same animals individually. The society involved chose cost-efficient animals but practiced an inefficient method of obtaining them. Apparently caloric efficiency was not the sole motivation behind the choice of a subsistence strategy.

While communal hunting is not the most efficient return on calories, it does maximize yield per unit of time. The 150 people utilizing the Bootlegger Trail site probably included only 35-40 adult males who participated in individual hunting (Ewers 1958:94). Use of the average figure and a total of 28 days estimated to move to the site and kill and butcher the animals indicates that 1050 man-days were spent to obtain an average of 669 adult bison. Using the success ratios and size of hunting parties in Table 18 would yield only 175 animals if each hunter spent this time hunting individual bison.

Time was important to these groups for two reasons. Initially, it was important to have a fair supply of food in hand when a move was planned. Even short moves were very time consuming and did not allow for auxiliary hunting efforts. Many of the moves had to be timed precisely to utilize seasonal resources. Individual hunting could not accumulate sufficient surpluses quickly enough, particularly when groups dispersed into family bands.

Second, time was at a premium when winter or other predictably lean periods were approaching. Any type of hunting was difficult during parts of the winter (Ewers 1958:14). Therefore, reserves were essential and had to be obtained during a short time in the fall. In the spring, after a long inclement period, people desired fresh meat and communal hunting represented the quickest way to accumulate it in quantity.

Communal hunting also maximizes the certainty of large yields and hence security. A review of the success ratios in Table 18 shows that only small mammals could be obtained from all attempts (success ratios of one to one or better). The northwestern Plains was a rich environment in terms of animal biomass. Over an extended period, a high average yield would result regardless of exploitation strategy. However, people cannot live on averages. Periods of minimum production present limits that occasional abundance cannot resolve. Communal hunting increases the minimum food available during lean periods by providing certain surpluses. This provides the security of at least some food to tide a population over lean periods.

The large absolute yields from communal hunting allow three other things important to northwestern Plains groups. First, high potential yields make possible large concentrations of people. During much of the year northwestern Plains groups dispersed into

small family bands. During communal gatherings, like large bison drives, significant ceremonies could take place (Lowie 1910:12). Kinship ties, another hedge against lean periods, could be made and strengthened. Food production was averaged and potentially lethal minimums were eliminated if small groups could rely on relatives for food when they could not obtain sufficient amounts of it themselves.

Second, large absolute yields and the resulting surpluses provide trade goods. Trade also averages available food and other objects, although quality not quantity is averaged. While trade might not result in an increased caloric supply, it provided some variety in the diet. Nomadic bison hunters often traded dried meat to sedentary village dwellers for maize, which provided a source of carbohydrates in the protein-rich diet. Other items such as the fragment of copper found at the site also were obtainable in this trade.

Finally, the large absolute yields of a bison drive provided a rare opportunity to indulge in the luxury of gluttony. After a kill, people devoured unbelievable quantities of meat in a single evening (Ewers 1958:87). This opportunity further contributed to a feeling of affluence and security. The long-term survival value of such a practice is difficult to assess but is a moot point. Ethnographic sources (Denig 1929; Ewers 1958) report that all groups enjoyed it, and hence it was a desirable activity.

In general, communal hunting seems the preferred strategy because of the security it afforded. Although not as efficient in caloric return, it was far more reliable. Throughout the year it offered a greater certainty of sufficient food through accumulated surpluses, greater success ratios, less invested time, and stronger kin ties. Through communal hunting, the society enhanced their survival chances in a seasonally variable environment. Thus, it is not surprising that throughout the world communal hunting occurs most frequently in environments that present hunters with periods of minimal production.

The motivations for choosing which animals to hunt individually are similar to those that dictate communal over individual hunting. The choice of animals to hunt individually involved four ordered motivating factors. First, caloric efficiency was being maximized. This does not imply that they hunted only the most cost-efficient animal. Instead, there was a lower limit of efficiency considered tolerable. Many of the taxa in Table 18 were eliminated from consideration as food sources because nothing with an efficiency index of less than 3.0 was considered worth hunting.

It might be argued that less cost-efficient forms could be killed whenever encountered on an expedition directed at a more cost-efficient taxon. This undoubtedly occurred to some degree and resulted in nearly free food since to do so required no additional investment of calories. However, these animals would not be free calories if they took time or efforts away from the pursuit of

the principal prey. The success ratios in Table 18 were calculated on the basis of single-minded pursuit of a single taxon. It would take some time to kill less cost-efficient forms, an arrow or two might be invested, and the carcass would be an added burden throughout the rest of the hunt. Killing some less cost-efficient forms might require a specialized technology. Burrowing and aquatic taxa can still escape, although injured, unless specialized arrows or techniques are employed. All of this would have detracted from hunting more cost-efficient forms and could have cost more in calories than it gained.

Avoiding dangerous animals was the second motivating factor. Bears have a relatively high efficiency index but rarely were obtained. Denig (1929:537) reported that bears normally were avoided. They were killed only when they threatened hunters or occasionally in winter dens. Badgers are a relatively cost-efficient form but highly aggressive and potentially dangerous. It was not difficult to avoid them and apparently the inhabitants of the site did just that. The efficiency index for bobcat and fox are very close. The bobcat is more dangerous and less common in the faunal remains of the site. In general, the less dangerous form was pursued more often if two forms were approximately equally cost-efficient.

The third motivating factor in hunting strategy was the certainty of a kill. Possible failure seems to have been avoided. If two animals were more or less equally cost-efficient and neither was particularly dangerous, the form with the highest success ratio was hunted most often. Cottontails and jack rabbits provide an example of maximization of certainty. They are equally cost-efficient, but cottontail hunting was more certain and more commonly practiced. The efficiency of hunting deer and pronghorn is similar. Pronghorn had a higher success ratio and were pursued more commonly. Maximization of certainty of kill was also one reason communal hunting was preferred over individual hunting. It was less likely the hunter(s) would return home empty-handed after any attempt. Lean periods tended to be eliminated and the yearly yield spread out, or averaged.

Finally, the fourth motivating factor was to maximize absolute yield from each attempt. In order to do this, larger animals were preferred. The caloric cost-efficiency for fox and ground squirrels is approximately equal, but the absolute yield for fox is greater. Apparently it was more desirable to return from a hunt with a single large animal, as fox remains are fairly common at the site while ground squirrels are not considered as a food source. Again this form of maximization is compatible with the choice of communal over individual hunting. Clearly, larger absolute yields were desired because they allowed surpluses, gluttony, trade, stronger kin ties through food sharing, and in general greater security throughout the year. When these four factors are applied to potential resources, in the order presented, the result is the strategy observed from the faunal remains at the site and in ethnographic accounts.

VI. CONCLUSIONS

The Bootlegger Trail archaeological site contains the debris and remnant architectural features created by the activities of a prehistoric bison kill and the processing of products that resulted from the kill. In Area D, identified as the kill area, a single cultural zone was identified at the base of a small bluff. In both areas B and E, identified as processing areas, two distinct strata separated by sterile sediments indicate successive occupations. In Area B, downslope from the kill, at least two additional cultural strata were identified. These appeared as indistinct and noncontinuous zones with minimal cultural material included. Radiocarbon and obsidian hydration assessments indicate that principal occupation of the site took place sometime during the 13th or 14th century A.D. Temporal diagnostic artifacts found in other sites of similar antiquity corroborate the radiocarbon and obsidian hydration assessments.

Excavations at the Bootlegger Trail site have added considerably to the available archaeological material culture inventory of Late Prehistoric period bison kill and processing sites in the northwestern Plains. By and large, the materials discovered at the Bootlegger Trail site duplicate those previously reported from other sites of similar antiquity. Indeed, northwestern Plains archaeologists have come to expect an artifact assemblage typified by an armory of small, side-notched projectile points; implements devoted to the processing of meat and hides such as stone knives, scrapers, stone and bone choppers, bone awls; and a variety of other bone tools. Other items that occur less frequently but with sufficient regularity as to offer no surprises include ornamental items, smoking pipes, and a smattering of ceramic sherds. Typically, Late Prehistoric bison kill and processing sites provide a remarkably uniform tool kit. Future studies will no doubt demonstrate considerable diversity of form and use, both spatially and temporally, but the basic configuration seems firmly established.

The artifacts and features present in the Bootlegger Trail site would have made the excavations a useful scientific endeavor, but if the Bootlegger Trail site has a unique contribution to make to our knowledge of northwestern Plains prehistory, this contribution must lie preeminently in the faunal remains recovered. From three separate areas of the site that contain a total of five identifiable stratigraphic units we excavated an absolute minimum of 171 adult and subadult bison and 56 bison fetuses. The vast majority of fetal animals displayed development consistent with seven to just short of nine months in utero. In cultural level I of the lower processing area, a few less developed fetuses (four- to seven-month fetuses) and a few near-term or possibly full-term calves occurred. Level I exhibited the greatest range of diversity in fetal development. If bison mating and birth habits have

remained constant over the last 1000 years (there is little reason to believe otherwise, as most natural populations' annual cycles closely correspond to seasonality), we must conclude that the Bootlegger Trail occupations occurred sometime between mid-February and early May, with mid- to late March the optimal time.

Analysis of archaeological materials, ethnographic records, and close observation of modern bison behavior have led a number of archaeologists to conclude that communal procurement of bison by means of traps and jumps was a practical procurement strategy only during the fall. In a commonly referred to statement, Frison (1970:5) argues

> Animal population studies indicate a fall period of buffalo jumping . . . . There are many reasons for driving buffalo at this time of year and for not driving them at other times. The animals themselves are in better condition at this time and they could be handled much easier, especially without horses. Like most wild animals, buffalo are in poor condition in early spring after the winter. With green grass which appears around the last of April or the first of May, the animals' condition begins to improve. They begin dropping calves during this period, which for all practical purposes makes the herds difficult for driving. A buffalo cow with a calf up to a week or two old is disagreeable, unpredictable, and disruptive of any driving endeavor.
>
> About the time the calving season is over and the calves are beginning to grow, the rutting season begins and lasts into the late summer. The behavior of both the cows and bulls at this time makes driving impossible. A single cow in rut in a herd is sufficient cause to disrupt any attempt toward controlled herd movements.
>
> On the other hand, during the spring and summer, the human group dispersed into single or small multi-family groups in order to better exploit the environment, and it was not economically advantageous to convene a group of people large enough for communal driving when the probability of success was lowered because of buffalo behavior. In addition, large quantities of meat were not desirable during the hot summer days considering the speed with which meat spoils and, besides, individual hunting techniques provided them with sufficient meat during this period.

Apparently as a result of information attained at the Vore Site (Reher 1977; Frison 1978:239-243) and no doubt other sites, Frison has ameliorated his stance on the annual communal fall hunt. He has recommended (1978:243-244) consideration of alternative hypotheses, emphasizing ". . . alternative sites, alternative procurement methods, or alternative subsistence strategies . . . ."

Using Frison's earlier statement as a springboard, others have expanded on Frison's comments (Keyser 1977:215).

> It is my contention that in north-central Montana, as in other areas of the Northwestern Plains (Frison 1973:79-80), fall communal bison procurement was the most significant yearly economic activity, since it was by communal procurement that groups obtained provisions for winter survival. Although bison were exploited year round, most of the year bison hunting was an individual or small group activity. Only during the fall is communal bison procurement a practical alternative. [Emphasis ours.]

Arthur (1975) has assembled a substantial body of ethnohistorical data that argues quite successfully for communal bison procurement and the aggregation of large aboriginal populations (1500-3000 persons) in the vicinity of bison pounds and jumps throughout the winter with somewhat less abundant documentation for similar occurrences in other seasons. In defending his thesis, Arthur attacks the analytical basis of Frison's and Reher's (Frison 1970, 1973) bison age determinations based on tooth eruption schedules and tooth wear patterns for bison. Reher (1977:21-22) responds quite adequately that regardless of whether or not winter kills, spring kills, or summer kills occurred, this ". . . does not alter the fact that autumn kills are still autumn kills."

Reher argues cogently (1977:22),

> Clearly, the historic and prehistoric information indicates a wide range of alternative strategies. At this point, it would be most constructive to seek general principles explaining all these strategies, rather than to perpetuate debate on the 'real' season of intensive hunting. For instance, it is sufficient . . . to propose that aggregational behavior was a function of buffalo productivity in all seasons. Seasonality is a secondary consideration, a consideration for refining the model in terms of specific areas and times, and need not be considered initially. The determinant effect of buffalo population upon mobility, group size, and other aspects of prehistoric organization is the principle that allows us to hypothesize where, when, and how we expect certain types of behavior to be manifested in the archaeological record.

Reher's arguments revolve around an investigation of range carrying capacity for bison as a determinant of "critical numbers" for human utilization. He concludes (1977:36)

> The reflection of these characteristics [dynamic, periodically fluctuating nature of the short-grass ecosystem] in human behavior will include the state of cultural systems as an equilibrium system responding to stochastic climatic input, and the rate of cultural change as a direct function of buffalo productivity. The state evidenced by widespread cooperative kills even may have been a relatively unusual event, if the entire system were known.

Clearly, many have far too long relied upon a !Kung Bushmen analogy to explain the archaeological manifestations represented on the northwestern Plains of North America. The few remaining marginally situated hunters and gatherers have influenced analogies of hunting and gathering peoples in prime habitats for too long. The abundance of animal resources represented on the Great Plains of North America in no way corresponds to the populations of the Kalahari Desert or central Australia.

The short-grass plains of North America supported an enormous biomass and probably much denser human populations than early estimates have led us to believe. Kroeber (1939:139) postulated 41,200 people on the northwestern Plains excluding the village tribes of the Missouri, an area that he calculates at 1,089,600 square kilometers, a population density of about 3.8 people per 100 square kilometers. Lee's (1968:35) Bushmen maintain a population density of 41 people per 100 square miles, or, using Kroeber's figures, about 16 people per 100 square kilometers. Given Lee's data, it is with some difficulty that one accepts Kroeber's figures that place the population occupying a relatively abundant resource zone at less than one-fourth that of people living in a desert with its limitations on water and resources dependent on water.

Perhaps we should begin to examine the possibility of larger population aggregates on a relatively permanent basis or smaller population aggregates maintaining a relatively sedentary lifeway. Using Deaver's rather conservative figures (Chapter V) that assume a population of 150 people eating an overabundance of fresh meat during the kill and process operation and preparing a rather nominal amount of dried meat, we discover that the 150 people are left with 10,300 kg of meat to either carry away, store, or remain and consume. If the people walk off with their stored products, each individual must carry his personal trappings and 69 kg, or 150 pounds, from cultural level I in Area B. From cultural level II, each individual's burden would amount to about 90 kg, or 198 pounds. Given the presence of pack or traction animals such as dogs to carry a portion of the burden and consume part of the surplus, our aboriginal population is still faced with a prominent surplus. In addition, we must face the question: Why move?

Kehoe (1973:4) has proposed application of the concept of an industry to the northwestern Plains aboriginal bison procurement system. To this we might add the concept of harvesting rather than of hunting the bison. The term harvesting does not imply domestication, rather that the people of the northwestern Plains had successfully adapted their cultures, populations, and procurement techniques into an essentially dynamic equilibrium with the Great Plains faunal and floral resources. Certainly, the effort involved in construction and utilization of bison pounds and jumps implies an almost certain knowledge of and ability to manipulate bison behavior. If correct, this brief note made on September 18, 1833, by Alexander Philipp Maximilian, Prince of Wied-Neuwied (Thomas and Ronnefeldt 1976:148), a highly regarded and normally

reliable observer, indicates that the aboriginal inhabitants of the North American Plains maintained a more intimate relationship with bison than we have credited.

> Among these animals [bison] there are some that are very large and fat, with longer horns than the others; these are such as have been castrated by the Indians when calves. They are said to become extremely fat and heavy.

The scenario that prefaced this report could have been written in various ways depending on interpretation of data and intellectual biases of the interpreter. The scenario as presented accounts for most of the observed data without indulging in unsubstantiated speculation. That the Bootlegger Trail site was occupied during the spring seems unquestionable. Both fetal remains and adult and subadult tooth eruption schedules confirm this. There seems little question that the site was used at the same season at least twice and probably as many as four times. Whether each cultural level represents one kill perpetrated by a relatively larger population or multiple events in a single season by smaller populations remains in question. The presence of articulated bony elements from nonbison species found *in situ* at the bottoms of both cultural units of the lower processing area argues that that area was in use for a limited time before the kill took place. In most instances, nonbison remains were in contact with but overlain by a substantial bed of bison bone. The most economical explanation is that the aboriginal inhabitants first occupied the site in late winter or early spring and, while preparing for the bison drive or waiting for a "critical mass" to assemble, utilized a variety of nonbison species. When operation of the kill commenced, small clusters of bison, possibly 10 or fewer, and conceivably as many as 50, were driven to the kill. Repeating the drive and kill over a three- or four-month interval would provide the population represented in the archaeological deposits. There exists a remote possibility that each stratigraphic unit represents several spring kills over a period of years, abandonment, and then repetition of the process at the same season over another subsequent set of years. The similarity of development exhibited by fetal specimens in Level II suggests that the kill occurred within a very closely spaced interval in one year or at almost precisely the same season in subsequent years. The evidence from cultural level I suggests either a series of kills spaced from February to as late as May in one year or kills spaced over that interval of time in subsequent years. Regardless of the alternative selected, the available evidence indicates a detailed knowledge of and ability to manipulate bison movement and behavior.

We agree that a critical mass of bison must exist for successful operation of a communal kill. No doubt fluctuations in bison populations or in access to those populations had a profound effect on aboriginal subsistence strategies. North American Indians dependent on the biomass of the northwestern Plains operated successfully in their environment. Indeed, they no doubt

represented a prominent force in the ecology of their habitat and, in turn, probably accounted in a dramatic way for fluctuations in bison numbers. Our present view is that with the exceptions of extreme depletion of bison populations, and possibly during rut and calving, the Plains hunters possessed the ability to take bison when and where they desired. We take the extreme stance that at most times during the Late Prehistoric period bison maintained a sufficient Plains-wide population that the critical mass necessary for a communal kill would accumulate naturally or be created by human control at almost any time of year.

APPENDIX I

ARTIFACT DESCRIPTIONS

by
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John W. Fisher, Jr.
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The accompanying artifact descriptions attempt to provide brief, concise statements about artifact form and construction. Artifact forms assigned to use categories such as projectile points, knives, endscrapers, sidescrapers, drills, etc., adhere to common usage. Since we undertook no investigation of micro-wear patterns or other diagnostic studies, implied usage is only meant to correspond with common terminology.

Despite the relative brevity of the descriptions, exhaustive measurement comparisons were accomplished and a variety of measurements not included in the descriptions exist. This holds particularly true for projectile points, as each specimen had 10 metric observations and 12 qualitative observations made. Because of the ease with which observations can now be compared and the range of comparisons possible, it is no longer reasonable to attempt to satisfy the usual "total data presentation" requirement. Instead, we have chosen to maintain a magnetic computer tape on file at the Department of Sociology, Montana State University. If an interested observer requests particular information, that information can be made available at nominal cost and with considerable speed of access.

Our observations consist of linear measurements in millimeters, weight in grams. Angles where appropriate are in degrees. The basic statistics presented for artifact forms with more than five specimens include mean, range, standard deviation, and number of specimens included in that particular observation (length, width, etc.).

LITHIC CATEGORIES

Archaeologists traditionally categorize stone artifacts into specific lithic types in an attempt to provide information about the general appearance of the artifacts, the properties inherent in the stone which may affect artifact production, and the possible material sources.

There are two major problems with a system of specific classification and terminology.

First, correct identification of many lithic types requires thin sections and sophisticated quantitative chemical analysis. This is particularly true of microquartz varieties, especially those commonly known as chert and chalcedony. The range of variation within these categories is tremendous due to changing geological processes and inclusions of various mineral and elemental components, both of which cause certain specimens with identical chemical composition and internal structure to appear different.

Second, specific categorization results in cumbersome and confusing terminology, and archaeologists seldom agree on the usage of

each term. Whenever a specific term is used, e.g., Knife River Flint, a series of connotations is suggested which may not be appropriate.

We have grouped the Bootlegger Trail site lithic assemblage into general geological classifications that demonstrate relationships between lithic types. We have utilized geological descriptions of each general category and the described range of variation within them to replace commonly used archaeological terminology.

LITHOLOGIC TYPES

All of the lithic artifacts were examined under a 10-45X microscope. Texture, i.e., grain size and shape, of the stone was the primary criterion for classification. Some attention was also given to the matrix surrounding the grains.

There are three major types of lithic material present in the artifact collection: extrusive igneous rocks, quartz of sedimentary origin, and quartz of metamorphic origin. Each of these types contains classificatory members.

Extrusive Igneous Rocks

Volcanic glass and a variety of other extrusive igneous rocks occur in the lithic assemblage. A group of the glasses is easily distinguished because it is amorphous. The other igneous rocks originate in lava flows and air- or water-borne ash falls, but it is sometimes difficult to distinguish basalts, glasses, and tuffs without thin sections. However, a crystalline structure does exist in each of these specimens. Silica content is often higher in the glasses than in other rocks originating in volcanic flows. A volcanic breccia of unknown origin is also present in the sample.

Quartz of Sedimentary Origin

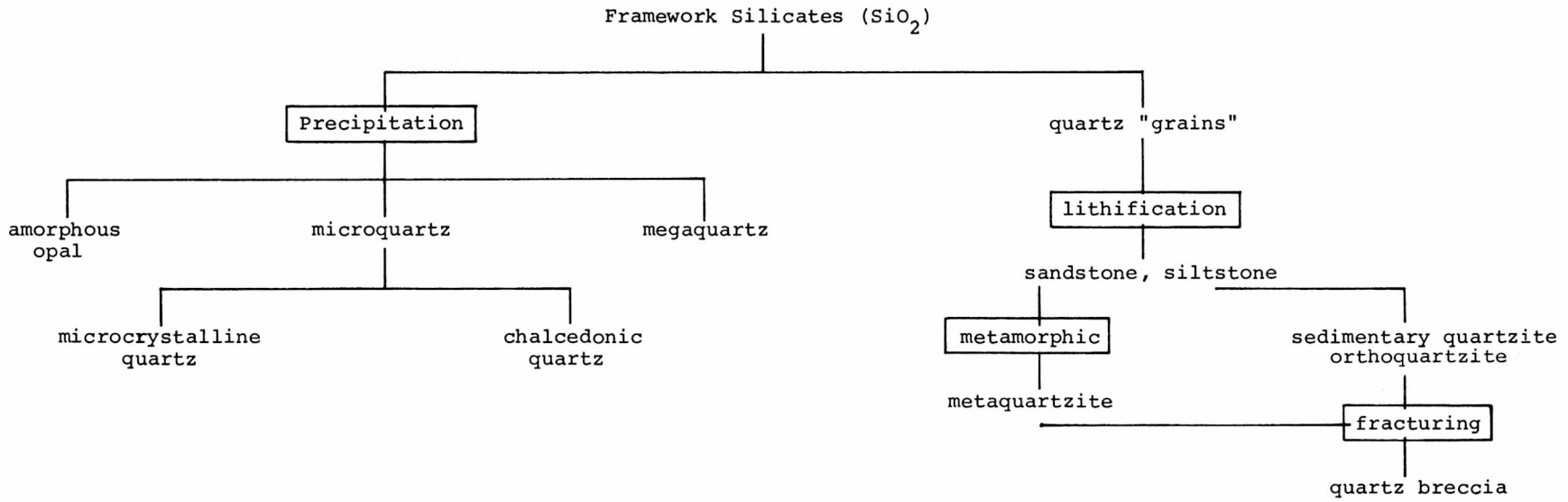
Quartz ranges in crystalline structure from very fine grains to large crystals formed by igneous, metamorphic, and sedimentary processes. Quartz of sedimentary origin constitutes the most prevalent raw material for stone artifact production at the Bootlegger Trail site.

Quartz-rich sedimentary rocks in the sample occur in two major groups: (1) micro- and mega-quartz and amorphous silica formed by chemical precipitation and (2) siltstones, sedimentary quartzites formed by the lithification of clastic materials, and quartz breccias forming in fault or fracture zones.

Precipitates

These rocks are easily delineated from the detrital materials; no grains are visible when using a 10.5-45X microscope.

Fig. 22. Quartz of sedimentary origin: formative processes.



Those items in boxes represent processes.

Color ranges from black to white, some are almost transparent, many are opaque.

Robert L. Folk (1974:80), a well known petrologist, discusses sedimentary quartz.

> Sedimentary quartz assumes three forms: (1) megaquartz, a general term for quartz overgrowths, crystals, geode and vein fillings, composed of equant to elongated grains larger than 20 microns; and (2) microquartz, divided into (2A) microcrystalline quartz, forming a pinpoint-birefringent aggregate of equidimensional grains usually ranging from 1-5 microns in diameter (but ranging from a fraction of a micron - - in the apparently isotropic cherts - - to 20 microns, the arbitrary upper limit); and (2B) chalcedonic quartz, forming sheaf-like bundles of radiating extremely thin fibers, which average about 0.1 mm long but may range from 20 microns to a millimeter long. All three types are transitional in some degree.

He continues (1974:80):

> Both forms of microquartz consist of nothing but finely crystalline quartz containing variable amounts of very minute liquid-filled spherical bubbles . . . .

During the investigation of artifacts from the Bootlegger Trail site no attempt was made to differentiate between microcrystalline and chalcedonic quartzes. This distinction requires the use of thin sections as was mentioned earlier.

The amorphous member of the precipitates, opal, ". . . is defined as an isotropic, hydrous silica gel with refractive index varying from 1.40 to 1.47" (Folk 1974:81). A small amount of opal is present in the sample in the form of opalized wood and/or bone and opalized sandstone. While the opal matrix is amorphous, the size and the shape of the quartz sand grains is visible in one of the sandstone specimens.

One projectile point is made of megaquartz.

Clastics

Siltstones, highly silicified silt-size quartz grains, form a distinctive group within the sample. Small mica flakes are apparent on the surfaces of these rocks. Quartz breccias consist of angular quartz fragments of variable sizes and shapes. The grains are cemented into rock by some variety of microquartz or by opal. Breccias are usually formed in fault or fold zones where quartz is crushed into small angular grains. Two projectile points are highly silicified breccia; they appear very different from the quartz breccias and may represent a mature form of those breccias from fracture zones. Sedimentary quartzites, also known

as orthoquartzites, consist of rounded sand grains cemented with silica. Many of the sedimentary quartzites and quartz breccias are difficult to differentiate from one another because the grains are so small. Thin sections are necessary to make definite distinctions.

Quartz of Metamorphic Origin

Metaquartzite is formed from highly quartzose sandstone through metamorphic processes. It is often difficult to differentiate metaquartzite from orthoquartzite. Although the two were indistinguishable in this study, both are probably present.

A single quartzite artifact may contain a section of large grains and a section of smaller grains. One nodule may produce both microcrystalline and quartzite artifacts, each formed by a separate geological process at the same or different times. A single core of structurally homogeneous material may produce artifacts ranging from dark to light, opaque to transparent.

Unknown

Several specimens cannot be positively identified lithologically. They will be referred to simply as "unknown."

LITHIC SOURCES

All of the lithic varieties, except obsidian, discussed above are readily available in the Tiber Reservoir area in the form of glacial till carrying material from Canada and stream cobbles from formations in the mountains to the west. The obsidian most likely originated on the Yellowstone Plateau.

SUMMARY

The lithic assemblage is classified into three fundamental petrologic categories: igneous, sedimentary, and metamorphic rocks. Within the igneous category only volcanic glasses, rocks from flows, and air- or water-borne specimens are represented. The sedimentary category is further divided into chemically precipitated varieties and detrital varieties. The metamorphic division contains only metaquartzites. Some specimens are of unknown lithology.

The delineation of types is based on the texture of the stone as seen in the microscope. A brief description of the rock is given in Table 20.

Table 20. Lithic types: characteristics.

Major Type-Source of Origin	Type	Subtype	Grain Size	Grain Shape	Cement	% Grains	Sorting	Color	Opacity	Comments
Quartz of sedimentary origin	Opal	Opalized sandstone or quartzite	Very fine to medium	Unknown (except for one)	Whitish opal	Unknown 50% (one)	Unknown-very well	White, cream, medium gray, pale reddish brown	Transparent	Those whitish in color appear very cloudy inside. Pale reddish brown is very unusual.
		Opalized wood or bone	N.A.	N.A.	N.A.	N.A.	N.A.	Pale yellow brown & buff, dark reddish brown & white	Opaque	Pale yellow brown background with parallel buff lines. Shows wood grain.
	Micro-quartz		Unknown	Unknown	N.A.	N.A.	N.A.	White, very light gray, medium dark gray, dark gray, brownish gray, dark reddish brown, rust brown, brown, lt. brown, pale yellow brown, tan, cream, buff	Translucent to opaque	Many are limestone replacements (fossil hash is visible giving mottled appearance). Brown shades are well represented.
	Mega-quartz		Larger than 1.23 cm (maximum dimension of artifact)	Unknown	N.A.	N.A.	N.A.	White	Transparent	

Table 20, continued.

Major Type-Source of Origin	Type	Subtype	Grain Size	Grain Shape	Cement	% Grains	Sorting	Color	Opacity	Comments
Quartz of sedimentary origin, continued	Siltstone		Very fine	Unknown	Silica	Unknown	Very well	Light gray, medium lt. gray, medium dark gray, dark gray, grayish black, brownish gray, grayish red, dark reddish brown	Opaque	Mica flakes readily observable, especially in darker colors.
	Quartz breccia		Medium to fine	Angular	Microquartz or opal	20%-50%	Very poorly to moderately	White, dark gray, light olive gray, rust brown, pale reddish brown, lt. brown, tan, yellow gray, dark reddish brown	Slightly translucent at thin edges; opaque	Most are mottled gray & white or gray & pale reddish brown.
Quartz of metamorphic or sedimentary origin	Quartzite		Fine to medium	Rounded to sub-angular	Silica	50%	Well	Light gray, dark gray, olive gray, light olive gray, green gray, dark reddish brown, lt. brown, tan, buff	Opaque	Gray mottled examples are similar in appearance to quartz breccias.
Extrusive igneous rocks	Volcanic glass (obsidian)		N.A.	N.A.	N.A.	N.A.	N.A.	Black	Translucent	

Table 20, concluded

Major Type-Source of Origin	Type	Subtype	Grain Size	Grain Shape	Cement	% Grains	Sorting	Color	Opacity	Comments
Extrusive igneous rocks, continued	With grains	Basalt-like	Fine	Unknown	Unknown	50%	Unknown	Dark gray	Opaque	
		Tuff	Fine	Unknown	Unknown	Unknown	Unknown	Medium gray & dark gray	Opaque	Layered with the two shades.
		Volcanic breccia	Coarse	Angular to sub-rounded	Unknown	30%	Very poor	Grayish red & buff	Opaque	Large buff grains with reddish background.
Unknown			Unknown	Unknown	Unknown	Unknown	Unknown	Medium light gray, medium gray, yellow-gray	Opaque	

CONCLUSIONS

This classification is adequate for the Bootlegger Trail site materials for three reasons.

1. The largest portion of the collection, quartz rocks of sedimentary origin, can be found in the immediate area in the form of glacial till or stream cobbles. There is little possibility of tracing origins of these materials.

2. Many currently employed designations for microquartz varieties have no basis in solid geological identification and are used inconsistently. It is more profitable to use general terms correctly than to use specific terms incorrectly.

3. Some specific terms are of little value in an archaeological context. For example, chert is composed of both microcrystalline and/or chalcedonic quartz and small amounts of impurities. Color and opacity are the most notable outward characteristics usually employed to distinguish chert from closely related chalcedony.

Perhaps, in the future, if more specific identification becomes feasible, definitive terms would prove useful. Presently, a geological description of the lithic types has greater utility for comparisons on a regional basis than does a vague generic term.

PRIMARY PROCUREMENT IMPLEMENTS

PROJECTILE POINTS

MacNeish (1958) established a preliminary grouping of Late Prehistoric period projectile points using the terms "Plains" and "Prairie" side-notched. Forbis (1962) and later Kehoe (1966) expanded this system into more detailed groupings. These groupings have received mixed reviews by practicing archaeologists (Reeves 1974:63). The failure of these schema to receive widespread adoption among Plains archaeologists testifies to the difficulty of identifying group members.

Using distinguishing criteria as provided by Forbis and Kehoe (insofar as possible) we coded all applicable metric and nonmetric observations for computer comparison. Application of a computer program specially devised to separate the points into appropriate groups resulted in correct assignments for 50% of the collection; the remaining 50% exhibited intermediate or different features from those grouped into established categories.

Perhaps in the instance of very large collections from specific localities the groupings created by Forbis and Kehoe have temporal meaning. Our sample is relatively small with many incomplete specimens.

Since the sample appears to represent occupations closely spaced in time, there seems to be little reason to rely on the established categories. Instead, we choose to describe our sample as two forms, side-notched projectile points with a wide range of acceptable variations and an unnotched projectile point form. The seven notched and two unnotched forms from Area E are not included in the sample.

Total Projectile Points and Identifiable Fragments: 455.

Side-notched projectile points and identifiable fragments, N=242. Outline, triangular, acute tip; sides, straight to convex; bases, straight, convex to slightly concave; notches, narrow rectangular to broad oval intersecting the point at nearly 90° to the long axis. (Fig. 23)

Material Type	BI%	BII%	D%	Total %
Obsidian	11	4	4	7
Microquartz	25	38	43	33
Opal	19	8	12	14
Megaquartz	1			-
Siltstone	17	22	14	19
Igneous		1		-
Quartzite	6	8	4	7
Quartz Breccia	20	15	18	19
Unknown	1	-	2	1
N =	109	85	48	242

BI	Length	Width	Thickness	Neck Width	Weight
Mean	19.7	12.3	2.9	8.1	.71
Range	11.4-32.1	1.0-16.7	2.1-4.2	5.0-15.0	.15-2.1
Standard Dev.	5.3	2.6	.5	1.6	.38
N	32	45	52	54	28

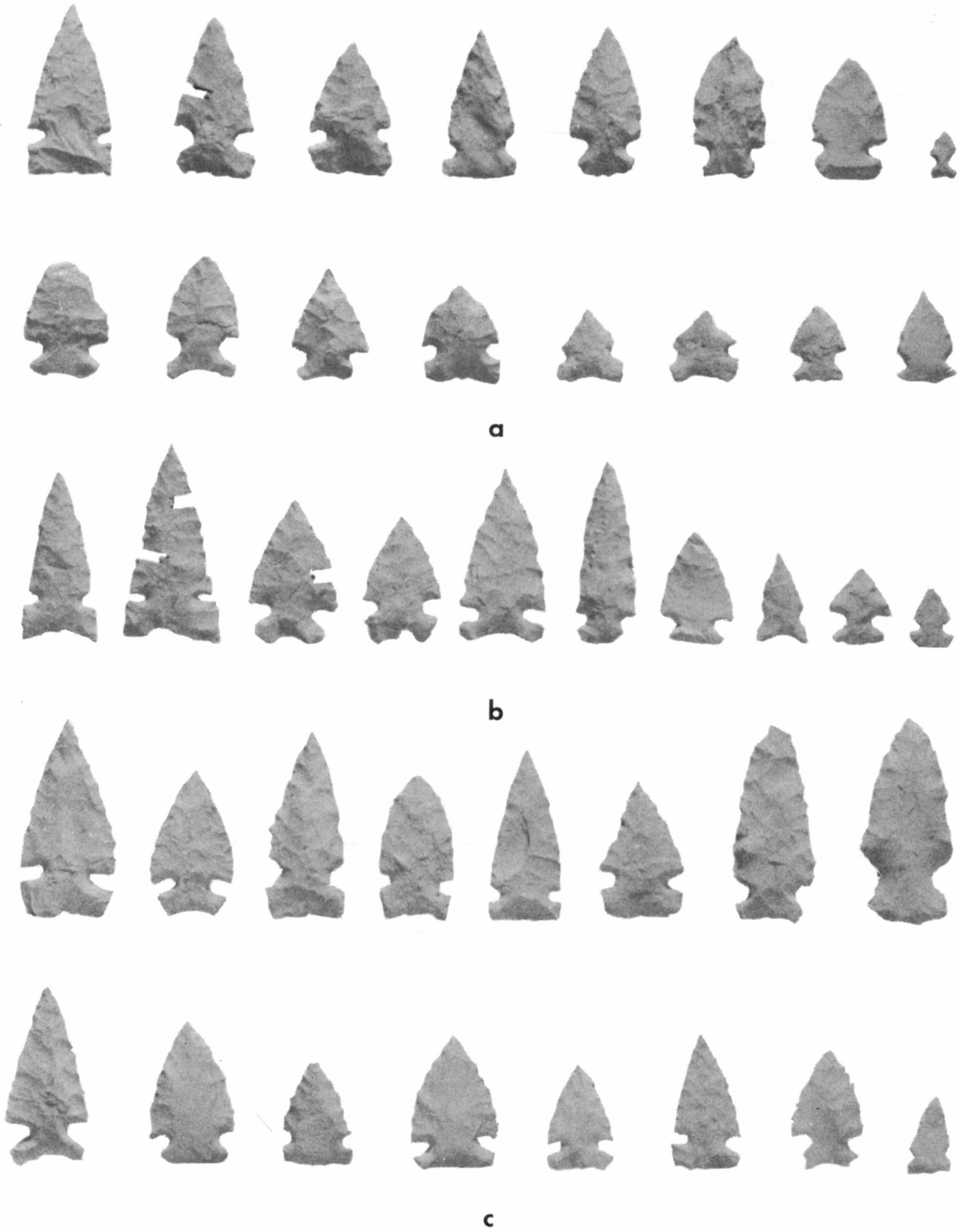


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Fig. 23. Side-notched projectile points.
a - Area BI.
b - Area BII.
c - Area D.

BII	Length	Width	Thickness	Neck Width	Weight
Mean	18.3	11.8	2.7	7.3	.55
Range	8.0-34.0	7.5-17.1	1.4-4.0	4.1-9.8	.15-1.3
Standard Dev.	5.9	2.1	.6	2.2	.29
N	37	51	59	54	29

D	Length	Width	Thickness	Neck Width	Weight
Mean	23.5	13.0	3.1	8.7	.99
Range	12.7-35.9	7.8-18.6	1.5-5.7	4.9-13.6	.1-3.4
Standard Dev.	6.3	2.2	.6	1.5	.7
N	32	44	45	43	16

Descriptive Characteristic	BI%	BII%	D%
Side Shape			
Straight	57	64	44
Convex	8	14	56
Concave		1	-
Uncertain	35	22	-
N=	72	74	48
Base Shape			
Straight	63	47	42
Convex	4	38	6
Concave	18	4	44
Uncertain	15	11	8
N=	72	74	48

Discussion: A truly wide range of forms characterizes the sample of side-notched projectile points. The range present in any one area or cultural level also appears in the others. In general, points from Area D exhibit larger metric dimensions than those

from either level of Area B. The dimensions, however, show considerable overlap at one standard deviation. The projectile points from Bootlegger seem to form a single, however variable, population.

Unnotched projectile points, N=46.

Outline, triangular; sides, straight to slightly convex; bases, straight, slightly concave to slightly convex. (Fig. 24)

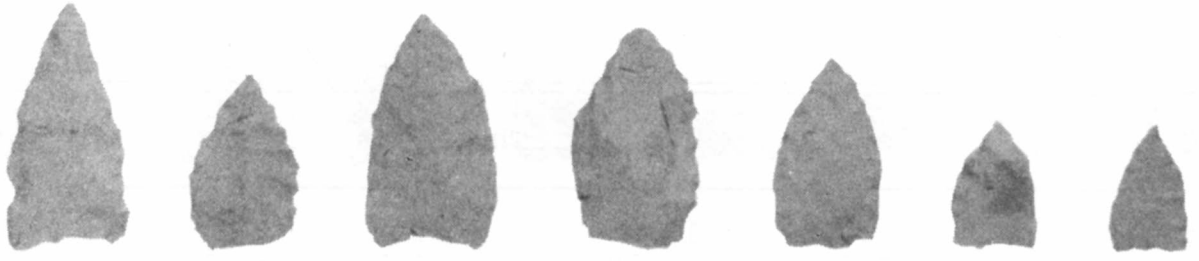

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Fig. 24. Unnotched projectile points (?).

Material Type	BI%	BII%	D%	Total %
Obsidian	14	22		17
Microquartz	18	17	100	20
Opal	18			9
Megaquartz				
Siltstone	9	13		11
Igneous	5			2
Quartzite	18	22		20
Quartz breccia	14	22		17
Unknown	5	4		4
N =	22	23	1	46

	Length	Width	Thickness	Weight
Mean	19.2	12.8	3.3	.83
Range	11.6-30.9	7.7-19.2	1.3-5.7	.20-2.9
Standard Dev.	4.9	2.6	1.1	.6
N	28	42	45	26

Side shape: Straight 30%, Convex 58%, uncertain 12%, N=46.

Base shape: Straight 68%, Convex 6%, Concave 20%, uncertain 6%, N=46.

Fragments, probably projectile point tips, midsections, and bases.

Material Type	BI%	BII%	D%	Total %
Obsidian	21	3	5	15
Microquartz	26	29	6	27
Opal	12	12	2	11
Megaquartz	-	-	-	
Siltstone	15	14	6	16
Igneous	2	3	-	2
Quartzite	9	14	1	10
Quartz breccia	13	25	2	17
Unknown	2	-	-	1
N =	86	59	22	167

SECONDARY PROCUREMENT OR PROCUREMENT SUPPORT IMPLEMENTS

CHIPPED STONE

Knives and Knife-like Fragments (Fig. 25a-d), N=70.

Bifacially, bilaterally (on complete specimens) modified broad oval (length less than 2x width) to narrow laurel-leaf (length greater than 4x width) shaped specimens with edge angles less than 50° are classified as knives.

Material Type	BI%	BII%	D%	EII%	Total %
Obsidian	8	4		100	6
Microquartz	54	50	100		53
Opal	-	8			7
Megaquartz	-	-			-
Siltstone	5	7			6
Igneous	5	-			6
Quartzite	10	-			3
Quartz breccia	18	2			20
Unknown	-	-			-
N =	39	28	2	1	70

	Length	Width	Thickness
Mean	62.5	22.5	7.5
Range	28.8-84.9	8.0-37.7	5.2-10.6
Standard Dev.	15.3	8.6	1.6
N	10	10	10

Discussion: Partially because of small sample size, knives consist of a range of forms that might ordinarily be divided into several groups. More importantly, we consider the range of variation exhibited in our class of bifacial, bilateral knives to represent specimens in different stages of use modification. Use of knives as cutting implements subjected them to dulling, breakage, and resharpening. Throughout the life of any specimen, it should become narrower and somewhat shorter. Most specimens exhibit some degree of beveling on worked edges, resulting in a tendency for the transverse cross section to change from a normally lenticular section toward a parallelogram section.

That these items altered from their original shape is adequately demonstrated by a single specimen that was broken, the short broken portion discarded, the longer portion retouched, resharpened, and reused. The two fragments still fit together (Fig. 25e).

Side-notched Knife (Fig. 25f), N=1, Area BI.

A single form identified as a side-notched, and thus probably hafted, knife is distinguished from projectile points only on the basis of size. Frison and others (1978:20) illustrate a similar specimen from north-central Wyoming.

Material: Red-gray-dark gray banded siltstone.

Dimensions:		
	Length	47.1 mm
	Width	28.9 mm
	Thickness	8.0 mm
	Neck Width	20.8 mm
	Notch Width	9.4 mm

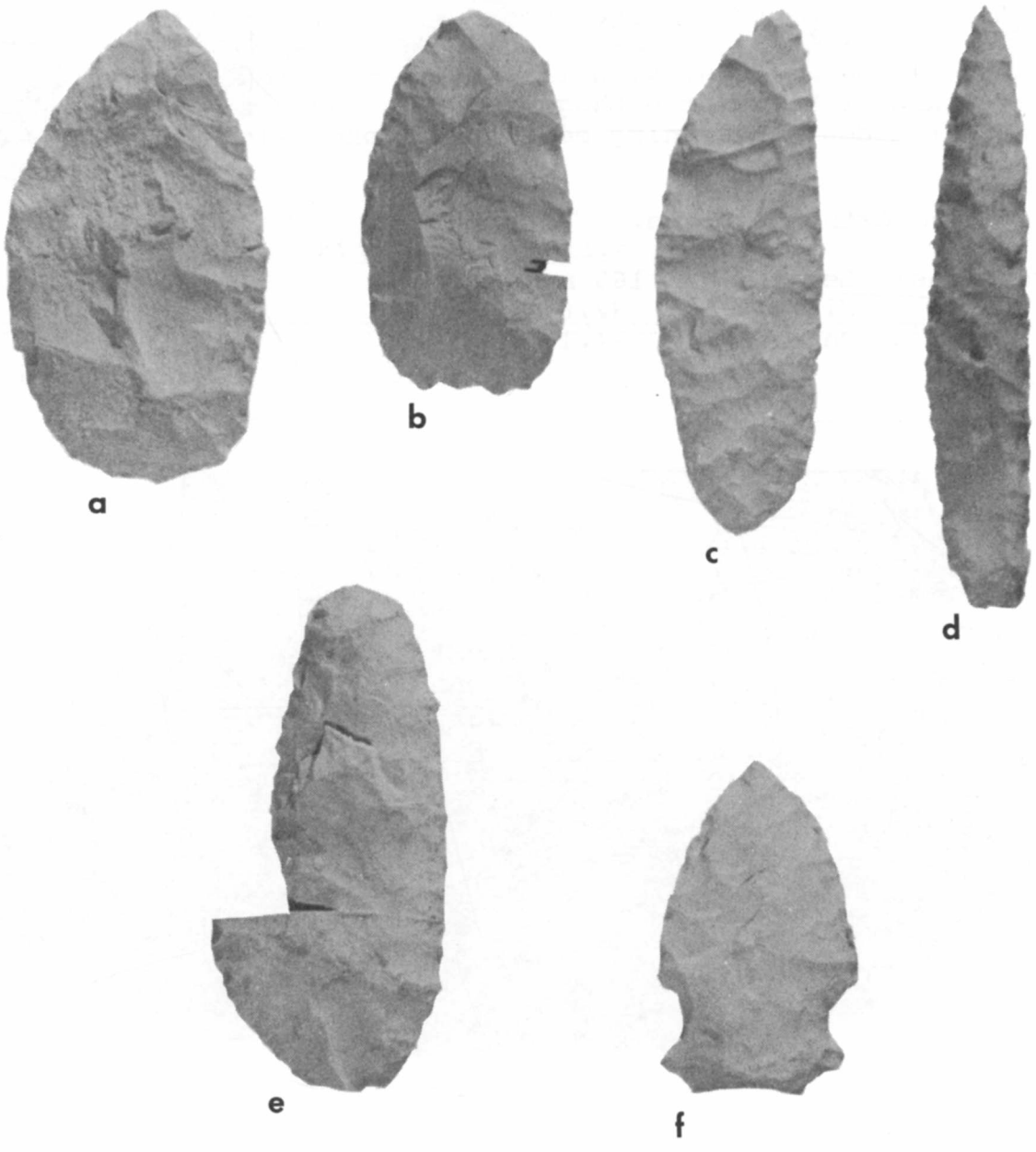

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Fig. 25. Knives.
a-d - Range of knife forms.
e - Broken remodified knife.
f - Side-notched knife.

Large Ulu-shaped Knife-chopper (Fig. 26), N=1, Area BII.

A single large bifacially, unilaterally modified specimen made from a tabular piece of orthoquartzite. The bifacially modified edge is rounded. Remaining edges are broken along natural cleavage planes.

Material: Orthoquartzite.

Dimensions:		
	Length	163 mm
	Width	82.8 mm
	Thickness	11.1 mm

Scale 1:1

Fig. 26. Ulu-shaped knife.

Endscrapers (Fig. 27), N=57.

Outline, roughly triangular. If viewed as an isosceles triangle, the base of the triangle ranges from flat to slightly rounded and forms the working bit of the scraper. Unifacial flaking produces a plano-convex cross section. Angle of working edge varies from 50°-90° with most specimens approaching 90°. Invariably, the endscrapers are manufactured from percussion flakes, with the bulb of percussion situated at the apex of the triangle. Some have been ventrally thinned to remove part or all of the bulb of percussion. The majority of the specimens have been modified over the entire dorsal surface.

Scale 1:1

Fig. 27. Endscrapers.

Material Type	BI%	BII%	Total %
Microquartz	82	67	75
Opal	6	8	7
Siltstone	3	4	4
Quartzite	6	-	4
Quartz breccia	3	21	11
N =	33	24	57

Dimensions	Length	Width	Thickness	Bit Width
Mean	22.6	19.9	6.3	18.1
Range	14.5-36.6	11.6-28.9	2.8-10.4	10.1-26.5
Standard Dev.	5.6	3.9	1.6	3.5
N	40	43	43	43

Micro-endscrapers (Fig. 28), N=11.

Scale 1:1

Fig. 28. Micro-endscrapers.

We reserved this category for specimens that exhibit most of the characteristics of the typical Plains end-scraper, that is, a roughly triangular outline, plano-convex cross section, unifacial flaking on the convex dorsal surface, and

a steep working edge or bit at the base of the triangle. These specimens were labeled micro-endscrapers because of the diminutive size. They differ slightly from most endscrapers in that the working edge, or steeply flaked bit, tends to be somewhat more rounded. Several of these specimens might be mistaken for chipped-stone drills or awls, but the lateral edges appear freshly broken and show no indication of crushing typical of drill usage.

Material Type	BI	BII	E	Total
Opal	1			1
Microquartz	2	4	1	8
Quartzite		1		1
Quartz breccia		1		1
Unknown		1		1
N =	3	7	1	11

Dimensions	Length	Width	Thickness
Mean	18.6	9.0	3.4
Range	12.7-30.8	7.4-10.7	2.3-4.2
Standard Dev.	5.5	1.2	.6
N	11	11	11

Drills (Fig. 29), N=15.

Scale 1:1

Fig. 29. Drills.

Outline, roughly triangular with acutely pointed tips. Four specimens have expanding bases. Cross section, lenticular to nearly diamond-shaped. Modification, bifacial and bilateral. Working edge appears to occur on lateral edges. Lateral edges range from straight to concave in outline.

Material Type	BI	BII	Total
Opal	2		2
Microquartz	2	7	9
Siltstone	1	1	2
Quartz breccia		1	1
Unknown	1		1
N =	6	9	15

Dimensions	Length	Width	Thickness
Mean	18.6	9.0	3.4
Range	12.7-30.8	7.4-10.7	2.3-4.2
Standard Dev.	5.5	1.2	.6
N	11	11	11

Pièces Esquillées (?) (Fig. 30), N=5.

Scale 1:1

Fig. 30. Pièces esquillées.

Outline, roughly rectangular. Cross section, plano-convex. Modification consists of bipolar battering on short margins of the rectangle. Most of these items appear to have been produced from small pebbles or exhausted cores, and little indication remains of original manufacturing procedures.

Material Type	BI	BII	Total
Opal	1		1
Microquartz	2	2	4
N =	3	2	5

Dimensions	Length	Width	Thickness
B/707/X/5	-	38.7	8.5
B/708/XI/50	24.4	15.6	6.5
B/709/IV/2	30.7	21.0	9.5
B/709/V/18	21.8	12.8	5.5
B/808/XI/13	43.2	30.0	10.9

Discussion: Pièces esquillées have long formed a part of the European Upper Paleolithic tool inventory. George MacDonald (1968) first discussed them in a New World context from the Debert site, a Paleo-Indian manifestation in Nova Scotia. The specimens from the Bootlegger Trail site exhibit all or most of the characteristics described by MacDonald (1968:85-90). MacDonald follows European practice and attributes them to the working of bone, antler, or hard woods, probably as wedges. We cannot necessarily attribute similar specimens from Late Prehistoric contexts with those same uses. Because these specimens have received infrequent discussion in the archaeological literature of the northwestern Plains, our identifications should be treated tentatively.

Pebble Tool (Fig. 31), N=1.

Scale 1:1

Fig. 31. Pebble tool.

Original outline of the pebble was ovate. Modification has produced a sharp point at one end. Cross section, flat oval. Apparently the pebble was split by striking a blow with a hard hammer and the pebble supported on a hard anvil, resulting in bipolar modification. The surface distal from the original blow was then subjected to bifacial modification. Approximately 2/3 of the original cortex remains.

Material: Microquartz.

Dimensions:

B/607/III/14	Length	34.3 mm
	Width	22.9 mm
	Thickness	8.0 mm

Cobble Choppers (Fig. 32a), N=10.

Outline and cross section, variable. All specimens retain a parabolic end or side from the original stream-rounded cobble. The opposite side is modified to some extent by the removal of flakes, usually unifacially. Most specimens exhibit a minimum of three large flakes (some, multiple large flakes) and some evidence of secondary retouch. Cortex is present on all examples.

Material Type	BI	BII	D	Total
Quartzite	3	5	1	9
Conglomerate			1	1
N =	3	5	2	10

Discussion: These implements are presumably used in the fracturing of bone and during butchering. No measurements are provided, as these specimens are highly variable in all dimensions. The largest measures 142 mm long, 114 mm wide, and 52 mm thick, the smallest 84 mm long, 95 mm wide, and 28 mm thick.

Cobble Spall Scrapers (Teshoa) (Fig. 32b), N=11.

Cobble spall scrapers consist of large quartzite flakes removed by direct hard-hammer percussion from the original stream-rounded cobble. An invariable aspect of these scrapers is that they maintain the cortex on the dorsal surface and a positive bulb of percussion is invariably visible on the ventral surface opposite the distal working edge. Outline, generally oval. Cross section, plano-convex. The original angle of the working edge typically ranges at around 10°-15°. Subsequent resharpening, most often unifacially, removing flakes from the ventral surface and leaving the cortex dorsal surface relatively intact, tends to produce steeper working edges throughout the life of the implement. Like the cobble choppers, these implements are highly variable in size and shape. No dimensions are provided.

Material Type	BI	BII	Total
Quartzite	1	10	11

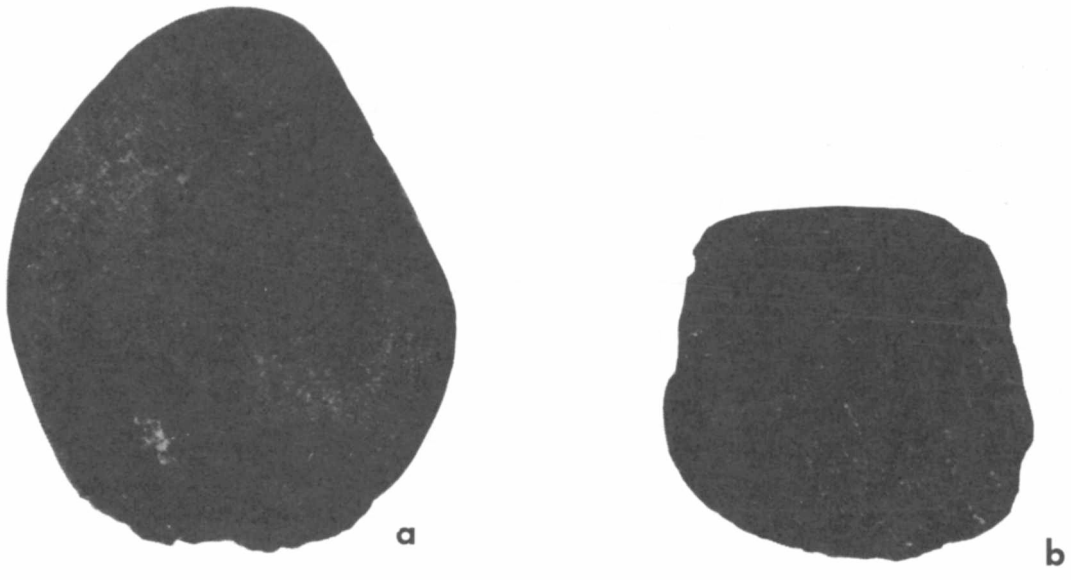
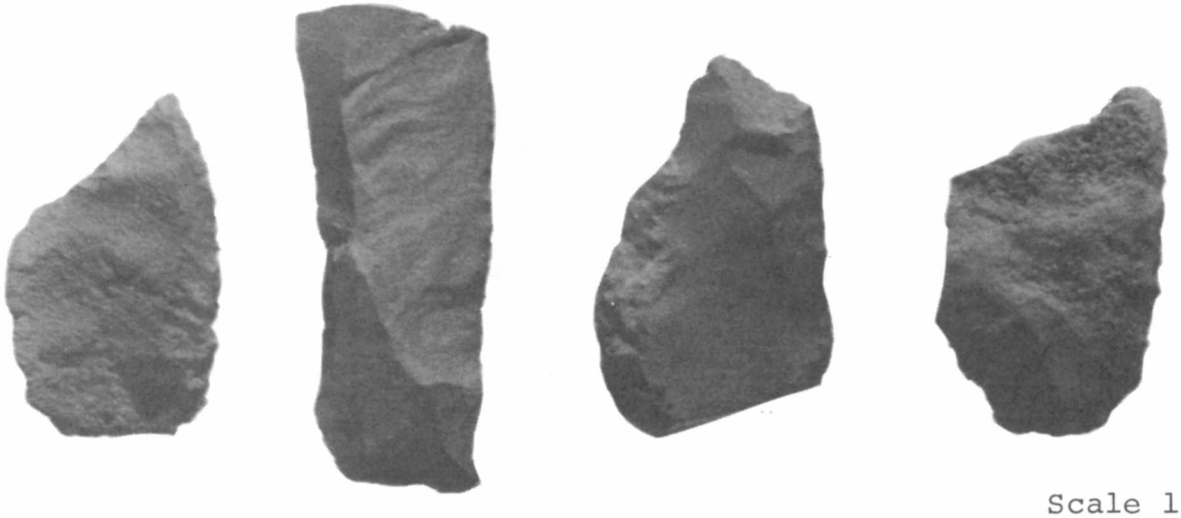


Fig. 32a. Cobble chopper. Scale 1:2
b. Cobble spall scraper.

Modified Flakes (Fig. 33), N=88.

Modified flakes consist of irregularly produced flakes on which at least one edge has received some unifacial or bifacial modification. Among those implements that have a dorsal surface with several flake scars and a ventral surface consisting of the flake scar that produced the specimen, modification tends to occur principally on the dorsal surface. The angles of working edges are highly variable but tend to be somewhat steeper than the edges of knives (greater than 50°) and usually less steep than endscrapers (less than 90°).



Scale 1:1

Fig. 33. Modified flakes.

Material Type	BI%	BII%	EII%	Total %
Opal	6	3		5
Microquartz	66	60	100	64
Siltstone	21	3		13
Quartzite	2	10		6
Quartz breccia	4	25		14
N =	47	40	1	88

Discussion: Many of the specimens in this category might be classified as sidescrapers. Twenty-six specimens show evidence of a blade-like manufacture with unifacial modification along one or both long lateral edges. Because of the high degree of variability within this class and the relatively small number of specimens, division into more precise categories seems impractical.

Utilized Flakes, N=99.

These are apparently randomly produced flakes that show modification by removal of small flakes during utilization. In most instances, it appears that the flake was used once and then discarded. On none of the specimens included in this category does indication of deliberate and repetitive retouch appear.

Material Type	BI%	BII%	Total %
Obsidian	14	5	10
Opal	5	7	6
Microquartz	24	59	38
Siltstone	38	7	25
Igneous	-	2	1
Quartzite	5	5	5
Quartz breccia	12	15	13
Unknown	2		1
N =	58	41	99

Discussion of Chipped-stone Specimens

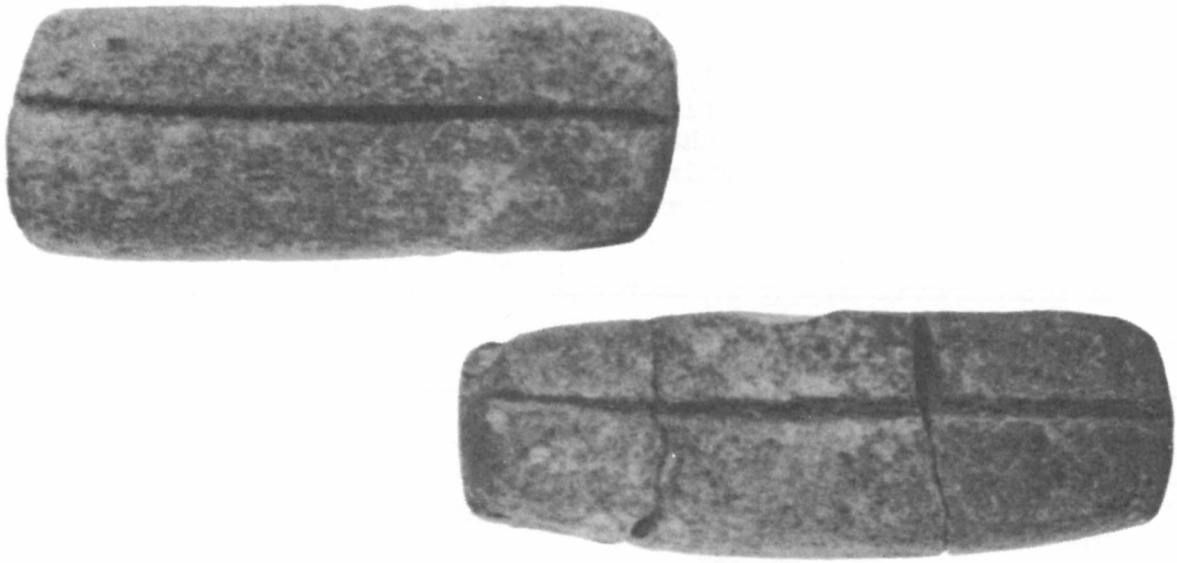
Three lithic types appear in the assemblage with greatest frequency: microquartzes, siltstone, and quartz breccia. Among those implements

that require durable working edges (endscrapers and presumably micro-endscrapers), the preferred lithic type seems to be one of the varieties of microquartz, most frequently the variety commonly referred to as Knife River flint. Implements that require a sharp, but possibly less durable, working edge show a wider range of variation, utilizing the somewhat softer or less durable siltstones, quartz breccia, and obsidian. Heavy-duty scrapers and choppers appear most commonly made from quartzites.

GROUND STONE

Shaft Abraders (Fig. 34), N=3.

Outline, nearly rectangular with rounded or eroded corners. Cross section, rectangular with oval corners. Two apparently paired specimens have a shallow, V-shaped groove on one surface along the longitudinal axis of the stone, with the groove approximately 5 mm wide, depth 2.5 to 3 mm. On a fragmentary specimen the groove is wider (about 10 mm) and rounded rather than V-shaped in profile. Material, sandstone. All specimens from Area B, Level I.



Scale 1:1

Fig. 34. Shaft abraders.

Dimensions	Length	Width	Thickness
B/709/IV/34	86.0	32.3	22.3
B/709/IV/61	92.2	32.4	21.5

Polished Cobble, N=1.

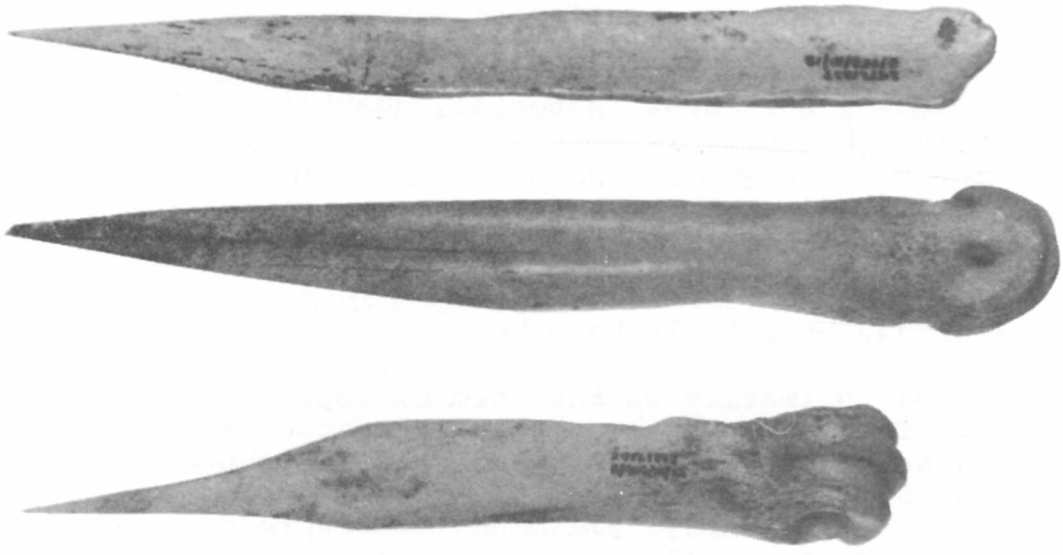
Outline, roughly rectangular with smoothed surfaces. One bluntly rounded end. Cross section, flat oval. All surfaces appear to be deliberately polished. Material, quartzite. Length 107.9 mm, width 80 mm, thickness 29 mm.

BONE TOOLS

A total of 342 bone tools have been identified from the excavations at the Bootlegger Trail site. We based our initial identification of bone tools primarily on the form of modification to the tips of the bone. The most prevalent characteristic is the presence of a smooth, somewhat rounded tip. The bone might additionally be polished. Striations occasionally appear on the surface of the bone. In the laboratory, all bone tools were examined under a low-power microscope (10.5-45X). Striations, if present, were emphasized by low cross lighting. The direction of striations was noted, whether parallel or at an angle to the long axis of the tool. Also included in the analysis were whether the bone belonged to bison or nonbison taxa and, where possible, identification of taxa. In addition, the particular element that each tool was made from was identified when possible. Presence or absence of epiphyses was also recorded. Was the bone split longitudinally? Is the tip of the tool sharp or blunt? Were both ends of the tool used (bipolar)? If the tool is unipolar, that is, if only one end is modified, the unused end was examined to determine whether the end was broken during or subsequent to the excavation of the tool or prior to excavation. Polish was also recorded. Polish alone was not considered sufficient for identification as a tool, except in those few cases where large areas were polished. It is believed that minor rounding, smoothing, and polishing of bone fragments, especially along edges and tips, may be produced by natural processes. Certain cultural practices, such as boiling, might also create similar edges. We often encountered difficulty attempting to distinguish between minor modification of bone through human utilization and modification of bone through other processes. As a result of the analysis, we have established 11 bone tool classes. These classes are based primarily on morphology. Because of the extreme variability within these classes, metrics are not presented. All measurements have been recorded and can be acquired on request.

Class I Bone Tools (Fig. 35), N=21.

Two criteria identify this class. All have a very sharp tip, and the sides of the tools are nearly parallel or gently tapering. Near the tip, the sides taper abruptly to form a prominent point. All members of this class are manufactured of split bone. Five specimens, highly polished; the remainder show some degree of polish.



Scale 1:1

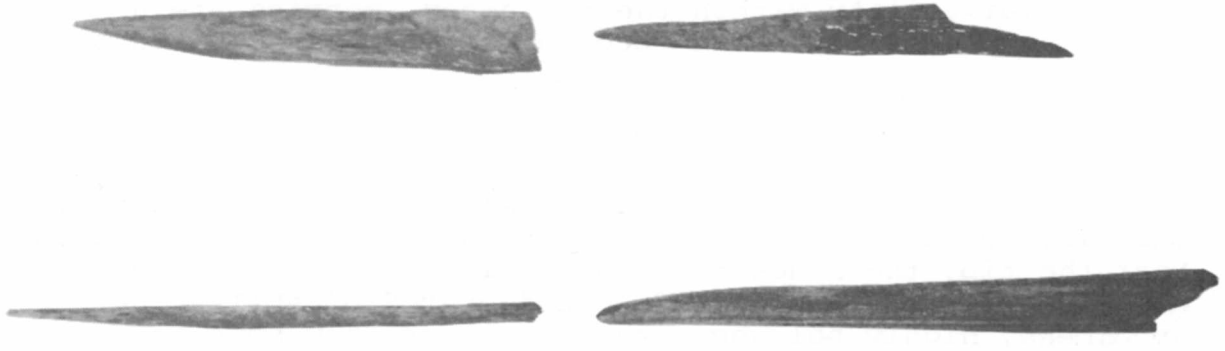
Fig. 35. Class I bone tools.

Bone elements: 2 deer or pronghorn metapodials, each with one condyle from distal epiphysis present.
2 possible scapula fragments.
2 scapulae split lengthwise through the glenoid cavity.
The remainder of split rib and/or unidentifiable long bones.

Distribution: Area BI, 4; Area BII, 14; Area D, 2; Area E, 1.

Class II Bone Tools (Fig. 36), N=10.

This class shares the criteria of a very sharp tip with Class I. They differ in that the entire tool is slender with a uniform taper converging to a sharp tip. These tools are made of splinters of long bone and rib.



Scale 1:1

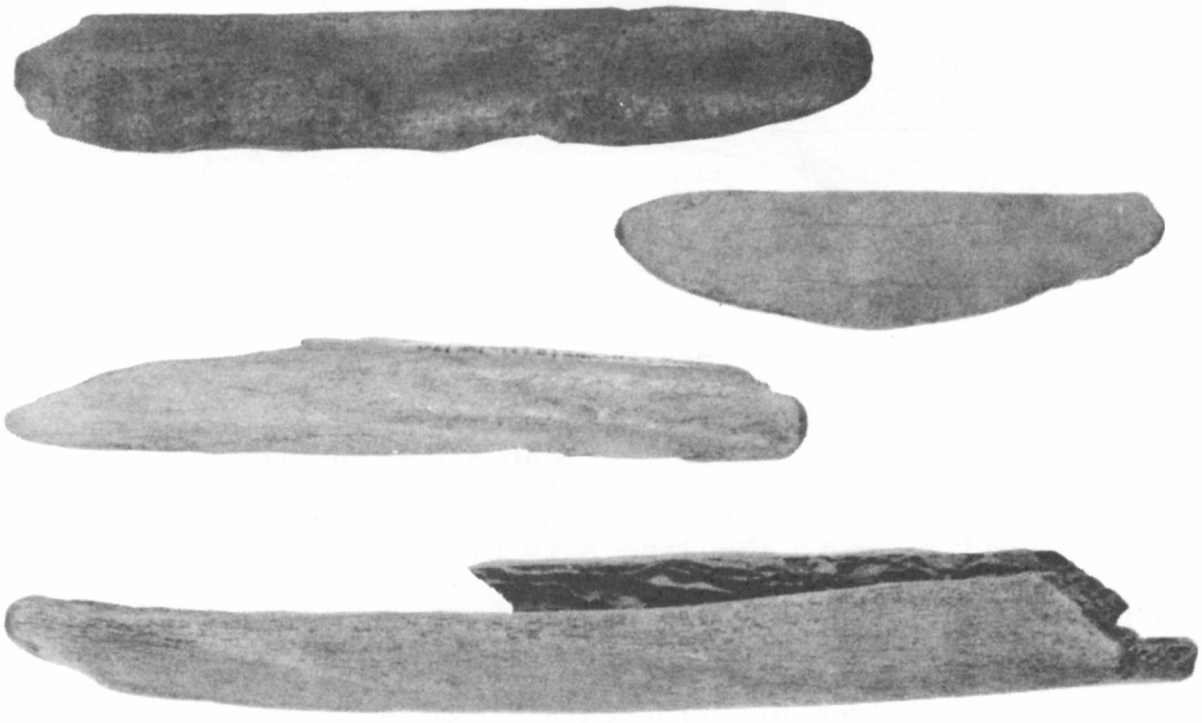
Fig. 36. Class II bone tools.

Bone elements: Splinters of long bone and rib.

Distribution: Area BI, 1; Area BII, 7; Area E, 1.

Class III Bone Tools (Fig. 37), N=21.

The important diagnostic of this category is the presence of bipolar modification. Thirteen specimens have one tapered and one narrow end, while the other end is broad and rounded. Seven have sharply pointed tips on both ends. One has two broadly rounded tips and some degree of smoothing and rounding on those surfaces. Two of the split bone tools are highly polished on exterior surfaces.



Scale 1:1

Fig. 37. Class III bone tools.

Bone elements: 18 longitudinally split ribs and long bones.
3 unsplit ribs.

Distribution: Area BI, 3; Area BII, 16; Area D, 1.

Class IV Bone Tools (Fig. 38), N=6.

Comprised of rib tools which retain the proximal (vertebral) extremities. They are characterized by unipolar modification. One specimen has a broad, flat tip; three have narrowed, tapered tips.

Bone elements: Ribs.

Distribution: Area BI, 2; Area BII, 3; Area D, 1.

Scale 1:1

Fig. 38. Class IV bone tools.

Class V Bone Tools (Fig. 39), N=3.

Two criteria define this tool type. Long bones provided the raw material, and the shaft of the bone has been broken diagonally. The working edge is at the end of the longest portion of the shaft. The working edge has little or no taper, is essentially straight and perpendicular to the long axis of the bone.

Bone elements: 2 metatarsals with proximal epiphysis.
1 metacarpal with proximal epiphysis.

Distribution: Area BI, 1; Area BII, 2.

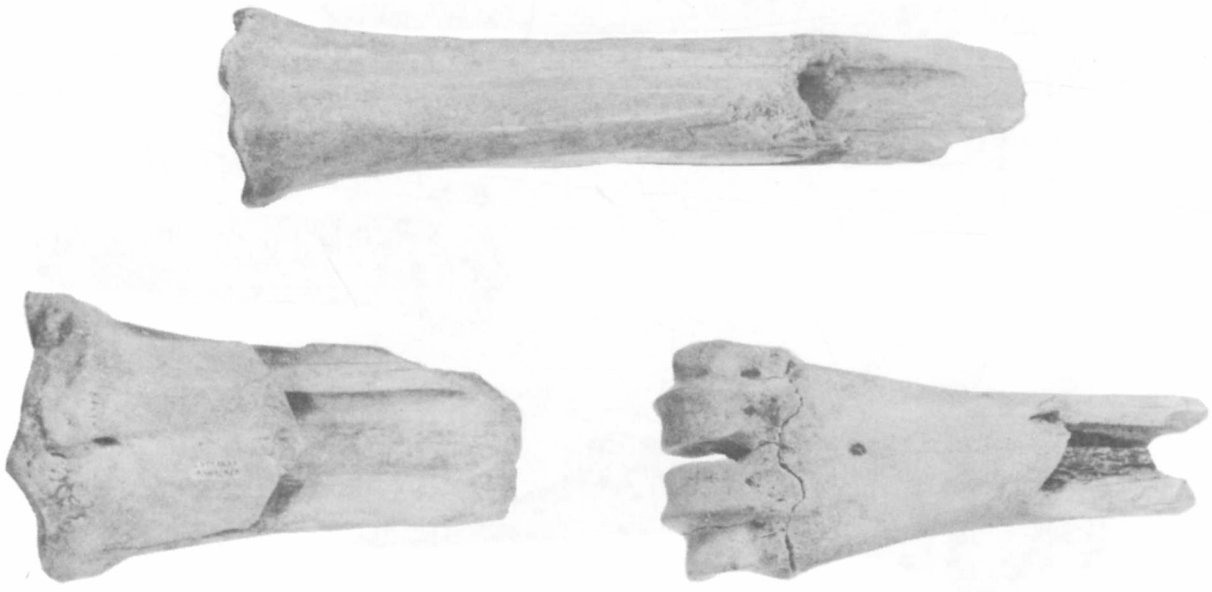


Fig. 39. Class V bone tools. Scale 1:2

Class VI Bone Tools (Fig. 40), N=13.

Unipolar modification on whole or split long bone. One epiphysis present. Narrow working surfaces limited to sharp projections from the shaft. Some polish is present on the working surfaces of all specimens.

Bone elements: Bison, 3 metapodials with distal epiphyses.
2 metapodials with proximal epiphyses.
1 humerus with distal epiphysis.
2 ulna with olecronon fossa.
1 radius with distal epiphysis.
1 large canid ulna with olecronon.

Distribution: Area BI, 3; Area BII, 6; Area D, 2.

Fig. 40. Class VI bone tools. Scale 1:2

Class VII Bone Tools (Fig. 41), N=2.

Bison humeri with proximal end removed and scalloped by removal of small flakes from around the circumference of the humerus shaft.

Fig. 41. Class VII bone tools. Scale 1:2

Distribution: Area BI, 1; Area BII, 1.

Class VIII Bone Tools (Fig. 42), N=30.

All those tools made of ribs not split lengthwise and retaining neither the vertebral nor sternal extremity. All exhibit unipolar modification. Tips of working surface range from broad and flat to sharply tapered.

Scale 1:1

Fig. 42. Class VIII bone tools.

Bone elements: Unsplit ribs.

Distribution: Area BI, 6; Area BII, 23; Area D, 1.

Class IX Bone Tools (Fig. 43), N=6.

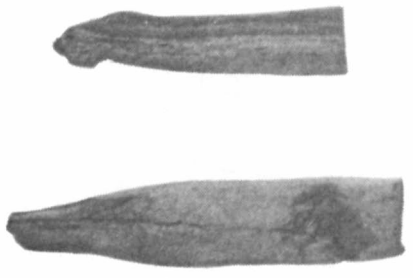
This category is reserved for those tools manufactured from bones with epiphyses removed that show little or no wear on the tips but are highly polished on one or more long flat surfaces on the side of the bone.

Fig. 43. Class IX bone tools. Scale 1:2

Bone elements: Split long bones and ribs.

Distribution: Area BII, 5; Area D, 1.

Class X Bone Tools (Fig. 44), N=2.



Scale 1:1

Fig. 44. Class X bone tools.

Both examples composed of small portions of cut rib or long bone. One specimen, a rib, small enough to suggest nonbison origin, has been girdled by incision entirely around the rib and snapped off. The other end tapers to a rounded tip. One side of this rib from approximately the midline to the tip has been removed. The other side has a deeply incised circular gouge. The second tool, of either rib or long bone, is flat and gently tapering. One end has been incised on one side and then snapped off along the incision. The incision runs at right angles to the long axis of the tool.

Distribution: Area BII, 2.

Class XI Bone Tools, N=228.

Consists of long, slender pieces of bones with unipolar modification. Sides are either gently tapering or roughly parallel. Tips either narrow and rounded or wide and rounded. Many of these specimens are very "iffy."

Bone elements: 54 split ribs.
65 long bone fragments.
109 unidentifiable (probably ribs).

CERAMICS

The Sample

A total of 169 potsherds were recovered from the Bootlegger Trail site during two years of excavation, nine in 1975 and 160 the following year.

The entire sample came from Area B, 158 from Level I. Of the remaining 11, seven came from Level II and two from the strata above Level I. Ninety sherds were recovered from one excavation unit and an additional 53 from the adjoining five units, all in the upper occupation level. The nine examples from the lower level also came from this part of the site. Isolated sherds were found throughout Area B.

Description of Data

Attributes of Structural Material

Texture. The use of texture here will follow Byrne (1973:30).

> Texture will generally be referred to as "blocky" (meaning that when broken the edge of the sherd appears to be extremely irregular, with numerous humps and hollows indicating where clumps of blocks of fired clay have broken off), "laminated" (referring to the situation where the sherd tends to split through one or more visible planes which lie parallel to vessel surface) or "compact" (indicating that the broken edge of the sherd tends to be straight and clean, with no evidence of blockiness or lamination).

Bonding Strength. Byrne (1973:30):

> In addition, the paste description may be modified by indicating that the material is more or less strongly bonded, resulting from a subjective assessment of the resistance of the relevant sherds to crumbling.

Temper. Consists mostly of a grit temper, primarily quartz. Some mica, feldspar, and granite are also present.

Color. The color of sherd exteriors ranges from light gray or tan to dark gray; the paste as seen along freshly broken edges is generally dark gray.

Thickness. The relative thicknesses of the sherds is of some importance in determining sherd/vessel affiliation or portion of the vessel from which a sherd derives.

Attributes of Surface Finish

Grooved-paddle stamping. The presence of low-relief, flat-topped bands. Frequently two or more parallel bands are evident on a single sherd. These were probably produced by striking the plastic clay with a parallel-grooved paddle.

Smooth. The absence of deliberate surface design.

Brushing. Characterized by very fine, roughly parallel striations.

Cord impressed. Indentations made by pressing one or more twisted cords into the plastic surface.

Incised. Lines cut into the surface with a sharp instrument.

Impressions. Any indentations of the surface.

The surface preparation of the sherds was examined with a 10X microscope. Sometimes cross lighting was necessary to make the relief visible. An attempt was made to ascertain methods used to produce the observable effects.

Data

The data was divided into three groups based on the part of the vessel from which the particular specimen came: rimsherds, neck sherds, and body sherds.

Rimsherds

B/908/X/35 (Fig. 45a), BI.

This sherd consists of a small section of the rim and neck of the vessel of which it was a part. In profile the sherd is in the shape of a very gently curved S, leaving an only slightly constricted neck. The sherd is gently curved (circumference).

The maximum thickness of the sherd is 10.0 mm (on the rim between neck and lip). Maximum length from top to bottom of the sherd is 46.5 mm; maximum lateral (side-to-side) dimension is 44.6 mm.

This specimen is tempered with angular particles of quartz, maximum dimension 1.0 mm. A small portion of the temper is slightly vitrified.

Decoration is confined to the exterior surface of the rim. There are two cord-impressed horizontal parallel lines beginning 3.5 mm below the edge of the lip and 3.9 mm apart. Two more cord-impressed parallel lines are 25.8 mm below the lip and are about 5.2 mm apart.

Between the second and third of the above-mentioned lines are four cord-impressed lines. Although they occur at three different distances below the lip and do not form a continuous line, they are oriented in the same general direction as the rest of the decorations. The edges of these discontinuous linear impressions are not as sharp and angular as those of the continuous impressions and appear to have been smoothed to some extent.

The texture of this sherd is blocky; bonding strength, medium.

B/907/X/14 and B/908/X/26 (Fig. 45b), BI.

Even with the reconstruction of these two specimens, the sherd is still quite small. The maximum dimensions are 42.5x25.5 mm. The maximum thickness occurs at the lip, where it measures 7.9 mm. The thinnest portion of the sherd is toward the anterior part, measuring 5.4 mm.

The paste is tempered with angular particles of quartz. Observed sand particles may be merely a fortuitous inclusion. The maximum size of the temper is 0.7 mm; most of the particles are smaller. Some of the temper is vitrified.

The top of the lip is flat and roughly perpendicular to the sherd. Parallel lines running diagonally from the interior edge of the lip to the exterior edge are incised into the flat part of the lip. The lines are spaced about 3.5 mm apart. The exterior surface is slightly uneven, but the finish cannot be reliably discerned.

The texture is laminated; bonding strength, medium.

The interior of the sherd has some organic residue coating it.

B/808/XI/4 (Fig. 45c), BII.

This sherd consists of a portion of the rim of the vessel plus part of the adjoining neck and shoulder. The diameter of the original orifice is estimated at 165 mm. This section is 100 mm of the rim or about 20% of the estimated total circumference of 520 mm. The maximum thickness is 10.1 mm; this occurs at the neck.

In profile view, the outline of the rim, neck, and shoulder forms an asymmetrical S. The lip is very gently curved inward; the neck is very strongly constricted.

The paste contains an abundant quantity of temper consisting of angular particles of quartz, feldspar, granite, and small quantities of mica. The size of the particles ranges from 0.2 mm to 3.1 mm, with the majority being about 1.3 mm. Temper is visible on the surface of the sherd, more on the interior than the exterior.

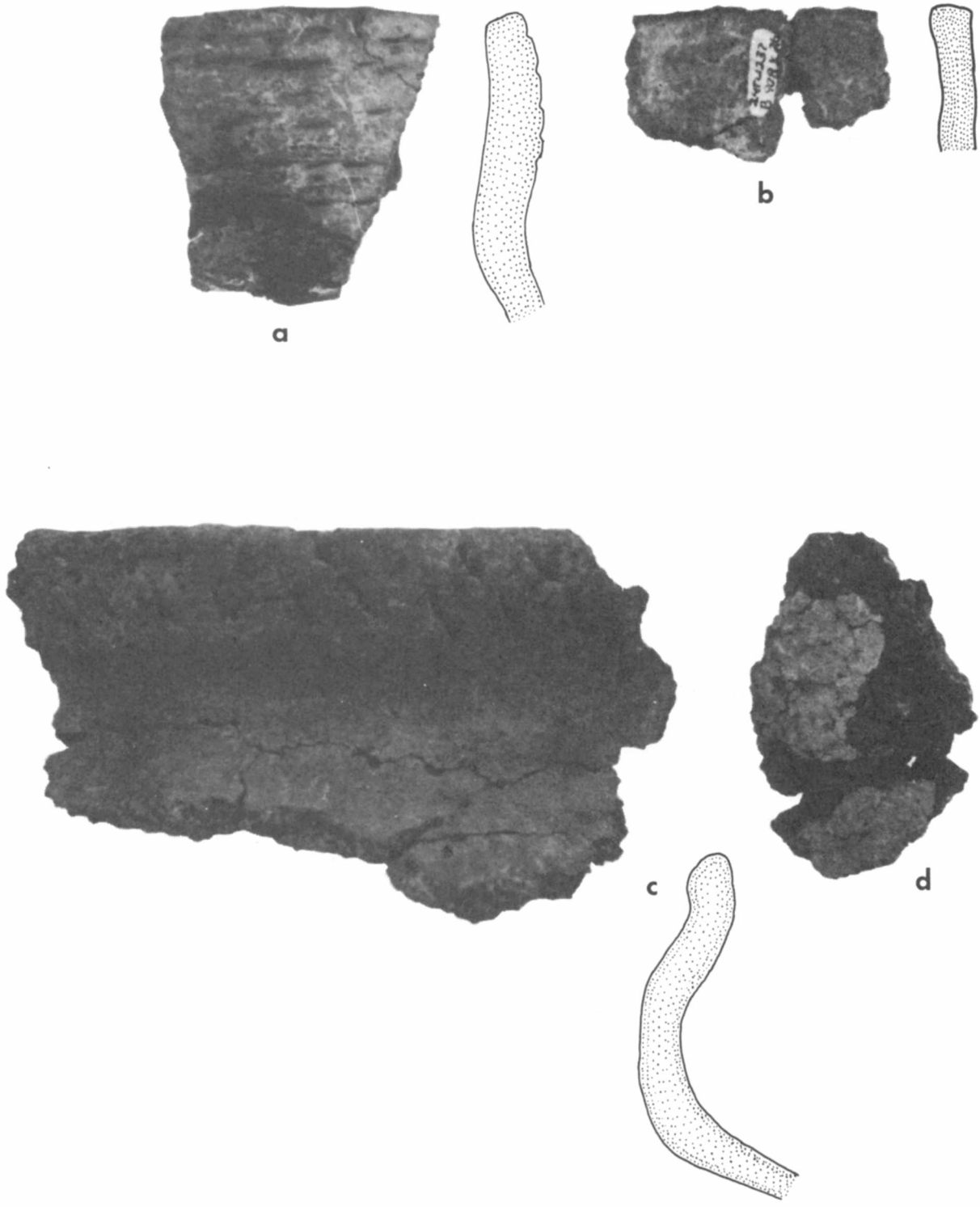
Readily visible decoration is confined to the rim of the sherd. There are two rows of impressions in the exterior surface. The first row consists of rectangular impressions approximately 3.7x6.0 mm, about 7.0 mm apart. This row is just below the lip. The long axes of the impressions are nearly vertical. In most cases, the lower part of the rectangle is more deeply impressed into the vessel than is the upper part.

Immediately below each rectangular impression and offset to one side slightly is an incised line. These incisions retain the same angle as the row above and form their own line. The average length of these lines is 9.2 mm, and they are spaced at about 8.0 mm from one another. Each incision is perceptibly wider and deeper into the surface at the bottom.

There are fine striations or brush marks on the neck. They are oriented horizontally and are roughly parallel to each other. The brush marks are restricted to the neck except for a minimal occurrence on parts of the shoulder.

The surface of the vessel at the shoulder is roughened. This area might have been check-stamped, but it is impossible to determine precisely what sort of treatment was applied.

This sherd has a laminated texture; bonding strength, weak, weaker than any other sherds except one unique, very thick body sherd (B/612/X/12).



Scale 1:1

Fig. 45. Ceramics.
a - B/908/X/35 Level I
b - B/907/X/14 Level I
B/908/X/26
c - B/808/XI/4
d - B/612/X/12

Neck Sherds

B/908/X/79 (and other numbers).

This reconstructed sherd consists of a small portion of the neck of the vessel and a fairly large part of the body. The maximum dimensions are 56.0x92.1 mm. The maximum thickness of the sherd occurs at the neck, where it measures 7.3 mm. The body thins to 4.0 mm toward the bottom of the vessel. The angle of the neck and the curvature of the body suggest a globular pot.

The temper consists of angular fragments of quartz, maximum size 1.9 mm, most particles about 0.7 mm. Some of the temper is vitrified.

The texture of the sherd is blocky; bonding strength, medium.

B/908/X/50.

This reconstructed sherd represents a small part of the neck and body of the vessel but is too incomplete to suggest a general morphology. The maximum dimensions of the sherd are 75.5x51.6 mm, and it is thickest at the neck, where it measures 7.3 mm. The body becomes thinner away from the neck, tapering to 6.0 mm.

The temper consists of rounded fragments of quartz and pieces of mica. The maximum size is 1.5 mm, most particles about 0.4 mm.

Brushing is evident on parts of the exterior surface at the neck and just below the neck. The surface of the sherd has very low, parallel, linear ridges which are virtually undetectable without cross lighting. They are probably grooved-paddle stamp marks that have been nearly obliterated by smoothing.

The texture of the sherd is very finely laminated; bonding strength, weak to medium.

Portions of both the interior and exterior surfaces have organic encrustations.

B/310/II/9 and B/908/X/38

Their curvature indicates that these two small sherds are probably neck sherds. They are both too small to provide any information about general vessel shape.

B/310/II/9 is 7.0 mm thick. It has brush marks on the exterior surface.

B/908/X/38 is 7.7 mm thick. It has a thick crust of organic material on the internal surface.

Both are grit tempered.

The texture is blocky; bonding strength, medium.

Body Sherds

The body sherds share certain characteristics. All are grit tempered. The texture of the sherds is usually blocky; more rarely, laminated. The bonding strength is weak in only a small number, and the majority are moderately bonded; none exhibit extremely strong bonding. Weakly bonded sherds resemble one rimsherd, B/808/XI/4.

The exterior surface finish of the sherds is either smooth or grooved-paddle stamped. Subsequent smoothing of the grooved-paddle-stamped marks has made some of them very low and frequently almost indiscernible without cross lighting. Others are not smoothed, displaying sharp edges, but these are also very low in relief.

Two sherds display a chevron pattern of bands that was produced by striking the vessel with the grooved paddle held at different angles. One sherd has a pattern of squares which were probably produced in the same manner.

A single vessel may be smooth on one portion and display the grooved-paddle stamping on another section, as is demonstrated by some of the larger reconstructed sherds.

The thickness of the body on a single fairly large, reconstructed sherd ranges from 4.3-6.6 mm. Another reconstruction of a portion of the body and neck of a vessel ranges in thickness from 3.7 mm at the thinnest part of the body to 7.5 mm at the neck.

There is one unique body sherd (B/612/X/12) present in the sample (Fig. 45d). It is so different from the rest of the specimens that it probably represents a separate vessel in itself. The distinguishing characteristic of this sherd is its extreme thickness of 13.0 mm. Maximum dimensions are 55.2x36.3 mm.

Angular fragments of quartz and mica appear as deliberate temper inclusions. Most of the temper particles range between 0.8 mm and 2.0 mm, but occasional particles as large as 3.4 mm appear in fracture surfaces. A small amount of rounded quartz sand grains probably represents a fortuitous inclusion.

A laminated internal texture, many fine fissures on the external and internal surfaces, and very weak bonding strength characterize this singular sherd. This undecorated sherd exhibits an irregular exterior surface, but the method of surface preparation remains indiscernible. Although visibly curved, the small size of the sherd precludes determination of the shape of the original vessel or the portion from which it came.

Summary and Conclusions

Three distinctive rimsherds represent three vessels. Discrete shapes and decoration serve to identify each rimsherd. An additional unique body sherd almost certainly represents a fourth otherwise unidentifiable vessel. The extreme thickness of this sherd separates it from all others in the sample. Only a remote possibility exists that this sherd derives from one of the three vessels identified on the basis of rimsherds. A possibility, indeed a probability, remains that more than four vessels appear in the body sherd sample, but because of homogeneity in their construction remain unidentified.

There are no complete vessels represented. Even reconstructions of large sherds do not give adequate indication of vessel size and shape.

The sherds are all alike in that they are tempered with a coarse grit. The weak bonding strength of some of the sherds is due, at least in part, to the use of large temper particles in abundant quantities. None of the examples exhibits strong bonding.

The surface of the sherds is either grooved-paddle stamped or smooth. Often the low-relief bands have been nearly obliterated by subsequent smoothing. A small number of sherds exhibit chevron or square designs.

The spatial distribution of the sherds (Fig. 16) suggests specialized activity areas in the site.

The presence of organic encrustations on the surfaces of the sherds suggests their use for cooking. Their presence in the processing area itself suggests that they may be linked to the processing of freshly butchered bison meat.

Ceramic Discussion

Comparison of ceramics from the Bootlegger Trail site with those described by Byrne (1973) shows some similarities in general features to the Late Saskatchewan Basin Variant from southern Alberta. Details of surface finish, paste, bonding, decoration, and rim form vary considerably. Physical comparison of the Bootlegger Trail site ceramics with those from the nearby Galata site (24TL26) (Smithsonian Collections) and the Ethridge collection from sites 24TL302, 303, and 304, housed at the Museum of the Plains Indian, Browning, Montana, shows considerable variation. There are numerous similarities of form, paste, and decoration in the Ethridge and Galata collections. The Bootlegger collection seems quite different. At the present time, sufficient collections probably exist of north-central Montana ceramics for a detailed description and analysis of ceramics. This comparison remains to be accomplished.

MISCELLANEOUS ARTIFACTS

Bone Beads (Fig. 46), N=24.

Scale 1:1
Fig. 46. Bone beads.

Constructed from sections of long bones, most are deliberately girdled and snapped off. Most ends appear to be dressed. Most cut lateral ends are straight, perpendicular to the long axis of the bone, and parallel to each other; a few have convex or uneven ends. Trianguloid, round, and ovate in cross section (nearly equally represented). About 1/3 of the sample have transverse and/or longitudinal striations. About 3/4 of the specimens have incisions concentrated near the cut ends. Some are highly polished; most show some degree of polish. Most are hollow.

Bone elements: Sections of dog, coyote, or rabbit long bone or unidentified bird bone.

Distribution: Area BI, 6; Area BII, 16; Area D, 1; Area E, 1.

Dimensions	Length	Diameter
Mean	21.0	6.16
Range	3.4-124.4	2.3-12.0
Standard Dev.	23.3	2.15
N	23	21

Girdled Bone Shafts (Fig. 47), N=26.

Fifteen are girdled and snapped off close to the epiphysis, three near the distal end of the bone, leaving most of the bone. Most incisions and subsequent breaks are perpendicular to the long axis of the bone. Some have apparently diverged from the intended course, leaving an uneven end. Cut ends appear to be dressed (beveled) similar to those on the bone beads. Generally ovate in cross section, a few are round or triangular. One bone, a burnt dog or coyote phalange, has a broken but ungirdled end. Most of the bone remains, and there is a series of incisions near the remaining epiphysis. One bone, a dog or coyote phalange, has an

uneven end with smoothed edges and a deep transverse notch with a perforation near the broken end (perhaps a whistle). Most of the bone remains. One complete dog or coyote phalange has a series of incisions near one epiphysis which almost girdle the circumference. No evidence of deliberate hollowing. Only a few of the bones show some degree of polish.

Scale 1:1

Fig. 47. Girdled bone.

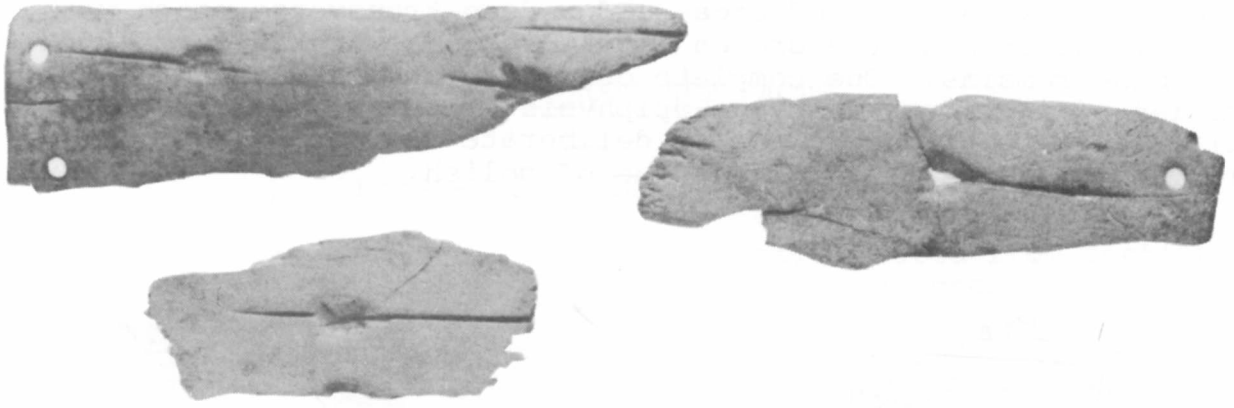
Bone elements:
2 proximal rabbit femurs.
2 distal rabbit femurs.
1 proximal rabbit tibia.
2 distal rabbit tibias.
14 dog or coyote phalanges.
1 rabbit phalange.
5 unidentified phalanges.
1 bird (?) tibia-tarsus.

Distribution: Area BI, 7; Area BII, 19.

Discussion: These bones probably result from bone bead production and were purposely selected.

Bow Guard (?) (Fig. 48), N=3 fragments.

Roughly rectangular in outline. Tabular in transverse cross section. Each bone has one end cut straight and perpendicular to the long axis of the bone. One has one straight side, but the rest of the edges are unevenly broken. Total of three perforations on two bones, all close to the perpendicular ends; one bone is unperforated. Decorated on the exterior surface by a series of distinctive and similar incisions and depressions. A straight incision runs into a depression gouged into the surface, then the incision begins again. These "decorations" are roughly parallel to the long axis of the bone and closely resemble an arrow symbol. One bone was broken at the incision point; half the incision and depression remain. Each bone has one set of decorations, and there is evidence of additional decoration on the broken edges. Some striations and other wear marks on the surfaces and edges. Two pieces are highly polished, the third shows some polish.



Scale 1:1

Fig. 48. Bow guard (?).

Bone elements: Scapula (?).

Distribution: Area BI, 3.

Discussion: It is highly probable that all three pieces came from one artifact. The surfaces appear different, but this is the result of variable preservation.

Worked Scapula (?) (Fig. 49), N=2.

Both are fragmentary. One is nearly complete and roughly oval in outline with one bluntly rounded end. The other is triangular in outline due to its fragmentary state. Exterior surfaces are smooth and polished; interior surface of larger piece is also smoothed and slightly polished. Finished edges are rounded and smoothed. The one finished edge of the broken piece is uneven but smoothed. Striations present on this piece.

Scale 1:1

Fig. 49. Worked scapula.

Bone element: Scapula (?).

Distribution: Area BI, 1; Area BII, 1.

Wapiti Canine Pendant (Fig. 50), N=1.

Scale 1:1
Fig. 50. Elk canine pendant.

Nearly complete wapiti canine; only extreme tip of root missing. Perforated near broken end; apparently bored on each side, as holes are slightly offset. Slightly polished.

Bone element: Wapiti canine.

From Area BI.

Dimensions: Diameter of perforation 2.5 mm.

Modified Belemnite Fossil (Fig. 51), N=1.

Scale 1:1
Fig. 51. Belemnite pendant.

Cylindrical with conical end. Round cross section (closely resembles a 30 M-1 ball). Incision around the circumference near the cylindrical end. May be polished to some extent.

Material: Belemnite.

From Area BI.

Dimensions: Length 36.2 mm
Diameter 7.8 mm

Pumice "Trough" (Fig. 52), N=1.

Scale 1:1
Fig. 52. Pumice "trough."

This specimen resembles a longitudinally broken long tubular bead, but all surfaces are smoothed. Outline rectanguloid (rounded ends). Cross section, lunate.

Material: Red pumice or scoria.

Dimensions: Length 14.6 mm
Width 11.0 mm
Thickness 5.7 mm

Shell Beads (Fig. 53), N=7.

Circular in outline. Tabular in cross section. Five vary little in thickness (from one section of the artifact to another). Two are uneven, probably due to variation in the shell itself.

Circular holes in the centers; distances between inside and outside diameters are fairly constant. Outside edges are smooth and rounded. Surfaces are smooth and perhaps have been polished. Grain of shell shows very clearly.

Scale 1:1

Fig. 53. Shell beads.

Material: Mollusc shell (?).

Distribution: Area BI, 7.

	Thickness	Diameter	Hole Diameter
Mean	4.6	13.9	4.3
Range	4.1-5.1	15.3-12.2	3.7-4.8
Standard Dev.	.4	1.1	.4
N	7	7	7

Shell Pendants (Fig. 54), N=2.

Scale 1:1

Fig. 54. Shell pendants.

One pendant was broken after excavation and is too fragmentary for identification.

The other is drop-shaped in outline. Generally ovate in transverse cross section, one side is flat and the other is slightly mounded. The smaller end is modified to provide a place of attachment (notched leaving a small knob). Four small notches on one lateral edge and one notch on the opposite edge. Surfaces are smooth and possibly polished. Edges are rounded and smoothed.

Material: Mollusc shell.

Distribution: Area BII, 2.

Dimensions: Length 17.5 mm
Width 8.9 mm
Thickness 3.1 mm

Shell "Drop" (Fig. 55), N=1.

Scale 1:1
Fig. 55. Shell "drop."

Drop-shaped in outline. Tabular in cross section. Edges are smooth and rounded. One surface is smooth and possibly polished. Shell grain shows clearly. Opposite surface is encrusted with a rough yellowish substance which is broken away around the edges, possibly occurring during manufacture of the artifact.

Material: Mollusc shell.

Dimensions: Length 30.9 mm
Width 13.7 mm
Thickness 2.2 mm

Smoking Pipes (Fig. 56), N=3.

Scale 1:1
Fig. 56. Pipe.

All three specimens are fragmentary. One fragment is a nearly complete bowl. Nearly cylindrical with a slightly constricted rim. As the outside of the bowl expands, the inside constricts (causing wall thickness to increase) until a small hole (with a diameter half or less than half of the outside diameter) is left in the bottom. Beyond this point, the exterior constricts slightly where the upper and lower portions join and then flares out again (as indicated by the unevenly broken portion). The interior also flares out, maintaining a fairly constant wall thickness. There is one small chip in the rim. Both interior and exterior portions are smooth and possibly polished. Uniform dark gray.

One of the two fragments consists of two reconstructed fragments. All fragments show a strong curvature. Thickness varies little. Some of the edges appear to be freshly broken; others are worn and smooth. These may have been worn since breakage or perhaps were original edges. Surfaces are smooth, possibly polished. All are mottled light brown in color.

Material: Steatite.

Distribution: Area BI, 1; Area BII, 2.

Dimensions: Length 16.8 mm (broken)
Inside diameter 8.3 mm
Outside diameter 12.5 mm

Copper Fragment, N=1.

Roughly rectangular in outline. Bent into lengthwise curve, then again cross-wise at about 45°. Tabular in cross section (but very thin); looks "C"-shaped in cross section due to bending. Edges are irregularly broken and torn. Green in color, encrusted with what may be soil or clay. Found in association with bone splinters and ochre.

Material: Copper.

From Area BI.

Dimensions: Length 20.4 mm
Width 7.8 mm
Thickness .7 mm

Section of Shovel Handle, N=1.

Distal portion. Cylindrical, with one expanding end terminating at a slightly diagonal sawn surface. Lathe head stock spur center mark (round depression with six small radiating prongs) on one end; some red coloring (paint?) on opposite end.

Material: Wood.

From Area BII.

Dimensions: Length 53.6 mm
Diameter 20.6-24.7 mm

Discussion: This specimen was found at a depth of 140 cm in Unit 609, Area B. Apparently deposited as a result of headward erosion and subsequently covered. The entire southwest 1/8 of Unit 609 had been subjected to erosion and fill.

APPENDIX II

LOCAL FAUNA OF THE TIBER RESERVOIR VICINITY

by Ken Deaver

Sorex cinereus and *Sorex merriami*. These two shrews are similar in habits, but very different in habitat preference. Both are principally insectivorous and active day and night. *S. cinereus* is found in moist habitats while *S. merriami* prefers an arid sagebrush area (Burt and Grossenheider 1964:3,5). Around the site *S. cinereus* would occupy the riverine biotope while *S. merriami* would prefer the breaks biotope.

The bats. Bats are not common near the site, but were seen occasionally early in the morning and late in the evening. All of the species in this area are insectivorous and either nocturnal or crepuscular (Burt and Grossenheider 1964). All are solitary or live in small colonies in this area as there are no suitable locations to serve as roosts for large colonies. Bats might be seen flying over any biotope in the area, but would roost only in trees and cliffs in the riverine biotope.

Ursus horribilis. Burt and Grossenheider (1964) recognize two species of brown bear. If lumped, the single name, *Ursus arctos*, would apply. The grizzly bear has a greatly restricted range today, principally limited to remote mountainous areas. However, early explorers, including Lewis and Clark, reported its presence in numerous localities on the prairie. A grizzly was sighted by Lewis and Clark at the mouth of the Marias River (Walcheck 1976: 22). The species is virtually omnivorous, normally solitary, and is active any time of the day or night (Burt and Grossenheider 1964:49). They do not hibernate but are inactive for periods during the winter. In the vicinity of the site they might have been found in any biotope but would have been encountered most often in the riverine or break biotope.

Procyon lotor. The raccoon is not reported in historic or modern accounts of the fauna of the area. However, they were observed several times during the 1976 excavation season. They were seen only in the riverine biotope. It is possible that their presence is the result of recent range expansion. No remains of this taxa have ever been reported from any archaeological context in the region. They will not be considered further as there is no reason to believe they were available to the original inhabitant of the site.

Mustela erminea and *Mustela frenata*. These two small weasels are similar in habits. They are both chiefly nocturnal and eat small mammals and birds. Both are solitary. They differ in size and slightly in habitat. *M. erminea* is normally confined to brushy areas near water. *M. frenata* is more cosmopolitan but still prefers areas with some cover and water (Burt and Grossenheider 1964:59,61). In the area near the site *M. erminea* generally would be confined to the riverine biotope while *M. frenata* was observed in both riverine and breaks biotopes.

Mustela nigripes. The black-footed ferret is now an endangered species. It is apparently active both day and night. It feeds principally on prairie dogs but takes other small mammals and birds. The species is believed to be solitary. It normally lives in or near prairie dog towns (Burt and Grossenheider 1964:62). One was reported in a prairie dog town a few miles east of Tiber Dam. In the vicinity of the site this species usually would be found in the upland biotope.

Mustela vison and *Lutra canadensis*. The mink and otter have similar habitat preferences but differ somewhat in habits. Both are found along streams and lakes. The otter is larger, somewhat social and more closely tied to the water for food and protection. The mink is usually solitary and eats small mammals and birds as well as aquatic resources (Burt and Grossenheider 1964:62,64). Both are found in the riverine biotope around the site.

Taxidea taxus. The badger is mostly nocturnal, lives in burrows, and digs out rodents, its principal food. It is solitary (Burt and Grossenheider 1964:67). Badgers were seen occasionally on the uplands in the vicinity of the site.

Mephitis mephitis. Striped skunks are largely nocturnal. They are at least partially omnivorous, feeding on mice, young birds, berries, and carrion. They are generally solitary (Burt and Grossenheider 1964:70). Near the site they were seen only as road-kills but normally occupy the breaks and riverine biotopes, occasionally venturing into the uplands.

Canis latrans. Coyotes are most active at night. They are omnivorous. They frequently were seen in groups of two or three in the vicinity of the site. They were found in all biotopes but most commonly in the breaks and riverine areas. Tracks were seen occasionally in the uplands. It seems likely that modern hunting pressure has forced them into areas that afford greater protection.

Canis lupus. Lewis reported seeing wolves very close to the site (DeVoto 1953:428). In Montana they now are confined to remote mountain localities. Wolves are omnivorous but feed primarily on birds and mammals. They are most active at night but are often abroad during the day. They are highly social (Burt and Grossenheider 1964:75). Around the site they might have been encountered in any biotope.

Vulpes velox. There is some confusion as to which species of fox inhabits the area around the site. Range maps in Burt and Grossenheider (1964:78) show only the swift fox in the area. Fox were seen on two occasions and identified tentatively as the red fox, *Vulpes fulva*. Lewis and Clark sighted a red fox at the mouth of the Marias. They reported a kit fox near Great Falls, a bit farther up the Missouri River (Walcheck 1976:22). This kit fox was almost certainly what Burt and Grossenheider call the swift fox. Most of the fox remains identified from the site are too

small for the red fox and more compatible with *V. velox*. It is possible that the site is near the edge of the ranges of both species. Both species are principally nocturnal. Both will take vegetable material but feed mostly on birds and mammals. They are solitary to seasonally social (Burt and Grossenheider 1964:77,79). The red fox prefers greater cover and would be most common in the breaks and riverine biotopes. The swift fox would be most common in the breaks and upland biotopes. The swift fox is less wary than the red fox and has been reduced greatly by hunting and poisoning (Burt and Grossenheider 1964:79). It seems likely that the swift fox is the aboriginal form in the area but is being replaced by the red fox which is favored in the modified niche.

Felis concolor. Lewis and Clark reported a mountain lion along the Missouri River (Walcheck 1976:22). Modern hunters and trappers are unanimous when stating that today the species is found no closer to the site than the Sweetgrass Hills, 50 km north of the site. The mountain lion is chiefly nocturnal. It is carnivorous and solitary (Burt and Grossenheider 1964:83). It would have been found in the breaks and riverine biotopes near the site.

Lynx rufus. The bobcat is mostly nocturnal and solitary. It feeds on small mammals and birds (Burt and Grossenheider 1964:86). The species is most common in the breaks in the vicinity of the site.

Marmota flaviventris. The yellowbelly marmot is diurnal and solitary to slightly social. It eats grasses. Burt and Grossenheider (1964:96-97) report that it occurs in part of the area around the site. However, it was not observed during the excavation seasons. This species prefers talus slopes and rocky areas which are rare in the vicinity of the site. It hibernates in the winter and estivates during the heat of summer. If present near the site it would occur in the breaks biotope.

Cynomys ludovicianus. The blacktail prairie dog is on the decline throughout much of its range. However, it is still fairly common in this area. Two active towns were observed and several others were reported. The animal is diurnal and highly gregarious, living in groups occasionally numbering over 100 individuals. It feeds chiefly on grasses but will eat insects. It does not hibernate (Burt and Grossenheider 1964:99). Today the animal usually is found on flat benches along the breaks. However, prior to modern agricultural practices it normally was found in the upland biotope.

Citellus richardsoni and *Citellus tridecemlineatus*. These two ground squirrels are similar in habits and habitat. Both are solitary to slightly social and principally diurnal. Both are nearly omnivorous but eat large quantities of seeds and green vegetation (Burt and Grossenheider 1964:105,108). A Richardson ground squirrel excavated a tunnel under the table where we ate lunch. It readily consumed everything we left behind. However, in controlled tests it clearly preferred peanut butter over all other offerings. Both forms estivate in late summer and do not

emerge until early spring. The Richardson ground squirrel is very common around the site, but the thirteen-lined ground squirrel rarely was encountered. Both are most common in the upland biotope.

Thomomys talpoides and *Perognathus fasciatus*. The northern pocket gopher and the Wyoming pocket mouse both probably occur in the site area but neither was observed. Both tend to be solitary and could be active day or night. *Perognathus* is principally granivorous while *Thomomys* feeds heavily on roots and tubers (Burt and Grossenheider 1964:134,138). Both would be found in the uplands around the site.

Castor canadensis and *Ondatra zibethica*. Both beaver and muskrats were seen in the Marias River. Both are solitary to social in small groups. The beaver is more nocturnal, but both are seen during the day. The muskrat feeds on many forms of aquatic vegetation while the beaver prefers trees. Neither truly hibernates (Burt and Grossenheider 1964:157,204). Both are restricted to the riverine biotope.

Peromyscus maniculatus. Deer mice are granivorous, nocturnal, and generally solitary. They do not hibernate (Burt and Grossenheider 1964:167). They are highly cosmopolitan in habitat preference and adapt well to the presence of man. They frequently were found in level bags left at the site. Two took up residence in the boxes containing the faunal collection. They were encountered frequently in all biotopes near the site.

Onychomys leucogaster. The northern grasshopper mouse is carnivorous, solitary, and active at any time (Burt and Grossenheider 1964:173). Around the site they might be found in the upland or breaks biotope.

Neotoma cinerea. Woodrats are vegetarians, principally solitary, and most active at night (Burt and Grossenheider 1964:178). Their nests and dens were seen occasionally in the breaks biotope around rock piles and boulders.

Microtus pennsylvanicus, *Microtus longicaudus*, and *Microtus richardsoni*. These three voles are all vegetarians, solitary, and active at any time. They prefer fairly lush vegetation (Burt and Grossenheider 1964:192,194,198). They are most common in the riverine biotope near the site.

Erethizon dorsatum. The porcupine is nocturnal and generally solitary. It eats buds and tree bark. It does not hibernate (Burt and Grossenheider 1964:209). Porcupines were seen in the riverine and breaks biotope in the vicinity of the site.

Lepus townsendi. This jackrabbit is nocturnal, a vegetarian, and generally solitary. It does not hibernate (Burt and Grossenheider 1964:214). Populations fluctuate and currently are low near the site. This species can run at extreme speeds over rough terrain. They are most common in the upland biotope near the site but are encountered in the breaks.

Sylvilagus nuttalli. Cottontails are vegetarians, generally solitary, and most active in the early morning. They do not hibernate (Burt and Grossenheider 1964:220). They are common in all biotopes near the site. They are not as fast as jackrabbits and can be run down easily by two people working together.

Cervus canadensis. Wapiti do not occur in the vicinity of the site today but were reported in the area by the Lewis and Clark expedition (Walcheck 1976:22). The species is vegetarian, generally crepuscular, and social in herds of 25 or more (Burt and Grossenheider 1964:228). Wapiti require some cover and would have been most common in the riverine and breaks biotope.

Odocoileus hemionus. Mule deer are browsers, nocturnal or crepuscular, and slightly social (Burt and Grossenheider 1964: 230). They were encountered on several occasions near the site and were virtually always in or near the breaks biotope.

Odocoileus virginianus. Both mule and whitetail deer occur in northern Montana. There still is substantial confusion over the exact aboriginal distribution of each species. The journals of Lewis and Clark do nothing to clarify this problem. They normally mention only the presence of "deer" and do not specify which type (Walcheck 1976:18). Whitetails are similar to mule deer but are slightly more social and prefer more forested habitat. If they ever occurred around the site they would have been most common in the riverine and breaks biotopes. None had been seen during the field seasons.

Antilocapra americana. Pronghorns are both browsers and grazers. They are principally diurnal and occur in small groups (Burt and Grossenheider 1964:235). They still are common around the site on stands of native vegetation in the upland biotope. Today they often drop their young in wheat fields, taking advantage of the protection afforded by the taller vegetation. Prior to the advent of agriculture they usually gave birth in gullies in the breaks biotope but spent most of the year in the uplands.

Bison bison. Lewis and Clark reported bison in virtually every entry in their journals while they passed through northern Montana (Walcheck 1976:22). They frequently estimated that herds along the Missouri River numbered up to 20,000 individuals (Hornaday 1974:389). Lewis reported one herd that stretched for 12 miles just southeast of the site (DeVoto 1953:428). Up to 1870 this situation remained largely unchanged. Even until 1880 most systematic bison hunting was carried on far south and east of Montana. However, with the destruction of southern populations, systematic attention was directed to northern herds and in 1880 approximately 100,000 bison hides were shipped out of northern and eastern Montana (Hornaday 1974:503). By late 1882 the only large herds of bison were located between the Marias and Milk Rivers. In 1884 a single box car of robes was sent east from the Montana and Dakota Territories. This was the last shipment (Hornaday 1974:513).

Bison are diurnal and gregarious throughout most of the year. They are grazers (McHugh 1958). They would have spent most of the time in the upland biotope around the site. However, they occasionally would have been found in the breaks or riverine area.

Ovis canadensis. Bighorn sheep were reported by Lewis and Clark near the mouth of the Marias River (Walcheck 1976:22). They were said to occur in the Sweetgrass Hills during this century. The species prefers mountain slopes and rugged terrain and may never have occurred at the site but was definitely available within 80 km. Bighorns are both browsers and grazers. They are diurnal and social during much of the year (Burt and Grossenheider 1964:238). If they ever occurred near the site they would have been most common in the breaks.

Other common faunal forms. In addition to the above-mentioned mammalian taxa a number of other animals are common in the vicinity of the site. Great blue herons (*Ardea herodias*), Canada geese (*Branta canadensis*), mallards (*Anas platyrhynchos*), and several other ducks were seen often in the riverine biotope. Several raptorial and ground birds are common in the uplands. Several fish, including goldeye (*Hioson alosoides*) were reported by Lewis and Clark (Walcheck 1976:24) and are still common in the Marias River. The bullsnake (*Pituophis melanoleucus*) and the prairie rattlesnake (*Crotalus viridis*) are common in the uplands and occasionally found in the breaks biotope. River mussels are fairly common in the Marias River.

APPENDIX III

SOIL MONOLITH: BOOTLEGGER TRAIL SITE, AREA B

by Marilyn Kenfield

This paper is a presentation of the results of several chemical and physical analyses performed on the Bootlegger Trail site monolith. An assessment is also made of the value of these analyses for determination of cultural vs. noncultural horizons. The archaeological site is located in Montana's glacial till plain in an area receiving approximately 12 inches of precipitation yearly. The monolith site itself is depositional, receiving both water- and wind-driven fines from the calcareous till.

Frigid temperature and ustic moisture regimes limit biologic activity and soil development. Additionally, 50% of annual precipitation falls during the summer and, as dashing showers (Gieseker 1933), drives the soil downslope. Consequently, the profile is poorly developed; and with erratic changes in organic carbon content (Table 21) classifies most readily as a Torrifluvent. This classification is consistent with the observation that most draws possess narrow strips of Fluvents along their bases. Furthermore, as illustrated in Fig. 57, feeder channels may produce small alluvial fans upon which associated Camborthids develop (Brownfield 1977).

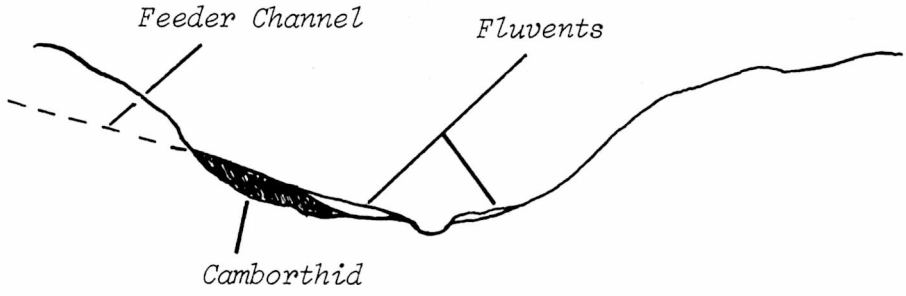


Fig. 57. Typical soil-forming localities.

Deposition of material over burned surfaces occurred frequently as evidenced by at least five buried A horizons. During this period of accumulation, salts were not leached appreciably so at 85 cm the soil is borderline saline with an electrical conductivity of 4.1 mmhos (Table 22). At 5 cm the soil is calcareous and at 45 cm faint calcium carbonate threads have formed. Small, infrequent pockets of lime occur as high as 13 cm.

Hand texturing the 0-5, 5-10, 20, 45, and 90 cm depth material indicated that the soil was a clay loam throughout. Subsequent mechanical analysis (Table 22) supported the clay loam classification below the 15 cm depth. Insufficient material precluded an analysis of the surface soil.

Table 21. Soil organic matter* and nitrogen content.

Sample Depth (cm)	Horizon Designation	Organic Matter (%)	Total Nitrogen (%)
0- 4	A11	5.8	.15
4- 8	A12	2.8	.05
8-10	Cca	2.1	-
14	Alb1ca	1.9	.05
23	Cb1ca	1.6	.05
30	Alb2ca	2.1	.05
34	Cb2ca	1.6	-
40	Alb3ca	2.6	.08
48	Cb3ca	1.6	.08
57	Cb3ca	2.0	-
61	Alb4ca	4.8	.15
67	Cb4ca	1.8	-
70	Cb4ca	2.1	.05
80	Alb5ca	3.9	.11
85	Cb5ca	2.1	-
87	Cb5ca	1.5	-
95	Cb5ca	1.4	-
110	Cb5ca	.8	-

*Organic Matter = Organic Carbon x 1.72.

Depending upon technique, bulk density values varied; however, relative changes in density were consistent. Both testing methods (Methods included paraffin-coated clods adjusted for wax volume and weight and unadjusted saran-dipped fragments.) produced determinations which were fairly high (Table 22). The presence of fine particles effectively reduces void space, increases bulk density, and indicates an ill-sorted material. The cultural horizon, sampled at 80 cm, was less dense due to the charcoal and bone present, but bulk density readings in such a layer can be expected to yield widely different values (e.g., 1.5 vs 1.05 g/cc) unless very large samples are used.

Under 5 and 10 power magnification, sand-sized quartz grains and root fibers displayed a glossy sheen. Such a coating may be responsible for filling small spaces between particles and increasing the soil's bulk density. Pores were unbridged and clean which is characteristic of either a young profile or slowly weatherable parent material. Random samples taken from 3 cm to 100 cm depths differed only in lime content. As mentioned previously, carbonate threads have formed at 45 cm and are concentrated along root channels. Areas of carbonate precipitation developed not as solid masses but as plate-like crystals.

Table 22. Selected soil properties at several depths.

Sample Depth (cm)	Horizon Designation	Electric Conductivity (mmhos)	Bulk Density* (g/cc)	Mechanical Analysis				pH Saturated Paste Extract
				% Sand	% Silt	% Clay	Textural Class	
23	Cb1ca	.56	1.7	30	36	34	clay loam	7.6
30	Alb2ca	.53	-	33	31	36	clay loam	7.6
40	Alb3ca	.64	1.58	39	32	29	clay loam	7.7
48	Cb3ca	.67	-	-	-	-	-	7.8
80	Alb5ca	2.83	1.05/1.5	40	31	29	clay loam	7.6
87	Cb5ca	4.1	-	36	32	32	clay loam	7.5
95	Cb5ca	4.0	-	30	35	35	clay loam	7.6
110	Cb5ca	4.0	-	42	29	29	clay loam	7.6

*Determined on paraffin-coated clods.

Table 23 shows the predictable phosphorus increase in cultural horizons where bone provides the phosphate source (Alb4ca and Alb5ca). The test was not a total phosphorus determination, but should give comparative available phosphorus values. The second buried A horizon also has a significant phosphorus increase due to the presence of bone fragments. The remaining A's, expressed as charcoal layers, do not exhibit an increase and hence, phosphate content may not be a reliable guide to noncultural, former surfaces. Organic matter increases (Table 21) should serve as more accurate indicators in such a situation. Organic substances, in particular bone, tended to lower the calcium content relative to the phosphorus. Ca:P ratios on a ppm basis varied from 65 in the A11 to 400 in the lower Cb5ca. The cultural horizons reduced those ratios to approximately 14. In comparison, pure bone mineral, calcium hydroxyapatite, has a Ca:P ratio of about 2. Acid soils would normally contain less calcium and therefore have lower ratios.

Table 23. Nutrient status of the soil.

Sample Number	Sample Depth (cm)	Horizon Designation	Meq/100 g*					P (ppm)
			K	Ca	Mg	Na	CEC	
1	0- 4	A11	1.7	16	5.1	.08	27	50
2	4- 8	A12	1.3	15	3.9	.08	22	25
3	8-10	Cca	1.1	18	3.9	.04	24	15
4	14	Alb1ca	1.0	20	4.1	.04	21	15
5	23	Cb1ca	.7	23	3.8	.08	19	20
6	30	Alb2ca	.6	24	4.1	.08	21	125
7	34	Cb2ca	.5	22	3.7	.12	16	40
8	40	Alb3ca	.6	27	4.4	.16	23	65
9	48	Cb3ca	.4	20	3.5	.12	19	140
10	57	Cb3ca	.3	20	3.4	.12	18	165
11	61	Alb4ca	.4	26	4.1	.20	26	345
12	67	Cb4ca	.4	18	3.7	.20	21	125
13	70	Cb4ca	.4	21	3.9	.20	21	225
14	80	Alb5ca	.4	24	4.8	.29	25	285
15	85	Cb5ca	.4	15	4.4	.16	19	230
16	87	Cb5ca	.5	16	4.5	.16	20	60
17	95	Cb5ca	.6	24	4.8	.20	21	35
18	110	Cb5ca	.5	23	4.1	.20	17	10

*To convert to ppm multiply meq/100 g by 10 times the milli-equivalent weight of the cation. For example: ppm Ca = meq/100 g x 200; ppm Na = meq/100 g x 230.

Figure 58, a graph of Table 23 information, illustrates potassium distribution. The highly soluble nature of this cation restricts

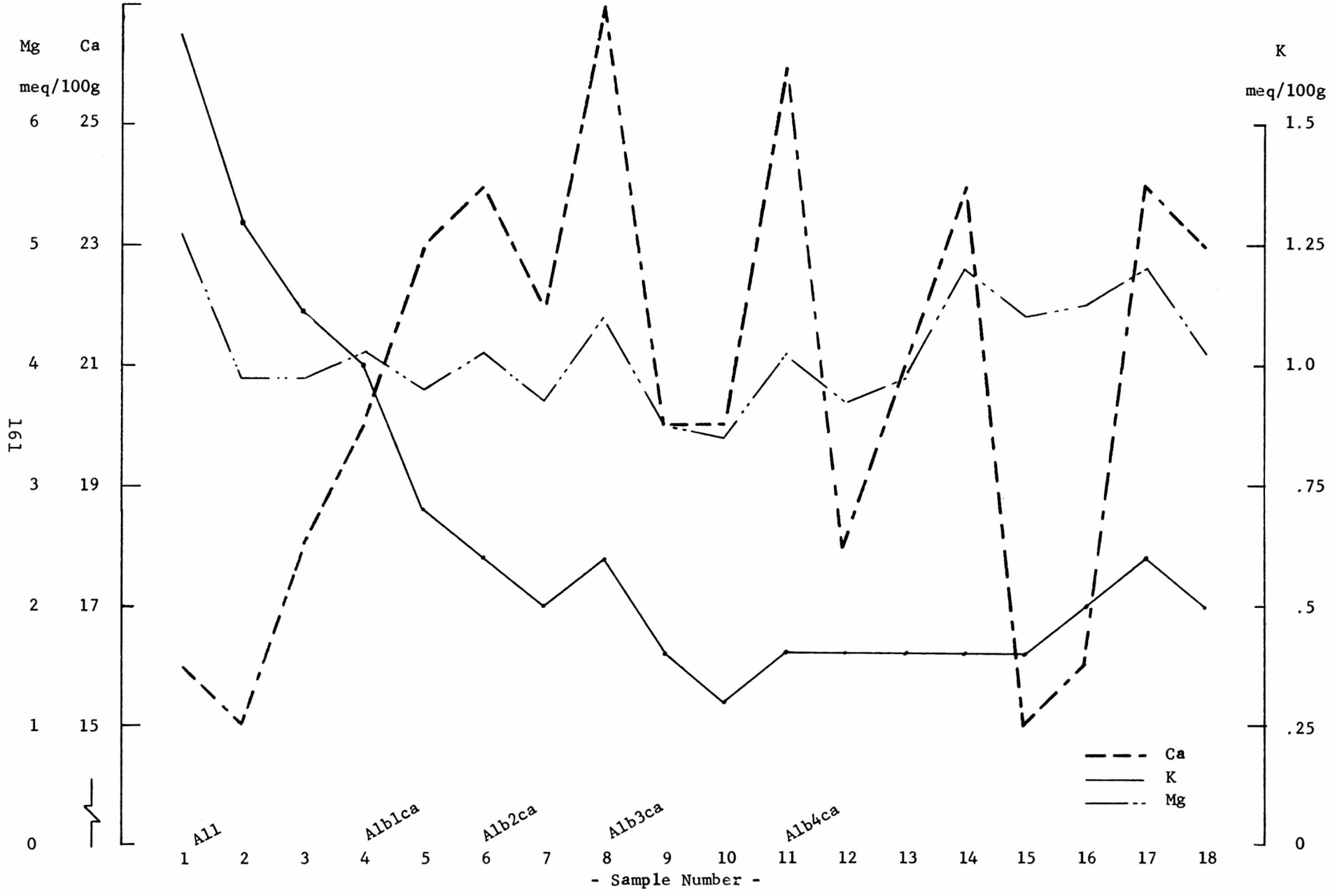


Fig. 58. Available calcium, magnesium, and potassium.

appreciable amounts to the surface soil where plant growth contributes to its renewal. Potassium content, therefore, failed to indicate either type of buried surface. In contrast, sodium which is also highly soluble but not a major plant nutrient, increased with depth. Fluctuations did not reflect horizonation arguing against the use of sodium content as a marker for stratification.

The cation exchange capacity (responsive to the amount of organic material present) is particularly useful as evidence for stratification in homogeneous materials (Table 23). Absence of large variations in clay content and type allow one to assign rises in CEC to increased organic matter content.

In summary, cultural horizons are well indicated by higher relative phosphate and nitrogen contents. Neither assay, however, proved to be a consistently accurate indicator of buried, noncultural surfaces. Organic matter distribution is a reliable guide to any former surface and in texturally and mineralogically homogeneous deposits can be inferred from the cation exchange capacity.

The results of this study would further suggest that the soluble cations should be used as corroborative evidence at best. The other discussed soil properties are far more conclusive guides to previous human activity.

MONOLITH DESCRIPTION

Regular renewal of soil material from upslope has prevented the development of a strongly structured profile. A frigid temperature regime and an ustic moisture supply also limit pedogenic processes.

Pedon: Semiarid grassland clay loam

A11 -- 0- 4 cm - Grayish yellow brown (10YR 5/2) clay loam, brownish black (10YR 3/2) moist; moderate fine granular structure; slightly hard, very friable, slightly sticky and non-plastic; noncalcareous; common fine roots; clear wavy boundary.

A12 -- 4- 7 cm - Grayish yellow brown (10YR 5/2) clay loam, brownish black (10YR 3/2) moist; weak medium subangular blocks breaking to weak fine plates; slightly hard, very friable; slightly calcareous; common very fine roots; abrupt smooth boundary.

Cca -- 7-13 cm - Dull yellow (2.5Y 6/4) clay loam, yellowish gray (2.5Y 5/4) moist; weak medium subangular blocks; slightly hard, friable; slightly calcareous; common very fine pores; common very fine roots; abrupt smooth boundary.

Alb1ca --13-15 cm - Charcoal discoloring the soil and indicating a former surface, otherwise similar to the above horizon.

Cb1ca --15-29 cm - Dull yellow (2.5Y 6/4) clay loam, yellowish gray (2.5Y 5/4) moist; weak medium prismatic breaking to moderate coarse angular and sub-angular blocks; slightly hard, friable; slightly calcareous; common very fine pores; common very fine roots; abrupt smooth boundary.

Alb2ca --29-31 cm - Charcoal layer including bone fragments; similar to Alb1ca.

Cb2ca --31-39 cm - Yellowish gray (2.5Y 5/3) clay loam, olive brown (2.5Y 4/3) moist; weak medium prismatic; slightly hard, friable; slightly calcareous; common very fine pores; common very fine roots concentrated along ped faces; abrupt smooth boundary.

Alb3ca --39-41 cm - Charcoal layer resembling Alb1ca.

Cb3ca --41-60 cm - Yellowish gray (2.5Y 5/3) clay loam, olive brown (2.5Y 4/3) moist; weak medium to coarse prismatic; slightly hard, friable; strongly calcareous, 1/2 mm threads of lime coat pores; common very fine pores; common very fine roots concentrated along planes of weakness; clear wavy boundary.

Alb4ca --60-65 cm - Dark olive brown (2.5Y 3/3) clay loam moist; charcoal-stained cultural horizon containing bone fragments; weakly prismatic; slightly hard, friable; calcareous; abrupt smooth boundary.

Cb4ca --65-77 cm - Yellowish gray (2.5Y 5/3) clay loam, olive brown (2.5Y 4/3) moist; structureless and massive; hard, friable; calcareous; common very fine pores, common very fine roots; abrupt smooth boundary.

Alb5ca --77-84 cm - Refer to Alb4ca.

Cb5ca --84- - Yellowish gray (2.5Y 5/3) clay loam, olive brown (2.5Y 4/3) moist; weak coarse prismatic; hard, friable; calcareous, many threads of lime along pores and root channels; common very fine pores; few very fine roots.

Additional Features

Location: Toole County, Montana, south of the Tiber Reservoir in the E½ of the NE¼ of Section 27, T30N, R3E.

Elevation: 3030 feet.

Slope: 2-3° in the immediate area, 4-5° farther up the draw.

Setting: The area receives 10 to 13 inches of precipitation during the year. Locally, weather may be modified by the presence of the large reservoir. The average annual air temperature is 40°-42°F; the frost-free period, 115-120 days. Using approximations suggested by the *Soil Taxonomy* (Soil Survey Staff 1975), mean annual soil temperature at 50 cm is about 6.5°C. For June, July, and August the average soil temperature ranges between 16° and 17°C.

Native vegetation: Grama grass, needle and thread, and western wheat-grass

Parent material: Reworked glacial till

Drainage and permeability: The soil is well drained and moderately permeable with medium runoff. Infiltration also occurs at a moderate rate.

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